image
not
available

# THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY AND SCIENCE.

VOLUME XLVI.

(Second Series.)

FROM OCTOBER 26, 1900, TO APRIL 19, 1901.

LONDON:

Printed and Published for the Proprietors by GEORGE TUCKER, at the Offices of "THE ELECTRICIAN," Salisbury-court, Fleet-street, E.C.

1901.

# INDEX TO "THE ELECTRICIAN."

# VOL. XLVI.

(Second Series.)

## SPECIAL INDICES.

* *Entries in these Indices are not included in the* GENERAL INDEX.

## SUB-HEADINGS IN GENERAL INDEX.

*Names of Authors of Articles and Papers are indexed alphabetically in the* GENERAL INDEX, *and not under the sub-headings.*

# General Alphabetical Index.

***Italic figures*** **denote that the subject matter is in the "Leading Articles" or "Editorial Notes."**

## O

### OBITUARY—

## P

### PARIS EXHIBITION—

### Paris Exhibition—Continued.

### PARLIAMENTARY INTELLIGENCE (including Provisional Orders and Private Bills)—

**PERSONAL** (see also Appointments, Presentations, New Year Honours), (Bose) 264, (Crompton) 2, 72, (Fisher) 684, (Lewis) 324, (Lloyd) 418, (Lodge) 228, (Melhuish) 26, (Murray) 191, (Partridge) 532, (Pringle) 676, (Ram) 722, (Rucker) 767, (Smith, G. W.) 647, (Tait) 608, (Thomson, J. J.) 767, (Wood) 684, (Wordingham) 110, 852

### POLICE—

## Q

## R

### REVIEWS OF BOOKS, &c.—

# Leading Articles and Editorial Notes.

**(In this Section LEADING ARTICLES are shown in Capitals.)**

## Leading Articles and Editorial Notes—(*continued*).

## Contemporary Electrical Science.

# Letters to the Editor.

# Scientific Societies—Papers, &c., read before.

# Tenders Invited, Received and Accepted.

*(Tenders Accepted are shown in Thicker Type).*

# Companies, Joint-Stock (New Electrical, &c.), Registered.

# Companies' (Joint-Stock) Meetings, Reports, Dividends, Statutory Returns, &c.

# Supplements to Volume XLVI.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,171. [No. 1, Vol. XLVI.] FRIDAY, OCTOBER 26, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

"FREE WIRING" by municipal authorities has been a subject to which much discussion has been devoted during the past year. At first this extension of municipal trading was thought to be illegal, but latterly the Local Government Board has signified its approval of the principle in certain cases. It will be seen by the report in another column, that the Brighton Corporation had proposed to introduce a bill in the next parliamentary session authorising the Council to wire consumers' premises through the medium of wiring contractors. This is considered to be the "thin end of the wedge" by the local Ironmongers' Association, and by their efforts the proposition was rejected at a meeting of the Brighton Council last week. No doubt some "free," hire, or hire-purchase system of wiring is a boon to small consumers and encourages a profitable class of demand; and if an electric lighting committee is unable to conclude suitable arrangements with a firm for this purpose there should be no objection to its undertaking the work itself—provided, of course, that the socialistic element in the council does not succeed in giving undue preference to the "free-wired" consumer at the expense of the general body of ratepayers. So long as the actual wiring is only to be carried out through the intermediary of contractors, there can be no injustice to local wiring firms.

IT will be remembered that about this time last year one of the largest electric supply companies in London was being severely blamed for having connected up consumers in the summer in anticipation of the completion of a new power station, and subsequently failing to supply them owing to a delay in getting the new works into operation. This year we have the converse. A summons was granted last Wednesday against another London electric supply company which had refused to connect up a consumer to its mains owing to the possibility of its not being in a position to supply him during the coming winter. The magistrate's decision in this case will be of interest, as the point is a most important one to central station engineers.

REFERENCE is made incidentally by our Paris Exhibition correspondent this week to a "time limit" cut-out, but, unfortunately, he has not been able to obtain any particulars as to the construction of this instrument. The essential feature of such a cut-out is that it does not break the circuit directly a short-circuit or overload occurs, but only after the increased current has been flowing for a certain number of seconds, so that the supply to the whole system is not interrupted unless absolutely necessary. Fuses, if they are to be reliable at all, will not fulfil this condition; in fact, in some instances, they have been known to act more quickly than electromagnetic cut-outs, so that a good "time limit" cut-out will be welcomed by engineers both of lighting and traction works. However, so much depends on the trustworthiness of a cut-out that no engineers will care to invest in new appliances of this kind unless they have an opportunity of investigating the working parts and convincing themselves that they are simple and safe in their action. Before recommending their employment, therefore, we should like to know more of their interior economy.

WIRELESS TELEGRAPHY has become a subject of such general interest that we feel sure our readers will appreciate the Paper, by Prof. BLONDEL and Capt. FERRIÉ, given in abstract in another column, on the present condition of wireless telegraphy. We think that the general impression produced by a perusal of this report will be one of admiration for the inventors who during the last few years have busied themselves with the practical side of the subject. Nevertheless, the last few years' work in wireless telegraphy has led to a smaller advance in our scientific knowledge of the subject than might have been expected. For instance, although Mr. MARCONI has been successful in producing syntony to a certain extent between sending and receiving stations, and although there has been considerable advance in the distances over which successful wireless signalling is

accomplished, a scientific explanation is still wanting of the action of the sending wire on the receiving wire. The authors of the Paper propose a theory of this action which reads well and helps to clarify our views as to the precise nature of this phenomenon. As for that most important piece of receiving apparatus, the coherer, they merely summarise the already published views of other authorities, and leave us as undecided as ever as to which of the conflicting theories of its action is the correct one.

A FEATURE of the last Parliamentary Session has been the unprecedented amount of legislation affecting the electrical industry, and tending to improve the conditions under which it had threatened to become too restrictive owing to the large extent to which is has been dependent on municipally-controlled undertakings. We present to our readers in the present issue the first portion of a summary of the results of this year's parliamentary work in the electrical field, and we trust that the new Parliament which has been elected will continue in the same broad-minded spirit to foster the endeavours of independent capital to promote industry and progress.

**Obituary.**—We regret to announce the death, on Tuesday, of Mr. John A. Newlands, late of the engineering department of the Postal Telegraph service at Edinburgh, at the age of 63.

**Wireless Telegraphy.**—It is reported that during the recent manœuvres of the British Fleet at Smyrna, messages were transmitted between ships 60 miles apart by means of wireless telegraphy.

**The Master Electrical Contractors' Association, Dublin.**—Prof. G. Forbes will deliver a lecture to this Association on "The Electrical Utilisation of Water Power and the Niagara Scheme," on November 5th.

**Barmen-Elberfeld Single Rail Railway.**—On the occasion of the German Emperor's visit to Elberfeld on Wednesday, the first section of this line was formally opened. A description of the line appeared in *The Electrician* for July 6th, page 395.

**Electrical Engineers (R.E.) Volunteers.**—Recruiting for this corps will commence on Thursday next, November 1st, at the headquarters, 18, Victoria-street, S.W., at 7 p.m., and will continue, until further orders, on every Tuesday and Thursday at the same time. Full information can be obtained by writing to the Officer Commanding at the headquarters.

**Society of Model Engineers.**—In conjunction with the inaugural meeting of the Balfour Institute, Liverpool, on the 13th inst., the Liverpool branch of the Society of Model Engineers held their meeting and exhibited a fine collection of models. The next meeting of the Society will take place at the Balfour Institute at 7:45 p.m. on November 7th.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Tangier—Tarifa | Jan. 3, 1900 |
| Ceara—Maranham | Feb. 20, 1900 |
| Pará—Maranham | Mar. 2, 1900 |
| Môle-St. Nicolas—Cap Haitien | Mar. 7, 1900 |
| Zanzibar—Mombasa | Sept. 20, 1900 |
| Paramaribo—Cayenne | Oct. 6, 1900 |
| Saigon (Cape St. James)—Thuanan | Oct. 23, 1900 |

**Welcome Home.**—Mr. R. E. B. Crompton, who has been in command of the Electrical Engineers (R.E.) Volunteer contingent in South Africa, returned on Friday morning last week on board the s.s. "Saxon." He was met at Southampton by his wife and other members of his family and proceeded to his London house, and on Saturday went down to his home near Bedale, in Yorkshire. He was received at West Tanfield Station with enthusiasm and a *feu de joie* of 21 fog signals, a torchlight procession escorting him home through illuminated streets. Mr. Crompton returned to London on Wednesday.

**Aluminium Conductors.**—We learn that the employment of aluminium conductors in the small Northallerton electric lighting system described in *The Electrician*, Vol. XLIII., p. 757, has been a great success, and that no trouble has been experienced with them up to the present. Some of the lines intended originally to take a maximum current of 100 amperes are being loaded nightly with 250 amperes without any ill effect, and brass socketted joints, put up in the first place merely as a make-shift, are still standing, and had not given way in one instance. The works themselves are doing well, and are so fully loaded that they have had to cease connecting up customers in order to await the delivery of new plant.

**Appointments.**—Mr. J. A. McClelland, M.A., has been appointed to the chair of Natural Philosophy in University College, Dublin, rendered vacant by the death some months ago of Prof. Preston. Mr. McClelland is a native of the North of Ireland, and studied physics under Prof. Anderson in Queen's College, Galway. After graduating there, he joined Trinity College, Cambridge, and continued to do physical research work in the Cavendish Laboratory under Prof. J. J. Thomson, receiving the degree of B.A. (Research) in 1897. It should also be mentioned that Mr. McClelland was formerly one of the "1851 Exhibition" Science Research Scholars. ——In succession to Mr. L. R. Wilberforce, who has recently been appointed Professor of Physics at University College, Liverpool, Mr. C. T. R. Wilson, M.A., has been selected for the post of Demonstrator in Experimental Physics at Trinity College, Cambridge, for five years.——Lord Kenyon has been elected President of the University College of North Wales, in succession to Mr. William Rathbone, who has retired.

**"Cantor" Lectures.**—A series of "Cantor" lectures on "Electric Oscillations and Electric Waves," was to have been delivered by Dr. J. A. Fleming at the Society of Arts last May, but had to be postponed on account of his unavoidable absence from England at the time. The lectures are now announced for the four Monday evenings, November 26th, December 3rd, 10th and 17th. The following is a brief syllabus of the lectures:—

LECTURE I.—*Electric Oscillations.*—Effects of self induction and capacity. Theoretical prediction and experimental verification of the oscillations in spark discharges. Magnetic screening and skin-effect. Magnetisation by oscillatory current.

LECTURE II.—*Electric Resonance.*—Free and forced oscillations. Damping and radiation. Conditions of resonance. Stationary oscillations in wires. Absorption.

LECTURE III.—*The Electromagnetic Medium.*—Connection of electric and magnetic phenomena. Dielectric constants. Mechanical stress and strain analogies. Atomic or electronic theory of electricity. Ether, electricity, and matter.

LECTURE IV.—*Electric Waves.*—Wave-motion. Conveyance of energy by waves. Waves of electric displacement in dielectrics. Hertz's oscillator and resonator, and his production of stationary waves. Detectors of electric waves. Production of waves. Effect of medium on waves. Interaction of molecules of matter and ether waves.

**Interference Films by Electrolysis.**—Mr. S. A. Vaughton, of Sutton Coldfield, sends us particulars of some rather pretty experiments he has devised and performed recently. He took a dish containing dilute sulphuric acid, placed in it as anode and cathode two pieces of sheet aluminium, and passed a strong current for a few minutes. He then found that the "water-line" of the anode had become strongly iridescent. He explains this after performing another experiment. The anode, while in a sloping position, is about one-third immersed in the bath and its upper surface is kept moistened by the gentle dripping of dilute sulphuric acid upon it. A current from six Bunsen cells is passed for 8min. or 10min., hydrogen being evolved at the cathode, but practically no gas being given off at the anode. The anode is now found to exhibit a series of wide horizontal bands of colour which pass several times through a perfect spectrum as one glances down the plate. These bands are not destroyed by the greatest possible heating, and, when examined by the aid of a Nicol, proclaim themselves as produced by interference at the two surfaces of a film. Weak acids and ammonia have no effect on the colours, but caustic soda solution destroys them. Mr. Vaughton concludes that the colours are due to the deposition on the aluminium of alumina films of gradually-increasing thickness

produced by the nascent oxygen liberated by the electrolysis at the anode.

**Girder-Cutting by the Arc.**—A contributor to the *American Electrician* describes in the current issue his experience of the utility of the electric arc for sawing through pieces of structural ironwork, such as girders and the steel linings of bank vaults. In every case he has found that the arc furnished the quickest, most convenient, and economical method. For successful sawing of structural steel, a current of not less than 350 amperes should be used for quick working. The arc carbon should be about 1¼in. diameter, and of course connected to the negative side of the circuit. A heavy aluminium band bolted round the carbon, and framed in a wooden handle, has been found the best method of holding the carbon. To steady the current, a length of No. 18 German silver wire, sufficient to absorb all but 70 volts or 80 volts at the required rate of current flow, wound on a wooden frame and immersed in a pail of running water, is usually employed. It is to be remembered that, because the structure is connected to the positive side, the insulation resistance to the ground of the source of supply must be investigated, and any earths on the negative side of the supply circuit must be removed. To protect the eyes of the operator, a sheet-iron box, heavily lined with asbestos and having an insulated hole for the carbon, is generally used; and the operator should always wear double dark glasses. Of course, the cutting-down by the arc is exceedingly rough and jagged; but in most cases this is a small drawback compared with the saving in time and labour.

**"Electric Lighting Boards (Ltd.)"**—We had recently the opportunity of seeing in operation a system of connecting boards, now being actively introduced by a company with the above somewhat too general title. The system will interest all those especially who may have need of glow lamps for advertising or for decorative purposes. The company supplies boards, strips, and cable so constructed that a lamp can be fixed and connected up at any point. These boards, strips, &c., consist of insulating material in which are embedded parallel conductors running the whole length of the board. The conductors are each merely a collection of very fine copper wires gathered approximately to a circular section, and are connected alternately to the positive and negative terminals of the board. Strips of a hard asbestos insulator separate consecutive conductors, and the whole board is surfaced with a preparation of cork dust. The lamps have as terminals two pins, each about an inch long, which penetrate the cork layer and support the lamp, besides connecting it to two of the conductors of opposite polarity. A lamp may be moved very rapidly from place to place on such a board, and will almost invariably at each place penetrate a couple of cables and light up, if, of course, the pins of the lamp are so held as not to lie along one cable. The strip for walls and the flexible cable are constructed on the same principle. The system should prove very useful to shopkeepers and theatres, for marquee, street, and table decorations, and for general advertising purposes, but we would suggest that the company should invent a trade name for the particular type of electric-lighting board they supply.

**London County Council Tramways.**—As has already been announced in our columns, the London County Council purchased the piece of conduit track exhibited by the Westinghouse Company at the recent Tramways and Light Railways Exhibition at the Agricultural Hall, in order to make use of it for experimental purposes. This has now been erected in the London County Council tramway yard at Camberwell. It is 250ft. long, and has a curve of 90ft. radius, and a gradient of 1 in 40. It is built on a series of cast-iron yokes each set on a concrete bed 4in. in thickness. The yokes are placed 5ft. apart between centres, and carry in addition to the track rails the two slot rails forming the surface of the slotted conduit. The conduit between the yokes is continuous throughout, and is of concrete with a 4in. wall. The conductors in the conduit are of L-iron, supported on earthenware insulators, and the sectional system has been adopted, so that only the length of conduit over which the car is actually passing is "live." This is accomplished by means of an electro-magnetic switch, which is closed as the car passes on to the section and opens as it leaves it. The conductors are placed side by side in the conduit, and current is collected by a flat plough hinged in a special manner beneath the car. The width of the slot is ¾in. The car is equipped with 35 H.P. motors, controlled by a magnetic blow-out controller at each end of the car. The usual hand brake is provided, as well as a Newell electric and magnetic brake, which combines the usual electric brake with two iron shoes which are magnetised and lowered on to the rail. A 75kw. 500 volt railway generator driven by a gas engine, temporarily hired from the Westinghouse Co., supplies current to the line.

**The Board of Trade Regulations as to Changing Supply Pressure.**—On Monday last a private and informal meeting was held of the representatives of the companies and local authorities supplying electricity in London, convened by the Westminster Electric Supply Corporation. The object of the meeting was to consider the reply of the President of the Board of Trade to the deputation which in July last (see *The Electrician* of July 27, pp. 503 and 514) waited upon him to obtain an alteration in clause 6 B of the Board of Trade Regulations. This clause prescribes that no change shall be made in the pressure of the supply to any premises "except with the consent of the consumer." The deputation proposed to substitute the words "except on such terms and conditions as may be agreed upon between the undertakers and the consumer, or, failing agreement, as may be settled by an arbitrator appointed by the Board of Trade." The companies represented at the conference were the Westminster, Metropolitan, Chelsea, City of London, County of London and Brush Provincial, Notting Hill, Brompton and Kensington, and Kensington and Knightsbridge. It will be remembered that Mr. Ritchie in his reply stated that the only notices to which he had been referred had emanated from the Westminster Electricity Supply Corporation, and that, in his opinion, "all the resources of civilisation had not been exhausted; and that further negotiations might remove the difficulties." He asked further that the companies should give him some more details as to the loss to the companies on the "recalcitrant customers." It was stated that out of a total of 5,800 customers of the Westminster company only 10 persons had objected to the change of pressure. At the meeting on Monday it was arranged to forward a further letter to the President of the Board of Trade, and to request him to receive another deputation on the subject at an early date. We understand that three-fourths of the companies and local authorities in the County of London have agreed to act together in this matter, and that the remainder are also expected to fall in line.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**(TO-DAY) FRIDAY, October 26th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "Exhibition of Experiments Illustrating Certain Phenomena of Vision," by Dr. Shelford Bidwell, F.R.S. (2) "On the Concentration at the Electrode in a Solution, with Special Reference to the Liberation of Hydrogen by the Electrolysis of a Mixture of Copper Sulphate and Sulphuric Acid," by Dr. J. S. Sand. (3) "Electromotive Force and Osmotic Pressure," by Dr. R. A. Lehfeldt.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Annual General Meeting at the Westminster Palace Hotel.

**SATURDAY, October 27th.**

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

*7.30 p.m.* Annual Meeting in the Lecture Hall, Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Included in the business of the evening is the President's Address and a Paper by C. H. Innes on "The Stress Produced in a Connecting Rod by its Motion."

**THURSDAY, November 1st.**

RÖNTGEN SOCIETY.

*8 p.m.* Ordinary General Meeting at 20, Hanover-square, W., when Dr. J. B. Macintyre, will read his Presidential Address.

**SATURDAY, November 3rd.**

INSTITUTION OF JUNIOR ENGINEERS.

*3 p.m.* Visit to the London Hydraulic Power Co.'s station at Millbank-street, Westminster. (Postponed from October 27th.)

# THE PARIS EXHIBITION.—X.*

(BY OUR SPECIAL CORRESPONDENT.)

The great success of the exhibition has been, undoubtedly, the moving platform. In alluding to it briefly in the first article of this series I promised a technical description of it, at a future date, and for the preparation of this description the engineers of the Cie. des Transports Electriques, the Westinghouse Company, and the Société d'Applications Industrielles have given me every facility. The general appearance of the platform was shown in the two illustrations (Figs. 2 and 3) on page 471 of the article above referred to, and the same article included a map in which the route of the platform was indicated. Its length is slightly over 2 miles, and it runs continuously in the closed quadrilateral shown.

The three platforms, one stationary, one moving at 2½miles or 3 miles an hour, and the third at 5 miles or 6 miles an hour are supported some 28ft. from the ground on a girder construction seen in Figs. 58 and 59; there is no gap between them, so that the passenger steps from one to the other in the direction of the motion, and if nervous he can assist himself with one of the posts placed at intervals along the edge of each of the moving platforms. The awning seen in Fig. 58 is not continuous, but only at the stations, *i.e.*, the points where the platform is accessible by stairways and inclined elevators, for there are no stopping places. The motors are fixed beneath the platform, and the general arrangement of the driving gear is shown in Fig. 59, the details being given in Fig. 60. It is seen that a beam fixed to the platform rests on a wheel geared to the motor, and moves forward with a speed corresponding to the peripheral speed of the wheel. In addition, the platform is supported on either side by rollers moving on rails. There are in all about 180 5 H.P. motors, 120 furnished by the Westinghouse Company, and 60 of the Alioth type. These run at 750 revs. per min., and the driving wheel at 78 revs. per min., corresponding to a peripheral speed of 2·7 metres per second in the case of the larger wheel which drives the fast-speed platform. The motors are 4-pole, and are all connected in parallel on a 500-volt continuous-current circuit.

FIG. 58.—VIEW OF MOVING PLATFORM FROM BELOW.

The following additional particulars of the Alioth motors are of interest :—

Armature—67 slots, 67 coils, 11 turns per coil.
Diameter of wire, 1·3mm.
Four-polar series, winding.
Fields—Series winding, 220 turns per pole.
Diameter of wire, 3·2mm.

| | | |
|---|---|---|
| Losses—Armature core | 160 watts | |
| do. wire | 300 do. | (hot.) |
| Fields | 120 do. | (hot.) |
| Total loss | 580 watts | |

Electrical efficiency = 86·5 per cent.

| | | |
|---|---|---|
| Induction in pole-pieces (steel) | 14,000 | C.G.S. units. |
| do. yoke (cast iron) | 7,000 | do. |
| do. air-gap | 5,300 | do. |
| do. armature core | 10,000 | do. |

Altogether the 180 motors require some 315 amperes normally, the current rising to 350 amperes or 400 amperes on Sundays.

The energy is supplied through a sub-station, the "Westinghouse Pavilion," within the exhibition, being received there at 5,000 volts three-phase and 25 ∿ per sec. from a steam-driven generating station at Moulineaux, over 8 miles lower down on the Seine. This sub-station also furnishes energy for the exhibition third-rail elevated railway, which follows the same route as the platform, but runs in an inverse direction. The line is 1 metre gauge, and the third rail is an ordinary Vignoles rail bolted down to creosoted wooden blocks as insulators, the track rails being bonded in the ordinary manner, and resting on wooden sleepers. Great credit is due to the engineers for having the line ready for the opening of the exhibition, as a great part of the material and plant for it, as well as for the moving platform, sub-stations, and the Moulineaux works was lost in the "Pauillac" on its way to the exhibition. The line has several sharp gradients and curves. There is a frequent service controlled by a complete system of automatic block signals on the Timmis system supplied by the W. R. Sykes' Interlocking Signal Co. Each train consists of a motor car and two trailers, the motor car being equipped with four 32 H.P. motors and a series parallel controller.

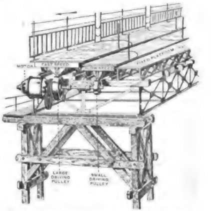


FIG. 59.—GENERAL CONSTRUCTION OF THE MOVING PLATFORM.

---

* Preceding articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, September 14 and 28, and October 5 and 12.

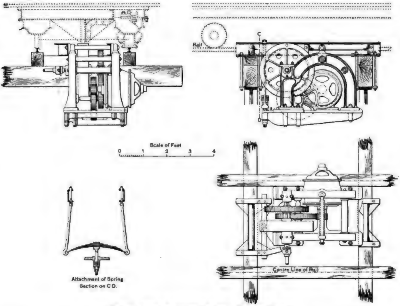


FIG. 60.—DETAIL OF GEARING OF ALIOTH PLATFORM MOTOR.

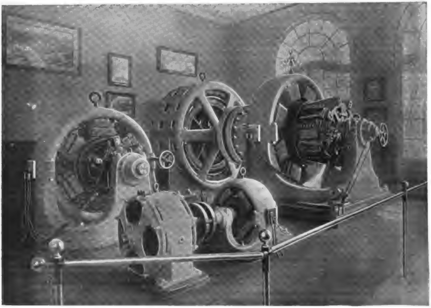


FIG. 61.—MACHINERY IN SUB-STATION.

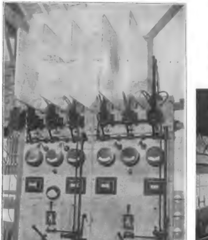


FIG. 62.—5,000 VOLT SWITCHBOARD IN SUB-STATION.

For the moving platform, the motor generator seen to the right in Fig. 61 is employed. It consists of an 850 H.P. three-phase induction motor (the largest yet built by the Westinghouse Co., and probably the largest induction motor at present existing), receiving the three-phase current directly at 5,000 volts, coupled to a 600kw., 550 volt, 8-pole, shunt-wound, continuous-current generator. This set runs at 300 revs. per min. Nine arcs in series on the 500-volt mains light the platform in the evening. For the railway two rotatory converters are employed, one of which is also seen in Fig. 61. These are six-polar and are started by small induction motors. They are compound wound, each develop 450kw., and runs at 500 revs. per min. As the converters supply current at 550 volts, three 170kw. stationary transformers—connected in mesh on the three-phase mains—reduce the pressure to 380 volts. Two auxiliary 30kw. continuous-current machines are also provided. They are driven by induction motors, which are supplied from three 10kw. 5,000:220-volt transformers. For starting up the platform generator, these are first run up to speed and supply current to the large continuous-current set, causing it to run as a motor. The large induction motor is then thrown across the 5,000 volt line. There are two switchboards in the sub-station, one for the high-pressure connection, and the other board for the low-pressure distribution and paralleling. The former, which is the more interesting, is shown in Fig. 62. The arm of the high-pressure automatic switch when switching off first makes a vertically-downward motion breaking the main contacts, and then falls out sharply, breaking circuit at the two vertical carbon contact plates at the top of the switch. Fig. 62 shows the switch closed, and in Fig. 65, which represents the switchboard at the Moulineaux generating station, the switch is seen in its "off" position. The latter are in addition fitted with a "time-limit relay" which allows any amount of overload for a short time, adjustable from 0sec. to 10sec., and from 100 amperes to 500 amperes.

FIG. 63.—ENGINE-ROOM AT MOULINEAUX.

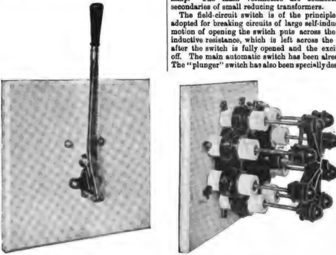
We now come to the Moulineaux works, where current is generated for supplying the sub-station just described as well as for the electrical extension into Paris of the Western Railway of France and a number of so-called "Tramways de Pénétration," which will run from various suburbs into the city, being on the overhead trolley system as far as the city walls, and on the Diatto surface knob system within Paris. The Moulineaux works, which are 3 miles or 4 miles distant from the exhibition sub-station, are connected to it by underground three-core cables, there being separate cables for the moving platform and for the exhibition railway, in addition to the one required for the Western Railway extension, which has a sub-station of its own containing three rotary transformers for supplying 500-volt current. The conductors are 110 sq. mm. section, and the diameter of the cables over the steel ribbon armouring is 12cm. They have been supplied by the Berthoud Borel Co. and the Société des Téléphones, and are insulated with jute and compound and lead covered. When all the tramways and railways have been completed, the station will have a large output, and by then nine 800kw. dynamos will have been erected. At the time of my first visit last July, however, the engine room presented the appearance shown in Fig. 63, only two of the generators being in running order, and a third being in process of erection. The engine room has a total length of 370ft. and a width of 66ft. The machines are three-phase, mesh-wound, and are designed to withstand a load of 1,000kw. for half-an-hour if necessary. They are of the standard Westinghouse type, with moving magnets, similar to those recently described in our columns in connection with the Willesden works of the Metropolitan Electric Supply Co. They have 38 poles, and run at 80 revs. per min. The alternators are driven by direct-coupled Dujardin-Corliss triple-expansion engines, the cylinder diameters being H.P. $22\frac{5}{8}$in., I.P. $35\frac{7}{16}$in., and the two L.P. cylinders $39\frac{3}{8}$in., with $32\frac{3}{16}$in. stroke. Surface condensers are employed, Seine water being utilised both as circulating water and for make-up feed.

Excitation is provided by two direct coupled Westinghouse sets, each generator producing 1,087 amperes at 125 volts.

The switchboard has at present six main circuit panels and three exciter panels. All panels are of white marble supported on a wrought-iron framework. Each exciter panel carries an exciter-field rheostat, a three-pole main switch, a main ammeter, a single-pole automatic cut-out, a pilot lamp, and a set of plugs for putting across any exciting-machine circuit a

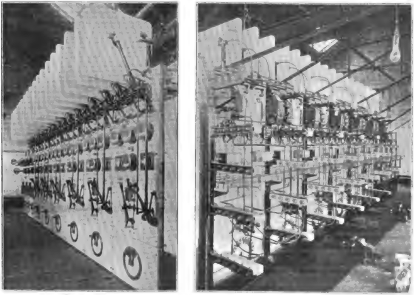
voltmeter for paralleling purposes. The alternator switchboards are each fitted with an alternator-field rheostat, a field-circuit switch, a field-circuit ammeter; and for the alternate-current main high-pressure circuit one "plunger" switch, three automatic high-pressure switches, each of 100 amperes 5,000 capacity, three ammeters, two voltmeters, and pilot lamp. The main voltmeters are connected across the secondaries of small reducing transformers.

The field-circuit switch is of the principle so frequently adopted for breaking circuits of large self-induction; the first motion of opening the switch puts across the circuit a non-inductive resistance, which is left across the field terminals after the switch is fully opened and the exciting circuit cut off. The main automatic switch has been already referred to. The "plunger" switch has also been specially designed for high-pressure polyphase work; the hand-lever alone is in front of the board; all "live" contacts, connections, &c., are behind. The



FRONT VIEW. BACK VIEW.

FIG. 64.—WESTINGHOUSE FOUR-POLE DOUBLE-BREAK SWITCH FOR TWO-PHASE CIRCUITS.



FRONT. BACK.

FIG. 65.—SWITCHBOARD AT MOULINEAUX WORKS.

contacts are of the socket and plug form ; the sockets—in this case six—are arranged in a circle, and are connected to their respective machine and main conductors. The plugs are fixed at the extremities of a star or spider, and are connected together in pairs, so that a double break is given to each circuit. It is actuated by a rod which passes through the marble panel connecting one end of the operating lever with the centre of the star carrying the plugs. Fig. 64 shows a similar switch, but with eight plugs and sockets instead of six, it being the pattern employed on four-pole two-phase circuits. The plugs as they are pulled out of the sockets form a partial vacuum, into which the air rushes as the plugs leave the sockets, the rush of air extinguishing the arc.

Electric motors are used for various purposes about the works—for centrifugal pumps drawing water from the Seine, for power in repair shops, &c.

Fig. 66.—Boiler House at Moulineaux.

The boiler-house (Fig. 66) is situated alongside the engine-room ; its size is 370ft. by 66ft. There are 27 semi-tubular boilers, by Messrs. Meunier, of Lille ; each has a heating surface of 2,400 sq. ft., and works at a pressure of 160lb. per square inch.

## THE ELECTRIC TRAMWAYS OF THE LONDON UNITED TRAMWAYS CO.

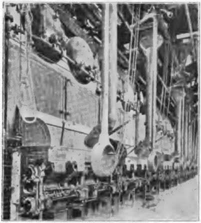
Two years ago (*The Electrician*, Vol. XLI., p. 786) we published a map showing the lines of horse tramway owned by the London United Tramways Co., which it was proposed to convert to electrically-operated ones, as well as some extensions to their lines which would be worked by electricity from the outset. Since then some modifications have been made in the original plans, the opposition of the London County Council to the overhead trolley having been to some extent overcome, and alterations having been made in the routes from other causes. The company, under the able management of Mr. J. Clifton Robinson, have been most active in putting up their overhead system, reconstructing their track, and completing their generating station, and it is anticipated that by the end of the year electric cars will be running. In fact, were it not for difficulties with the Kew Observatory authorities, horse traction might almost have been superseded already on a considerable portion of the company's lines. According to the act authorising it to construct electric tramways, the company is obliged to lay its lines and return conductors in such a way as not to interfere with the work of the observatory, the Board of Trade being the arbiter as to what can be reasonably demanded. A conference between representatives of the Royal Society, the Board of Trade and the company will be held on October 31, when it is to be hoped that all differences may be amicably settled. Including "light railways," there will eventually be over 30 miles of track electrically operated. One power station now being built at Chiswick will supply the whole line with electrical energy, partly direct and partly through two sub-stations.

View of Engine Room at London United Tramways Co.'s Power House.

The illustrations in this article show the present state of the undertaking, and we reserve a full description of the system for a future occasion. The site at Chiswick occupies 4 acres, a large part of which is devoted to car sheds. In the engine room the erection of two continuous-current sets is practically complete. Each of these consist of a 750 H.P. vertical cross-compound Allis engine, and each of these engines drives two 250 H.P. B.T.H. generators mounted on the crank shaft on either side of a heavy fly-wheel. Originally it was intended to run the lines on the three-wire system, but now these generators will be run in parallel. They supply current at 500 volts directly to the line, and a 5,000-volt three-phase generator developing 500kw. is to be put in which will generate current for the two rotatory transformer sub-stations. The condensing plant includes surface condensers and cooling

London United Tramways Co.'s Car Sheds.

towers. As seen in our illustration, very little has now to be done to the boiler house, the Babcock-Wilcox boilers with Vicars automatic stokers being already erected. A chain coal-conveyor supplies coal to the bunkers and removes the ashes. The chimney is of steel plate, and not of brick.



Boiler Room at London United Tramway Co.'s Power House.

The lines are double track almost throughout, and are supported from span wires attached to ornamental posts on edge of the footway. One of the sharpest curves is at Young's Corner, Chiswick, shown in our illustration, where the line from Shepherd's Bush meets the main line running along High-road, Chiswick. When completed the whole system will extend from Shepherd's Bush and Hammersmith in the east to Hounslow and Uxbridge westwards, and as far as Hampton Wick in a southerly direction.

Young's Corner, Chiswick.

**The Opacity of Ink to Röntgen Rays.**—It is stated that as a result of experiments made by Signor Briguiti, of the State Archives in Rome, he finds that ink is very opaque to Röntgen rays if it contains red lead, cinnabar or ultramarine

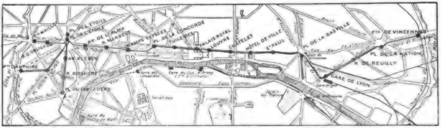
## THE PARIS METROPOLITAN RAILWAY.

After years of discussion, the Paris municipal authorities decided four years ago to build an underground metropolitan railway. It was originally proposed that this railway should be narrow gauge, it being suggested in some quarters that this was for political reasons to ensure its independence from the State railways, which are of standard gauge. In any case, in the act authorising the Paris municipality to build the line it was specified that standard gauge should be employed as well as that the maximum width of the cars overall should be 7ft. 10½in., and the clearance between the car and the tunnel wall at 6ft. above the rails 27in. However, at one place at least the tunnel is so low that ordinary rolling stock could not go through it, as an examination of the above illustration will show. Until recently Paris has had to rely almost entirely on its omnibus and tramway service and the "Ceinture" railway which corresponds more or less to our Outer Circle line in London. The Metropolitain, when the whole system is complete, will cross Paris at several places.

Station with Vaulted Roof.

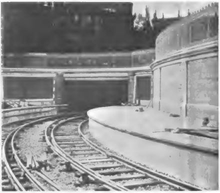
Train in the Hôtel de Ville Station.

The sections recently opened are shown by the thick lines in the map below. The length of these is about 7 miles, and, as seen by the two sectional drawings on p. 12, the crown of the tunnel is only a few feet below the roadway. In one place, near the Bastille, it emerges into the open air and crosses a canal. At this point there are several sharp curves, including a double one only 165ft. radius, otherwise the shortest curve is 250ft. radius and the steepest gradient about 4 per cent. At the terminal stations the trains are brought round a loop. The two parts of the station are joined together by a semicircular piece of single track, laid in a narrow tunnel, the radius at this part being about 100ft. On p. 12 will be found a scale drawing of the standard section of tunnel employed. On sharp curves the walls are carried out further. The usual construction adopted at stations is a vaulted tunnel, the height of the vault above the rails being about 16ft. Some stations, however, have iron roofing, with brick arches between the beams, which construction we also show in section.



MAP SHOWING ROUTE OF RAILWAY.

TUNNEL AT ENTRANCE TO HÔTEL DE VILLE STATION.



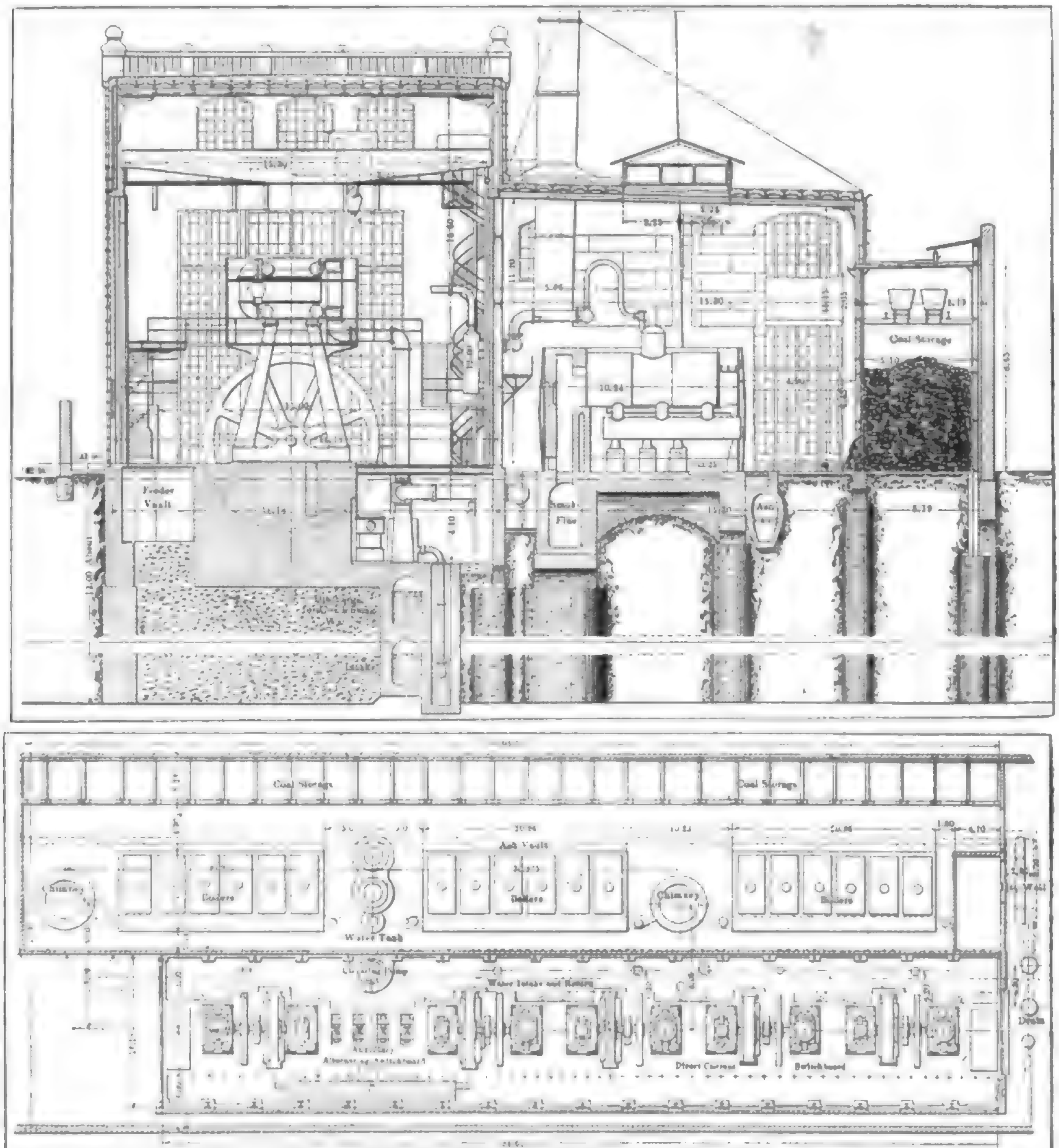
PLACE DE LA BASTILLE STATION.

DOUBLE-CONTROLLER MOTOR CAR.

One of the conditions imposed by the municipality on the contractors is that the view across the open spaces and streets must not be obstructed by any covered entrance to the stations. Consequently, a station is only indicated at the surface by a board placed above a flight of stone steps. Lifts are unnecessary, as the depth of the rails below the surface varies only

from 20ft. to 25ft. On this account also, accommodation for booking offices, &c., is somewhat limited as regards head-room. The station at the Place de L'Etoile is an exception to the others, as here a number of lines meet, so that some additional passages are necessary. Here also a sub-station has been placed and lifts are being erected to connect the various tunnels which pass under one another.

Two patterns of motor cars are employed, some with single controllers and others with controllers at each end, as shown on page 10. Locomotives have not been adopted, each train consisting of one motor car and two trailers. The motor cars are equipped with two 120 H.P. Westinghouse motors with laminated field poles and slot-wound armatures. Special attention has been paid to the ventilation both of the magnets

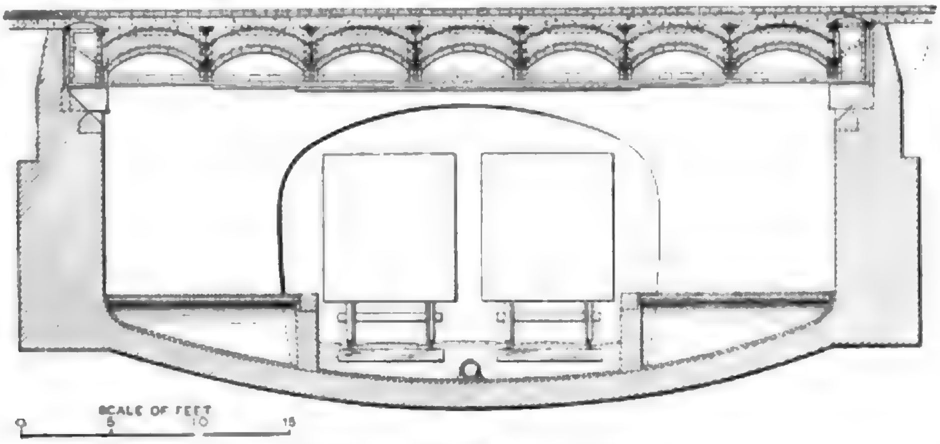


SECTION AND PLAN OF POWER HOUSE.

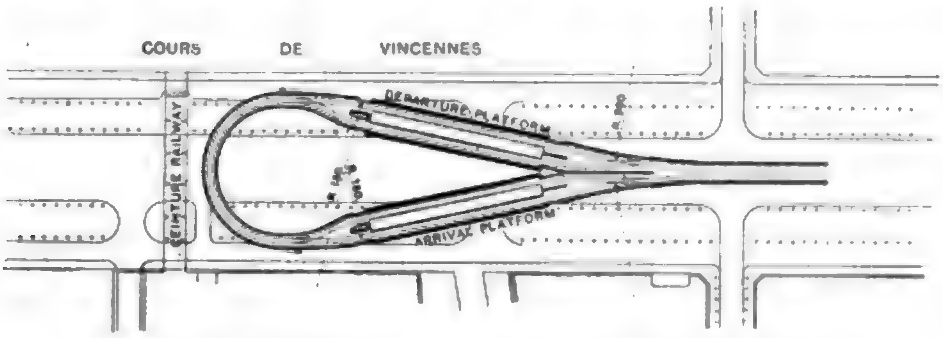
and armature, so that the motors can be considerably overloaded with safety. Another feature of the motors is that the binding of the armature coils is laid in grooves in the core. The controllers are of the series-parallel magnetic blow-out pattern. In the roof above the driver's platform is an automatic circuit breaker, and also a toggle-joint fuse box carrying a copper wire fuse which is replaceable in a moment if burned out, and which may be easily removed if it is desired to open the circuit in the absence of the driver.

In constructing the track, ordinary Vignole rails have been employed, weighing 105lbs. per yard run and in lengths of 50ft. The third rail for taking the current to the cars is a double-headed rail weighing 79lb. per yard. The track rails are laid on metal sleepers 7ft. 2in. long, with about 32in. between centres, and every fourth sleeper is 2in. longer on the inner end in order to carry the support of the third rail, which is a cast-iron chair carried on two iron pins fitted to an iron base. This is insulated by prepared wooden blocks.

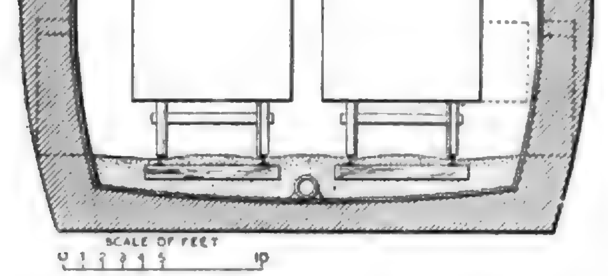
A Wurts lightning arrester is placed alongside the fuse box, of the ordinary form for cars. All the above apparatus is of Westinghouse manufacture, but the air brakes are of French make. They are made by Soulerin, of Paris, and air compressors and motors are furnished by Amelin and Renaud, also of Paris. These motors, of the spherical ironclad type, are geared to the compressor, which has two cylinders 90deg. apart, and supplies air to a reservoir in which the pressure is kept at about 65lb. per square inch. The output of this motor is only 1½ H.P. Contact to the third rail is obtained by means of two shoes of the ordinary double-link form.



SECTION OF STATION WITH IRON ROOF.



CONNECTION BETWEEN ARRIVAL AND DEPARTURE PLATFORM AT GARE DE LYON STATION.



SECTION OF STANDARD TUNNEL.

The power-house is still in course of construction, current at present being supplied to the line from generating stations belonging to other companies. The new power house is being built near the Gare de Lyon terminus on the banks of the Seine A plan and section of this are given on page 11. It will contain three batteries of six boilers, one 1,500kw. continuous-current generator which will produce current at 600 volts for direct supply to the line, three 1,500kw. three-phase direct coupled sets generating three-phase current at 5,000 volts, and 25 ~ per second, and auxiliaries in the shape of rotatory transformers, exciters, storage batteries, &c. The sub-stations are also in course of construction. The one at the Place de L'Etoile will contain stationary transformers and rotatory converters, the latter apparatus being supplied with current at 430 volts from the former and having an aggregate output on the continuous current side of 1,000kw. at 600 volts. There will also be two batteries of 250 Tudor cells with a capacity of 2,000 ampere-hours at a one-hour discharge. These are placed in separate rooms to the transforming plant. The lifts in the sub-stations will be hydraulic, but the pumps for them will be electrically driven.

The line is leased to a company by the municipal authorities, who receive a royalty on the fares collected. Contrary to the practice on the Central London Railway there are two classes and return tickets are issued.

---

**Accident on the Paris Metropolitan Railway.**—A serious collision occurred on Friday morning close to the Place de la Concorde station of the Paris Metropolitan Railway. The line is worked on the automatic block system, and conflicting accounts are given as to the precise cause of the accident. The true explanation appears to be that a train, which was being brought to a standstill outside the station in response to a signal against it, backed for several yards, presumably owing to a failure of the brakes to act promptly when endeavouring to stop the train on an up grade. In backing it entered the section which had been already signalled clear to the train following, and this train rushed into the one in front with considerable orce. The driver of the hinder train and one of the passengers were seriously injured and several others were cut and bruised.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from The Electrician Office, post free, on receipt of published price.

"Die Atmosphärische Elektricität ihre Vertheilung und Wahrscheinlichen Ursachen." By C. Liebenow. (Halle-a-S.: Wilhelm Knapp.) 2 marks.

"The Mechanical World Pocket Diary and Year Book for 1901." (Manchester: Emmott & Co.) 6d. net.

"High-Speed Steam Engines." By W. Norris and B. A. Morgan. (London: P. S. King & Son.) 10s. 6d.

## ELECTRICITY WORKS ACCOUNTS.

### Canterbury Municipal Electric Supply Works.

Dating from February last year, the accounts of the Canterbury municipal electric supply undertaking, analysed in our first table, cover the first year of working. The results attained are extremely satisfactory. Not only have the interest and sinking fund charges—amounting jointly to 5·92 per cent. of the mean capital—been met, but a balance of £406 has been cleared. Directing attention to the revenue account, it will be seen that the seat of economy lay in the very low generating costs. At 1·04d. per unit the aggregate generating costs might well have been associated with an output 20 times that of Canterbury last year. All the several items of generating costs present uniformly excellent figures. The management and property charges, representing as they do a fair average in relation to the output, and the load factor of 10·8 per cent. are very creditable, considering that they obtained during a first year.

Up to March 31 last generating plant to the capacity of 150kw. had been installed. The capital expenditure was £32,445, representing £216 per kilowatt. Of the total borrowed capital of £33,435, £32,685 was raised at 2½ per cent. and £750 at 3 per cent.

### Winchester Electric Light and Power Co. (Ltd.)

The Winchester undertaking is another electricity supply concern which, like that of Canterbury, exhibits really excellent results for the first year of working. Considered in relation with the very low output of 56,707 units sold and a load factor of but 7·25 per cent., the costs in general may be considered as exhibiting better results even than those of Canterbury. The fuel charge at Winchester is better than might have been expected, while the other items of generating costs, as well as the collective management and property charges, are exceedingly low under the conditions. The total costs figure of 2·8d. is just a penny under the average value which obtained in company-owned stations of similar output in 1898.

Comparing Winchester with Canterbury the difference in the relation of the output to the plant capacity must be noticed. In the former the units sold per 8 c.p. lamp capacity of plant installed were 6·05; with the latter concern the units sold were 32·5 per 8 c.p. lamp capacity. On the other hand, the outlay in capital per kilowatt installed was £102 at Winchester as compared with £216 at Canterbury.

After paying interest charges to the extent of £157 and £137 to the contractors for the maintenance of the station the net balance for the year was £280. Of this sum £121 was written off for the reduction of preliminary expenses, the remainder being absorbed by a 2½ per cent. dividend.

| | CANTERBURY. | | WINCHESTER. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Canterbury Corporat'n | | Winchester Elec. Light & Power Co., Ld. | |
| *Date of Commencement of Supply* | February, 1899. | | May, '98. | |
| *System of Supply* | 3-wire con. current. | | 3-wire con. current. | |
| *Chief Engineer* | Norman Staniland. | | H. N. Warburton. | |
| **YEAR ENDED** | MAR. 31, **1900.** | | DEC. 31, **1899.** | |
| **QUANTITIES—** | | | | |
| Units generated | 210,188[a] | | 73,085 | |
| " SOLD (TOTAL) | 152,553 | | 56,707 | |
| " sold to consumers | 99,527 | | 56,707 | |
| " sold for public lighting, &c. | 53,026 | | nil | |
| " used on works | 27,638 | | 6,979 | |
| UNITS SOLD per 8 c.p. LAMP CAPACITY | 32·5 | | 6·05 | |
| Maximum supply demanded | 161 kilowatts | | 39·2 kilowatts | |
| Number of public lamps | 12 arc, 243 incan. | | nil | |
| Number of consumers | 193 | | 122 | |
| Connections to mains in 8-c.p. lamps | 8,083 | | 10,180 | |
| CAPACITY OF PLANT IN 8-c.p. LAMPS | 4,690 | | 9,380 | |
| CAPACITY OF PLANT IN KILOWATTS | 150 | | 300 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | £33,435 | £223 | £45,000 | £150 |
| Share | — | — | 25,000 | 83·3 |
| Loan (including Debenture charges) | 33,435 | 223 | 20,000 | 66·7 |
| RECEIVED (TOTAL) | 33,435 | 223 | 24,175 | 80·6 |
| Share | — | — | 10,975 | 35·6 |
| Loan (including Debenture charges) | 33,435 | 223 | 13,200 | 44·0 |
| AUTHORISED, NOT RECEIVED (TOTAL) | — | — | 20,825 | 69·4 |
| Share (unissued) | — | — | 13,865 | 45·2 |
| Share (uncalled) | — | — | 160 | 0·53 |
| Loan (including Debentures) | — | — | 6,800 | 22·7 |
| REPAID (TOTAL) | 1,127 | 7·52 | — | — |
| RESERVE OR SINKING FUND | — | — | — | — |
| DEPRECIATION FUND | — | — | — | — |
| EXPENDED (TOTAL) | 32,445 | 216 | 30,474 | 102 |
| Lands and buildings | — | — | 3,351 | 11·2 |
| Plant | — | — | 15,807 | 52·7 |
| Mains | — | — | 10,490 | 35·0 |
| Miscellaneous | — | — | 826 | 2·75 |
| BALANCE OF CAPITAL ACCOUNT | 989 | 6·59 | −6,299[b] | 21·0 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £3,169 | 4·988d. | £1,218 | 5·155d. |
| Revenue from supply | 2,269 | 3·570d. | 1,166 | 4·890d. |
| " meters, &c. | 83 | 0·131d. | 62 | 0·255d. |
| " public lighting | 813 | 1·280d. | — | — |
| " sale of lamps, &c. | 5 | 0·002d. | — | — |
| " miscellaneous sources | — | — | — | — |
| **EXPENDITURE—** | | | | |
| TOTAL COSTS | £1,256 | 1·975d. | £659 | 2·789d. |
| WORKS COSTS | 778 | 1·224d. | 530 | 2·243d. |
| *Generation of Electricity* | *664* | *1·045d.* | *509* | *2·154d.* |
| Fuel (including cartage, &c.) | 349 | 0·549d. | 288 | 1·220d. |
| Oil, waste, water, stores | 17 | 0·027d. | 17 | 0·072d. |
| Wages at station | 261 | 0·411d. | 202 | 0·855d. |
| Repairs & maintenance at Station | 37 | 0·058d. | 1 | 0·004d. |
| *Distribution of Electricity* | *36* | *0·057d.* | *21* | *0·089d.* |
| Wages, &c. | 10 | 0·016d. | 20 | 0·085d. |
| Repairs, renewals of mains, &c. | 26 | 0·041d. | 1 | 0·004d. |
| *Public Lighting* | *78* | *0·123d.* | — | — |
| Attendance | 44 | 0·069d. | — | — |
| Renewals | 34 | 0·052d. | — | — |
| MANAGEMENT CHARGES, &c. | 478 | 0·752d. | 130 | 0·550d. |
| *Royalties* | — | — | — | — |
| *Rent, rates, taxes* | *24* | *0·038d.* | *68* | *0·288d.* |
| *Management* | *454* | *0·714d.* | *62* | *0·263d.* |
| Salaries | 358 | 0·563d. | 36 | 0·152d. |
| Stationery, &c. | 21 | 0·033d. | 8 | 0·034d. |
| Establishment charges | 33 | 0·052d. | 5 | 0·021d. |
| Law charges, &c. | 42[d] | 0·066d. | 13[c] | 0·055d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £1,913 | 7·52% | £422[d] | 1·66% |
| Carried to Depreciation Fund | — | — | — | — |
| Carried to Res. or Sinking Fund | 833 | 3·27% | — | — |
| Net int. on loans (incl. Deb. charges) | 674 | 2·65% | 157 | 0·618% |
| BALANCE FROM LAST ACCOUNT | — | — | 40 | 0·158% |
| Do. AVAILABLE for DISTRIBUTION, &c. | 406 | 1·60% | 324[e] | 1·28% |
| *Deficit* | — | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | 2½% | — |
| % of TOTAL COSTS to GROSS REVENUE | 39·6% | | 54·1% | |
| Expenditure per kilowatt capacity | £8. 7s. 6d. | | £2. 3s. 11d. | |
| REVENUE PER KILOWATT CAPACITY | £21. 2s. 7d. | | £4. 1s. 2d. | |
| Expenditure per 8-c.p. lamp capacity | 5s. 4½d. | | 1s. 4¾d. | |
| REVENUE PER 8-C.P. CAPACITY | 13s. 6½d. | | 2s. 7½d. | |
| REVENUE PER 8-C.P. CONNECTED | 7s. 10d. | | 2s. 4½d. | |
| Price charged for lighting, per unit | 6d.[b] | | 7d., 4d. and 2d.[a] | |
| " for power, per unit | 3d.[b] [ann.[c] | | 3d. | |
| " for public lighting | £25 per arc lamp per | | — | |

CANTERBURY.—REMARKS—a Of the units generated 17,300 units are given as the difference between charge and discharge of battery and 12,395 units as loss on mains, &c. b Subject to discounts. c £3 10s. per incandescent lamp per annum. d Insurance.

WINCHESTER.—REMARKS—a On the maximum demand system. b Over-expended. c Includes £5 to insurance and £8 to auditing. d After deducting £137 amount due to contractors under contract for maintenance. e Out of this is paid the dividend and £121 in reduction of preliminary expenses.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3, SALISBURY COURT, FLEET ST., LONDON.

*Telephone*: 949 Holborn. *Telegrams*: "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| **United Kingdom** | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| **Postal Union** ... | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## SPECIAL NOTICE.

**Last week's number of "THE ELECTRICIAN" completed Vol. XLV. With this week's number is issued (Gratis) the Index to the Volume.**

**Complaints of non-receipt should be promptly made to the Publisher.**

## SMALL ISOLATED ELECTRICITY WORKS.

An important consideration affecting the development of the electric supply industry in the United Kingdom is the attitude adopted by consulting electrical engineers towards the creation of separate supply works in individual areas each controlled by its own local authority. We have frequently touched upon this question, and have called attention to its bearing both upon the electrical industry and upon national industrial development. But we are induced once more to notice this matter, partly on account of the large increase in the number of quite small electricity supply works throughout the country during the past year or two, and partly through some remarks embodied by Mr. C. S. VESEY BROWN in an article on "Electricity Supply for Small Towns," which we published in our last issue. Mr. VESEY BROWN advances the following views:—"It is perhaps too late now for an alteration in the law with respect to the granting of provisional orders, but the writer is firmly of the opinion that if each town and district was originally made the owner of the right to supply electricity, and given, say, five years in which to make up its mind to supply under statutory powers, and if nothing was done to carry out these obligations, to transfer the concession, either by auction or by some equally convenient means, that there is not a town or district in this country which would not be operating an electricity works at the present day." With regard to these remarkable views, we may say in the first place that we sincerely hope that it is *not* "too late for an alteration in the law with respect to the granting of provisional orders"—especially to local authorities. But we do not look for such alteration as Mr. VESEY BROWN appears to desire. We look, on the contrary, for legislation which will restrict rather than extend the period during which a local authority with a dog-in-the-manger policy can legally pretend to be making up its mind about local electricity supply. To contend that so long a period as five years of municipal-minded uncertainty is essential or at all desirable in the public interests is really preposterous. We look also—contrary to Mr. VESEY BROWN again—for a change in legislation which will diminish rather than augment the number of local authorities in the United Kingdom

which will be able to acquire power to erect separate electricity works. Diminution in this number of local authorities, of course, would naturally be effected by transferring the right to obtain powers from the smaller to the larger local authorities, in such a manner as to foster an increase in the area and population supplied from each separate electricity works. The present tendency to erect a separate supply station in each little village and hamlet is injurious to the industrial welfare of the country, and in the long run it will prove highly injurious also to the best interests of electrical industry. This is all the more manifest when regard is paid to the claims which are being advanced on behalf of such municipal works, and are being largely recognised, that these works are to be protected from competition from independent concerns capable of supplying in a cheaper and better manner. Protective policy extended to petty areas is not necessarily petty, but is likely to be stupendous, in its national issues.

Not merely politicians, however, with a mania for carrying municipalisation to its utmost limits, but, in a lesser degree, the consulting engineers within the very doors of the electrical profession, are responsible for the modern tendency towards increase in the number and corresponding decrease in the size of electricity supply works—this process of fractioning which we have been describing. Half a loaf is better than no bread; even a small slice is preferable to nothing; and where the number of clamourers for jobs is far in excess of the number of jobs available, there is much that is potent in human nature to urge each individual to seize each small fraction of a legitimate job and make it his own exclusively, whenever it comes within his reach. When, for example, a consulting engineer in a comparatively small way of business is engaged by the local authority of a small town, bordering upon a large city with a flourishing electricity works, to report on a scheme of electricity supply, his professional instinct tells him that this small town forms naturally a fraction of the proper area of the neighbouring works; but his business instinct tells him, contrarily, that if he recommends that the town be merged in the city by the disposal of its provisional order to the larger concern, he will be paid no more than the few guineas for his report, and will lose the usual commission upon the cost of erecting separate works. Knowing, or shrewdly suspecting, as in the majority of cases the engineer would do, that the local authority engaging him means to have its own electricity works whatever he may advise, it is, perhaps, too much to expect of human nature that the man would refuse to allow less wise counsels to prevail than those which he knows to be the best. He can hardly be expected to throw up a job merely because his clients do not wish to have it carried out in the most satisfactory manner. Nevertheless, we think that consulting engineers are often largely to blame for not calling the attention of their clients, in the first instance, to the superior merits of a scheme by which they would obtain electric supply more cheaply and often more securely from existing larger works in the neighbourhood. The technical aspects of the question cannot be supposed to present themselves to the non-technical mind of even an unbiassed town councillor, and it is the duty of the consultant to see that those he is advising are at the outset presented with a clear statement of the true character of the problem and its best solution.

Those whose mental purview is unable to grasp the broad and far extending outlines of the question we are considering, have sometimes criticised our strong expressions of opinion, on the ground that they do not consider they are quite justified. "What matters it," they say, "if every little village and hamlet in the country does happen to be provided with its own small electricity works in a corrugated iron shed or disused barn? The works have cost little: will have done something to justify their existence in the few years of their life; and they can be sold for something whenever a better electric supply is available in the neighbourhood." All this sounds very plausible; but it is nevertheless fallacious. Beyond question, there is no objection to the mere existence of a steam driven or gas-driven dynamo in a barn, in any village or small town where such a form of electric supply can be made to pay. The mischief is not in the works themselves, but in the vested interests which they represent. It is in such vested interests as these, firmly established, that the broader and fuller development of electricity supply in the future will meet with a formidable obstacle, comparable with, or perhaps even greater than, the obstacle which the early development of electric lighting in this country encountered through the vested interests in gasworks. History is merely repeating itself, with this difference, that the enemy is now a traitor in the electrical camp instead of an avowed foe outside of it.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Unipolar Discharge.*—When the charge of a body is increased beyond a certain point, a disruptive charge takes place through the surrounding medium. On raising the temperature of the body to incandescence, the discharge potential is lowered, and the lowering is greater for negative than for positive charges. Hence at a certain difference of potential, either positive or negative, a negative charge alone will be discharged. This is the unipolar discharge produced by heating, and J. Stark offers the following explanation for it: At the surface of the glowing body, positive and negative ions are liberated, partly owing to the high temperature, and partly owing to the ultra-violet light radiated from the body. Under the force exerted by the charged body, these ions are driven into the gas, and produce or increase the conductivity of the latter. If the body is negatively charged the negative ions will be sent out with the greater force, and since their speed is greater in every case than the speed of the positive ions, they will produce a greater amount of gaseous ionisation than the positive ions would in a similar case. That ionisation, and not mere field strength, is the determining factor is shown by the fact that if a carbon filament charged to $-100$ volts is confronted with an electrode at $-5{,}000$ volts, no charge passes, since the negative ions cannot leave the glowing filament. But a discharge passes at once on earthing the electrode.

[J. Stark, *Physikal. Zeitschrift*, October 15, 1900.]

*Relays in Wireless Telegraphy.*—In a polarised relay the armature is immediately attracted by the core as soon as the first traces of a current traverse the coil. But before the relay circuit is closed the armature has to perform its excursion, which takes a certain time, $t_1$. Such a retardation does not occur on breaking the circuit, as the least motion of the armature interrupts the relay circuit. The question of successive relays is treated by Guarini and Poncelet in accordance with these considerations. If $t$ is the duration of a signal at the transmitting station A, $t_1$ the duration of excursion of the armature of a Guarini relay at R, and $t^1$ that of the relay at the receiving station B, then the net time available for the registration of the signal at B is

$$T = t - (t_1 + t^1).$$

If there are $n$ relays between A and B, this formula becomes

$$T = t - (t_1 + t_2 + \ldots\ldots + t_n + t^1).$$

To have $T > 0$, $t$ will have to be larger than the remaining terms, and that becomes increasingly difficult as the number of successive relays is increased. M. Guarini therefore con-

structs the relays so as to have very small armature excursions, and to be sensitive to currents of only 0·00005 amperes. In wireless telegraphy, a limit is set to $t$ not by the capacity, as in line wires, but by the inductance of the transmitting coil, which plays a corresponding part.

[GUARINI and PONCELET, *Comptes Rendus*, October 8, 1900.]

*Magnetic Field due to a Moving Electric Charge.*—As a further test of the mutual action between a moving charge and a magnetic field (see *The Electrician*, Vol. XLV., p. 894) V. Crémieu has tried whether any converse effect is produced, *i.e.*, whether a changing magnetic field produces any motion of an electric charge suspended in it. The apparatus consists essentially of an aluminium disc mounted in a glass frame and suspended by three silver wires close together. The disc is perforated in the middle so as to allow the core of an electromagnet to traverse it without touching it. The coils of the electromagnet nearly touch the disc above and below. The disc is divided into two portions joined by plates of mica, so that when it is charged through the silver suspension there are two separate charged bodies in the magnetic field. The force experienced by each charge should be

$$\epsilon \frac{dH}{dt}$$

where $\epsilon$ is the charge and H the field. Hence the working of the magnetising circuit should produce a deflection of the suspended disc. The moment of the force should have been $600$ to $800 \times 10^{-8}$ ergs., which should have given a deflection of 10cm. to 14cm. on the scale used. But no deflection whatever was observed, thus confirming the negative result previously obtained. The author, therefore, again concludes that there is no force experienced by a moving charge in a magnetic field.

[V. CRÉMIEU, *Comptes Rendus*, October 8, 1900.]

*Magnetisation and Torsion.*—From the ample materials supplied by Grösser, K. Schreber has unravelled the following regularities in the complicated relations between magnetisation and torsion: Every iron or steel wire free from torsion acquires a permanent twist under magnetisation, which, with increasing field intensity, tends towards a maximum. The direction of the torsion is, strange to say, independent of the direction of magnetisation. In fact, it is reversed several times in the same wire as the field increases in strength. In iron the previous history of the wire does not seem to affect the amount of the twist, but in steel it does, to an extent which cannot as yet be stated in a simple manner. Moreover, the permanent twist is greater in steel than in iron. Besides the permanent twist, the wire experiences a temporary twist, which increases with the field as soon as the permanent twist has attained its maximum. Beyond that maximum, also, the temporary twist has always the same sign. An eye looking along the lines of force would always see the twist taking place in the direction of the hands of a watch. This practically diminishes the torsional elasticity in that direction. The observation recalls the phenomenon of the twisting of cathode rays in a magnetic field running along them.

[K. SCHREBER, *Physikal. Zeitschrift*, October 13, 1900.]

*Frequency of Alternate Currents.*—A. Samojloff has accidentally discovered a very simple method of determining the frequency of an alternating electric light current. In the course of some physiological experiments on the intermittent excitation of the retina, made with a disc consisting of black and white sectors, he noticed that when illuminated by a glow lamp the disc appeared to stand still when revolving at a certain rate. That rate was the rate at which the alternations of black and white at any given point of the disc were synchronous with the alternations of the luminosity. The periodical partial extinctions of the filament, though imperceptible to the eye, were evidently sufficient to make the intermediate grades between a maximum or minimum of whiteness disappear, and thus to produce the appearance of a disc at rest. Hence it is only necessary to place a revolving disc near the lamp and to alter its speed until it appears to stand still. The number of white sectors, multiplied by the revolutions per second, gives the number of reversals per second of the current. The frequency of a Wehnelt interrupter may be similarly determined by mounting it in parallel with an arc lamp and treating the latter as an alternate-current lamp. This may be done in daylight.

[A. SAMOJLOFF, *Ann. Physik*, No. 10, 1900.]

*Glow in Vacuum Tubes.*—If the influence of heat upon the electric glow in a gas is to be determined it is not advisable to heat the whole tube, as in that case the conditions of discharge are totally changed. J. Stark therefore employs a looped carbon filament, with its plane normal to the axis of the tube, carefully insulated, and rendered incandescent by an independent current. To avoid justifying Lehmann's supposition that the dark space observed round the glowing body is a dark cathode space due to an independent discharge, the author works with a high-potential continuous current rather than an induction coil. All the results point to the theory that a simple increase of temperature stops the luminosity of a gas under an electric discharge. Hittorf's idea that this is due to a stoppage of the phosphorescence is hardly tenable in view of the dark spaces observed at ordinary temperatures. The probable explanation is that the increase of temperature brings about an increase in the conductivity, and a consequent reduction of the potential gradient. This is corroborated by the fact known for some time, that in a stratified discharge the dark portions are the portions of minimum potential gradient.

[J. STARK, *Ann. Physik*, No. 10, 1900.]

## PARLIAMENTARY RECORD FOR 1900.

The prelude to the year of electrical activity in Parliament which is now closed, and especially the prelude which struck the keynote to the Private Bill legislation for schemes for wholesale electricity supply, was undoubtedly the Joint Committee of both Houses of Parliament, which sat last year to consider the legislative and national aspects of what has been called, somewhat uncouthly, the supply of "electricity-in-bulk." Hitherto the applications of electrical power to the technical industries, which have already been so widely made on the Continent and in foreign countries, have been checked in this country by many causes, perhaps the chief among them being the opposition of the municipalities to any attempt on the part of private individuals to cater for the public in the supply of electric current. This year, however, Parliament has kept such opposition within limits, and has passed several measures dealing with the supply of electrical power which are of the utmost importance from the point of view of the electrical engineer and of the public. Apart from these great supply schemes, the year has been one of exceptional activity in electrical matters in Parliament, as there has been a great increase in the number of bills for electric tramways and for electric lighting, and in addition a few bills for quite novel schemes, such as electrical carrier-bridges over rivers and the Manchester and Liverpool Express Railway on the mono-rail system.

We have already described the nature of the different supply schemes before Parliament, and during the sittings of the Committees we gave, week by week, reports of the discussions and of the evidence. Now that the session is closed it may prove of interest if we consider briefly the results that have been achieved by Parliament during the session in connection with these measures.

The important schemes for distribution of electrical energy over large areas merit first attention, and at the outset a word may be said in reference to the constitution of the House of Commons Committee, presided over by Sir James Kitson, to which the principal electric power schemes were referred. Lord Balcarres in the House of Commons moved that the committee to consider these schemes should be chosen by the Committee of Selection. After some opposition

and considerable discussion this motion was carried, so that, instead of being relegated to the tender mercies of the usual "Hybrid Committee," containing large representations of supporters and opponents of the schemes, each fighting for his own hand, these bills were sent to a strong committee of seven members. It is most gratifying that the importance of the issues at stake was recognised by the House. Although two of the schemes did not come before this committee, its decisions were adopted and applied, so far as possible, to these two schemes, so that uniformity might be obtained throughout.

In all, seven different power schemes came before Parliament last session. Five of these affected areas situated in England, while two were Irish schemes. One of these last (the Shannon Bill) passed the House of Commons successfully, but was rejected by the House of Lords. Of the five English schemes four have passed both Houses and have received royal assent. These are the County of Durham Electrical Power Supply Bill, the Lancashire Electric Co.'s Bill, the South Wales Electric Power Bill, and the North Metropolitan Electric Supply Bill. The fifth scheme, the Tyneside Electrical Power Bill, failed to get beyond the first stage of committee. Perhaps this ought not to surprise us, for it will be remembered that to a certain extent the Durham and Tyneside schemes were rivals. A glance at the maps of their areas, given in our issues of May 4 (p. 58) and May 11 (p. 80), will show that they overlapped considerably, as each included some 65 square miles along the south bank of the River Tyne. Either, then, this strip had to be cut out of one of the schemes or free competition between the companies allowed in this area. As to the first alternative, the whole argument for the Tyneside Company was based on the benefit of having its area equally along *both* banks of the river; while as to the second, the local authorities along the south bank approved of the Durham scheme and opposed the Tyneside bill, except the authorities of Felling and Hebburn, which opposed both. It was impossible, therefore, for the Committee to cut out this strip of land from the Durham scheme and give it to the Tyneside, and we do not consider that they acted unwisely in refusing, at the present stage, to allow competition between the companies. The Committee made it clear, however, that unless a local authority was willing to supply electricity at reasonable rates *for all purposes*, it was right that the public should be allowed supply from some other body willing to undertake the duty. Here, however, various authorities expressed their ability and their readiness to give such supply at rates which compared quite favourably with the proposed rates in the bill, and this no doubt influenced the Committee. One thing at least is gained by the discussion of this scheme. The principal local authorities have, by their statements in evidence, practically pledged themselves to give a good and cheap supply of electricity for motive power as well as for lighting.

Another point against the Tyneside bill was that, whereas the area of the Durham scheme included large rural districts where there will be, for a time at least, only small or average consumers, the Tyneside promoters had simply drawn a line round the "fat" industrial districts along each bank of the river, and paid little attention to small consumers. This lack of special protection for small consumers was specially referred to by the chairman of Committee, and was admitted by the promoters. Further, by the inclusion of rural areas the Durham scheme may, and probably will, lead to the growth of industries in such areas, thus relieving the pressure in towns. This was a strong argument in favour of the Durham bill.

The most pleasing feature in the discussion of the Durham scheme was the very sensible view taken by the local authorities of the area involved. Almost all supported the scheme; several have already arranged to take supply. The opposition of the districts of Felling and Hebburn need not be dwelt on here. Unfortunately, however, the House of Lords were influenced by that opposition, and only allowed wayleaves to the company in these two districts. The ridiculous consequence of this is apparent. Suppose Felling and Hebburn become convinced, as we have tried to convince them, that their own schemes for a cheap supply of electricity are quite Utopian, and that they could do much better by taking supply from the new company: they cannot now get such supply, because the company has no power to give it in these districts. Yet in the original bill the company did not seek to compel these authorities to take supply from it, but sought only powers to give supply in bulk to the local authorities should they desire it. Had this power been given by the Lords, as it was given by the Commons, then Felling and Hebburn might have gone on with their own schemes, and have suffered no more inconvenience from the company than they will now, except that under the original bill the company might have supplied in bulk to factories in the district, which cannot be supplied under the scheme at present under discussion by Felling and Hebburn.

Had the Lancashire Bill become law in the form in which it passed the House of Commons its scope would have been considerably wider, and therefore even more interesting than it now is. But the House of Lords has thought proper to exclude from the scope of the bill the areas of Liverpool, Manchester, Bootle, Salford, and Stockport. Even "docked" in this manner, however, the Lancashire scheme is a most important one for electrical progress in this country. It is the largest of all the schemes brought before Parliament this year. The opposition to the scheme consisted principally in the familiar objection by municipalities to a company having power to lay mains through their streets, which were alleged to be already over-crowded. Perhaps there was something to be said for the argument that the saving gained by placing generating stations near collieries would be absorbed by the cost of mains to outlying districts; but we do not think that it is sound, especially in a district like the Lancashire coal field, and we entirely fail to understand the statement made by the engineer to the Manchester Corporation (as reported in our issue of June 22), that "it is not practicable to carry electricity for a long distance in this country." This statement seems ridiculous unless by "practicable" is meant "economical," in which case, since the problem has not yet been tried on a large scale here, it can only be considered as an expression of opinion. No doubt this large scheme, when it comes to be actually carried out, will present many problems requiring consideration with a view to economical working; but these will rather be problems as to choice between alternative courses, and not serious obstacles to its completion.

There was a very great resemblance between all the schemes which have passed Parliament. The Durham scheme, as we have already said, was practically the Lancashire scheme in miniature; or perhaps it would be nearer the truth to say that the Lancashire scheme was really the Durham scheme taken four times over, for the promoters do not intend to supply the whole area ultimately from one generating station, but from four, the sites being at Wigan, St. Helens, Little Lever, and Eccles, near Manchester, each station to have a capacity of 15,000kw. A glance at the map of the area, on p. 81 of *The Electrician* for May 11, will show that these four stations are all situated in the South Lancashire coal field, so that the cost of fuel will be low. There was one important distinction, however, between this and the Durham scheme, in that the Lancashire promoters did not ask powers to supply individual consumers directly. Thus there is no competition either directly or indirectly with any of the local authorities.

In the case of the South Wales Power Bill, again, the promoters did not seek anything in the nature of a monopoly of supply in their area, but only "the right to trade in the ordinary course of commercial competition in the business of electrical supply" to "wholesale consumers," that is, persons undertaking to take not less than 20,000 Board of Trade units per annum. One feature of the South Wales Bill is that the promoters are all connected with the industries of the area embraced by the measure, the extent of this interest amounting to as much as £22,000,000 of capital. Thus the principal customers of the company will be the promoters themselves, so that this company has an excellent prospect. The principal Welsh collieries and seaports are included in the area (see the map on p. 57 of *The Electrician* for May 4), which extends altogether to 1,084 square miles.

Compared with the Lancashire and South Wales schemes, that of the North Metropolitan bill is small, so far at least as concerns area of supply, which is only 18 square miles in extent. But the scheme is important when we consider the nature of that area, for it adjoins the metropolis and has a great population. Yet at the present time, with the exception of the Harrow district, it is absolutely barren of electricity supply. The nature and extent of the area will best be understood by reference to our map of the district on p. 207 of *The Electrician* for June 1. Leaving aside the probability of the growth of small manufacturing trades, especially in the neighbourhood of the river Lea, when once a good supply of electric power is provided, the area at present contains many establishments where such supply would be most advantageous, and also a considerable number of light railways and tramways, on which sooner or later electric traction is bound to be used. The promoters of this measure do not propose to sell to consumers directly, but only to those who have already Parliamentary authority to supply electric current. No serious opposition was made to the scheme, and it has become law with but little change from its original form.

The clauses drafted by the Committee of the House of Commons to mark the limitations of the general powers granted to the electric power companies were given in our reports of the proceedings before the Committee. It will be seen from these clauses that the companies have authority to supply electricity for power only, except that where it is used for power, there also it may be used for lighting works premises. If any company desires to supply for lighting, other than a supply in bulk to a local authority, it must procure a provisional order in the usual manner. The second clause in this section prevents any supply by the company in the area of an "authorised distributor" without the consent of that authority, but it is fortunately enacted that the Board of Trade shall have the right to decide whether consent is unreasonably withheld. This will prevent any "pigheadedness" on the part of local authorities from depriving the population of their districts of a good and cheap electrical supply. The third clause, as we have already pointed out (*The Electrician*, July 6, p. 407), may lead to friction between local authorities and companies in arranging the terms in the provisional order upon which the municipal authority may take over a portion of the company's system.

Besides these general clauses, special arrangements had to be made in some of the bills on the question of overhead wires. Thus in the Durham area on this point urban authorities are given an absolute veto for their districts, while rural authorities have a qualified veto. Elsewhere urban authorities have only a qualified veto. A serious argument was made by the local authorities in the case of the Lancashire scheme that they ought to be given a voice in the construction of mains, material used, covering, &c., but the Committee very rightly decided that the local authority should have no power over the *nature* of the cable, but over the *route* only. The Committee also reduced the standard dividend from 10 per cent., as proposed in all the bills, to 8 per cent., but allowed an additional 1 per cent. to be paid for every 5 per cent. reduction in the price charged for current.

These, then, are the principal features of the four electric power schemes which have received the sanction of Parliament during the 1900 Session. To carry them out effectively will, of course, take some time; but the Committee has taken care that due expedition shall be made by decreeing that, if within two years of the date of the passing of the bill the promoters have not substantially commenced to carry out its powers, and if within four years they have not erected generating stations, an order may be made by the Board of Trade bringing such company's powers to an end. The areas of supply of the schemes we are considering are among the very best industrial areas of England. What exactly are the prospects of financial success in relation to the schemes it would be hard to say, and indeed useless to speculate upon. So much depends upon the encouragement received from manufacturers, and time alone will show what that is to be. As regards supply in bulk to local authorities, we feel assured that it would be a great advantage to local authorities to take such supply instead of generating for themselves. The passing of these bills by Parliament is certain to lead to others being promoted; and indeed, already similar schemes are being prepared for next session dealing with parts of Lanarkshire, Ayrshire, Renfrew and Dumbartonshire, and with the neighbourhood of Glasgow.

Before turning from these power projects to the minor bills before Parliament, we may take a glance at the rejected Irish scheme—the Shannon Water and Electric Power Bill. A map of the area and an explanation of the nature of the scheme were given in *The Electrician* for July 13. There seemed good reason to hope that had this scheme been carried out, industries would have sprung up providing occupations for the people of the districts, and bringing money to their pockets, but the House of Lords Committee considered of more importance the prospect of damage being done to the salmon fisheries, said to be worth £10,000 a year, and rejected the bill. If it be objected that the growth of industries in the district when such a scheme should be carried out is purely hypothetical, it may at once be answered that the damage to the salmon fisheries from such a scheme is equally hypothetical. And if a choice had to be made between the two, there need be no hesitation in deciding which is calculated to procure "the greatest good for the greatest number." It is especially regrettable that this scheme was rejected, because as an instance of generation of electrical energy by water power it would have been of the greatest interest. We hope a further effort will be made to have the measure carried through Parliament, and we are glad to learn that such an effort is likely to be made.

The power schemes have undoubtedly been the most important electrical measures before Parliament this year. But there are many points in the minor measures which merit our attention. The one possessing greatest novelty was the proposal for an electric express railway on the mono-rail principle from Manchester to Liverpool, the speed of the trains to reach as much as from 110 miles to 120 miles per hour. It seemed to be recognised that in the traction of the future electricity will have a foremost place, and that a much higher speed can be attained electrically than by steam. Much evidence was given on the merits and possibilities of the scheme. But in spite of this, difficulties, both legal and engineering, presented themselves to the mind of the Committee, and finally the bill was rejected. The legal points were (1) the question whether sufficient protection was given by the bill to the districts intervening between Manchester and Liverpool, none of which would benefit directly by the railway, as there were to be no stoppages between the terminal stations; and (2) the fact that the proposed line interfered with the use of land at Liverpool acquired by the Mersey Docks and Harbour Board, and intended to be used for additional docks. The first of these points does not seem to us to be serious; if the district councils receive payment for allowing a right of way, that ends their claim, and all that could reasonably be asked is that such payment should be on a higher scale than if they benefited by the scheme. The second point is more serious, as nothing can well be allowed to interfere with the construction of docks in an important seaport like Liverpool. The engineering difficulty, however, was probably the most serious of all. This was the difficulty of applying sufficient brake power to a train travelling at such a high speed as 110 miles per hour. Several statements were made as to air brakes, short-circuiting motors, &c., but these failed to convince the Committee. If there is any real difficulty here, then for the safety of the public it is well that the scheme should be rejected; but surely this is a question which could be readily solved. We have already suggested that a good way to determine the possibilities of this method of traction would be to construct a line purely for light parcel and mail traffic. The experience thus gained would decide whether passenger traffic could safely be entered upon. It is satisfactory, in the interest especially of electrical development, to learn that the Liverpool-Manchester Mono-Rail Bill is likely to come before Parliament next session in an amended form.

(*To be concluded.*)

## HUB MOTOR AUTOMOBILES.

We have had an opportunity of inspecting an extremely neat-looking motor car made by the Hub Motor Co. Its essential feature is that the motor itself is built into the hub of the wheel, so that no gearing of any sort is visible. A section of the wheel and motor for a two-passenger carriage is shown in Fig. 1. The hub is 9in. in diameter and the wheel 20in. The motor has four laminated poles dovetailed in a cast-iron yoke, which forms the hub of the wheel. Wooden spokes are driven into flanges cast into sockets on the yoke. Thus the field magnet revolves with the wheel, and the armature, which is geared to it through single reduction gearing revolves four times as fast, so that the actual reduction effected is 5 to 1. The vehicle shown to us was built for two passengers, the motors being fitted on both hind wheels, the two front wheels being used only for steering. A battery of 44 small cells is placed in a box behind the seats. The cells were arranged in four groups which could be connected in series or parallel by means of a controller, the motors always remaining in parallel. A larger type of carriage is shown in Fig. 2, in which there are four motors, one in the hub of each wheel. This carriage is built higher, the diameter of hubs and wheels being 11in. and 44in. respectively, and the ratio of the reduction being about 12 to 1. In both cases the accommodation for accumulators is small. The vehicle, which is built by an American company, is not yet on the market in this country. In addition to the syndicate which will shortly be selling these motor vehicles in this country, a second syndicate is being formed to purchase the patent rights so far as they concern omnibuses and heavy vehicles. On behalf of the latter syndicate, which is to be called the Palace Electrical Omnibus Co., Messrs. Shippey Bros. have placed an order for two omnibuses, which will be sent from the United States towards the end of January, one for 40 passengers, to run from Kilburn to the Marble Arch, and one for 30 passengers, to run from Liverpool-street to Knightsbridge. If these heavier vehicles prove successful the former of these two lines will be an important feeder to the Central London Railway.

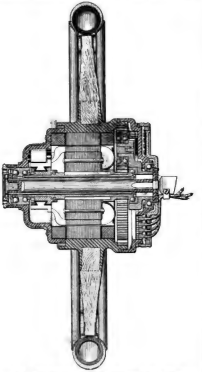


FIG. 1.—SECTION OF WHEEL, SHOWING MOTOR AND GEARING.

A "HUB MOTOR" AUTOMOBILE.

## THE THEORY OF COMMUTATION.*

BY C. C. HAWKINS, M.A., M.I.E.E.

§ 1. **The Short-Circuit Equation with Brush-Contact Resistance taken into Account.**—To reduce the problem of commutation in the continuous-current dynamo to its simplest case, let the machine which is to be investigated be one in which the thickness of the brushes is equal to the width of a commutator sector, so that there is never more than one section short-circuited at a time at each set of brushes. Then at any time during short-circuit if $i$ be the instantaneous current in the short-circuited coil, and J be the normal current in one branch of the armature winding ($= C_a \; 2p_1$ where $p_1 =$ the number of pairs of brush arms, and $C_a =$ the total armature current), the current in sector 1 is $i_1 = J + i$ and the current in sector 2 is $i_2 = -J + i$, the direction of the current before commutation being regarded as the positive direction round the short-circuit (Fig. 1), and due regard being paid to the algebraic sign of $i$. Thus, at the commencement of short-circuit, $i = J$, $i_1 = 2J$, and $i_2 = 0$; as reversal proceeds, $i$ sinks to zero and changes its sign; and finally, if the current is exactly reversed at the end of short-circuit, $i = -J$, $i_1 = 0$, and $i_2 = -2J$. If $r$ be the resistance of the short-circuited coil AB, and $r_c$ be the resistance of one commutator connector, *e.g.*, BD, then by Kirchoff's laws the equation to the short-circuit on the supposition that the brushes have no contact resistance is

$$-L\frac{di}{dt} + f(t) - ri - r_c(J + i) - r_c(-J + i) = 0;$$

$f(t)$ is the E.M.F. due to the mechanical rotation through the external field, and every ohmic loss is reckoned as negative. This equation may also be written

$$-L\frac{di}{dt} + f(t) - (r + 2r_c)i = 0$$

or

$$-L\frac{di}{dt} + f(t) - Ri = 0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

---

* From a brochure on the same subject, published by *The Electrician* Printing and Publishing Co. All rights reserved by the author.

where $R = r + 2r_c$ = the resistance of the complete short-circuit. The curve of reversing field or E.M.F., being a concave curve, is expressed by some such equation as $e = f(t) = E_0 + Ht^n$, where $E_0$ is the initial value at the start and is reckoned positive or negative according as short-circuit begins behind or ahead of the neutral line in the dynamo, or vice versa in the motor, and H is negative in the dynamo and positive in the motor. The power to which $t$ should be raised varies in most machines between the first and second powers, and is not strictly constant throughout any great length of the interpolar region. As, however, the time of short-circuit only coincides with a small angle of movement, a fairly close approximation may be made by assuming the E.M.F. to rise after a linear law; a mean inclined straight line may then be drawn through the portion of the curve lying between the beginning and end of short-circuit, and the equation becomes in its general form, $f(t) = E_0 + Ht$.

So far, however, the effect of the brush contact resistance has been left out of account, and the importance of this is so great that it will be found to be in fact *the* decisive factor in the problem of commutation. As the brush leaves the leading sector D and passes on to sector C, the area in contact with the former continuously diminishes, while that of the latter continuously increases, the one varying inversely to and the other directly as the time. If $R_1$ = the contact resistance of one set of brushes when resting exactly on a single sector, and T = the total

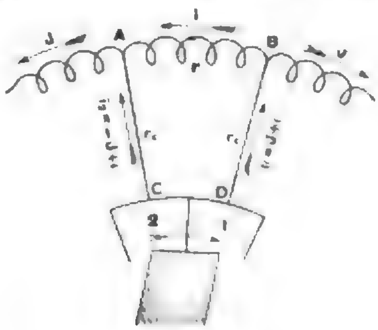


FIG. 1.

time during which short-circuit lasts, the resistance of the brush-toe is at any moment $R_1T/T-t$, while that of the brush-heel is $R_1T/t$.

The full equation to the short-circuit is therefore

$$-L\frac{di}{dt} + f(t) - ri - r_c(J+i) - \frac{R_1T}{T-t}(J+i)$$

$$-\frac{R_1T}{t}(-J+i) - r_c(-J+i) = 0 \quad . \quad (2)$$

or $$-L\frac{di}{dt} + f(t) - Ri - \frac{R_1T}{T-t}(J+i) + \frac{R_1T}{t}(J-i) = 0 \quad . \quad . \quad . \quad (3)$$

The solution of the above equation has been completely effected by Prof. Arnold and Dr. G. Mie in a series of articles published in the *Elektrotechnische Zeitschrift* for February 2, 16, and 23, 1899; and the object of the present Note is to draw greater attention to the interesting results which follow therefrom. Since these articles have not, so far as the writer is aware, been translated into English, the mathematical solution of the problem is repeated, with the kind permission of the authors, together with certain further explanations for which the writer is indebted to the courtesy of Dr. Mie.

At the time $t = T$, $i$ becomes $-J$; hence, at the time $T-\delta$, when $\delta$ is very small, *i.e.*, just at the end of the period of commutation, equation (3) gives as a first approximation

$$-L.(di/dt)_{t=T-\delta} + e_T + J.R - \frac{R_1.T}{T-t}.(J+i) + 2JR_1.\frac{T}{T} = 0 \quad . \quad (4)$$

or $$L.(di/dt)_{t=T-\delta} + R_1T.(J+i/T-t) = J.(R+2R_1) + e_T \quad (5)$$

Now, as $t$ approaches T, $J+i/T-t$ becomes more and more nearly equal to $-(di/dt)_{t=T}$. If the commutation is not exactly performed, and the current is either under- or over-commuted, $(di/dt)_{t=T}$ becomes infinite, or the function $i$ makes a jump vertically up or down to the value $-J$,—a condition which could not physically exist and which must inevitably imply sparking. But even when commutation is exactly performed, $(di/dt)_{t=T}$ can still be infinite if the slope of the curve of $i$ at the final moment is so steep that it becomes vertical. Sparking is absent only when $di/dt$ is throughout finite, and the problem of sparkless commutation therefore consists primarily in finding the conditions which render $(di/dt)_{t=T}$ finite.

There are thus two possible cases. Either, (I.) $(di/dt)_{t=T}$ is finite, in which case the limiting value of $J+i/T-t = -(di/dt)_{t=T}$, and equation (5) gives

$$L.(di/dt)_{t=T} - R_1T.(di/dt)_{t=T} = J.(R+2R_1) + e_T$$

or $$(di/dt)_{t=T} = -\frac{J.(R+2R_1)+e_T}{R_1T-L}; \quad . \quad . \quad . \quad . \quad . \quad (6)$$

if $b_1$ = the length of the brush surface parallel to the axis of rotation, and $\beta$ = the width of a commutator sector in the direction of rotation, the current-density in the leading brush-tip at the last moment, or the final $s_1$ is then

$$-\frac{T}{b_1.\beta}.(di/dt)_{t=T} = \frac{T}{b_1.\beta}.\left(\frac{J.(R+2R_1)+e_T}{R_1T-L}\right).$$

Or (II.) $(di/dt)_{t=T}$ is infinitely great.

To distinguish the condition which decides which of these two cases holds, let $\frac{J.(R+2R_1)+e_T}{L} = C$, and $R_1T/L = \tau$. Let $T-t = t_x$; then since $i_1 = J+i$, equation (5) becomes

$$\frac{di}{dt} + \tau.\frac{i_1}{t_x} = C,$$

$$\frac{d(i_1-J)}{d(T-t_x)} + \tau.\frac{i_1}{t_x} = C,$$

$$-\frac{di_1}{dt_x} + \tau.\frac{i_1}{t_x} = C,$$

$$\frac{di_1}{dt_x} - \tau.\frac{i_1}{t_x} = -C \quad . \quad . \quad . \quad . \quad . \quad (7)$$

of which the integral, when $\tau \gtrless 1$, is

$$i_1 = C\frac{t_x}{\tau-1} + A.t_x^{\tau}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

where A is a constant of finite value; or when $\tau = 1$, is

$$i_1 = -C.t_x.\log_e t_x + A.t_x \quad . \quad . \quad . \quad . \quad (9)$$

Thus, if $\tau \gtrless 1$, from equation (8)

$$J+i = C.\frac{T-t}{\tau-1} + A.(T-t)^{\tau} \quad . \quad . \quad . \quad . \quad (10)$$

and $$-\left(\frac{di}{dt}\right)_{t=T} = \frac{J+i}{T-t} = \frac{C}{\tau-1} + A.(T-t)^{\tau-1}. \quad . \quad (11)$$

Now, if $\tau > 1$, the right hand side of equation (11) must have a finite value, whatever the value of A. But, if $\tau < 1$, the right-hand side becomes $-\frac{C}{1-\tau} + A.\frac{1}{(T-t)^{1-\tau}}$; then since $(T-t)$ is infinitely small, the second term is infinitely great, unless A is itself $= 0$, when $0 \times \infty$ is indeterminate.

If $\tau = 1$, from equation (9)

$$J+i = -C.(T-t).\log_e(T-t) + A.(T-t). \quad . \quad (12)$$

and $$-\left(\frac{di}{dt}\right)_{t=T} = \frac{J+i}{T-t} = -C.\log_e(T-t) + A. \quad . \quad (13)$$

The rate of change of current at the last moment must then always be infinite, since $\log_e(T-t)$ is infinity—unless C be itself $= 0$. There must be one point in the magnet field which will give $C = 0$, viz., when $e_T = -J(R+2R_1)$, but the consequence of the brushes not being set exactly at this one point will be an infinite rate of change of the current at the last moment. Further, it will be shown later in this particular case when $C = 0$ and $\tau = 1$ that A is also $= 0$.

Thus, except in the special case of $A = 0$, when $\left(\frac{di}{dt}\right)_{t=T}$ is finite for every value of $\tau$, the final rate of change of the current is $\infty$ when $\tau < 1$, or $R_1 < \frac{L}{T}$, and is finite when $\tau > 1$, or $R_1 > \frac{L}{T}$.

The next step must therefore be to determine the value of A in the practical case of the dynamo or motor, and the solution of this question will at the same time establish the method of calculating the instantaneous value of the short-circuit current.

Let $\frac{t}{T} = x$ be taken as the variable, and equation (8) be multiplied by $\frac{T}{L}$, with the introduction of $\tau'$ as the symbol for $\frac{R \,.\, T}{L}$; thus

$$-T \,.\, \frac{di}{dt} + f(t) \,.\, \frac{T}{L} - \frac{R \,.\, T}{L} \,.\, i - \frac{R_1 \,.\, T^2}{(T-t) \,.\, L} \,.\, (J+i)$$
$$+ \frac{R_1 T^2}{t \,.\, L} \,.\, (J-i) = 0, \qquad (14)$$

or since $f(t) = E_0 - H \,.\, t$,

$$-\frac{di}{dx} + E_0 \,.\, \frac{T}{L} + H \,.\, \frac{T^2}{L} \,.\, x - i \,.\, \tau' - i \,.\, \tau\left(\frac{1}{x} + \frac{1}{1-x}\right)$$
$$- J \,.\, \tau\left(\frac{1}{1-x} - \frac{1}{x}\right) = 0 \quad (15)$$

The integral of this equation can be developed in a series of powers of $x$, as

$$i = J \,.\, f_1(x) + E_0 \,.\, \frac{T}{L} \,.\, f_2(x) - H \,.\, \frac{T^2}{L} \,.\, f_3(x). \quad . \quad . \quad (16)$$

where
$$\left.\begin{aligned} f_1(x) &= a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \ldots . \\ f_2(x) &= \qquad b_1 x + b_2 x^2 + b_3 x^3 + \ldots . \\ f_3(x) &= \qquad\qquad c_2 x^2 + c_3 x^3 + \ldots . \end{aligned}\right\} \quad . \quad . \quad . \quad (17)$$

In order to determine the value of the "$a$" coefficients, let it first be assumed that there is no external E.M.F. at work, or $f(t) = 0$, and let the "$a$" power series be inserted in equation (15).

Thus, $i = Jf_1(x)$ and equation 15 becomes

$$\frac{J \,.\, df_1}{dx} + J \,.\, f_1\tau' + \frac{J \,.\, \tau(f_1 - 1)}{x} + \frac{J \,.\, \tau \,.\, (f_1 + 1)}{1-x} = 0 \quad . \quad (18)$$

where the power series $a_0 + a_1 x + a_2 x^2 + \ldots$ has to be inserted for $f_1$. A difficulty then arises in so far as for $x = 0$, the term with $1/x$ becomes infinite; but as it is known that the initial value of $i$ is J or $a_0 = 1$, this difficulty disappears. Thus, for $x = 0$

$$J\frac{df_1}{dx} + J\tau' + \frac{\tau(i - J)}{x} + 2J\tau = 0.$$

But,
$$\lim_{x=0} \frac{i - J}{x} = \left(\frac{di}{dx}\right)_{x=0},$$

similarly to the expression in equation (5); therefore, dividing by J,

$$a_1 + \tau' + a_1\tau + 2\tau = 0,$$

or

$$a_1 = -\frac{2\tau + \tau'}{1 + \tau}.$$

The remainder of the coefficients, $a_2$, $a_3$, $a_4$, may then be found as follows:—

Taking equation (18) with J divided out,

$$\frac{df_1}{dx} + f_1\tau' + \frac{\tau \,.\, (f_1 - 1)}{x} + \frac{\tau \,.\, (f_1 + 1)}{1-x} = 0 \quad . \quad . \quad (18a)$$

and inserting the power series

$$\left.\begin{aligned} \frac{df_1}{dx} &= a_1 + 2a_2 x + 3a_3 x^2 + 4a_4 x^3 + \ldots . \\ f_1\tau' &= \tau' + a_1\tau' x + a_2\tau' x^2 + a_3\tau' x^3 + \ldots . \\ \frac{\tau(f_1 - 1)}{x} &= a_1\tau + a_2\tau x + a_3\tau x^2 + a_4\tau \,.\, x^3 + \ldots . \\ \frac{\tau(f_1 + 1)}{1-x} &= 2\tau + (2 + a_1)\tau x + (2 + a_1 + a_2)\tau x^2 \\ &\qquad + (2 + a_1 + a_2 + a_3)\tau x^3 + \quad . \quad . \quad ^* \end{aligned}\right\} (19)$$

Now, since when $x = 0$, the sum of the first terms of the above four expressions, viz., $a_1 + \tau' + a_1\tau + 2\tau = 0$, it follows that the terms containing any one power of $x$ must also separately vanish; since the first vertical rows on the right-hand side of equation (19) = 0,

$$x\{(2a_2 + a_1\tau' + a_2\tau + (2 + a_1)\tau)$$
$$+ x(3a_3 + a_2\tau' + a_3\tau + (2 + a_1 + a_2)\tau) + x^2(\ldots) + \ldots\} = 0$$

whence, dividing by $x$

$$2a_2 + a_1\tau' + a_2\tau + (2 + a_1)\tau + x(\ldots .) + x^2(\ldots .) + \ldots .\} = 0$$

and this must be true for every value of $x$. Therefore if $x = 0$,

$$2a_2 + a_1\tau' + a_2\tau + (2 + a_1)\tau = 0$$

or
$$a_2(2 + \tau) = -\{a_1(\tau' + \tau) + 2\tau\}.$$

Similarly for any other power of $x$ the sum of the coefficients must = 0, and we obtain in general

$$a_1(1 + \tau) = -(\tau' + 2\tau)$$
$$a_2(2 + \tau) = -\{a_1(\tau' + \tau) + 2\tau\}$$
$$a_3(3 + \tau) = -\{a_2(\tau' + \tau) + a_1\tau + 2\tau\}$$

and so on.

*(To be concluded.)*

* $\frac{1}{1-x}$ being $= 1 + x + x^2 + x^3 + \quad . \quad . \quad .$

## THE PRESENT STATE OF WIRELESS TELEGRAPHY.*

BY PROF. A. BLONDEL AND CAPT. G. FERRIE.

In this Paper the name "Wireless Telegraphy" is taken to refer only to the transmission of signals by means of Hertzian waves without the intermediary of conducting wires connecting the communicating stations. The history of wireless telegraphy may be briefly summarised as follows: In 1888 Hertz performed his famous experiments, but the absence of a sensitive detector did not permit him to think of distance signalling. In 1890, however, M. Branly discovered the principle of his "radio-conductor." This was re-named "coherer" in 1893 by Prof. Lodge, who in working with the instrument destroyed its temporary conductivity by a clockwork hammer. M. Popoff, among others, confirmed the experiments of Prof. Lodge, and, in particular, made decoherence automatic by putting the coherer in series with cells and a relay which operated a circuit controlling the hammer. Later, Mr. Marconi applied M. Popoff's vertical wire "feeler," improved the apparatus for producing the waves—making the receiving and sending ends symmetrical—and modified for the better the construction of the coherer. Mr. Marconi also enclosed his apparatus in a metal screening-box, and employed numerous non-inductive resistances as shunts on the relay coils &c., and thus protected his coherer from radiation produced either externally or internally to the screening-box.

The results obtained by various experimenters show the following facts: The distance which can be signalled across depends on the height of the vertical wires used, and is greater on sea than on land. On sea, in 1897, Marconi's instruments in the Italian navy covered 9 miles with vertical wires 70ft. to 100ft. long. In 1899, again, between Dover and Boulogne, a vertical wire 110ft. high sufficed for 26 miles. In the same year two vessels of the English navy communicated at a distance of 64 miles with wires 160ft. and 180ft. long. In 1900, Mr. Marconi spanned 77 miles with only 140ft. of vertical wire. In France, M. Tissot, using apparatus due to MM. Ducretet and Popoff, signalled over sea to a distance of 35 miles with vertical wires of 90ft. In Russia, M. Popoff accomplished the same distance with wires of 180ft. Captive balloons and kites have been employed on land for suspending vertical wires. Thus Dr. Slaby, in 1897, with wires of 910ft. long signalled 12 miles; M. Voisenat, in 1898, accomplished nearly 6 miles with 120ft.; and Mr. Marconi, in 1899, signalled successfully between Salisbury and Bath, 31 miles, using high kites. Lastly, M. Lecarme, in 1899, established communication between Mont Blanc and Chamounix, and found that a free balloon with a wire of 150ft. could communicate with the sending wire (120ft. long) when at a distance of 5 miles, and at a height of about 2,400ft.

The law connecting height of vertical wire and distance of good signalling has been given by Mr. Marconi, and confirmed by Mr. Gavey, as $H \propto \sqrt{D}$. Moreover, the heights of the sending and receiving wires should be the same and the wires should be parallel. The authors' own experiments confirm these statements fairly well, but point out that the heights may be simultaneously varied within certain limits so long as their sum is kept constant.

*Theory of Wireless Telegraphy.*—The authors discuss, briefly, the various theories which have been proposed to explain exactly the action of the emitting on the receiving vertical wire. Then, after referring to a former Paper by one of them (Blondel), which showed that the vertical wire oscillator is equivalent to a semi-oscillator of

* Abstract of a Paper read at the International Electricity Congress, Paris.

the Hertz type, they proceed to offer the theory which seems to them to be best. The electrical oscillations spread up the wire and agitate the ether round the wire. From there the waves spread through the surrounding ether; the lines of electrostatic force being in planes through the wire and abutting normally on the earth, the lines of magnetic force being circles having the wire as axis. These lines of magnetic force are especially abundant near the surface of the earth in consequence of the well-known concentration effect in the propagation of waves along conducting surfaces. But the concentration does not prevent the loss into space, in the form of hemispherical waves, of a large portion of the original energy.

The receiving wire being cut at divers heights by the spreading circles of magnetic force becomes the seat of oscillatory electromotive forces which act on the coherer. The longer the wire the more circles of magnetic force cut it, and the stronger the effect on the coherer. Guided by this theory the authors have tried experiments when the capacity of the oscillator was much increased and the self-inductance much diminished. The apparatus was then, virtually, a plate condenser with a very short vertical wire, and with this arrangement medium results were obtained.

In discussing the apparatus used in the production of the waves the authors remark that little progress has been made, owing to the exclusive attention paid by experimenters to the receiving apparatus. It is known, however, that the induction coils employed should be as powerful as possible, the sizes most used being those giving 10in. to 16in. sparks between points. Of course between balls, with the balls attached to wire and earth, the spark becomes reduced to 1in. or 2in. The kind of interrupter used in the primary of the induction coil seems to matter little in practice. The authors have tried an alternating-current transformer supplying a pressure of 30,000 volts and above, and one of them has had built recently a new unipolar type of transformer giving a pressure of 100,000 volts. But the use of high-voltage transformers is limited by the facts that they are dangerous and absorb a great deal of power. In all cases it is found that the material of the vertical wire is almost without influence on the signals, that complete insulation—say, by ebonite suspension—is very necessary, and that covered wire may, perhaps, be useful, in that convective leakage is prevented by the insulation; but far the most important factor is the height of the vertical wire.

In the receiving apparatus considerable improvement has taken place, especially with regard to the coherer. To explain the action of the coherer, M. Branly supposes that some modification or orientation of the molecules take place through the action of electric force. Dr. Lodge attributes the diminution of resistance to welding between particles in contact. Whatever the intimate cause of the phenomenon of "coherence" it has been shown by one of the authors (May, 1900) that a coherer, in circuit with cells and a galvanometer, coheres when the potential difference at its ends exceeds a certain amount which has been named the "critical voltage." This voltage must not be exceeded by that of the cells *plus* that due to the self-induction of the relay circuit in the wireless telegraph receiver; and since the "critical voltage" is higher with the more oxidisable metals it is advantageous to employ filings of the less oxidisable metals. To keep the filings in the same state of oxidisation it is advisable to exhaust the space between the electrodes. To alter the pressure with which a filing presses its neighbours, M. Tissot uses magnetic filings, and moves to and from the coherer a magnet whose lines of force are parallel to the tube.

It was natural, as in telephony, to attempt to transform the received impulses up to voltages more suitable for detection. Mr. Marconi uses such a transformer and calls it a "jigger." Its secondary is wound in layers containing successively fewer turns, and is included in the relay-coherer circuit. The authors' experience of the "jigger" is that the small central condenser added by Marconi as an attempt to realise syntony has no perceptible action in this direction. According to Mr. Marconi, the "jigger" increases the distance of signalling by 30 per cent. to 60 per cent.

Among those things to which investigators should pay attention, the authors mention spontaneous decoherers. M. Tommasina has endeavoured to replace the hammer decoherer by a magnetic decoherer, but, unfortunately, the filings of the coherer ultimately become so magnetised that the "critical voltage" is greatly lowered. The same experimenter has stated that good auto-decoherers can be made with certain kinds of microphone carbon powder. MM. Ducretet and Popoff have used steel powder successfully for a similar purpose.

Other detectors have been tried by Righi, Tuman, and others. One of the present authors has used a Geissler tube containing two large electrodes almost in contact, but found it less sensitive than the filings coherer. M. Neuzschwender makes a detector by taking a strip of mirror and dividing the silvering by a slit. If the arrangement be breathed upon so that some moisture is deposited on the slit a current of some magnitude can pass. The incidence of electromagnetic radiation, however, diminishes very greatly the current passing. With this "anti-coherer" M. Bela Schafer has covered 34 miles, using wires 90ft. in length.

Telephones as detectors have not been very successful. They would undoubtedly be useful if put in series with a cell and a rapid auto-decohering coherer. With the extreme sensibility of the telephone, coherers of very low "critical voltage" could be used.

One of the gravest practical disadvantages of wireless telegraphy arises from the fact that messages despatched from any station may be read by stations for which the messages are not intended. To overcome this difficulty Dr. Lodge and Dr. Muirhead have developed a syntonic system in which the receiving coils and capacity are tuned to the period of the emitting apparatus. Mr. Marconi has used earth connected wires placed near the vertical wires and parallel to them, in order to attain tuning. And M. Blondel proposed, in 1898, a synchronisation system in which a telephone with a certain frequency of vibration selects the radiation emitted from a vertical wire charged at the same frequency by means of an interrupter. Lastly, M. Guarini Foresio has, while putting forward some erroneous theories, proposed a system of automatic relays of which the results are not yet known.

## CORRESPONDENCE.

### ADELAIDE MUNICIPAL TRAMWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The attention of our client, Mr. Bingham, has been called to your issue of the 12th inst., which contains a paragraph relating to the Adelaide tramways to the effect that the main difficulty up to the present in the completion of the municipal scheme of tramways for the city "is a pledge which the City Corporation was drawn into some months ago to support a fourth proposal made by an outside company promoter. This gentlemen" (obviously referring to Mr. Bingham, as it is common knowledge that he is negotiating the project) "has now failed to fulfil his financial guarantees, and, the Corporation being thus freed, no great difficulty is anticipated in carrying out the municipal proposals with the financial support of the constructing companies."

The statement in regard to the non-fulfilment of the financial guarantees being absolutely untrue, we are instructed by Mr. Bingham (who reserves all his rights in regard to the libellous reflection cast upon him), to call upon you to inform us the source from which you obtained the information thus published in your paper.—Yours faithfully, PAINES & CO.

14, St. Helen's-place, London, E.C., Oct. 20, 1900.

(*Reply.*)

1, 2 and 3, Salisbury-court, Fleet-street, London.
Oct. 24, 1900.

SIRS: I have to acknowledge the receipt of yours of the 20th, and in reply beg to disclaim any intention of making any reference to Mr. Bingham, whose name we hear for the first time from yourselves in connection with this matter, and we propose to publish your letter with the same prominence as was given to our note upon "Electric Traction in Australia," which was supplied to us in the usual course by our correspondent in that country, as relating to questions of public interest.—Yours faithfully,

p.p. "The Electrician" Printing & Publishing Co. (Ltd.),
GEO. TUCKER.

Messrs. Paines, Blyth and Huxtable,
14, St. Helen's-place, E.C.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 17 to Oct. 23, with the ports of destination:

*Africa*—Alexandria, £41; Cape Town, £10; Durban, £502; East London, £60; Port Elizabeth, £116. *Australasia*—Fremantle, £36; Hobart, £210; Lyttleton, £68; Melbourne, £122; Perth, £284; Port Chalmers, £109; Sydney, £7,741; Wellington, £103. *Belgium*—Ostend, £256. *Brazil*—Rio de Janeiro, £55. *Ceylon*—Colombo, £9. *Chili*—Santiago, £25; Valparaiso, £31. *Denmark*—Copenhagen, £136 (telegraph wire). *Germany*—Hamburg, £250 (telegraph material). *Gibraltar*, £34. *Greece*—Piræus, £100 (telegraph apparatus). *Holland*—Amsterdam, £85; Rotterdam, £27. *Hong Kong*, £43. *India*—Bombay, £246; Calcutta, £1,658 (including £825 telegraph wire); Karachi £12. *Japan*—Tokio, £505; Yokohama, £4,406 (including £3,793 telegraph cable). *Russia*—St. Petersburg, £192. *Sweden*—Gothenburg, £496 (including £396 telegraph wire). *Uruguay*—Monte Video, £30. Total £18,553, against £16,961 in the corresponding week last year (Oct. 18 to Oct. 24).

# LEGAL INTELLIGENCE.

### Toppin v. Sanderson.

In the Lord Mayor's Court (London) last week Mr. Edwin Toppin sued Mr. A. J. Sanderson, managing director of the Electrical Inkless Printing Syndicate (Ltd.) to recover £500 cash and £4,500 in fully-paid £1 shares in the syndicate under a commission note dated May 16, 1898. The commission note set out that in consideration of plaintiff introducing defendant to the inventor of a patented printing invention, and in the event of defendant purchasing the invention defendant was to pay plaintiff a commission of 10 per cent. upon the difference between the price given and that received from a joint stock company to be formed. Defendant, through a nominee, had purchased from a Mr. Greene a patented printing device, and this had been sold to the syndicate. The point the Court was asked to decide was whether the parties had been brought together and purchase effected through plaintiff's instrumentality.

After a lengthy hearing the jury were unable to agree, and were discharged without giving a verdict.

### London Electrical Cab Co. (Ltd.).

In the Companies Winding-up Court, on Wednesday, Mr. Justice Wright had before him a petition for a compulsory order against the London Electrical Cab Co. (Ltd.). The petition was opposed.

Mr. COUNSELL said he appeared for the petitioners, Messrs. C. R. Foster and others. The company was incorporated in 1896, with a nominal capital of £150,000 in £1 shares, the vendors being the British Motor Co. and the Electrical Power Syndicate, who were to grant the company licences under which it was to manufacture and work its cabs in the metropolis. Only 63,000 odd £1 shares were allotted. No dividends had ever been paid by the company. In 1898 a prospectus (the second) was issued asking subscriptions for the remaining shares, and in response 12,900 shares were allotted. The allegations of the petition were that the directors had no right to go to allotment, and that they had no right to pay away a sum of £21,000 to the vendors, and the petitioners asked for a compulsory order. The company was not in voluntary liquidation.

Mr. STEWART SMITH, for the company, opposed the petition. The only effect of a compulsory order would be to put an end to the only two assets the company possessed, viz., two licences. The whole of the company's assets had been already divided in a debenture holders' action.

His LORDSHIP said it was clear the company could not go on. Its undertaking seemed to have been sold.

Mr. STEWART SMITH admitted that that was so, so far as it was possible. The amount realised was £3,362 gross, about £1,000 of which was divisible amongst the debenture holders, some of whom were the petitioners. The licences granted were not transferable, and one expired on the liquidation of the present company. It was important to remember that even although the company could not work the licences itself it could prevent others from doing so. A compulsory order would no doubt serve the purposes of the licensors, but would not benefit the company.

His LORDSHIP said there appeared to be 16,000 shareholders opposing the petition and none supporting it. Was anyone paying the royalties under the licences?

Mr. BRAMWELL DAVIES, Q.C., who also opposed the petition, said that some were paid while the cabs were being used. He thought it was £4 per annum per cab. The plant had now been sold, and royalties were only payable on the user. Under these circumstances he contended there was no ground for a compulsory order.

His LORDSHIP reserved his decision.

### Coventry Gas Fitting, Electrical, and Engineering Co. (Ltd.)

In the Companies Winding up Court, on Wednesday, Mr. Justice Wright heard a petition for the compulsory winding-up of this company. Counsel stated that since the petition had been presented the company had called a meeting of its creditors and had laid before them a scheme of reconstruction. The directors desired that the petition should stand over for six weeks.

His LORDSHIP allowed the case to stand over for six weeks with liberty to apply to restore the petition to the list any time after the first fortnight

### National Telephone v. Exchange Telegraph Co.

In the Queen's Bench Division, on Wednesday, Mr. Justice Lawrance and Mr. Justice Kennedy directed that this action should not be heard before Dec. 1, both parties consenting.

### Workmen's Compensation Act.

**Bishop v. Moran.**—In the Court of Appeal recently an action was heard seeking to set aside a judgment of Judge Parry in the Manchester County Court. The plaintiff in the County Court action (a labourer named Moran) was in the employ of a chairmaker at 19s. a week. In July, 1898, he cut off the tips of his fingers. He was paid full wages while away from work. He returned to his work with his then employer (Bishop) in August, 1898, and in the following December commenced proceedings under the Workmen's Compensation Act for compensation, and was awarded 3s. a week. Bishop paid this sum weekly, but reduced Moran's wages by 3s. to 16s. a week. In February, 1899, Moran left Bishop's employment, but Bishop continued paying the 3s. weekly compensation till March, 1900, when he learned that Moran was in the employ of the Manchester Corporation at 22s. a week. Upon this Bishop appealed to Judge Parry to cancel the payment of the 3s. a week, but Judge Parry declined to accede to this request. The case was then taken to the Court of Appeal, who, after taking evidence, adjourned the case in order to obtain the learned County Court judge's reasons. After these had been given and considered by the Court, the Lords Justices said the appeal must be dismissed, with costs.

### FORTHCOMING LEGAL CAUSES.

The following list of cases of electrical interest have been entered for hearing at the Royal Courts of Justice, London, during the Michaelmas sittings:—

COURT OF APPEAL.—CHANCERY DIVISION.—*General Appeals.*

*Rucker v. London Electric Supply Corporation (Ltd.).* (Appeal of plaintiff from order of Mr. Justice Farwell, dated February 12, 1900.)

*City of London Electric Lighting Co. (Ltd.) v. Corporation of London.* (Appeal of defendants from order of Mr. Justice Farwell, dated May 3, 1900.)

*Cuba Submarine Telegraph Co. (Ltd.) v. West India and Panama Telegraph Co. (Ltd.).* (Appeal of defendants from order of Mr. Justice Farwell, dated May 29, 1900.)

*Isle of Thanet Electric Tramway and Lighting Co. (Ltd.) v. Abbot.* (Appeal of plaintiffs from order of Mr. Justice Byrne, dated June 21, 1900.)

*Chamberlain and Hookham (Ltd.) v. Corporation of Bradford.* (Appeal of plaintiffs from order of Mr. Justice Farwell, dated May 25, 1900.)

*Hawkes v. Leyton Urban District Council.* (Appeal of defendants from order of Mr. Justice Buckley, dated Feb. 28, 1900.) This action is for an injunction for nuisance.

*Attorney-General v. London County Council.* (Appeal of defendants from order of Mr. Justice Cozens-Hardy, dated April 6, 1900.) This action raises the right of the London County Council to run omnibuses.

QUEEN'S BENCH APPEALS.—*Final List.*

*National Telephone Co. Ltd.) v. Corporation of Huddersfield.* (Appeal of plaintiffs from judgment of Justices Grantham and Channell, dated June 20, 1900.)

*National Telephone Co. (Ltd.) v. Corporation of Tunbridge Wells.* (Appeal of plaintiffs from judgment of Justices Grantham and Channell, dated June 18, 1900.)

CHANCERY DIVISION.

Before Mr. Justice Stirling.

*Crompton & Co. (Ltd. v. Albright.* (Action.)

Before Mr. Justice Wright.—*Actions for Trial.*

*Electric Construction Co. (Ltd.) v. Vanderpump and others.* (With witnesses and motion for judgment.)

*Re Madras Electric Tramways Co. (Ltd.), Electric Construction Co. (Ltd.) v. Cooper and others.* (With witnesses and motion for judgment.)

Companies Winding-up.—Petitions.

*River Plate Electric Light and Traction Co. (Ltd.)*

*London Electrical Cab Co. (Ltd.)* [This case is reported above.]

*Recording Telegraphs (Ltd.)*

*Coventry Gas Fittings, Electrical and Engineering Co. (Ltd.)* [This case is reported above.]

Before Mr. Justice Cozens-Hardy.

*Evered v. Electrical Undertakings (Ltd.)* (Action.)

Before Mr. Justice Farwell.

*Corporation of Wolverhampton v. British Electric Traction Co. (Ltd.).*

QUEEN'S BENCH DIVISION.—(*Special Juries*).

*Attorney General v. National Telephone Co. (Ltd.)* (Declaration.)

*Gwynne and another v. Medical Electro-Thermic Generator Co. (Ltd.) and another.* (Personal injury.)

Non-Juries.

*National Telephone Co. (Ltd.) v. Hack and others.* (Injunction.)

*National Telephone Co. (Ltd.) v. Exchange Telegraph Co. (Ltd.)* (Injunction.) [See report of this case above.]

# MUNICIPAL, FOREIGN & GENERAL NOTES.

**Aberdeen.**—For some time past the Tramways committee have been in doubt as to the most suitable system of electric traction for Union-street. It is now proposed to ask two firms who own surface-contact or third-rail systems to each put down a section in Aberdeen so as to give the committee an opportunity of judging the features of the various systems. The committee have also requested the Westinghouse Company to submit an offer for their conduit system.

**Association of Municipal Corporations.**—A general meeting of this association was held on Tuesday to receive a report on the Telegraph Act, 1899 (Municipal Telephones), which was adopted at a recent conference of corporations. In February the matter was referred to a sub-committee with power to procure expert assistance as to the practicability of establishing municipal telephone exchanges. The committee consisted of representatives from Manchester, Salford, Bolton, Hull, Plymouth, Sunderland, Huddersfield, Wigan, Southport, and Eastbourne. Several meetings were held, and in May the committee reported that in their opinion "the establishment of municipal telephony was both practicable and desirable." The chairman of the committee (Ald. Southern, Manchester) and other

gentlemen were deputed to wait upon Mr. Hanbury, Secretary to the Treasury, to obtain information upon the following points :—

1. Whether the Government would allow a postponement of interest and sinking fund charges for a period of, say, three years.

2. Whether the Government would consent to extend the period of repayment of capital beyond the termination of the licence.

3. Whether the Government could give any guarantee that the municipal telephone plant would be acquired by the Government at the termination of the period of licence. 4. Whether the Government would grant the withdrawal or modification of the royalty of 10 per cent. on gross receipts.

Mr. Hanbury's replies were as under :—

1. Shall receive fair consideration.

2 and 3. If the Government acquired the plant at the termination of the licence they would acquire it at a price, and the money paid would furnish the means for paying off borrowed capital. The Treasury minute either did already, or should be made to, provide for this.

4. No prospect of such relief could be held out at present.

In July, when the sub-committee's report was received, the Conference resolved

That this Conference recommends municipalities contemplating the establishment of a system of municipal telephones to apply for licences to expire in 1911, unless there are special or local circumstances rendering a longer licence desirable.

Sir Albert K. Rollit, M.P., presided at Tuesday's meeting, when the Mayor of Huddersfield moved the adoption of the report on municipal telephones. He said the Huddersfield Council had over and over again asserted the principle of municipal control over the streets. They had no quarrel with the National Telephone Co. except on the ground of their charges, which were, they urged, excessive. The Town Clerk of Salford seconded, and the Town Clerk of Cheltenham said he understood the Government undertook, at the expiration of the licence, to purchase the plant at such a price as would repay the capital borrowed. He thought the Government should also repay to the local authority any sums that might have been spent in respect of capital, sinking fund, and interest over and above the income that had been received. It was not sufficient that they should repay the bare capital, because in establishing the telephone service and bringing it into good working order for the Government to acquire municipalities might have spent money which had not been recouped to them. Mr. Robinson, of Tunbridge Wells, said that borough had obtained a licence, and the contracts for the installation work had been let. They had already secured about 330 subscribers, and the reduced tariff which the National Company had been forced to adopt by the threatened competition of the Council had secured for the company an increase in the number of its subscribers from 100 to 300. This result was altogether a public benefit, and there would be no charge upon the rates. In reply to the Town Clerk of Salford, the Town Clerk of Tunbridge Wells said their licence extended beyond the year 1911. They did not see their way to repay interest and sinking fund in 11 years, and had, therefore, taken out a licence for 21 years. The National Company had not yet decided whether inter-communication should be established, but if they agreed to this their licence would be extended on the same terms as the Corporation licence. The indications at present were that the company preferred to compete with the municipal service. The resolution was then agreed to unanimously.

**Birkenhead.**—The sub-committee recently appointed to consider the advisability of reducing the charge for electric current to 4d. per unit has presented a report in which they estimate the total demand for electricity in the borough for the year ending March next at 315,223 units, comprising ordinary consumers for lighting 222,330 units, power consumers 5,111, ferry lighting 70,638, street lighting 7,414, and Bidston and Noctorum 10,000. This consumption would have to be increased by 33 per cent. before the income at 4d. per unit covered the expenditure. At present the charge commences at 6d., with subsequent reductions, making the charge vary from 3½d. to 6d. per unit. The sub-committee express the opinion that the charge cannot be reduced to 4d. without loss. However, they recommend a reduction to ordinary consumers after Dec. 31 to 6d. per unit for the first hour, 3d. for the second, and 1½d. after. For power and heating, a reduction is recommended from 6d. to 4d. per unit for the first hour, 3d. for the second, and 1½d. afterwards. These reductions would reduce the estimated surplus on the year from £375 to £200. The Gas, Water and Electrical committee recommend the Council to relieve them of the management of the electric lighting undertaking and instruct the Selection committee to report as to its future management.

**Boston.**—An electrical expert is to be engaged by the Paving and Lighting committee to report upon the advisability of establishing electricity works. The Council obtained a provisional order this year.

**Bournemouth.**—A conference between the directors of the Bournemouth and Poole Electricity Supply Co. and a committee of the Corporation will be held at the London offices of the company to discuss the question of the acquisition of the company's undertaking by the Corporation.

**Bradford.**—The members of the Bradford Electricity committee were entertained to dinner on the 15th inst. by Councillor F. H. Shaw. The company included Mr. Chattock (chief engineer) and his assistants, Messrs. W. Jones, S. T. Dalton, and E. S. Saunders. Councillor Shaw referred to the great demand for electric current for both lighting and power, which had been a feature of their electricity undertaking from the commencement. The toast of "The Electrical Engineer and his Deputies," was proposed by Councillor Akam, and Mr. Chattock replied. Councillor Croft, responding to the toast of his health as deputy-chairman of the committee, said that the reduction in price of current from 2½d. to 1d. per unit for certain purposes had made their balance-sheet look bad, but he believed that ultimately the works would yield a handsome return. In 12 months the output had increased nearly 50 per cent.

**Brighton.**—The minutes of the Lighting committee presented at the Corporation meeting last week recommended that it be resolved to send out a circular to wiring contractors in the borough, informing them that electric motors exceeding 5 H.P. would be supplied at 460 volts pressure. It was resolved to request the General Purposes committee to include in the bill to be promoted in Parliament next session power to enable the Council to wire consumers' premises through the agency of wiring contractors. In moving the adoption of the minutes, the chairman (Councillor Briant) said he understood some opposition had been raised by the Ironmongers' Association, who had passed a resolution at a meeting, attended also by several electric wiring contractors as well as members, regretting that the committee should see the necessity of trying to obtain powers to undertake inside electric wiring. He (Councillor Briant) said that, so far from the Corporation electricity undertaking interfering with the business of wiring contractors, it had virtually made that business, probably nine-tenths of which would not have been secured but for the Corporation supplying the light at such a reasonable rate. The complaint in the past had been that the wiring contractors had not pushed the wiring except where there were considerable fittings to be supplied, because it was, he urged, on the fittings that they got their profits. If undertaken by the committee the wiring would be done through the wiring contractors. Councillor Blaker moved the exception. The traders concerned honestly thought the proposal of the committee was the thin end of the wedge to rob them of their business. He was prepared to admit that these traders would not have done so much business but for the Corporation electricity undertaking, but if there had not been the electric light they would have done business in some other form of illuminant. The committee's proposal was unjust from a trading point of view, and it was outside the duties of a corporation to go in for such a branch of work. Councillor Carden said he attended a meeting of the ironmongers the previous night, and believed he was successful in convincing them, for they had passed a resolution to the effect that they saw no objection to the proposal as it stood. What was wanted was to put the light into weekly tenement property, and he hoped the Council would agree to the proposal. Ald. Sendall was afraid if the proposition was agreed to that the result would be that the work would be handed over to one contractor to the exclusion of the others. Eventually the amendment proposed by Councillor Blaker was carried, and the proposal of the committee rejected.

**Brussels-Antwerp Electric Railway.**—The *Financial News* reports that this scheme has been revived and fresh proposals have been submitted to the Government. In order to obtain a maximum of speed, by which the distance could be covered in about 25 minutes, the line is to run partially underground. The expenditure is estimated at 50,000,000f.

**Buenos Ayres.**—The Municipal Council have granted a concession to Messrs. A. Gutierrez & Co. for constructing an electric tramway on the overhead trolley system, from the Darsena Sud to Recoleta, Palermo, and Belgrano, and joining up with a line from the boundary of the municipality to the Tigre.

**Cardiff.**—At a special meeting of the Electrical committee on Tuesday the subject of the recent dispute between members of the staff of the electricity department was discussed, and a proposal made by Mr. Appelbee that the services of Mr. Illingworth, mains superintendent, be dispensed with was agreed to. Mr. Illingworth declined to attend the meeting. It was decided to advertise for a successor at a commencing salary of £150 per annum.

**Castleford.**—The Council have decided to support the application of the United Kingdom Tramway, Light Railway and Electrical Syndicate for powers to erect electricity works and to construct an electric tramway between Pontefract, Castleford, Normanton, Whitwood, Featherstone, and Knottingley.

**Country House Lighting.**—Llangibby Castle, the Welsh seat of Dr. Rutherfoord Harris, M.P., has been provided with an electric lighting installation by the Alliance Electrical Co.

**Dalkey (Dublin).**—The Council will oppose the application of Messrs. Porte, Sykes & Co. for a provisional electric lighting order.

**Darwen.**—The electric tramways were officially inspected by Mr. A. P. Trotter on behalf of the Board of Trade on Friday last.

**Dudley-Cradley Heath Electric Tramway.**—The tramcars on this line resumed running on Friday last after a suspension of about a fortnight.

**Dundee.**—At a special meeting of the Council last week it was decided to promote a bill for (*inter alia*) additional electric tramways.

**Eccles.**—An inquiry was held here last week into the application of the Corporation to borrow £5,308 for electric lighting purposes. The town clerk (Mr. W. H. Hickson) said the original loan was £12,114, and this had been over-spent. Practically the whole of the money was spent on extensions of the original scheme. The inspector (Col. Marsh) said that the proper time to have applied for additional borrowing powers was when the extensions were made. If the Corporation were going to carry out any further extensions, it would be better to have a definite scheme. Mr. Hickson replied that a larger scheme would be submitted to the board shortly. The estimate for transformers had been increased from £300 to £1,362. No allowance had been made in the original estimates for about 100 meters (costing about £5 each) and instruments (£223. 17s.). Their loss for the first year was £789, but that was chiefly owing to repayment of principal and interest. There was no opposition.

**Edinburgh.**—From Oct. 4 to Oct. 18 the electricity department received applications for an equivalent of 2,337 8 c.p. lamps for lighting and 122 H.P. in motors (equal to 2,928 8 c.p. lamps), a total of 5,625 8 c.p. lamps.

**Education (Commercial and Technical) in Germany.**—The development of technical education in Germany has culminated in the proposal to establish a commercial university, to enable students to acquire, besides a thorough theoretical training, special instruction in modern languages, mercantile law, harbour construction, &c. This university is to have the same status as that of the University and Technical High Schools. The site chosen for the new institution is at Hamburg.

The Prussian Government, which in 1896-7 granted £161,519 for technical education purposes, has increased the grant for 1900-1 to £275,643.

The importance of the German machine-tool and machine-making industries has led to the decision that at least one year's practical training in the workshops shall be obligatory for students going in for the examination for the engineering diploma. The object of this rule is to amend the present custom by which many students with no practical experience leave the technical high schools to accept positions where the absence of experience gained in practical working proves a drawback to their advancement, and discloses a prevalent weakness in the German methods of technical instruction. There is a growing tendency to associate the technical high schools with the large industrial works of Germany, and the committee of the Union of German Ironworks has recently decided to encourage this movement and to recommend that the obligatory practical year's work above referred to shall be undertaken immediately after the student leaves school. The co-operation of the Union of Iron and Steel Manufacturers, the Union of German Machine Makers, and the Union of German Engineers is likely to be given to this new departure.

Another proposal is for a union of all the chief commercial schools in the country into a central body. A strong point in this connection is to be the study of the English language. Dr. Dunker, director of the Berlin Commercial Continuation Schools, points out that of the entire export trade of Germany 33 per cent. goes to the British Empire or the United States, and only 5½ per cent. to France and French-speaking colonies. Hitherto a far larger share of the students' time has been devoted to the study of the French language.

**Electricity Supply in the North Metropolitan Area.**—Public notice is given that in accordance with the provisions of the North Metropolitan Electric Power Supply Act (1900), arrangements are being made to supply electricity to local authorities or other authorised undertakers in Hendon, Barnet, Edmonton, Ware, Hertford, Welwyn, St. Albans, and Chingford.

**Fatality from Electric Shock.**—An inquest was opened at the St. Alphege Mission Room, Greenwich, on Wednesday, on the body of Arthur Robinson, aged 18, who died from the effects of an electric shock received at the works of the Blackheath and District Electric Lighting Co. Deceased was employed as a carpenter by Mr. E. J. Ford, of Blackheath, and on Monday was fixing fillets round a switchboard at the Blackheath Company's works.

An apprentice to Mr. Ford, named TURNER, said he went behind the switchboard to unfasten a belt with a spanner, so that deceased might draw it, and directly afterwards saw a flash and heard a groan. Rushing round he saw deceased lying on the ground. They had both been warned to be careful, as the work was dangerous.

FREDERICK PETERS, employed at the works, said he saw the deceased fall while he was apparently taking out a bolt. He thought the deceased's hand must have slipped on to the switch.

Mr. J. A. CONSTABLE, electrical engineer at the works, said he warned deceased and Turner not to touch or go near the switchboard. After the inquest on the body of a man named Howard, who was killed at the works last February, he had received a copy of certain regulations which had been drawn up by the Dangerous Trades committee of the Home Office, with the view to guarding against fatal accidents in electrical generating works, but admitted that he had not read them all.

Dr. DAVIS said that death was due to electric shock.

The inquiry was then adjourned until Wednesday next.

**Frome.**—A special meeting of the Council was held this week to consider a preliminary report by Mr. F. H. Medhurst on electric lighting, and it was decided to apply for a provisional order.

**Gorton.**—An inquiry was held last week into the application o the Council to borrow £13,111 for refuse destructor works.

**Hexham.**—A provisional order is to be applied for by the Council, who have instructed Messrs. Lacey, Clirehugh and Sillar, of London and Manchester, to prepare a preliminary report on the electric lighting question. The application of the Northern Counties Electricity Supply Co. for an order will consequently be opposed.

**Leeds.**—The accounts of the Electric Lighting department for the year ended March 25 have been issued and shows the total income from sale of current, meter rental, &c., to be £36,220. 15s. 5d.; working expenses amounted to £9,929. 10s. 10d., interest £12,473. 6s. 10d., and, after paying insurance and law charges, there was a balance profit of £13,817. 18s. 9d. Sinking fund instalment absorbed £5,316. 0s. 2d., leaving a net profit of £8,501. 18s. 7d. During the year an expenditure of £75,006. 11s. 7d. on capital account was incurred, making the total expenditure £307,522. 3s. 3d. (including £217,420 paid to the Yorkshire House-to-House Co.) The working expenses per unit sold (1·19d.) were the lowest recorded in the history of the undertaking for a complete year. The units sold were 2,005,840 and the number of consumers was 1,393, representing an equivalent of 106,263 8 c.p. lamps connected. The average consumption per 35 watt lamp was 21 units, yielding a revenue of 7s. 1·8d. per lamp. The capacity of the electricity works had been increased during the year by the addition of a 640kw. steam alternator set, bringing the total capacity up to 3,040kw., and two similar sets remained on order at the close of the year. New trunk mains have been laid to Hunslet, and are being laid to Chapeltown, Roundhay-road, and other districts. In view of the necessity for further extensions, the committee had considered the question of the system of supply, and the manager of the department was instructed to make a tour in America to obtain information on the subject. A report was also obtained from the consulting engineers (Messrs. Hopkinson and Talbot), and in accordance with their advice the two-phase alternating system is to be adopted for future extensions. Plans were being prepared for the development of the Britannia Mills site on these lines.

**Legality of Conditional Wiring Connections.**—At the West London Police Court, on Wednesday, application was made to Mr. Rose for a summons against the Notting Hill Electric Light Co. for failing to connect premises according to act. It appeared that the occupier of a house in Upper Phillimore-gardens, Kensington, had applied to the company to connect his premises, but the company only consented to the application on condition that the occupier would sign an agreement to allow the premises to be disconnected if it were found that their plant was insufficient for the coming winter. It was contended that the agreement was unreasonable. Mr. Rose (the magistrate) suggested that the company had not made default in the terms of their act, but the applicant submitted that the company was bound to supply electricity without any agreement. Otherwise, the company might connect the premises one day and disconnect them the next. A summons was granted in order to test the question.

**Leith.**—The electric lighting mains are to be extended to Newhaven and Trinity at an estimated cost of about £12,000.

**Light Railways.**—The Darlington Light Railway order is to be opposed by the Council.

Mr. T. Nevins has submitted plans and specifications of the Cheltenham-Cleeve light railway, and he has already placed orders in America for the cars, rails, &c., delivery in Cheltenham being expected in December next.

The Light Railway Commissioners recommend the Board of Trade to sanction the construction of the Kidderminster and Bewdley light (electric) railway, the inquiry into which was held last week, as reported in our columns.

An inquiry was held at Swansea, on Wednesday, into the application of the Corporation to construct electric tramways in the borough and adjoining districts. The scheme comprised nine new tramway routes, including extensions to Sketty, Port Tennant, Forestfach and Morriston. Mr. Lloyd, Q.C., for the promoters, said that in 1896 the Corporation endeavoured to obtain powers for what is known as the triple scheme (lighting, traction and refuse destruction), and in 1898 the Swansea Improvements and Tramways Co. made an unsuccessful application under the Light Railways Act. An agreement had been come to with the chief opponents of the present scheme (the tramways company) and opposition from that source was withdrawn. It was agreed that the Corporation should construct the lines, and grant the company a lease. The Corporation reserved the right to purchase the existing

tramways. Mr. Emile Garcke, chairman of the Swansea Improvements and Tramways Co., said the lines would be a great public convenience. His company were promoting light railways, extending the tramways into the neighbouring districts, and they had withdrawn opposition to the Corporation scheme on the terms mentioned. The consulting engineer, Mr. J. E. Waller (Kincaid, Waller and Manville), gave technical details. The Commissioners subsequently adjourned the inquiry to London.

**Limerick.**—The Local Government Board have declined to sanction the Council's application for a loan of £22,000 for electric lighting, on the ground of the heavy rates levied in Limerick. The total rates for the year ended March 31 last amounted to 11s. 1d. in the £, and the engineering inspector (Mr. Cowan) reported that he thought it not unlikely that in the event of an installation of electric lighting being put down only a small revenue would be obtained for the first two years at least, and that the work would entail a probable outlay of £2,000 a year, equal to an addition of 7d. to the rates.

Now that the electric lighting scheme has been postponed, it is probable that the joint electric tramway and lighting scheme, which was under discussion by the Council some months ago, will be revived.

**Liverpool.**—The West Derby electric tramway route was formally opened on Sunday.

**London County Council.**—At Tuesday's meeting the adjourned report of the Highways committee on a site for a generating station at the Camberwell tramway depôt was considered. It was agreed that the Council seek parliamentary powers to acquire property adjacent to the existing depôt.

The Highways committee presented a report on the receipts and expenditure during the year to March 31, in connection with the Council's tramways. The total capital expenditure had been £893,816. 10s. 5d., and the total receipts for the year were £468,630. 8s. 2d. The working expenses were £375,639. 5s. 9d., showing a profit on working of £92,991. 2s. 5d. To this was added £14,957. 11s. 2d. from the March quarter of 1899, making the total £107,948. 13s. 7d., out of which had had to be paid interest and sinking fund charges for the 15 months to March 31, 1900 (£53,101. 4s. 5d.), leaving a disposable balance of £54,847. 9s. 2d. Mr. BOULNOIS, M.P., said he saw that the cost of 41 horses was charged to capital account, which extended over a period of 25 years; but, on the other hand, the whole of the money derived from the sale of horses was credited to revenue. He was somewhat uneasy about the accounts in the face of that fact. He would not say the accounts were cooked, but he thought they had been prepared for platform use. In no private business would an accountant permit those horses to be charged to capital account. Mr. BEACHCROFT referred to a letter sent to the Council by the secretary of the Municipal Tramways Officials' Association, in which it was stated that Mr. Benn (chairman of the Highways committee) had informed a deputation that the question of including employés in the superannuation scheme of the Council should be brought forward after the election. Electoral assistance was promised in the letter from members of the Association to those councillors who supported the Association in the matter of superannuation. That, he thought, showed clearly the difficulties which they and all other municipal authorities had to face when they became large employers of labour. Mr. S. WEBB said, so far from it being unusual to charge horses to capital, it was done by every tramway company, not for 25 years, but for ever. Mr. BOULNOIS, M.P., said the accounts of the London Tramways Co. showed that company had a horse renewal fund of from £15,000 to £22,000 a year. Mr. H. P. HARRIS hoped the tramway question would not be made an electioneering one. He held in his hand a bill issued during the recent general election asking electors to "Vote for Benn, who voted for and secured a 10 hours' day, one day's rest in seven, and better wages." As a matter of fact, those good things were recommended by a unanimous committee and granted by a unanimous Council, although one reading the bill would picture Mr. Benn, sword in hand, cutting his way through resisting warriors. Mr. BENN said the leaflet alluded to was framed upon one issued by the London Municipal Society in favour of another candidate, Mr. Westacott. With regard to Mr. Boulnois' criticism, the practice followed by the committee with regard to the horses was exactly that of their predecessors, the Tramway Company. The working of the Southern Tramways by the Council resulted in a return of 5·8 per cent. on the ratepayers' money invested, while the Northern Tramways, which were leased, resulted in a return of 4·73 per cent. The report was then approved.

On the proposal that an electric tramway should be constructed along the Thames Embankment, the Highways committee stated that the scheme would raise considerable opposition, and place difficulties in the way of the Council's securing parliamentary powers to carry out its other tramway proposals, which might otherwise be in the main unopposed. The committee therefore considered it inadvisable to proceed with the scheme next session, and in this view their action received the full Council's approval.

The Parliamentary Committee asked for permission to renew the application to Parliament for power to reconstruct as a double line for electric traction the existing single tramway line from Camberwell Green to Vauxhall. Permission was granted.

The Technical Education Board reported that the new electrical engineering department at the South-Western Polytechnic had rendered the institution second to none in London in respect of accommodation for instruction in the branch of practical work. The equipment of the advanced laboratory for electricity and magnetism exhibited some novel features worthy of attention, and much of the apparatus had been constructed in the Polytechnic itself. The Battersea Polytechnic, owing to the new arrangement, was also now provided with excellent facilities for instruction in electrical engineering.

**Marylebone (London).**—Having definitely decided not to purchase Marylebone portion of the undertaking of the Metropolitan Electric Supply Co., the Vestry now appear to be anxious to obtain a provisional order. At the meeting last week permission was asked that the Vestry's solicitor be instructed to serve the statutory notice on the Metropolitan Company of intention to apply for an order to supply electricity in the parish. The proposer (Mr. Lewis) said the resolution was substantially passed at a former meeting of the Vestry. If they got an order, they would then be in a better position to go to the company. After points of order had been settled, Mr. Lewis was permitted to move his resolution, with the addition of the words "as soon as possible." Mr. W. Sutherland moved an amendment that the Vestry apply for a provisional order to generate and supply electricity in the parish. The amendment was lost, and Mr. Lewis's motion was then agreed to.

**Municipal Telephony.**—Forced by the action of the Salford, the Manchester Corporation have been compelled to again take up the telephone question. Mr. A. R. Bennett has been engaged to report on the matter, and especially as to the continuance of the monopoly of the National Company, and as to the desirability of municipalisation. The Telephone committee has also had a conference with the Salford Telephone committee and representatives of the Mutual Telephone Co., and it is now probable that the whole of the local authorities in the Manchester area will take joint action.

**Newport (Mon.)**—Up to date £91,235 has been expended on electricity supply works, of which £80,815 has been sanctioned, and it is now proposed to apply for further borrowing powers for £30,000, for extensions to mains, for transformers, and for the proposed change of pressure to 250 volts.

**Paisley.**—A special meeting of the Council will be held on Monday to consider four proposals in regard to the construction and working of electric tramways. Terms have been obtained from Mr. W. M. Murphy, Messrs. J. B. and J. Atherton, English Industrials (Ltd.), and the London and Provincial Traction Co.

**Pateley Bridge (Yorks.)**—A meeting was held last week to discuss the question of establishing electricity works. Mr. G. Harrison, electrical engineer, Ripon, attended and said that there was sufficient surplus power at a local corn mill to provide motive power and to supply 750 8 c.p. lights. He estimated the cost at £2,000. A resolution in favour of the scheme was passed.

**Penzance.**—As announced in our last issue, 28 applications were received for the position of consulting electrical engineer, the Electric Lighting committee having examined these, the number was reduced to eight, viz., Messrs. Lacey, Clirehugh and Sillar, Mr. F. J. Warden Stevens, Mr. James N. Shoolbred, Mr. W. H. Trentham, Mr. Reginald P. Wilson, Mr. Thomas L. Miller, Messrs. Medhurst and Lloyd, and Mr. Robert Hammond. As the committee has not been able to obtain certain desired information respecting the standing of the candidates, the final selection has not yet been made.

**Personal.**—Mr. T. W. W. Melhuish, who, for the past 14 years, has occupied the position of manager and chief engineer of the central electric lighting station of the Imperial Continental Gas Association at Vienna, has recently been appointed consulting and inspecting electrical engineer to the Association and to some other companies in which the Association is interested. Mr. Melhuish will now remove from Vienna to 23, Boulevard Militaire, Brussels, as this town is more conveniently situated in regard to his new duties.

**Peterborough.**—The Council have applied for a further loan of £5,000 for electric lighting.

**Poplar (London).**—At the meeting of the District Board of Works last week, the Electric Light committee reported on the question of the recent accident to one of the engines at the electricity station. Statements by the resident engineer (Mr. A. Blackman) and the chief generating assistant (Mr. Roles), together with a communication from Messrs. Babcock and Wilcox, were also submitted. Mr. Blackman said that the accident was beyond question due to the quantity of water being carried into the engine at the moment the pressure in the two boilers equalised, and this, he believed, to have been caused by the extremely unskilful firing of the boilers, the effect of which would be greatly contributed to by the fact that No. 3 boiler, which had the high-water level, was not covered with

any non-conducting composition, the provision of which was included in Messrs. Babcock and Wilcox's contract, and had since been placed in position. Messrs. Babcock and Wilcox stated that, apart from the question of liability, they were willing, without prejudice, to bear the cost of repairing the engine (£190). The committee now recommended that the reference on the minutes be discharged, and at the same time expressed their full confidence in Mr. Blackman and his assistants, and advised the board to endorse such expression. The adoption of the report was moved by Mr. Valentine, who asked that the board should give an unanimous vote absolving their engineer from all blame, and after a long discussion this was agreed to.

**Power Transmission.**—The Helios Co. are supplying a generating plant comprising two 400kw. steam dynamos for the works of the Feutcher Hütten Gesellschaft at Kneuttingen, Lorraine, Germany.

**Provisional Electric Lighting Order Notices.**—Wisbech Corporation and Gainsborough District Council give the usual official intimation of intention to apply for provisional orders.

**Provisional Order Transfer.**—East Stonehouse District Council intend to transfer to the Corporation of Devonport the East Stonehouse Electric Lighting Order (1898), the consideration being £200.

**Railway Carriage Lighting.**—The Belgian State Railway authorities have placed a contract with the Société Electricité et Hydraulique, Charleroi, for the electric lighting on the Stone system of a large number of railway carriages.

The Aussig-Teplitz (Austria) railway authorities have adopted a similar system of electric lighting on the Berlin-Karlsbad express service.

**Rhondda.**—The Council are desirous of obtaining powers to construct an electric tramway between Porth and Tonypondy.

**Rickmansworth.**—Terms have been arranged with the United Electric Light and Power Co. in regard to an application for a provisional order. The company undertake to supply current for public lighting at 3d. per unit on a three, five, or seven years' contract. The right to purchase the undertaking is reserved.

**Rosario.**—*The Review of the River Plate* states that the River Plate Electric Light and Traction Co. has prepared plans for altering the generating plant at Rosario station in accordance with the recent decision of the Arbitration Court. The work is estimated to cost £95,000. The system is to be changed from alternating to continuous current, and all the mains in the central streets will be placed underground.

**Sleaford.**—An inquiry has been held here into the application of the Council to borrow £7,000 for electric lighting. The clerk to the Council (Mr. Charles Clements) gave particulars of the population, rating value, &c., and the consulting engineer (Mr. E. Bremner Smith) submitted plans and estimates of the scheme. There was some opposition.

**Smethwick.**—The Council are promoting an Omnibus Bill for, *inter alia*, powers to purchase and extend the local tramways.

**Sofia (Bulgaria).**—A system of electric tramways for this city is practically completed, and the lines are to be opened for traffic in November. The plant has been supplied by La Société Electricité et Hydraulique, Charleroi.

**Stoke-on-Trent.**—An inquiry was held here last week into the application of the Corporation to borrow £2,165 for the purchase of a site for electricity generating works.

**Stratford-on-Avon.**—The Council having decided to apply for a provisional order, a special Electric Lighting committee was constituted at the last meeting.

**Stromness (N.B.).**—A proposal has been made to establish electricity works in this town. It is believed that sufficient water power is available in the neighbourhood to generate electric current for public lighting. Gas, which is indifferent in quality, is 7s. 6d. per 1,000.

**Stroud (Gloucester).**—The Streets and Highways committee have been instructed to obtain information as to the cost of obtaining a provisional order, and in the meantime opposition is to be entered against the application of a company for sanction for electric lighting powers.

**Taunton.**—The British Electric Traction Co. has acquired the Taunton Tramways provisional order from the Taunton and West Somerset Electric Railway and Tramways Co., and propose to at once start the work of constructing the permanent way. The British Electric Traction Co. will take current from the Corporation, and have contracted for 60,000 units per annum, and if the tramways cease to work within seven years they will pay half the cost of laying down extra machinery. Application is, therefore, to be made to the Local Government Board to sanction a further loan of £3,200 for extra generating plant to meet these requirements.

**The Telephonograph.**—At Berlin, Profs. Stumpf and Neeson, of the Berlin University, have succeeded in some interesting experiments in the study of the peculiarities of Siamese music by the aid of the telephonograph. The singular but harmonious musical effect of the Siamese octave of seven equal intervals was reproduced, it is stated, with great accuracy and distinctness.

**Trunk Telephone Extensions.**—The trunk telephone system of the country has been extended to Aylesbury, Bucks.

**Wormit (Dundee).**—A committee of ratepayers has been appointed to confer with the directors of the Tayside Electric and Gas Light Co. in regard to electric lighting, and particularly in regard to the purchase of the plant of Mr. Alexander Stewart.

### NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

**"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.**

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Shoreditch* (London) Vestry invite tenders for steam feed, blow-off and drain pipes, feed-pump and water storage tank and sundry iron work; two slow-speed Corliss engines, direct-connected current generators (output about 800kw. each set), condensing apparatus, pipes and sundry iron work. Specifications may be obtained after 29th inst. at the offices of the Vestry's electrical engineer (Mr. C. Newton Russell), Coronet-street, Hoxton, N., and specifications may also be inspected, but not obtained, at the offices of the consulting electrical engineers (Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster. Tenders must be forwarded to Dr. H. Mansfield Robinson, Vestry clerk and solicitor, Town Hall, Old-street, E.C., before noon, Nov. 20. An advertisement contains further particulars.

*Lowestoft* Corporation invite tenders for the supply of two water-tube boilers, fittings, economiser, &c.; pipework, &c., in engine and boiler house; and a 250kw. steam dynamo (vertical, enclosed, high-speed engine). An advertisement gives further particulars, and specifications may be obtained from the town clerk (Mr. R. Beattie Nicholson), 115, High-street, Lowestoft, after 20th inst. The works are to be carried out in accordance with the plans of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen street-place, London, E.C. Tenders to town clerk's office by noon of Nov. 2.

*Lowestoft* Corporation also invite tenders for wiring the town hall. An advertisement gives further particulars, and tenders must be delivered to Mr. R. Beattie Nicholson before noon Nov. 2.

*London County Council* invite tenders for the supply of about 150 arc lamps for the electric lighting of Victoria Embankment and Westminster Bridge. An advertisement contains further particulars, and specifications may be obtained at the engineers' department, County Hall, Spring-gardens, S.W. Tenders must be in by Nov. 13.

*Belfast* Gas and Electric committee invite tenders for steam pipes, pumps, &c., condensing plant, boilers, mechanical stokers and superheaters, coal and ash-conveying plant, and switchboard extensions. An advertisement gives further particulars, and specifications may be obtained from the city electrical engineer (Mr. Victor A. H. McCowen). Tenders to town clerk (Sir Samuel Black) by noon of Friday, Nov. 23.

Tenders are invited by the *Nottingham* Guardians for an electric lighting installation at the new workhouse. An advertisement gives particulars, and additional information can be obtained from the architect (Mr. Arthur Marshall, A.R.I.B.A.).

*City of London* Corporation Streets committee invite tenders for a mechanically-driven dust cart. Tenders to town clerk before Nov. 10.

*Swansea* Corporation require tenders for electricity meters, demand indicators and main fuses. Tenders to town clerk by noon 29th inst.

*Walker* Council require tenders for dust destructor, boilers, &c. Tenders to 5, St. Nicholas-buildings, Newcastle-on-Tyne, by Nov. 12.

*Heywood* Corporation invite tenders for wiring premises in district. Tenders to town clerk.

*Rhyl* District Council require tenders for the erection of refuse destructor and electricity station buildings. Tenders by Nov. 5.

*Devonport* Corporation require tenders for the erection of electricity station buildings. Tenders by Nov. 2.

*St Albans* Corporation invite tenders for a transfer of their provisional electric lighting order.

*Pemberton* Council invite tenders for electricity generating plant by Nov. 5.

*Ayr* Corporation invite tenders for electric tramcars. Tenders by Nov. 1.

*Spanish* Admiralty authorities invite tenders by Nov. 22 for (amongst other goods) electrical material required in the arsenal of Caraca during 1901-2. The *Madrid Gazette* of 14th inst. contains further particulars.

## TENDERS RECEIVED AND ACCEPTED.

As announced in our last issue, the Southampton Harbour Board have accepted the tender of the Clayton Engineering and Electrical Co. for the supply of a 30-ton portable electric crane. Following is a list of the tenders received :—

| | | | |
|---|---|---|---|
| Clayton Engineering and Electrical Co. (*accepted*) | £735 | Bow, McLachlan Co. | £1,100 |
| J. Booth & Bros. | 1,326 | Fullerton, Hodgart & Barclay | 970 |
| Chatteris Eng. Works Co. | 1,150 | Stothert and Pitt | 950 |
| | | Southgate Engineering Co. | 798 |

The tender of Messrs. Barry, Henry & Co. has been accepted by the Fulham (London) Vestry for coal-handling plant at the electricity supply works. The following is a full list of the tenders received

| | | | |
|---|---|---|---|
| Barry, Henry & Co (*accepted*) | £796 | W. B. Haigh & Co. | £985 |
| Graham, Morton & Co. | 1,194 | Mirrlees, Watson & Yaryan Co. | 875 |

Durban (Natal) Corporation have accepted the following tenders for electric tramway plant :—

| | | | |
|---|---|---|---|
| Macartney, McElroy & Co. (poles and overhead equipment) | £16,994 | 10 | 10 |
| Ditto (electric tramcars) | 18,600 | 0 | 0 |
| Dick, Kerr & Co. (steam and electricity generating plant) | 26,240 | 10 | 0 |

Barnsley Corporation have placed an order with Messrs. D. Bruce Peebles & Co. for a 600 H.P. generating set, consisting of a combined lighting and traction machine direct coupled to a Willans engine.

Watford District Council have accepted the tender of Mr. Wm. Boby for a feed-water heater and softener for the electricity works at £751.

The Brockie-Pell Arc Lamp (Ltd.) inform us that the contract for arc lamps for the public lighting of the Poplar (London) district has been obtained by the company. The lamps are of the well-known Brockie-Pell type, manufactured under the patents of which the company are the sole owners.

Dundee Town Council have accepted the tender of the Barrowfield Ironworks for three steel water tanks for the electricity supply station at £776.

Aberdeen Town Council have accepted the tender of Messrs. Mavor and Coulson for two 200kw. generating sets and balancing sets at £5,144.

Birkenhead Tramways Committee have accepted the tender of the Loraine (U.S.A.) Steel Co. for the supply of 110 tons of steel tramway rails.

Medomsley (Durham) Parish Council have accepted the tender of Mr. G. H. Armstrong for the electric lighting of the northern and central portion of the district.

Hackney (London) Vestry are recommended by their Electric Lighting committee to accept the following tenders for electric lighting plant, &c. :—

| | | | |
|---|---|---|---|
| Johnson and Phillips (public arc lamps and switchboard) | £5,248 | 18 | 0 |
| Ditto (switchboard and instruments, boosters and motors—Parts 2 to 5) | 2,160 | 0 | 0 |
| S. Z. de Ferranti (switchboard and instruments, boosters and motors, &c. Part 1) | 2,976 | 10 | 0 |
| Aiton & Co. (pipework and valves) | 5,065 | 0 | 0 |
| Cole, Marchent and Morley (condensing plant) | 4,749 | 0 | 0 |
| Chamberlain and Hookham (house meters) | 3,632 | 10 | 0 |
| Klein Engineering Co. (cooling apparatus) | 1,960 | 0 | 0 |
| Worthington Pumping Engine Co. (feed pumps) | 753 | 0 | 0 |
| Manlove, Alliott & Co. (disinfector laundry machinery for electric power | 701 | 2 | 0 |
| Higginbottom and Mannock (overhead crane) | 638 | 0 | 0 |
| W. T. Allen & Co. (arc lamp pillars) | 13 | 5 | 0 |

The following tenders were received for cables, trenching, troughing, house services, &c. :—

| | Trenching. | | | Troughing. | | | Cables. | | | Boxes. | | | House services. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| British Insulated Wire Co. (*accepted*) | £14,339 | 0 | 0 | £5,236 | 0 | 0 | £18,973 | 10 | 10 | £5,867 | 14 | 0 | £2,000 | 0 | 0 | £46,416 | 4 | 10 |
| *Siemens Bros. & Co. | 12,899 | 6 | 8 | 7,047 | 6 | 8 | 17,697 | 16 | 8 | 5,859 | 14 | 0 | 1,600 | 0 | 0 | 45,104 | 4 | 0 |
| Western Electric Co. | 14,982 | 0 | 0 | 7,722 | 0 | 0 | 19,506 | 6 | 3 | 4,646 | 10 | 0 | 1,000 | 0 | 0 | 47,856 | 16 | 3 |
| Callender's Co. | 15,202 | 0 | 0 | 7,624 | 18 | 9 | 18,966 | 12 | 6 | 4,030 | 18 | 0 | 2,100 | 0 | 0 | 47,924 | 9 | 3 |
| Ditto† (alternative) | 15,202 | 0 | 0 | 7,624 | 18 | 9 | 16,817 | 19 | 2 | 4,030 | 18 | 0 | 2,100 | 0 | 0 | 45,775 | 15 | 11 |
| W. T. Henley's Co. | 18,536 | 16 | 8 | 7,940 | 3 | 4 | 20,416 | 2 | 6 | 4,399 | 19 | 2 | 1,625 | 0 | 0 | 52,918 | 1 | 8 |
| W. T. Glover & Co. | 11,073 | 6 | 8 | 12,519 | 16 | 8 | 24,182 | 6 | 8 | 6,438 | 5 | 0 | 1,750 | 0 | 0 | 55,963 | 15 | 0 |

* Messrs. Siemens Bros. & Co.'s tender was passed over chiefly on account of the objections which the firm raised to the liability for accidents and wages clause, and their unwillingness to accept the five years' guarantee. The contract was therefore allotted to the British Insulated Wire Co., who are at present carrying out work under an earlier contract.

† Not to specification.

## APPOINTMENTS VACANT AND FILLED.

Bury Electric Lighting committee require an assistant engineer for their electricity station. Applications to the engineer and manager (Mr. S. J. Watson). See advertisement.

An experienced electrician, conversant with latest developments in the distribution of electricity supply, is required to manage a new electrical department. See advertisement.

Warrington Corporation require an electrical engineer to take charge of their electricity generating station. An advertisement contains additional particulars, and applications must be delivered to the town clerk (Mr. J. Lyon Whittle) by noon Nov. 7.

British Electric Traction Co. require a resident engineer with experience in tramway permanent way construction. Applications to secretary, Donington House, Norfolk-street, London, W.C. See advertisement.

Great Northern Railway of Ireland require a resident electrical engineer. Applications by Nov. 1.

---

Mr. Vincent Hill, at present general manager of the Hull and Barnsley Railway Co., has been appointed to succeed Mr. A. Willis as general manager of the South Eastern and Chatham Railway Co. Mr. Willis is retiring owing to ill health, but his services will be retained by his company in a consultative capacity in connection with the legal business of the joint committee of the lines. Mr. Hill was associated with the Chatham Company prior to his appointment to the Hull and Barnsley Co.'s service.

Mr. H. L. Mills, mains electrician at the Islington (London) electricity department, has been appointed mains superintendent at Southampton at £150 per annum.

Mr. J. S. E. Townsend, B.A., Trinity College, Cambridge, has been appointed assistant demonstrator in experimental physics for five years at the University.

## BUSINESS NOTICES.

Mr. C. L. Turner, M.I.E.E., has commenced business as a consulting electrical and mechanical engineer at Post Office-chambers, 26, Brown street, Manchester.

Messrs. J. Watson and G. Blackburn (trading as Blackburn & Co.), electrical engineers, &c., 5, Craven-street, and 11, Westbourne-mews, London, W., have dissolved partnership. Debts by Mr. Watson, who continues under the style of W. Aram & Co.

The partnership between Messrs. W. H. Chambers and G. A. Edwards (trading as W. H. Chambers & Co.), electrical engineers, 5, Milk-street, London, E.C., has been dissolved.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Cornelius Bennett Harness, described as late managing director of the Medical Electrical Institute (Ltd.), has been adjudicated bankrupt. The first meeting of creditors will take place on 31st inst. at 24, Railway-approach, London Bridge, and the public examination on Nov. 8 at the Court House, Wandsworth.

The trustee (Mr. B. S. Dunn, 10, Coleman-street), in the bankruptcy of E. L. Joseph, electrical engineer, Northampton Works, Canonbury, London, has been released.

Recording Telegraphs (Ltd.) is to be wound-up voluntarily. Mr. G. H. Chantrey, 57, Moorgate-street, London, E.C., is liquidator.

A meeting of the Kelvinside Electricity Supply Co., Ltd. (in voluntary liquidation), will be held at 28, Renfield-street, Glasgow, on Nov. 21, to receive an account of the winding-up.

The creditors of the British Blahnik Arc Light Co., Ltd. (in liquidation), must send particulars of their claims to the liquidator (Mr. W. H. Chantrey), 57, Moorgate-street, E.C., before Nov. 24.

---

**Plant for Sale**. Oldham Electric Light committee invite offers for lead battery boxes, plates, and copper connections. An advertisement gives some further particulars, and offers are to be sent to the superintendent (Mr. Arthur Andrew), Gas and Water Offices, Oldham, by Nov. 4.

**New Belgian Carbon Factory**.—New works for the manufacture of arc lamp carbons have been recently erected by La Compagnie Internationale d'Electricité, Liége. The capacity of the plant is about 4,000 metres per day.

**H.A.C. Headquarters Lighting.**—Messrs. Donnison, Berlyn, Sillem & Co. are wiring the headquarters of the Honourable Artillery Company for the electric light, and the work is to be completed in time for the reception of the C.I.V.'s on Saturday.

**B. T. H. Plant.**—Pamphlet No. 76, for October, issued by the British Thomson-Houston Co., contains particulars of various standard rheostats manufactured and supplied by that company. Our illustrations show the construction of the "packed card" rheostats, which derive their name from a special method of construction. A tube of asbestos on a steel mandrel is wound with German silver wire or ribbon, and is taken from the mandrel and pressed into the card form shown in Fig. 1. These cards form the unit resistances used in making up the rheostats. The cards are assembled side by side with asbestos between successive cards, the number of cards depending upon the resistance required in the rheostat. To increase the radiating surface iron plates somewhat wider than the cards are inserted at intervals between the resistances, and project beyond the surface of the resistance section. The cards and iron plates are then clamped by end plates and bolts as shown in Fig. 2. The advantages claimed for this type of rheostat include facility for inserting new resistance cards in case any become damaged, and freedom from injury to the resistance material in case of overloading, as the constructive material is free to expand or contract.

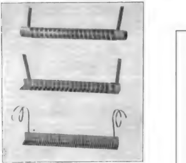


Fig. 1.

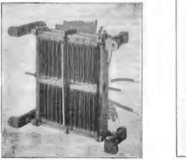
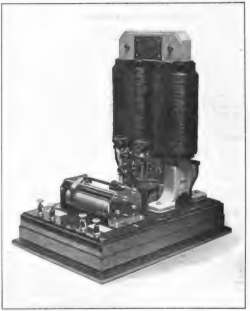


Fig. 2.

**A.E.G. Plant and Material.**—We have received from the Electrical Company, 122-124, Charing Cross-road, London, W.C., the British representative house of the Allgemeine Elektricitats-Gesellschaft, Berlin, an elaborately-illustrated pamphlet, showing to some extent the operations of the parent company, its world-wide ramifications, and of its capacity for supplying complete plant for all branches of the electrical industries. The share capital of the A.E.G. is £3,000,000 sterling, with £712,000 in debentures, and with affiliated companies possessing a capital of £10,000,000 sterling. The reserve fund of the A.E.G. is £1,370,000. The total area of the company's works is 57 acres, and the number of employés on Jan. 1 last 14,000. The dividends paid by the company from 1890 to 1899 have varied from 7½ per cent. to 15 per cent., the latter dividend having been paid for the past three years. The total output of dynamos and motors in 1890-91 was 610, and in 1898-99 12,000, representing a wattage for the latter year of 163,000,000. The illustrations in the pamphlet give excellent views of the company's various works and also of the departments into which these works are divided. It is claimed that the incandescent lamp works have an annual output of 10,000,000 lamps, equal to one-half the yearly consumption in all Europe. The company have contracted for 72 electric railways and tramways, comprising 2,400 miles of track equipped with 4,300 car motors, and with 3,500 cars running. The generating stations for which the company is responsible include the Rheinfelden works, the largest water power station in Europe. Copies of this pamphlet, and of a second publication giving a description of the A.E.G. pavilion at the Paris Exhibition (where a number of Nernst lamps are shown), can be obtained on application.

**Electro-Medical Apparatus.**—Messrs. Isenthal & Co., 85, Mortimer-street, London, W., have placed upon the market a continuous-current transformer for cautery and surgical exploration lamps. The transformer takes half an ampere at 20 volts, and will deliver 20 amperes at 4 volts. Its weight is about 25lb. Our illustration shows the complete apparatus.



Continuous Current Transformer for Surgical Work.

**Machine Tools, &c.**—Mr. H. F. L. Orcutt, 30 and 32, Farringdon-road, London, E.C., representative of Messrs. Ludw. Loewe & Co., of Berlin, forwards a fully-illustrated catalogue of machine tools, small tools, gauges, &c., manufactured by the Berlin house.

**Westinghouse Plant.**—The British Westinghouse Co. (in circular No. 1,032 for October) describe and illustrate the Westinghouse No. 56 tramway motor. The particulars include details of the mechanical construction.

**Switch Gear.**—A useful list of automatic motor-starting switches, main switches, traction panels, switchboards and general switch gear is now ready, and can be obtained of the Electrical Transmission Co., Albert Works, Hammersmith, London.

**"Griffin" Chilled-Iron Wheels.**—The British Griffin Chilled-Iron and Wheel Co., 139, Cannon-street, London, E.C., manufacturers of a special type of chilled-iron wheels for railways and electric tramways, have secured the contract for wheels and axles for 300 goods waggons now on order for the Burma State railways.

**Stop Valves**.—Messrs. Templar and Ranoe, Spon-street, Coventry, have ready for distribution to the trade a well got-up catalogue of steam stop valves specially designed for high pressure. The first illustration in the list is of the valve used on the main electric lighting engines in the British section of the Paris Exhibition. Excellent testimonials accompany the list from large users of these valves, including Messrs. Willans and Robinson, the electricity stations at Lincoln and Shoreditch, and the G.N.R. station at Holloway, London.

"**Manual of Electrical Undertakings**."—The new (5th) edition of Mr. Garcke's excellent "Manual of Electrical Undertakings" will be published the first week in November, and will contain general information relating to over 1,250 electrical undertakings. Mr. Garcke claims for his manual that it is a record of all electrical companies formed under the Joint Stock Acts, and of all electrical undertakings belonging to local authorities. A large section of the work is devoted to the personnel of these concerns, and the financial particulars and historical notes given in the book are very complete. The coloured diagrams, with which the work is freely interspersed, aid materially the usefulness of a publication which shows evidence on every page of careful compilation. The price of the new edition will be 12s. 6d.

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

September 7, 1900.

15,920. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric furnaces. (C. P. Steinmetz, United States.)*

15,921. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric cut-outs. (W. Le R. Emmet, United States.)*

15,951. A. Schlatter. London. An automatic switch for groups of transformers with members of various capacity.*

15,957. C. Contal and P. Gassier. London. Improvements in induction bobbins.

15,965. A. J. Boult. London. Improvements in or relating to electric barometers or barometric indicators. (C. A. Miglioretti, Italy.)

September 8, 1900.

16,000. Veritys Limited and W. R. Ridings. London. Improvements in electric switches.

16,013. C. O. Bastian. London. Improvements in secondary batteries.

September 10, 1900.

16,049. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric accumulator bars. (W. Le R. Emmet, United States.)*

16,050. The British Thomson-Houston Co. (Ltd.). London. Improvements in controlling high potential electric circuits. (E. W. Rice, jun., United States.)*

16,051. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

16,052. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

16,064. B. Klein. London. A new or improved apparatus for automatically charging accumulators.

16,081. C. de Kando. London. A device for putting into and cutting out of circuit liquid rheostats operated by means of compressed air.*

16,082. C. de Kando. London. Combined reversing switch and automatic maximum current interrupter for multiphase reversed current motors.*

September 11, 1900.

16,094. E. Walsh. Dudley. Walsh's connection rope to table attachment for use in the drawing in of electrical cables through iron, earthenware, or other conduits.

16,127. The British Thomson-Houston Co. (Ltd.) London. Improvements in dynamo-electric machines. (C. P. Steinmetz, United States.)*

16,128. The British Thomson-Houston Co. (Ltd.) London. Improvements in compounding electric alternators. (E. W. Rice, jun., United States.)*

16,129. The British Thomson-Houston Co. (Ltd.) London. Improvements in dynamo-electric machines. (C. P. Steinmetz, United States.)

16,130. The British Thomson-Houston Co. (Ltd.). London. Improvements in high-potential electric switches. (E. M. Hewlett and W. Le R. Emmet, United States.)*

16,144. G. J. Churchward and F. L. Wait. Swindon. Improvements in apparatus or means for varying the speed of electromotors.

16,145. T. A. Edison. London. Process of making metallic duplicate phonograph records.*

16,147. T. J. Ryan. London. Improvements in electrically-propelled motor vehicles.*

16,148. T. J. Ryan. London. Improvements in electrically-propelled motor vehicles.*

16,159. E. B. Clark. London. Improvements in and relating to lifting magnets.*

16,164. A. C. Heap. London. Improvements in electrical measuring instruments.

September 12, 1900.

16,225. R. Kennedy. Leeds. Improvements in measuring electrical energy and in apparatus therefor.

16,226. L. L. Berridge and B. Kerr. London. Improvements in or relating to machinery or apparatus for covering electric cable wires and other cores.

September 13, 1900.

16,289. H. W. Sullivan. London. Improvements in induction coils or transformers.

16,290. G. A. Campbell. London. Improvements in and connected with electric circuits for the transmission of energy by variable currents.*

16,291. C. D. Abel. London. An electromagnetic regulator of the admission valves of gas or oil motors. (La Société Anonyme des Anciens Etablissements Panhard et Levassoir, France.)

16,293. J. Imray. London. Improvements in electric furnaces. (La Société Electro-Metallurgique Française, France.)

16,299. E. Schultz. London. Improved construction of electric switch.

16,308. C. Shore and C. Heap. Manchester. Improvements in switchboards applicable for electric call apparatus.

September 14, 1900.

16,323. S. S. Berry. Huddersfield. Improvements in or connected with electrical switches.

16,357. J. D. O'Brien. London. Improvements in underground electric railway systems. (C. A. Ralph, United States.)

16,375. H. H. Hill and W. F. Hill. London. Improvements in accumulator boxes.

16,389. J. Phillips. London. Improved apparatus for trimming commutators.

16,395. J. S. Raworth. London. Improvements in electric locomotives.

16,408. J. von der Poppenburg. Germany. Improvements in the electrodes of electro chemical accumulators.*

September 15, 1900.

16,421. J. Edmondson. Halifax. Improved automatic electrical cut in and cut-out switches.

16,458. A. G. W. Baxter. London. Improvements relating to the terminals of fuses, switches, and other electrical appliances.

16,466. A. Goldschmidt. Liverpool. Improvements in electro hydraulic brakes.

16,483. M. E. Field. London. Improvements in portable electric batteries.*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

19,103. Kabelwerk Rheydt Actiengesellschaft G.m.b.H., and Zapfe and Hohnholz. Telephone conductors or cables.

19,384. Lorrain (Macdonald). Electric clock systems.

19,640. Armstrong and Orling. Electromagnetic wave apparatus.

19,710. Brown. Wireless telegraphy.

19,781. Hunter. Electrical switches.

20,110. Lopez, Morin, Martin and Griner. Electrical accumulators. (Date applied for under International Convention, April 1, 1899.)

20,189. Nisbett. Indicating or recording and controlling the speed of electric railway cars or vehicles and other machinery.

20,277. Eckstein and Coates. Electrical selector switch.

20,321. Pye. Construction and arrangement of electrical resistance coils.

20,387. Sehr. Manufacture of cement applicable for uniting porcelain, glass, metal and other substances for the manufacture of electric glow lamps and for dental and other purposes.

20,438. Barker. Means for holding shades or globes for electric and other lights.

20,655. Albion Clay Co. (Ltd.) and Lawton. Apparatus for use in forming joint ends on electrical conduits, drain pipes, and the like.

20,670. Houghton. Electric switches.

1900.

1,618. Kingsland. Method of and devices for regulating or controlling electrical switches.

2,340. Ducretet. Telephones.

2,710. Mordey and Fricker. Electricity meters.

5,293. Thomson. (Accumulatoren und Elektricitats Werke Actien Gesellschaft vorm. W. A. Boese & Co.) Lead presses for making plates for electric accumulators and the like.

5,397. Heidel. Armature for dynamo-electric machines.

7,031. Lake (Dudley). Electric clocks.

7,133. Lake (Washburn and Tinkham). Incandescence electric lamps.

8,226. Schmitt. Plates for secondary batteries.

10,133. Duncan. Voltmeters.

11,991. British Thomson-Houston Co. (Ltd.) (Hall). Rheostats for electric motors.
12,016. Ryan. Electrically propelled motor road vehicles.
12,018. Ryan. Electric propulsion for motor road vehicles.
12,111. Szczepanik and Kleinberg. Electrical jacquards and dobbies.
12,152. Heim. Method of increasing the capacity of lead secondary batteries in practical use.
12,537. Ribbe. Electric accumulator plates.
12,876. Johnson, Palmer and Cornen. Trolley for overhead electric traction.
12,971. Bruck. Electric switches.
13,044. Siemens Bros. & Co. (Ltd.) (Siemens and Halske Aktiengesellschaft). Electric railways in which transformers are carried on the train.
13,280. Ackermann. Arc lamps.

## COMPANIES' MEETINGS AND REPORTS.

### Cuba Submarine Telegraph Co. (Ltd.).

The fifty-eighth ordinary general meeting of this Company was held on Wednesday, Mr. Charles W. Parish presiding.

The SECRETARY (Mr. James Scott) read the notice convening the meeting.

The CHAIRMAN said: Before making comparisons of our revenue account with the figures laid before you twelve months ago, I may repeat what I mentioned at our last meeting, that we no longer estimate the receipts for the last two months of each half year, but wait till we are able to give you the actual results made up from the returns we receive from Cuba, and considering how complicated the accounts are, I think it indicates careful management on the part of our staff that we are able to lay before you the completed accounts within four months from the end of the half-year. I refer to this matter because the traffic receipts which were shown in the accounts ending June 30, 1899, profited from our having under-estimated the earnings in the last half of 1898, while the comparative statement of monthly traffics in the accounts now before you give the actual earnings of each month corrected from the returns. I will therefore take for the sake of accuracy the traffic from January to June, 1899—as shown in the statement, and amounting to £18,823—as the figure to be compared with the traffic for the first half of this year, which amounts to £13,177, thus showing a decrease of £5,646. This is a very serious falling off, but you will have been prepared for it, for I have clearly warned you at our meetings that you should remember we were bound to lose the exceptional amount of business which the revolution and war in Cuba gave rise to, and that we should suffer further from the low rates which competition and circumstances had forced upon us. In addition to our actual traffic receipts of £13,117, we have £2,158 as interest on investments, &c., giving a total of £15,336. The expenses have been £6,296, we have carried £2,000 to Reserve Fund, the dividend on the preference shares requires £3,000, and from the balance we are able to propose a dividend at the rate of 5 per cent. per annum on the ordinary share capital, leaving £5,204 to carry forward to the next half-year, as compared with £5,165 brought forward from Dec. 31, 1899. Comparing the £6,296 of expenses of the half-year now before us with those for the same period of 1899, you will find they are £961 less, for the total expenses then amounted to £7,257. Of this reduction £672 fall under the head of expenses at stations, and belongs chiefly to the items of salaries and wages and printing and stationery; also we have not had any expenses for alterations and repairs to offices, which amounted to £285 in 1899. The remaining reductions come under the items of depreciation on stores and cable in stock, and current law charges, while income-tax appears at an increased figure.

I will now call your attention to the balance-sheet. On the debit side you will notice that "Sundry creditors, including reserve for liabilities," amount to £9,635, as compared with £18,520 on June 30, 1899. This difference is chiefly due to the smaller business we are now doing, and to the large out-standings we had formerly in connection with the Government business during the war; beyond this account there is no item requiring explanation. On the credit side our sundry debtors are also reduced on account of the smaller business, and the claim for £8,174 for repairs to the cables damaged during the Spanish-American war is still outstanding. I have unfortunately no definite news to tell you regarding this claim, or of our concessions and general position in regard to the Government of the United States. The negotiations which Her Majesty's Ambassador is carrying on on our behalf with the United States are still proceeding, but I fear that until the American Elections are over and the President elected, we cannot hope for any definite news. It is, I feel, somewhat discouraging for those of us who are engaged in business to have to meet these long delays, but we must remember that the United States Government and the Cuban Authorities have still many points of the greatest importance to settle as to the future government of the Island. On the other hand it is very hard that we should not be paid the subsidy due to us for the coast cables, and we shall be much disappointed if this is not settled before long. We should now receive about £3,000 for the subsidy due for three half-years. There is one other matter I would like to refer to, which is the lawsuit we are having with the West India and Panama Company in regard to the construction of part of our agreement. I will not trouble you with the details, as the case is still before the Courts, but you will be glad to learn that the result of the trial in the High Court was completely in our favour. The West India and Panama Company thereupon gave notice of appeal, which will probably be heard at the end of this year or early next year. I now move the adoption of the reports and accounts.

Mr. GEORGE KEITH seconded, and the resolution was carried unanimously, as were resolutions approving the dividends at the rate of 10 per cent. on the preference and 5 per cent. on the ordinary shares; the re-election of Mr. C. W. Parish as a director, and re-appointing the auditors.

Mr. E. WEDGWOOD: Can you give us any hope regarding future half-years? I mean that the dividends will not be decreased to increase the reserve fund. The reserve fund is now very large in proportion to the capital. In the old chairman's time it was indicated that £100,000 would be a reasonable limit for the reserve, but we have now got a considerable increase on that figure, and it is open to question whether our dividends should be allowed to decrease with such a large reserve to fall back upon. You see now we have very little more than half the dividend we used to get.

The CHAIRMAN: We have only put £2,000 to reserve this half-year, and must be guided by the state of our cables. When Mr. Greenwood stated that £100,000 might be the limit of the reserve we had not the coast cables. We have now a bigger responsibility on our shoulders, and our cables do not grow younger.

A vote of thanks to the chairman and directors terminated the proceedings.

### The Consolidated Telephone Construction and Manufacturing Co. (Ltd.).

The nineteenth ordinary general meeting of this company was held on Wednesday, Mr. Hubert F. Jackson (chairman of the company) presiding.

The CHAIRMAN, in moving the adoption of the report and accounts, said that the present Directors came into office, some of them in July and some of them in October of last year. They had, of course, a very large amount of back work to look into in order to get some hold of the position. It was decided, as the result of mature consideration, to ask Mr. Kerr, who was the then general manager of the Chili Telephone Company, to take the position of managing director of this company. The directors raised no objection to the fact, when explained to them, that Mr. Kerr was his (the chairman's) brother-in-law. He thought he might say that that appointment had given very happy results. The board had obtained an efficient manager of the factory in Mr. Dundas, and the results which he had given them in the short time he had been in the Company's employment were, he thought, satisfactory. The old directors had taken exception to the statement in the report that the whole of the profits had been made during the last five months of the year under review, but he thought that they were better able to judge than the late directors, who had not the figures before them. As regarded the value of the company's assets, they would see from the auditor's certificate that that gentleman had taken some exception as to the value at which the assets were entered in the balance sheet, because he could not be looked upon as a valuer. The Chairman then dealt with the Company's assets in detail, and claimed that their values were sufficiently assured to warrant their being placed to the credit of the revenue account. The profit for the year, £1,192, he contended, was very unsatisfactory when they considered the number of years the company had been in existence, but, on the other hand, it was rather better than the profits for several years past. The old Directors in their circular stated that the profit was the same as the previous trading profits, and in answer to that he wished to call attention to the fact that the average trading profit for the last five years was £835. The total profit shown in the revenue account for the year under review would have been £1,724 had it not been for the fact that during the transition stage they had had to pay double salaries and also the balance of the expenditure incurred by the shareholders' committee. It would be observed that the board had written £3,622 off stock, and they believed that it was now valued at what it was actually worth. With reference to the directors' proposal to pay an interim dividend, the only justification necessary for that was, he thought, the fact that the Directors were prepared to take the responsibility of advising the shareholders to pay that dividend. The clause in the report with reference to the National Telephone Co. explained itself, but he might say in this connection that the Directors' efforts to increase this company's scope had resulted in the last few days in a very considerable order being received from Australia. It was a very long time since the company had received an order from Australia, or, indeed, from any other colony. Referring to the business of the Anglo-Portuguese Telephone Co., he expressed the belief that that concern was capable of giving very much greater profits than it had ever done in the past. At the present time they had very important negotiations in progress with the Portuguese Government, and with the Electric Tramways Company in Portugal, with reference to their system, which would probably result in something satisfactory for this company. The old directors had expressed some fear with regard to the important assets of the company, which were comprised of interests in the subsidiary companies, but in his (the chairman's) opinion there was no foundation for taking such a view of the matter. As to the lawsuit in which the Edison-Gower Bell Co. and this company is concerned, and which had been for many years in progress, the company's lawyers advised them that the final stage had been entered upon, and that they might hope to hear something definite before long. Hitherto the business of the Consolidated Company had been restricted to the sale of telephones and telephonic apparatus. They had, however, from time to time had many inquiries with regard to the furnishing of electric light materials, and in order to fulfil orders in that direction the board had made an arrangement to secure a very con-

siderable share in a business in London which had its own factory and a regular business. That concern was earning a considerable profit, which was being increased day by day, and at the next meeting he hoped to give them full details of the arrangements. Alluding to Colonel Gouraud's nomination of himself as a candidate for a seat on the board, the chairman said that they had no wish to add to their number. The Directors who superseded Colonel Gouraud many years ago had left him out in the cold, so to speak, for some 15 years, but now, after being superseded in their turn by the present board, they were advocating his election. He would not express any opinion as to their motive for taking such a course, but he thought that it would be far better for the company's business if the matter had never been brought forward and grievances ventilated in the public press. In conclusion he moved the adoption of the report and accounts and the payment of an interim dividend for the six months ending September, 30, 1900, at the rate of £3 per cent. per annum, less income tax, to be paid on and after the 15th prox.

Mr. WOOLLEY (a director) seconded the motion.

Mr. FITZGERALD asked the chairman to answer a series of written questions which he had sent to the Board.

The CHAIRMAN having done so, Mr. FITZGERALD alluded to the profit for the period under review as unsatisfactory. They must remember that he had managed the business for 15 years. The directors, in their report, declared that the whole of the profit was made in the last five months of the year, but a late director—Mr. Growing—who, unfortunately, was not present, could have told them a very different tale. Perhaps they thought what he was saying was very comical. He was somewhat astonished to observe that the "wonderful" balance sheet was swallowed by certain stockbrokers, but he did not swallow it. They would never find him on the board again. He concluded by moving, as an amendment: "That the report and accounts be referred back to the directors with the request that the accounts be made up in the same manner as formerly, and submitted to an adjourned meeting to be held in a month's time."

Mr. A. H. BAKER considered Mr. Fitzgerald's amendment, which he seconded, a very prudent one, as the shareholders ought to be in a position to compare this balance-sheet with those issued in previous years. If the figures in the present balance sheet were correct, he congratulated the directors on the result of the year's trading, but he did not wish to be misled. He desired to know if the proposed dividend had been earned, and if the assets were still intact.

The CHAIRMAN replied that they had sold their National Telephone shares prior to their recent fall in price, and the proceeds were in the bank. In addition they had sold 550 shares of the United River Plate Telephone Co, and that money was also in the bank. They would observe that the dividend mentioned in the report was an interim dividend, which had been earned during the current year, and it had nothing whatever to do with the period covered by the balance sheet. As to the amendment, the report and balance-sheet had been circulated amongst the shareholders, and the directors had received proxies amounting to 114,733 against 21,001 held by Colonel Gouraud.

Colonel GOURAUD: I am surprised there are so many.

Mr. J. G. GRIFFITHS, F.C.A. (auditor) said that the board had given him every explanation with regard to the value of the assets, and no doubt they were right in their opinion with regard to the value of the securities, but he was not sufficiently assured on the matter to allow them to be placed to the credit of the revenue account without calling the attention of the shareholders to the matter.

Col. GOURAUD dealing with the assets of the company placed to the revenue account, contended that the item of the private lines installation ought never to have appeared on the credit side of that account. If the dividend was to be paid he should want a written contract from the directors that they took the responsibility for the money, and he should use his votes against the payment of the dividend unless the directors were prepared to carry out his desire. He wished to know whether the Chairman was interested in the Telautograph Company, some of whose shares were held by the Consolidated Company?

The CHAIRMAN repeated the statement that the interim dividend was to be paid out of profits earned since March 31. He was largely interested in the company Colonel Gouraud had referred to, and he believed that the investment would prove advantageous to this company. He was not the promoter of that company.

Mr. Fitzgerald's amendment was then submitted to the meeting and negatived by a large majority, and the chairman's resolution for the adoption of the report and accounts was agreed to.

Colonel Gouraud demanded a poll, which the chairman announced resulted as follows:—For the resolution, 116,133; against, 23,001. The resolution was therefore declared by the chairman to be carried.

The retiring director and auditors having been re-appointed, the meeting terminated with a vote of thanks to the chairman.

## Western Telegraph Co. (Ltd.).

The report of the directors of this company for the half-year to June 30 states that the revenue amounted to £230,434. 19s. 9d. and the working expenses to £80,579. 15s. 2d. After providing £11,031. 12s. 4d. for debenture interest and sinking fund, and £3,210. 5s. 7d. for income tax, there remains £135,613. 6s. 8d.; to which is added £6,790. 19s. 6d. from Dec. 31, making £142,404. 6s. 2d. A quarterly interim dividend (absorbing £31,189. 10s.) has been paid, and £50,000 transferred to reserve. The directors now recommend a final dividend of 3s. per share, making, with interim dividends, 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both tax free, which together will amount to £51,832. 10s., leaving £8,571. 0s. 8d. to be carried forward. The dividend and bonus are payable Nov. 1.

The company has recently acquired an interest in the capital of the River Plate Telegraph Co. (Ltd.). The directors of the Western Company will become directors of the River Plate Company.

An amount of £400,000 4 per cent. debenture stock has been constituted; of this amount £348,777 has been allotted to the late holders of the same amount of 4 per cent. debenture stock of the Western Company in lieu of their being paid off at par. The balance remains at present unissued.

Additional cables have been successfully submerged between Para and Rio de Janeiro, and are being continued from the latter city to Montevideo.

**ELECTRIC STREET CAR MANUFACTURING SYNDICATE (LTD.).**—An extraordinary meeting was held last week at Wolverhampton, when a resolution was adopted approving an agreement for the sale of this company's business to the Electric Tramway Maintenance and Construction Co. (Ltd.). The Street Car Company's business was established about three years ago for the manufacture of motor cars. The Electric Tramway Maintenance and Construction Co. will, it is stated, acquire 20 acres of land at Wednesfield for extending the works. Mr. Thomas Parker, chairman of the Electric Street Car Syndicate, will join the board of the Maintenance Company.

**MONTE VIDEO TELEPHONE CO. (LTD.).**—The report of the directors for the year ended July 31 states that the net profit was £9,269. 16s. 5d., after providing for working expenses in Monte Video and London and for depreciation of stock of materials. Adding £2,258. 3s. 5d. brought forward, the available balance is £11,527. 19s. 10d. From this £3,500 is transferred to reserve, and the directors recommend dividends at the rate of 5 per cent. per annum on the preference and 2½ per cent. per annum on the ordinary shares, £1,880. 7s. 10d. being carried forward. There has been a continued increase in the number of subscribers during the past year, with a corresponding improvement in receipts. Mr. J. G. Le Marchant has been elected a director on the resignation of Mr. H. Ward.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BLACKMAN EXPORT CO. (LTD.).**—This company was registered on Oct. 5, with a capital of £20,000 in £1 shares (5,000 preference), to deal in, import, and export ventilating and similar apparatus and other goods manufactured or dealt in by the Blackman Ventilating Co. (Ltd.). The first directors are M. Shillito, H. R. Griffin, J. L. Copping, and H. J. Trautmann (managing).

**BRITISH ELECTRIC STREET TRAMWAYS (LTD.).**—This company was registered on Oct. 18, with a capital of £500,000 in £1 shares, to construct, equip, maintain, and work electric tramways and railways, and to carry on business as electricians, engineers, tool makers, &c.

**COLWYN BAY ELECTRIC LIGHT AND POWER CO. (LTD.).**—This company was registered on Oct. 17, with a capital of £3,000 in £1 shares (1,000 preference), to carry on business as electricians, electrical and general engineers, suppliers of electricity, makers of electrical apparatus, &c., and in particular to take over the business formerly carried on by Messrs. T. S. and H. R. Jones, at Vron Haulog. Mr. Rowland H. Hughes is the first managing director.

**KING ARC LAMP CO. (LTD.).**—This company was registered on Oct. 18, with a capital of £5,000 in £1 shares, to acquire patent rights relating to an electric lamp known as the "King" arc lamp, and to carry on the business of electric lamp, plant, and fittings manufacturers, electricians, electrical engineers, &c. The subscribers are: H. W. Gorringe, F. Alexander, Lavinia Williams, G. Hearsey, S. R. D. Thorpe, C. B. King, jun., electrical engineer, and C. R. Smith, electrician.

**EXCHANGE TELEGRAPH CO. (LTD.).**—The annual return to Aug. 14 has been filed. The capital is £246,250 in 8,125 "A" and 16,500 "B" shares of £10 each, of which 8,023 "A" and 16,200 "B" have been taken up. £9 has been called up on each of 6,000 "A" and £1 on each of 2,023 "A" shares, and £56,023 has been received. £8 per share is considered as paid on 2,125 "A" shares, and all the "B" shares are issued as fully-paid.

**LANGDON-DAVIES ELECTRIC MOTOR CO. (LTD.).**—The annual return to Aug. 24 gives the capital as £70,000, in 20,000 preference and 50,000 ordinary shares of £1 each, of which 15,850 preference and 44,007 ordinary have been taken up. £1 has been called up on each of the preference and 4,007 ordinary shares; 40,000 ordinary shares are considered as fully-paid.

**WHITE, JACOBY & CO. (LTD.).**—The annual return to Sept. 13 gives the capital as £4,000 in £1 shares, 3,022 of which have been taken up. £1 has been called up on each of 665 shares and 2,357 shares are considered as fully-paid.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 30d. per oz. (Oct. 25). Consols (2¾ per cent. 98⅛–98¼ for money, 98¼–98⅜ for account; 2½ per cent. 97½–98 (Oct. 25). Stocks and Shares Continuation Days, Nov. 12 and 27; Ticket Day, Nov. 13; Pay Days, Oct. 26 and Nov. 14; Mining Share Carry-over Days, Nov. 9 and 26.

**CALCUTTA ELECTRIC SUPPLY CORPORATION (LTD.).**—An interim dividend at the rate of 5 per cent. per annum has been declared for the half-year to June 30.

**CASTNER-KELLNER ALKALI CO. (LTD.)**—An interim dividend on the original capital (as well as on the new capital allotted to the shareholders of the Aluminium Co.) at the rate of 8 per cent. per annum has been declared for the six months ended 30th ult.

**ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)**—During the week this company invited applications for an issue of 19,900 £5 6 per cent. cumulative preference shares at par.

**STOCK EXCHANGE NOTICES.**—Nov. 13 has been appointed a special settling-day in the further issue of 5,000 £5 fully-paid shares (Nos. 20,001 to 25,000) of the *Telegraph Manufacturing Co. (Ltd.)*, and the shares, together with the 10,000 ordinary £5 fully-paid shares (Nos. 1 to 10,000) of the *Folkestone Electricity Supply Co. (Ltd.)*, and £500,000 4 per cent. debenture stock of the *National Telephone Co. (Ltd.)*, have also been ordered for quotation in the official list. Application has also been made to the committee to appoint a special settling day in, and to grant a quotation to the further issue of 10,000 6 per cent. cumulative preference (£10 fully paid) shares and 15,000 ordinary (£10 fully paid) shares of the *British Electric Traction Co. (Ltd.)*, and also to appoint a special settling day in the further issue of 4,300 (£1 fully paid) shares (Nos. 140,001 to 144,300) of *Pearson's Fire Alarm System (Ltd.)*.

**SUBMARINE CABLES TRUST.**—In accordance with the terms of the trust deed, tenders are invited from certificate holders of certificates to be redeemed out of surplus income accrued to Oct. 15, at a price not to exceed £120 per certificate, the certificate holder retaining the coupon of reversion attached to any certificate thus redeemed. Certificate holders desirous of surrendering their certificates on these terms should communicate with the secretary stating the lowest price they are willing to accept.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| *Birmingham Tramways. | Oct. 20 | 4,431 | + 183 | 15 | 68,846 | + 3,090 |
| Blackpool Corporation .. | „ 18 | 333 | + 99 | 29 | 25,947 | + 6,759 |
| Blackpool and Fleetwood | „ 20 | 259 | − 66 | 16 | 18,663 | + 30 |
| Bolton Corporation ...... | ... | ... | ... | ... | ... | ... |
| Bradford Corporation... | „ 21 | 515 | + 166 | 29 | 15,093 | + 3,366 |
| Brisbane Trams ......... | Sept. 5 | 1,843 | + 366 | 9 | 16,687 | + 3,419 |
| *Bristol Trams & Carriage | Oct. 20 | 2,994 | − 67 | 16 | 55,899 | + 675 |
| *Buenos Ayres & Belgrano | Sept. 23 | 2,017 | − 427 | 12 | 26,766 | − 281 |
| Central London Railway | Oct. 20 | 5,465 | + 44 | 12 | 58,396 | ... |
| City & South London Ry. | „ 21 | 1,708 | + 689 | 16 | 24,592 | + 9,338 |
| Cork Elec. Trams ......... | „ 18 | 410 | + 33 | 42 | 17,463 | + 1,454 |
| Dover Corporation ...... | „ 20 | 198 | + 11 | 29 | 7,006 | + 388 |
| Dublin & Lucan Rly. | „ 20 | 111 | + 12 | 16 | 1,736 | + 319 |
| Dublin United ......... | „ 19 | 3,496 | + 487 | 16 | 61,430 | + 8178 |
| Dublin Southern Dist.... | „ 19 | 750 | + 155 | 16 | 17,120 | |
| *Glasgow Corporation ... | „ 20 | 9,252 | − 126 | ... | ... | ... |
| Hull Corporation ......... | „ 20 | 1,574 | + 903 | 16 | 22,236 | + 11,861 |
| *Liverpool Corporation... | „ 13 | 8,628 | + 1,467 | 41 | 322,332 | + 40,657 |
| Liverpool Overhead Rly. | „ 21 | 1,594 | + 23 | 16 | 27,376 | + 1,202 |
| *Sheffield Tramways ...... | „ 21 | 2,480 | + 1,422 | 42 | 93,813 | + 33,369 |

* Partly electrical.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | NAME. | Previous Week's Price, Oct. 17. | | Price Wednesday, Oct. 24. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 24. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd. | ¾ | ¾ | ¾ | ¾ | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | 10½ | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 19/8 | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 102 | 105 | 4 6 6 | ... | 103 | ... |
| 19,561 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 30,000 | 5 | ... | Calcutta Elec. Supply Ordinary (fully paid) | 6 | 6½ | 6½ | 6¾ | ... | ... | 6⅛ | 6⅜ |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 12 6 | February and August | 9⅝ | ... |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | „ „ | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7½ | 6½ | 7½ | 4 0 0 | March | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December... | 111½ | 111 |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,879 | 10 | 8/0 | City of London Electric Lighting Ord. | 8 | 9 | 8 | 9 | 4 8 11 | February and August | 8½ | 8½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 12½ | 13½ | 4 9 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 124 | 130 | 125 | 131 | 3 17 10 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | 9 | 8⅞ |
| 30,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 5 0 0 | March and September | 11½ | ... |
| £200,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 109 | 111 | 108 | 111 | 4 1 10 | ... | ... | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | ... | | 5½ | 6 | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 5 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2½ | ... | ... | 2⅛ | 2 |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 18 5 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 13½ | 14½ | 13½ | 14½ | 3 15 10 | April and October | 14½ | 13½ |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 7 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 7 | ... | 98½ | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | „ | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ¾ | 1 | ¾ | 1 | 12 16 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 6 18 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 165 | 185 | 165 | 185 | 4 6 6 | April and October | ... | ... |
| £115,800 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | „ „ | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 5 | February and August | 15½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | „ „ | ... | ... |
| [illegible] | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | ... | | 97 | 100 | ... | ... | 99½ | 99½ |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 3 | 4 | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 29,457 | 5 | ... | Do. Do. | 11 | 12 | 11 | 12 | ... | ... | 11½ | 11⅛ |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,600 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £147,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 101 | 103 | 101 | 103 | 4 17 1 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 21½ | 22½ | 23 | 24 | 3 8 11 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd) | 10½ | 10½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 13,600 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 10 | 10½ | 10 | 10½ | 4 15 3 | May and November | ... | ... |
| 45,000 | 10 | 11/0 | British Elec. Trac. Ord. | 13½ | 14½ | 12½ | 13½ | 7 8 2 | ... | 13½ | 13½ |
| 50,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 4 | February and August | 13½ | 12½ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 121 | 123 | 121 | 123 | 4 1 4 | ... | 121 | 120½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5 | 4½ | 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 3½ | 4½ | 3½ | 4½ | ... | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 101 | 107 | 104 | 107 | 4 13 8 | ... | ... | ... |
| £120,000 | Stock | 13/9 | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 6 1 0 | ... | ... | ... |
| 200,237 | 10 | 3/0 | Central London Ordinary | 10 | 10½ | 10 | 10½ | 2 17 1 | June and December | 10½ | 10½ |
| £555,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 55 | 61 | 59 | 61 | 2 5 2 | February and August | 59 | ... |
| 37,500 | 10 | 1/3⅓ | Do. Ordinary (Nos. 22,501 to 60,000) | 5 | 6 | 5 | 6 | 2 9 4 | „ „ | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 133 | 143 | 138 | 143 | 3 9 11 | „ „ | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £244,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 120 | 125 | 123 | 125 | 3 4 5 | May and November | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 20½ | 21½ | 20½ | 21½ | 3 12 6 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 9 | „ „ | ... | ... |
| £[illegible] | Stock | 4½% | † Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | 9½ | 10½ | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 4% | Liverpool Overhead Railway Ordinary | 8½ | 9 | 8½ | 9 | 4 8 11 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 13 6 | „ „ | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 104 | 106 | 104 | 106 | 3 16 0 | January and July | ... | ... |
| £[illegible] | 100 | 5% | Montreal Street Railway Sterling 5% Mort. Debs. (1908) | 103 | 105 | 104 | 105 | 4 15 0 | ... | 104½ | ... |
| £140,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 4 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 3½ | 3½ | 3½ | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | 17 | 18 | ... | February and August | ... | ... |
| 4,000 | 10 | 4/0 | Do. 5 per Cent. Preference | ... | | 10½ | 10½ | 4 13 0 | „ „ | ... | ... |
| 13,134 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 13½ | 11½ | 13½ | ... | ... | ... | ... |
| 30,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10½ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 101 | 107 | 101 | 107 | ... | ... | ... | ... |
| 640,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 2 1 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 17. | Price Wednesday, Oct. 24 | Rate per Cent. Yielded. | Dividends Due. | Business Done During Week Ending Oct. 24: Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 103 | 99 103 | 3 17 8 | January and July | ... | ... |
| 35,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,000 | 100 | 5% | Do. 5 per Cent. Debentures | 86 90 | 86 90 | 5 11 1 | | ... | ... |
| £632,120 | Stock | 15/0 | Anglo-American | 55 59 | 56 57 | 5 5 6 | Feb., May, Aug., Nov. | 56 | 55 |
| £3,984,640 | Stock | 30/0 | Do. Preferred | 107½ 109½ | [illegible] 11[illegible] | 5 1[illegible] [illegible] | " " | 10[illegible] | 10[illegible] |
| £3,984,640 | Stock | 27/0 | Do. Deferred | 1[illegible] 11 | 1[illegible] 1[illegible] | 12 11 2 | " " | 10[illegible] | 10[illegible] |
| 15,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 165 175 | 166 176 | 4 11 5 | Jan., Apr., July, Oct. | ... | ... |
| £1,549,495 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 102 | 101 103 | 3 17 10 | " " | 10[illegible] | 10[illegible] |
| 16,000 | 10 | 6/0 | Cuba Submarine Ordinary | 6½ 7½ | 6½ 7½ | 1[illegible] [illegible] [illegible] | February and August | 7[illegible] | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 16 | 15 16 | 6 5 0 | " " | ... | ... |
| 12,931 | 5 | 2/0 | Direct Spanish Ordinary | 4 5 | 4 5 | 4 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ 11 | 1[illegible] 10[illegible] | 6 10 0 | Jan., Apr., July, Oct. | 10½ | 10½ |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 101 | 99 101 | 4 5 0 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 148 151 | 14[illegible] 15[illegible] | 4 1[illegible] 11 | Jan., Apr., July, Oct. | 15[illegible] | 149½ |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 99 102 | 99 102 | 3 [illegible] [illegible] | " " | 101 | 9[illegible] |
| £1,432,265 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 11[illegible] 12[illegible] | 11[illegible] 12[illegible] | 3 7 10 | May and November | 11[illegible] | 117½ |
| 250,000 | 10 | 2/6 | Eastern Extension | 15 15½ | 15½ 15[illegible] | 4 11 10 | Jan., Apr., July, Oct. | 15[illegible] | 15[illegible] |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000 issued at £3 pm all pd.) | 5[illegible] 7[illegible] | [illegible] 7[illegible] | ... | ... | 6[illegible] | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 115 | 115 118 | 3 7 10 | February and August | 118½ | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 102 | 99 102 | 3 18 6 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% 104% | 101% 104% | 3 17 8 | May and November | ... | ... |
| 180,227 | 10 | 4/6 | Globe Telegraph and Trust | 10½ 11 | 1[illegible] 11½ | 4 1[illegible] [illegible] | Jan., Apr., July, Oct. | 11[illegible] | 10½ |
| 180,042 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 15½ | 15 15½ | 3 17 5 | " " | 15½ | 15½ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 32 34 | 3[illegible] [illegible] | 3 1[illegible] 6 | January and July | [illegible] | ... |
| £44,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 101 | 99 101 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 37/6 | Indo-European | 60 61 | 6[illegible] 6[illegible] | 4 1[illegible] 4 | May and November | [illegible] | [illegible] |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 106 | 103 10[illegible] | 5 12 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 104 | 100 103 | 3 17 9 | June and December | ... | ... |
| 11,839 | 5 | 6/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,341 | £100 Cert. | 6% | Submarine Cables Trust | 124 127 | 124 12[illegible] | 4 13 [illegible] | " " | ... | ... |
| 15,630 | 10 | ... | West African Telegraph | 2½ 3½ | 2½ 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 101 | 98 101 | 4 19 0 | March and September | ... | ... |
| 30,006 | 3½ | ... | West Coast of America | ½ 1 | ½ 1 | ... | ... | ... | ... |
| £160,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 10[illegible] 10[illegible] | 3 14 4 | January and July | ... | ... |
| 88,321 | 10 | 1/0 | West India and Panama | ½ 1 | ½ 1 | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ 7½ | 6½ 7½ | 5 0 0 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 6 7 | [illegible] 7 | 6 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 108 | 10[illegible] 108 | 4 13 6 | January and July | ... | ... |
| 277,000 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 14½ 14½ | 14½ 15 | 4 13 4 | Mar., June, Sept., Dec. | 14½ | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd series, 1906) | 103 106 | 103 106 | 4 14 4 | June and December | ... | ... |
| £1,313,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 101 104 | 10[illegible] 1[illegible] | 3 16 2 | ... | 103½ | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £3 | 4/0 | Chili Telephone (fully paid) | 3½ 3½ | 3½ 3½ | 5 14 4 | August | ... | ... |
| 321,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Maint. | ... | ... | ... | July | ... | ... |
| 72,690 | 1 | 2½% | Monte Video Telephone Ordinary | ½ ½ | ½ ½ | 5 0 0 | November | ... | ... |
| 64,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ½ 1 | ½ 1 | 5 0 0 | " | ... | ... |
| 500,000 | 5 | 3/0 | National | 4½ 4[illegible] | 4[illegible] 4[illegible] | 6 [illegible] [illegible] | February and August | 4[illegible] | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 15 15 | 15 16 | 4 0 0 | " " | 15 | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 15 15 | 15 15 | 4 0 0 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 5 5½ | 5 5½ | 4 15 3 | " " | 5 | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 97 100 | 9[illegible] [illegible] | 3 11 [illegible] | June and December | [illegible] | [illegible] |
| £[illegible] | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | ... | ... 1[illegible] | ... | ... | ... | ... |
| 17,[illegible] | 1 | 0/4 | Oriental | ½ 1½ | ½ 1[illegible] | 4 5 11 | April and October | ... | ... |
| 55,000 | 5 | 4/6 | United River Plate | 4½ 5½ | 4½ 5½ | 4 13 4 | July | ... | ... |
| 16,423 | 5 | 2/6 | Do. 6% Cumulative Preference | 4½ 5½ | 4½ 5½ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 107 | 104 107 | 4 13 6 | " " | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 2d. | Alliance Electrical Co. 6% Cum. Pref. | 1 1½ | 1 1½ | 4 5 11 | ... | 1[illegible] | ... |
| 125,000 | 1 | 7½d. | Anglo-American Electricity Motor 6 per Cent. Cum. Pref. | ½ ¾ | ½ ¾ | 7 7 5 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 99 | [illegible] [illegible] | 4 4 1 | ... | ... | ... |
| 40,000 | 5 | 5/0 | British Insulated Wire Ordinary | 11 12 | 10 11 | 4 1[illegible] 1[illegible] | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6½ 6½ | 5½ 6½ | 4 16 0 | ... | ... | ... |
| 100,000 | 5 | 1/6½ | British Westinghouse 6% Preference | 4½ 5½ | 4½ 5½ | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Brush Electrical Engineering | 1½ 2 | 1[illegible] 1½ | [illegible] [illegible] [illegible] | September | 1[illegible] | 1½ |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 6 per Cent. Pref. Non-Cum. | 2½ 2½ | 2 2½ | 5 [illegible] [illegible] | " | 2[illegible] | 2[illegible] |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 10[illegible] 111 | 10[illegible] 111 | 4 0 11 | March and September | ... | ... |
| £1[illegible] | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 10[illegible] 11[illegible] | 1[illegible] 11[illegible] | 4 7 2 | January and July | ... | ... |
| 3[illegible] | 5 | 10/0 | Callender's Cable Construction Ord. | 12½ 13½ | 12½ 13½ | 5 11 8 | " " | 1[illegible] | 12[illegible] |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 5½ | 5 5½ | 4 11 11 | " " | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 114 | 110 114 | 3 19 11 | November and May | ... | ... |
| 300,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 1½ | 1 1½ | 6 [illegible] [illegible] | ... | 1½ | 1[illegible] |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 97 100 | 97 100 | 4 1[illegible] [illegible] | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ½ 1 | ½ 1 | 6 1[illegible] [illegible] | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ½ 1½ | ½ 1½ | 5 6 8 | ... | ... | ... |
| 51,000 | 3 | 2/[illegible] | Crompton and Co. (Nos. 1 to 51,000) | 3½ 4½ | 3½ 4½ | [illegible] [illegible] 11 | January and July | [illegible] | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 102 | 99 10[illegible] | 4 1[illegible] [illegible] | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ½ 1½ | ½ 1½ | [illegible] 6 [illegible] | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ 2½ | 1½ 2½ | 8 [illegible] [illegible] | February and August | 1[illegible] | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ 4½ | 3½ 4½ | 6 13 4 | " " | ... | ... |
| £344,[illegible] | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 92 | [illegible] 92 | 4 7 6 | June and December | [illegible] | ... |
| £100,000 | Stock | 2½% | Do. 5% Deb. [illegible] | 9[illegible] 10[illegible] | 9[illegible] 1[illegible] | ... | ... | ... | ... |
| 35,000 | 5 | 6/0 | Edmundson's Electricity Corporation, Ltd. | 4½ 5 | 4½ [illegible] | [illegible] [illegible] [illegible] | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | [illegible] 101 | [illegible] 101 | 4 7 [illegible] | ... | ... | ... |
| 112,[illegible] | 2 | 1/2½ | Electric Construction, Limited | 2 2½ | [illegible] [illegible] | 5 [illegible] [illegible] | January and July | 2[illegible] | ... |
| [illegible] | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ 2½ | 2½ 2½ | 5 [illegible] 2 | July | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 10[illegible] | 10[illegible] 10[illegible] | 3 1[illegible] 2 | January and July | 10[illegible] | ... |
| 3[illegible] | 5 | 4/0 | Henley's Telegraph Works Ordinary | 12½ 13½ | 12½ 13½ | 5 1[illegible] 1 | February and August | [illegible] | 13½ |
| 3[illegible] | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 5½ | [illegible] 5½ | 4 1 11 | " " | [illegible] | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 104 112 | 10[illegible] 1[illegible] | 4 [illegible] 4 | " " | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 2[illegible] 2[illegible] | 2[illegible] 2[illegible] | 4 1[illegible] 5 | " " | ... | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 1[illegible] 102 | [illegible] 10[illegible] | 3 1[illegible] [illegible] | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | [illegible] 3[illegible] | [illegible] 3[illegible] | 4 [illegible] [illegible] | March and July | [illegible] | 3[illegible] |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1899 | 101 10[illegible] | 101 10[illegible] | 3 1[illegible] 1[illegible] | January and July | ... | ... |
| 2[illegible] | 5 | 9/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11½ | 5 4 4 | ... | ... | ... |
| 2[illegible] | 5 | 2/6 | Do. 6 per Cent. Cumulative Preference | [illegible] [illegible] | [illegible] [illegible] | 4 1[illegible] 1 | ... | ... | ... |
| 3[illegible] | 5 | 5/0 | Willans and Robinson Ordinary | 11½ 11½ | 11½ 11½ | 6 1 [illegible] | April and October | 1[illegible] | 11½ |
| 7[illegible] | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | [illegible] 7[illegible] | 6[illegible] [illegible] | 4 2 [illegible] | " " | 7[illegible] | 7[illegible] |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 10[illegible] 107 | 10[illegible] 107 | 4 0 4 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.


Kabelwerk
Duisburg

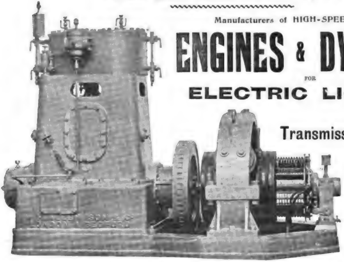

THE SIMPLEX STEEL CONDUIT CO.
BIRMINGHAM & LONDON

# W. H. ALLEN, SON & Co., LIMITED,

## QUEEN'S ENGINEERING WORKS, BEDFORD.

AND

27, OLD QUEEN STREET, WESTMINSTER, S.W.



Manufacturers of HIGH-SPEED ENCLOSED

## ENGINES & DYNAMOS

FOR

## ELECTRIC LIGHTING

AND

## Transmission of Power.

COMPLETE
INSTALLATIONS
CARRIED OUT.

**STANDARD SIZES of ENGINES from 10 to 1,000 Horse Power.**

---

CHICAGO: HIGHEST AND ONLY AWARD FOR TROLLEYS. DIPLOMA AND MEDAL FOR INSULATORS.
BRUSSELS: 1897, "HORS CONCOURS, MEMBRES DU JURY."

# ROBT. W. BLACKWELL & CO., LIMITED,

ENGINEERS AND CONTRACTORS FOR

## ELECTRIC TRAMWAY CONSTRUCTION AND EQUIPMENT.

POLES, TROLLEY-WIRE, FEEDERS, RAILBONDS, INSULATORS, TROLLEYS, MOTOR-TRUCKS, ENGINES, LINE MATERIAL and SUPPLIES OF EVERY DESCRIPTION.

**59, CITY ROAD, LONDON, E.C.**

Telegrams: "KURKEE LONDON." Codes. "A B C," "A 1," "Liebers," &c. Telephones: 1479 & 1480 London Wall.

---

# THE NEW
## PRESSED MICA
# INSULATOR.

TRADE MARK

**In Sheets.**
**Hard & Flexible.**
**In Moulded Forms**
**Of Any Description.**

**MICA** cut to any Template. **MICA** in the Slab and Knife-trimmed.

**MICA CLOTH. ASBESTONITE. MICA PAPER.**

**D. JAROSLAW, 5, George Street, Tower Hill, London, E.C.**

TELEGRAMS: "MONAZITE LONDON." CONTRACTOR TO THE ADMIRALTY.

**BELLISS & MORCOM LTD.**

(SUCCESSORS TO G. E. BELLISS & CO., LTD.),

LONDON OFFICE: 9, Victoria Street, S.W. ENGINEERS, BIRMINGHAM

SPECIALITY: **PATENT SELF-LUBRICATING QUICK-REVOLUTION ENGINES FOR ELECTRIC LIGHT, POWER OR TRACTION.**

**OVER 160,000 H.P. SUPPLIED OR IN HAND FOR**

**MUNICIPAL AUTHORITIES (Lighting & Tramways)**—
St. Pancras, Shrewsbury, Southampton, Bury, Croydon, Chester, Port Elizabeth (South Africa), Wolverhampton, Kingston-on-Thames, Bedford, Ayr, Cheltenham, Taunton, Leeds, Blackburn, Sunderland, Gibraltar, Belfast, Llandudno, Shoreditch, Edinburgh, Canterbury, Leith, Burnley, West Hartlepool, Bootle, Gloucester, Aberdeen, Coventry, Worcester, Rochdale, Darwen, Harrogate, Wakefield, Hammersmith, Woking, Newport, Battersea, Hampstead, Bournemouth, East London (South Africa), Cardiff, Buxton, Bloemfontein (South Africa), Tynemouth, Hereford, Glasgow, Bury St. Edmunds, Hastings, Govan, Ealing, Stirling, Greenock, Beckenham, Hoylake and West Kirby, Middleton, Hackney, Grimsby, Southport, Halifax, Poplar, Birmingham.

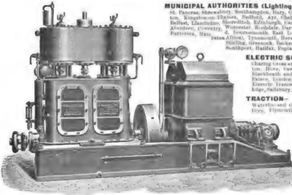
**ELECTRIC SUPPLY COS. (Lighting & Tramways)**—
Charing Cross and Strand, Winchester, Reading, Guernsey, Carlow, Northampton, Hove, Oswestry, Electricity Supply Co. for Spain (Madrid), Windsor, Blackheath and Greenwich, Colombo, House-to-House Co., London; Crystal Palace, London, Bristol Tramways, London United Tramways, Queenstown Electric Tramways, Central London Railway, Ventnor, Bromley, Alderley Edge, Salisbury, Montrose, Brechin, Newcastle.

**TRACTION**—
Waterloo and City Railway, Metropolitan and District Railway, Hull, Blackburn, Plymouth, Isle of Thanet Light Railways (Electric), Sunderland, Wolverhampton, Bury, Belfast, West Hartlepool, Bootle, Aberdeen, Rochdale, Darwen, Waterloo and Baker Street Railway, Great North of Scotland Railway, Tynemouth, East London (South Africa), Russian Railways.

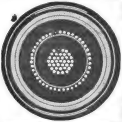
Large numbers of these Self-Lubricating Engines have also been supplied to the British and other Governments, the principal Shipbuilding, Engineering and Steel Works in the United Kingdom, to Railway and Steamship Companies at home and abroad, and to many Public Institutions.

**Established 1852.**

Telegraphic Address
"BELLISS, BIRMINGHAM."



Representing our EC/10 STANDARD ENGINE, 250 B.H.P.
— *70 IN USE OF THIS SIZE ALONE.* —



**SOCIÉTÉ D'EXPLOITATION DES CÂBLES ÉLECTRIQUES**

(SYSTEM BERTHOUD, BOREL and CO.)

**CORTAILLOD, SWITZERLAND.**

**PATENTED**

**LEAD-COVERED CABLES**

MANUFACTURED FOR

**TELEPHONE, TELEGRAPH,**
**ELECTRIC LIGHT.**

Special highly-insulated CABLES for High-Tension Alternate Currents,
As used at Vienna, Insbruck, Lucerne, Vevey, Montreux, Cologne, Monaco, &c.

**AYRTON-MATHER**

**ELECTROSTATIC VOLTMETERS**

*For Direct or Alternating Currents of any Frequency.*

**Latest Improved Pattern.**

**9" DIAL Price £10.**
(usual size)

**FOR 1,000, 2,000 and 5,500 VOLT CIRCUITS.**

ACCURACY GUARANTEED.

**NALDER BROTHERS & THOMPSON, Ltd.**
(Managing Directors: F. H. NALDER and E. THOMPSON),
**34, Queen Street, LONDON, E.C.**
Telegrams:—"OCCLUDE LONDON." Telephone No. 124 BANK

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,172. [No. 2. Vol. XLVI.] FRIDAY, NOVEMBER 2, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

# NOTES.

WE notice, not without apprehension, that in some of the addresses of candidates for the new Borough Councils a strong point is being made of supplying cheap electric lighting to the working classes on the free wiring and penny-in-the-slot principle; and that, of course, this is to be undertaken by the local authorities. No exception can be taken to the working classes having electric light if they want it, or to their having it as cheaply as is equitable to supply it. But the terms in which these electoral addresses are couched reveal only too plainly the class prejudices to which they appeal, and convey the impression that whoever else may pay dearly for electricity —whether the well-to-do consumers or the ratepayers—the working man shall have it dirt cheap. On the other hand, some of the groups of candidates strongly condemn the lavish expenditure incurred or contemplated on electric lighting by the old parish authorities, and pledge themselves to a policy somewhat less adventurous. These conflicting ideas came to an issue at the polling stations yesterday; but the results were not known when we went to press last night. Let us hope that the new Municipal Councils will encourage electric lighting like their predecessors; but it cannot be for the permanent benefit of the electrical industry that it should be fostered by any form of preferential treatment likely to render it more costly to the classes who require to use it most.

ARISING out of the municipal elections at Manchester, a serious charge has been made against Alderman HIGGINBOTTOM, who has been nominated as Lord Mayor of that city. A Mr. S. NORBURY WILLIAMS has published an address violently attacking him and practically accusing him of using his influence as chairman of the Electric Lighting Committee to obtain orders for firms with which he is more or less connected, either by business or friendly ties. We are happy to see that Alderman HIGGINBOTTOM has been able to meet these charges and refute them point by point. Nevertheless, the incident illustrates once again the difficult questions that will inevitably be raised during the gradual extension of municipal trading, and shows that even such honourable and highly-esteemed men as Alderman HIGGINBOTTOM may be called upon for explanations on delicate matters involving at the same time their personal interests and those of the corporations of which they are the trusted servants.

THE REPORT of MR. A. A. VOYSEY, the City Electric Inspector, to the City of London Streets Committee, for the year ended March 31 last, has recently been published and, interesting throughout, is in many respects a curiously informing document. The first part of the report reviews the history of electric lighting in the City, in so far as this relates to "the events which led up to the granting of the City of London Electric Lighting Order, 1899, to the Charing Cross and Strand Electricity Supply Corporation," a matter emphatically of future importance to, even if not of great present influence on, electric lighting in the City. With regard to the change in the pressure of supply from 100 volts to 200 volts, Mr. VOYSEY considers very unsatisfactory the inability of the Board of Trade to make any conditions affecting the price of supply, when such a change of pressure is sanctioned. There is reason in the contention that if the change is introduced to enable supply to be made at a lower cost, the consumers' interests should be safeguarded by insisting on a reduction in price.

IN that part of his report which recounts progress during the year in the business of electric supply and public lighting Mr. VOYSEY states that only 11 meters were submitted to him for testing, and he expresses the opinion that "every meter used in the City ought to be tested" by the electrical inspector. He reports that negociations with the two supply companies are in satisfactory progress "for the testing of all meters at Guildhall without any expense to the Corporation." In other matters, however, there is not quite the same bright prospect that Mr. VOYSEY's ambitions will be realised in the immediate future. For instance, he would

like to see electric lighting extensively used in the side streets; but unfortunately this matter "has been delayed for several years in the endeavour to obtain a legal settlement of differences" with the supply company, with the details of which our readers are already familiar. Another restriction which apparently is troubling Mr. VOYSEY is that he is not yet armed with the power and means for testing the mains, with a view to determine "the value of the supply given to the public lamps."

PROF. BLONDEL'S able survey of the development of the electric lamp during the past decade, given in a condensed form on another page, will, we are sure, be read with attention even by those not directly interested in the problems of electric lighting. It must be admitted that progress has been very real from the point of view of construction, both with regard to the arc and incandescent lamp—but yet not so great as perhaps might have been hoped for a generation ago, if we view the matter from the standpoint of the efficiency of the lamp considered as a particular kind of energy transformer. True, we are promised in the Nernst lamp and the Welsbach and other similar filaments twice the efficiency of the usual carbon filament; but even in these so large a proportion of the electrical energy is, after conversion, radiated or otherwise dissipated in the form of heat, that the yield of illuminative energy cannot be more than 15 per cent. or 20 per cent. of the electrical energy supplied to the lamp. Some years ago it was freely prophesied that the remarkable behaviour of vacuum globes in the field of a high-frequency, high-pressure current would lead very quickly to the evolution of lamps which would rival the glow-worm in efficiency. But for the consummation of this dream we may have to wait far into the twentieth century, and we must admit that the highest development in electric lighting effected up to the close of the nineteenth century still constitutes a method involving such enormous waste that, from a purely scientific point of view, it cannot but be stigmatised as primitive.

**Royal Society.**—The first ordinary meeting of the session will be held at 4:30 p.m. on Thursday, November 15th.

**Batteries for Motor Cars.**—It is announced that the Automobile Club de France has decided to hold an electrical accumulator competition in May next.

**Pacific Cable.**—A bill enabling New South Wales to join the other British Colonies and Great Britain in the construction and maintenance of a Pacific cable has passed the New South Wales Legislature in all its stages without opposition.

**Wreck of a Cable Steamer.**—On September 22nd the Canadian Government c.s. "Newfield" became a total wreck near Digby, Nova Scotia. Fortunately no lives were lost. The "Newfield" was a boat of 785 gross tonnage and her captain was Mr. J. H. Campbell.

**Appointment.**—Mr. C. T. R. Wilson, M.A., has been appointed to the post of demonstrator in experimental physics at the Cavendish Laboratory, Cambridge, and not, as stated in our issue last week, at Trinity College. Mr. J. S. E. Townsend has been appointed assistant demonstrator in the same laboratory.

**Oldham-Ashton and Hyde Tramway Strike.**—It is stated that Mr. G. R. Askwith, appointed by the Board of Trade as arbitrator between the Oldham-Ashton and Hyde Tramway Co. and its employés succeeded in coming to terms with the parties on Wednesday. It is understood that the arbitration will now be proceeded with on the condition that all the men on strike are reinstated.

**French Renderings of English Names.**—We have on one or two occasions pointed out the inaccuracies of the French technical press in its reproduction of English names. An esteemed fortnightly contemporary, publishing in its last issue a forecast of the B.A. meeting held nearly two months ago, surpasses itself in this respect. One paragraph of 10 lines contains the following atrocities: J. A. W. Aldpége for J. G. W. Aldridge, Elbbings for Gibbings, Barber for Barker, and Potch for Gotch.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Tangier—Tarifa | Jan. 3, 1900 | — |
| Ceara—Maranham | Feb. 20, 1900 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Môle St. Nicolas—Cap Haitien | Mar. 7, 1900 | — |
| Zanzibar—Mombasa | Sept. 20, 1900 | — |
| Paramaribo—Cayenne | Oct. 6, 1900 | — |
| Saigon (Cape St. James)—Thuanan | Oct. 23, 1900 | Oct. 28, 1900 |

**Wireless Telegraphy.**—Wireless telegraphic apparatus is now actually being erected at La Panne, Belgium, and on one of the Dover-Ostend mail boats, in order that communication between the ship and the shore may be continuously maintained.——The employment of wireless telegraphic apparatus on our warships is continually being extended by the Admiralty, and it is stated that, with the object of increasing the efficiency of the defences to the entrance of the Thames and Medway, wireless telegraph apparatus has been fitted at Sheerness and Shoeburyness.

**Post Office Telegraphs and the Elections.**—The manager of the Press Association has addressed a communication to the Post Office, paying a high compliment to the efficiency of the telegraph service during the period of the General Election, when an enormous amount of press work had to be dealt with. In acknowledging this letter, the Postmaster-General expresses his satisfaction that, notwithstanding the great pressure upon the wires and the unfortunate fire at the Manchester Post Office, the efforts of the staff and the arrangements made for coping with the extra work proved so successful.

**China Telegraphs.**—According to a *Standard* telegram, the Pekin-Taku-Chifu telegraph line is now worked partly by wire and partly on the Marconi system. The same telegram announces that the German and Japanese Governments have concluded negotiations for the laying of a submarine cable between Tsing-tau and Nagasaki, a distance of 450 miles, the laying of the cable to be commenced as soon as the cable is ready. The Nagasaki line is to be prolonged later to the South Sea Islands, and the Shanghai line to Fuchow, Amoy, Swatow, and thence on to Canton.

**Telegraphic Communication with H.M. Forces in China.**—The Postmaster-General announces that arrangements have been made for facilitating and cheapening telegraphic communication with Her Majesty's military and naval forces on active service in China. The Eastern, Eastern Extension, and Great Northern Telegraph companies have generously undertaken to transmit telegrams to and from officers and men at half rates (2s. 9d. per word instead of 5s. 6d.). Shanghai is to be used as the last word in the address in all cases, but will not be charged for. Telegrams must be handed in at postal telegraphic offices, and not at the companies' stations.

**Motor-Driven Fire Pumps on Board Ship.**—The cadet ship "Conway" has been fitted with new fire-extinguishing apparatus. A tank holding 4,000 gallons is fixed about 7ft. above the deck, but in addition, should a more powerful jet of water be required, pumps have been provided which can be driven either by electricity or steam. The motor is supplied from a storage battery charged by the ship dynamos, and the capacity of the cells suffices to work the pumps seven or eight hours at full speed, the battery already on the ship having been increased in size for this purpose. To deal with the increase of load a second dynamo has been added to the electric lighting plant.

**Institution of Electrical Engineers.**—We remind our readers that the first meeting of the new session in London will be held on Thursday next week, when Prof. John Perry will deliver his inaugural address. The meeting of the local sections also begin this month. At Glasgow Mr. W. A. Chamen is down to read a Paper on "Electrical Supply" at the first meeting on the 14th inst., and the Newcastle, Manchester, and Dublin local sections resume their meetings on the 12th, 13th, and 22nd insts. respectively. A new local section is also being formed at Birmingham, due to the efforts of Mr. John C. Vaudrey, the city electrical engineer, and Mr. Henry Lea, but the details have still to be settled.

We are informed that the twelfth annual dinner of the Institution of Electrical Engineers will be held in the Grand Hall of the Hotel Cecil on Monday, December 3rd, and we understand that the Commander-in-Chief, Lord Wolseley, is among the guests who have already accepted.

**Electrical Engineers (R.E.) Volunteers.**—The following are extracts from a letter received by Major Crompton from Captain Lloyd, R.E.:—Captain Lloyd has been appointed Deputy Assistant Adjutant-General for transport, in addition to his duties as officer commanding. Sergeant Phillips, Corporals Hossack, Q.M.S., Wordmore, R.G.A., with three civilian engine drivers have gone to Koomati Poort to bring up rolling stock. Captain Leaf with his detachment, including Sergeant Graham, Corporal Sellon, Lance Corporals Peart and Levin have also gone to Koomati Poort with No. 2 engine and lighting gear to enable night work to be carried on, and to bring up captured rolling stock. Colour-Sergeant M. Rorke has returned from the front to Pretoria, and has been sent to Waterval to bring in captured engines, boilers, and dynamos. Corporal Sellon has been discharged from hospital and is now at work in Pretoria. Apart from special duty above shown, Sergeant Phillips, Corporals Hossack and Hodgson, and Sapper Young are regularly on traction work, in addition to eight drivers belonging to the steam transport (civilians). Captain Lloyd reports that the Electrical Engineers (R.E.) Volunteers will probably leave South Africa by November 4.

**Kew Observatory and the London United Tramways Co.**—Sir Courtenay Boyle, Secretary to the Board of Trade, presided at a conference on Wednesday between the Board of Trade and representatives of the Royal Society and the London United Tramways Co. As mentioned in our last issue, an agreement has to be arrived at as to the means in which the Tramways Company shall arrange its circuits so as not to affect in any way the work conducted at Kew Observatory. The Board of Trade was represented by the Chairman, Mr. F. J. S. Hopwood, Sir Thomas Blomfield, and Mr. A. P. Trotter, its electrical adviser; the Royal Society and Kew Observatory by Mr. Christie (Astronomer-Royal), Mr. R. T. Glazebrook (Director of the National Physical Laboratory), Lieut.-Col. Raban (Director of Works at the Admiralty), Admiral Sir W. J. Wharton (Hydrographer to the Admiralty), and Profs. W. E. Ayrton, J. Perry, and A. W. Rücker. On behalf of the Tramway Company and kindred interests were Mr. George White and Mr. J. Clifton Robinson (Chairman and Engineer respectively of the London United Tramways Co.), Sir Benjamin Baker and Sir William Preece. The proceedings were private and the result of the conference has not yet been announced.

**The Last Signs of Life.**—M. A. D. Waller has communicated recently to the Académie des Sciences an electrical method of distinguishing between dead and living matter. The principle on which he bases his test he states somewhat as follows: Living matter responds to an electrical stimulus by yielding an after-current directed in the same sense. The same matter, killed by heating, does not respond to such excitation, unless, indeed, it does so in an opposite sense due to polarisation. This phenomenon is characteristic of all living matter, animal or vegetable. It is the last sign of life, and may be applied on the field to afford a measure of, so to speak, the *amount* of life remaining in a portion of dying matter. In practice the most necessary apparatus is a delicate galvanometer, with an exciting contrivance, a compensator, a key and electrodes. For energetic excitation the discharge of a condenser may be used, and a commutator is desirable in order to permit current reversal. The object undergoing the test is first connected, by means of the electrodes, to the galvanometer and any deflection compensated. Then while the galvanometer is short-circuited the electrical stimulus is administered. On putting the galvanometer again in circuit with the object operated upon, a small deflection may or may not be observed. The stimulus is then repeated in the opposite direction, and the after-effect again noted. The detection of a deflection indicates that the matter is living; a total absence of effect shows that it is dead. The value of the electromotive force of this after-effect varies with the nature of the matter in question, the vigour of the electrical stimulus, and the time allowed between the stimulus and the measurement. It sinks more or less rapidly with the gradual extinction of vitality, and vanishes completely at the boiling temperature.

**The Institution of Junior Engineers.**—The annual general meeting of this Institution was held on October 27th, at the Westminster Palace Hotel, the retiring chairman, Mr. Basil H. Joy, presiding. There was a large attendance of the members. After the usual preliminary business, the council's report on the work of the past year was presented and adopted. It stated the net increase in membership had been 30, the membership roll now numbering close on 600. M. Gustave Canet, of Paris, and Prof. W. E. Dalby, of London, had been elected honorary members. The Institution premium for the best Paper read by members during the session had been awarded to Mr. E. W. Porter, A.M.I.C.E., for his Paper on "A Comparison of Railway Bridge Structures of Moderate Dimensions, and of Methods of Determining their Working Loads." Seven meetings had been held and 11 visits paid to works, apart from the visits arranged in connection with the Summer meeting at Newcastle-upon-Tyne and Sunderland. The Institution had been represented at the receptions given last June by the Société des Ingénieurs Civils de France in connection with the Paris Exhibition. A list of donations to the library was appended, followed by a copy of the accounts. From the latter it was noticed that the office fund, which has been in existence for several years, makes but slow progress; it was started with the object of providing the means for opening an office and reading room, but it would appear that some substantial contributions are needed before this can be carried into effect. This matter was subsequently discussed at the meeting very fully, and is to receive special consideration by the council. The scrutineers reported the election of the following new officers and members of council: Chairman, Mr. Percival Marshall; vice-chairman, Mr. Ernest King; hon. librarian, Mr. Lewis Rugg; hon. auditors, Messrs. Adam Hunter and A. W. Marshall; secretary, Mr. W. T. Dunn; members of council, Messrs. Louis F. Awde, W. Rushworth Beckton, H. Norman Gray, and W. G. Wernham.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**SATURDAY, November 3rd.**

INSTITUTION OF JUNIOR ENGINEERS.

*3 p.m.* Visit to the London Hydraulic Power Co.'s station Millbank-street, Westminster. (Postponed from October 27th).

**MONDAY, November 5th.**

ROYAL INSTITUTION.

*5 p.m.* General Monthly Meeting.

SOCIETY OF CHEMICAL INDUSTRY.

*8 p.m.* Meeting of the London Section in the Chemical Society's Rooms, Burlington House.

**TUESDAY, November 6th.**

INSTITUTION OF CIVIL ENGINEERS.

*8 p.m.* Ordinary Meeting, when Mr. James Mansergh, the President, will deliver his Address. The presentation of Medal and Prizes will also be made.

**THURSDAY, November 8th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Prof. John Perry, F.R.S., will deliver his Inaugural Address.

**FRIDAY, November 9th.**

FARADIAN CLUB.

*8 p.m.* Club Smoking Concert at the St. James's Restaurant (Regent Saloon).

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Temperature of the Acetylene Flame.*—From the heat of combustion of acetylene, its temperature is calculated to be between 2,100deg. and 2,420deg. But the experimental values so far obtained vary from the melting point of platinum down to 1,400deg. That some parts of the flame possess a temperature higher than the melting point of platinum may be proved by introducing very fine platinum wires into it, and showing that they melt. E. L. Nichols has made some careful measurements by means of thermo-couples consisting of fine platinum and platino-rhodium wires. The difficulty in all such measurements is to avoid conduction, which reduces the temperature of the hot junction below that of the flame in which it is immersed. The author has therefore employed the expedient of using four different diameters of wires, ranging from 0·19mm. to 0·08mm., and extrapolating the curves thus obtained down to a zero diameter. The temperature of the hottest portion thus obtained was found to be 1,920deg., or 100deg. above the highest temperature obtained with the thinnest wire. An ordinary gas jet under the same conditions gave a temperature of 1,780deg., or a few degrees above the melting point of platinum. Commercial Wollaston wires may be melted even in a candle flame, but then they are not pure platinum.

[E. L. NICHOLS, *Phys. Review*, 10, 1900, and *Physikal. Zeitschrift*, October 20, 1900.]

*Becquerel Rays.*—M. Maier describes a particularly active radium preparation obtained by Giesel. It shows a clear white spontaneous luminescence. On a highly sensitive bromide plate its rays produce a strong impression in 80 seconds, while the ordinary pitchblende requires an hour for the same amount of action. The rays are capable of penetrating an iron plate 4mm. thick and a layer of mercury 20mm. thick and yet producing an impression in four minutes. The substance has shown no measurable diminution of radio-activity in the last eight months. The author has found that the magnetic deflection of the rays is very sensibly diminished by placing the substance in a vacuum. Efforts to obtain evidence of refraction and regular reflection failed. Special attention was paid to diffraction and interference. The rays were sent through a slit 1mm. wide, formed by very thick steel plates, and had further to traverse a slit 0·05mm. wide. But no diffraction was observed, thus confirming Becquerel's negative results. Equally unsuccessful was the attempt to produce polarisation by means of tourmaline. But all bodies appear to produce diffused reflection of Becquerel rays, and some bodies, like ebonite, aluminium, lead, and iron, acquire a secondary radio-activity on prolonged exposure, which disappears, however, in a short time.

[M. MAIER, *Physikal. Zeitschrift*, October 20, 1900.]

*Secondary Electrolytic Action.*—If after the electrolysis of a concentrated solution of "hypo" the quantity remaining in solution is determined, it is found that the quantity which has disappeared does not correspond to that calculated from the transformation of the hypochlorite into chloride at the cathode, and of the formation of chlorate at the anode. More hypochlorite disappears than is foreseen by the theory, and too much chlorate appears. The amount of the error is very great, often attaining over 25 per cent., and it increases with the concentration of the salt. A. Brochet accounts for this irregularity in the following manner: The immediate neighbourhood of the anode is always acid; hence, beside the hypochlorous acid transformed into chloric acid by the current, some of the highly-concentrated acid undergoes spontaneous oxidation. An attempt to produce this phenomenon at feeble concentrations failed, owing to the impossibility of obtaining consistent values. The secondary electrolytic action is the reason why no hypo solution can be effectively electrolysed with a concentration amounting to more than 12·7 grammes of active chlorine per litre.

[A. BROCHET, *Comptes Rendus*, October 15, 1900.]

*Harmonics in Alternating Currents.*—A considerable element of the danger to human life attending the use of alternating currents lies in the "harmonic" currents superimposed upon the sinusoidal curve. To eliminate these harmonics, Pérot proposed the employment of synchronous motors of small inductance. G. Claude has devised a means which is based upon the use of suitable condensers. If the alternator has a resistance R and inductance L, and it is branched with a circuit having an inductance $L^1$, a resistance $R^1$, and a capacity, $C^1$, a harmonic characterised by the equation

$$e_n = E_n \sin n\omega t$$

may be reduced to any desired extent by giving a small value to $R^1$ in the equation

$$e^1_n = E_n \frac{R^1}{\sqrt{(R+R^1)^2 + (n\omega L)^2}} \sin (n\omega t - \phi_1).$$

The resonating circuit would practically only affect the harmonic it was intended to neutralise, and would leave untouched the fundamental sinusoidal curve. A disadvantage in comparison with Pérot's method lies in the fact that a special resonating circuit would be required for each harmonic. On the other hand, the resonating circuit is inert, and offers no risk of introducing fresh harmonics, as Pérot's synchronous motors are apt to do.

[G. CLAUDE, *Comptes Rendus*, October 15, 1900.]

*Atmospheric Potential during a Solar Eclipse.*—Some time ago (see *The Electrician*, Vol. XLV., p. 880, October 5) Oddone published the results of an attempt to discover an influence of a solar eclipse upon the atmospheric potential. The results were very doubtful. There appeared to be a slight increase of positive potential, but that may have been due to the formation of clouds. J. Elster was so fortunate as to take some observations near the town of Algiers, within the area of totality, and therefore of much greater importance than the Pavia observations. He found a steady and decided diminution of the positive potential from 177 volts at 12:30 p.m. to four minutes after totality, which occurred at 4:29 p.m. The minimum observed was 113 volts, and at 5:47 p.m. the original potential was nearly attained. This looks like a well-established connection between potential and solar illumination of the atmosphere. The author inclines to the opinion that during the eclipse masses of air were aspirated from the sea which had different electric charges. As a matter of fact, a fresh breeze was blowing in from the sea during the whole afternoon. The result is directly opposed to that of Oddone at Pavia, unless we assume that there is some casual connection between them. On the other hand, the new observation corroborates that at Wolfenbuttel in 1889, which showed an increase of positive potential after totality.

[J. ELSTER, *Mem. Soc. Spettroscopisti Italiani*, 29, 1900.]

*Neutral Point of Thermo Couples.*—A. Abt describes a simple method of determining the neutral point in thermo couples which is specially suited to demonstration purposes. It is based upon the equation

$$E = (t_1 - t_2)[a + b(t_1 + t_2)].$$

The temperatures of the junctions are changed until the current disappears. When that occurs, the neutral point is the arithmetical mean of the temperatures $t_1$ and $t_2$ of the junctions respectively. The arrangement as described consists of two wooden frames with openings closed by plates of asbestos, one on each face of the frame. Holes are bored in the plate, and thick steel rods are inserted through the holes. One end of each rod contains receptacles for the bulb of a thermometer and for one junction of the thermo couple, while the other is heated by a Bunsen flame. Images of the thermometers and of the galvanometer scale are thrown upon a screen, and the heating is carried on until the current disappears, or until it reaches a maximum, while one junction is kept at the temperature of the room. The neutral point is 117deg. in a brass-lead couple, 276·8deg. in an iron-silver couple, and 232deg. in an iron-zinc couple.

[A. ABT, *Ann. de Physik*, No. 10, 1900.]

# THE PARIS EXHIBITION.—XI.*

(BY OUR SPECIAL CORRESPONDENT.)

Besides the moving platform itself, the large number of "inclined elevators" have been a popular means of transportation in the exhibition. Although several lifts were exhibited and afforded a means of reaching the first floor of the more important buildings, they were patronised only to a limited extent—possibly because they were completed so late—and the inclined elevators were all the rage, especially those leading up to the moving platform. These inclined elevators or moving carpets are in reality no novelty. They have been employed in the United States for a long time, and in this country at Harrod's Stores in London and, more recently, at the Crystal Palace. The latter example was recently described in the columns of *The Electrician* (Vol. XLV., p. 592), and the same description may be taken to apply to the Reno inclined elevators at Paris, in fact, one of these was illustrated in this article.

FIG. 67.—VIEW OF PARTIALLY CONSTRUCTED ESCALATOR, SHOWING FORM OF LINKS.

The "escalator," exhibited by the Otis Elevator Co. of New York and the invention of Mr. Charles D. Seeberger, is a very different thing, and promises to obtain greater popularity than the older type of inclined elevator. Instead of an inclined carpet moving upwards, it consists of a series of actual steps which when at rest resemble a stairway, and can be used as such. These steps are fixed to an endless chain running over sprocket wheels, and appear to rise out of the ground at the bottom and to sink in and become a series of level planks at the top landing. An idea of the construction of the links of the chain, and the means employed for keeping the steps horizontal at whatever angle the chain is inclined is given in Fig. 67, which shows the escalator in process of construction, some only of the steps being fixed. The chain is driven by an electric motor fed by one of the exhibition supply circuits. The movement of the chain is even and the steps fit closely, so that it is quite easy to walk up—and even to walk down—at the same time as the chain is moving upwards. I am indebted to Mr. Seeberger for the following additional particulars:

The chain is made up of a number of crucible steel castings with 1⅜in. cold-rolled steel pins at 8in. centres. The length of each link is 18in. The bearing surfaces at the end of the links are provided with phosphor-bronze bushings inlaid with graphite for automatic lubrication. All the work is made to micrometer measurements, and is interchangeable throughout. Each step is provided with four wheels, also self-lubricating, and these roll continuously on brackets. The ratio of the speed reduction between the motor and sprocket wheel is 100 to 1. The sprocket wheel at the head of the flight is bronze and engages both the ascending and descending chain so that the system is in balance. Each step consists of an iron frame with a wooden centre forming the tread. The riser is rigidly attached to the frame, and when on landings the edges of the treads are in contact, while when on the incline the edge of the tread and the riser of the next step are in contact, so that there are no cracks or joints in which the skirt of a dress or point of an umbrella can lodge. The size of each step is 18in. by 48in. with 8in. rise. A normal speed of about 2ft. per second is employed, and it is estimated that the capacity of the escalator is about 10,000 passengers per hour. A handrail travels at the same speed as the steps, and is composed of a single piece of belting of elliptical section.

FIG. 68.—SNAP-SHOT OF UPPER LANDING.

Mr. Seeberger is at present introducing a modification of this escalator, in which the chain is circular, so that one chain serves to convey passengers both up and down. This form would, of course, have the advantage that the down-going passengers would supply the energy to the system, and, in consequence, less power would be required from the motor than for single upward traffic.

In my last article but one I described the generating sets exhibited by Swiss firms. Another small country which has some interesting engines and dynamos in operation is Belgium. In the Van den Kerchove engine, which drives a dynamo by the Compagnie Internationale d'Electricité of Liége, an interesting valve is employed. This is illustrated in Fig, 69, which is a section at the end of the cylinder. The valve takes the place of a Corliss valve, but is a balanced cylindrical one instead of the usual lift valve employed in

---

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, September 14 and 28, and October 5, 12 and 26.

Corliss engines. Its construction is clearly indicated in the figure, and its chief advantages are that the pressure on it is perfectly balanced, there being steam all around the cylindrical valve, and that the valve works noiselessly, and should have less wear and tear than an ordinary Corliss valve. The admission valves are worked by a detent, and as they fall back the dash pot comes into action only after the valve opening is covered, so that the cut-off is sharp. The exhaust valves are driven by a positive motion without the aid of cams or return springs. The main dimensions of the tandem engine exhibited are: H.P. cylinder 680mm., L.P. cylinder 1,090mm. and stroke 1,200mm. Fig. 71 shows some diagrams taken from this engine, and a general view of the cylinders and valve gear is obtained in Fig. 73.

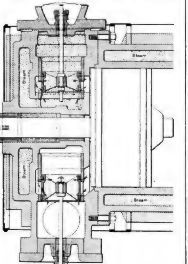


Fig. 69.—Van den Kerchove Valves.

The Liège dynamo is a three-phase alternator, supplying 1,000kw. at 2,200 volts, and running at a speed of $83\frac{1}{3}$ revs. per min., and 50 ∿ per sec. Its flywheel magnet has 72 poles and the armature is star-wound. An electric motor is employed for barring. This machine supplies current for the light and power distribution in the Trocadero section of the exhibition through the intermediary of star-connected transformers; and motor generators, of which one is seen in Fig. 72, are also employed for supplying continuous current.

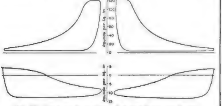


Fig. 70.—Diagrams taken from Van den Kerchove Engine.

Another Belgian dynamo is that of the Charleroi firm, "Electricité et Hydraulique," a firm which, it may be mentioned incidentally, is supplying motor-generators for one of the remodelled sub-stations of the Metropolitan Electric Supply Co. in London, and manufacturers of the Heyland motor described in Mr. Eborall's recent Paper. I referred briefly on a former occasion to the French-built machine exhibited by this company, and the Belgian one is built from the same designs, and has the same feature of extreme narrowness in proportion to its diameter. As seen in Fig. 73 and Fig. 74, the dynamo is of the flywheel magnet type. It develops 880 apparent kilowatts at 2,000 volts to 2,200 volts, with a power factor of 0·85. Its frequency is 50 ∿ per sec. when running at 94 revs. per min. The following are the chief data:—

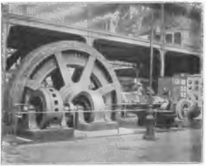


Fig. 71.—1,000 k.w., 3-phase Alternator and Motor Generator, by the Compagnie Internationale d'Electricité, of Liège.

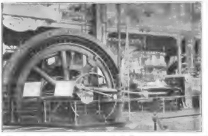


Fig. 72.—General View of Electricité et Hydraulique Alternator driven by Bollincks Engine.

| | |
|---|---|
| Weight without exciter | 42 tons. |
| Weight of the exciter | $1\frac{1}{4}$ tons. |
| Weight of magnet wheel | 20 tons. |
| Number of poles | 64. |
| Cross section of iron per pole | 31 sq. in. |
| Number of turns per pole | 50. |
| Nature of magnet winding | Copper strip. |
| Dimensions of copper strip | 4·1in. wide by 0·031in. [in thickness. |
| Total weight of copper on field poles | 2 tons. |
| Copper loss at full load for field winding | 15kw. |
| Full load exciting current | 150 amperes. |
| Bore of armature | 236in. |
| Exterior diameter of armature core plates | 252in. |
| Breadth of armature iron, including insulation and air spaces | 10in. |
| Total weight of magnetic iron | 3·55 tons. |
| Number of armature stampings | 460 |
| Thickness of each stamping | $\frac{1}{50}$in. |
| Number of armature slots | 384. |
| Dimensions of slot | 0·79in. by 1·34in, deep. |
| Number of wires per slot | 6. |
| Arrangement of wires per slot | 3 in series, 2 in parallel. |
| Number of coils per phase | 32. |
| Total weight of armature copper | 0·5 tons. |

The makers of these alternators call attention to the comparatively light weight of the machines, which it appears is in some part due to the large thin appearance which has been alluded to. The form of the carcase is that of an inverted U, stiffened at intervals by means of ribs. One of the legs of the U is extended in order that the armature iron may be bolted against it. At the end of the other leg a ring of forged steel is let into a circular slot, the ring serving as a clamp to tighten the core discs of the armature and to retain them in position. This tightening is performed by a large number of bolts spaced round the ring.

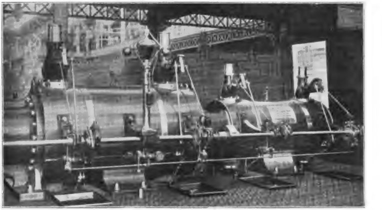


Fig. 73.—Van den Kerchove Engine.

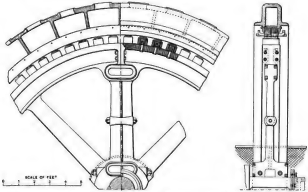


Fig. 74.—Elevation and Section of "Electricité et Hydraulique" 3-Phase Alternator.

Each of the magnet wheels is cast in two pieces; the weight of metal put into each is that stated by the engine builders to be necessary in order to give a variation of angular velocity during one revolution at constant load of less than 0·5 per cent. The poles are oval in form, and the field coils are worked at a rather high number of watts per square inch. Each of the field coils is wound upon a brass bobbin, heavily insulated by means of fireproof insulation; these bobbins are held in position by means of the extended pole shoes, which are cast in one piece with the cast-steel poles. The slip rings for conveying the exciting current to the field magnets are mounted upon the shaft, upon that side of the magnet wheel remote from the exciter; the brushes pressing on these rings (which are in duplicate) are carried by a cast-iron standard bolted to the under frame of the generator.

The exciter armature is mounted on the main shaft close to the field-magnet flywheel. Its bedplate is bolted to two pieces of channel iron parallel to the shaft, resting on pieces of U iron and built into the foundations, so as to project into the well. It is to the projecting parts of these, to which brackets lend an additional support, that the exciter is bolted, and in this way it is brought quite close to the magnet wheel.

## ELECTROMAGNETIC THEORY.—CXIX.*

BY OLIVER HEAVISIDE.

(*Continued from page 863, Vol. 45.*)

§ 477. The case above considered, § 465, of an electrified line moving in its own line casts light upon that of a moving point-charge, because it explains how the infinities arise that rendered the interpretation so obscure. In the theory of the moving line there is nothing in the distribution of the displacement that is seemingly impossible to understand. Referring to Fig. 26, we have a continuous transition from plane waves to a limiting conical wave, through intermediate hyperboloidal waves.

But how about the applied force needed to maintain the motion of the electrified line? We might expect it to be infinite because of the linear concentration of the electrification. Or it might be infinite only at the end of the line, and finite elsewhere. But we could not expect it to be zero. And yet the distribution of the displacement, being always perpendicular to the electrified line, does not indicate any moving force in the line of motion, whilst transversely there is a balance. The moving force due to the induction also seems ineffective. What is the explanation of this conflict between expectation and appearances?

It is the appearances that are deceptive. The moving force due to the stress (electric and magnetic) is indeed perpendicular to the electrified line in any plane containing the line; but since it is infinite, any finite force along the line compounded with it is lost sight of. We get no information immediately as to whether there is or is not a moving force along the line. To find out, we must generalise the problem, reduce the infiniteness to finiteness, see what the force along the line then is, and finally revert to the original problem and see what the limiting value of the force turns out to be. This means that we must examine the moving force upon an electrified cone instead of a line.

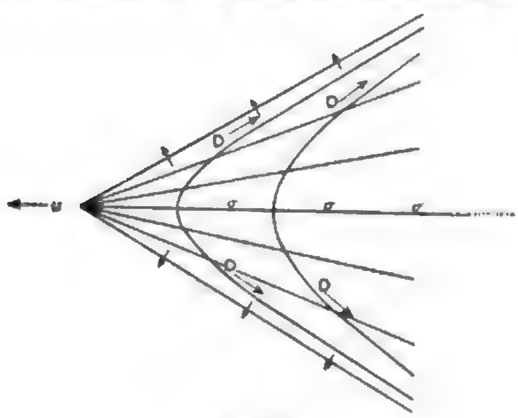


FIG. 26.

Referring to Fig. 26, here reproduced for convenience, there are two intermediate conical equipotential surfaces exhibited. Let the inner one be the electrified surface. Abolish the electric and magnetic disturbance inside this cone, but have everything else the same as before.

To show that the substituted problem is electromagnetically real in the same sense as the previous problem, we have merely to show that the circuital equations are satisfied at the electrified cone. The equations referred to the fixed ether being

$$\operatorname{curl}\mathbf{H} = \rho\mathbf{u} + p\mathbf{D}, \tag{1}$$

$$-\operatorname{curl}\mathbf{E} = p\mathbf{B}, \tag{2}$$

become, when referred to reference space moving with the cone,

$$\operatorname{curl}(\mathbf{H} - \mathrm{V}\mathbf{u}\mathbf{D}) = p'\mathbf{D} = 0, \tag{3}$$

$$-\operatorname{curl}(\mathbf{E} - \mathrm{V}\mathbf{B}\mathbf{u}) = p'\mathbf{B} = 0. \tag{4}$$

So $\mathbf{H} = \mathrm{V}\mathbf{u}\mathbf{D}$, because $\operatorname{div}\mathbf{H} = 0$; and at the conical surface

$$\mathrm{V}\mathbf{N}(\mathbf{E} + \mathrm{V}\mathbf{u}\mathbf{B}) = 0 \tag{5}$$

expresses the second circuital law. That is, curl is $\mathrm{V}\nabla$, and this is turned to $\mathrm{V}\mathbf{N}$ at a surface, $\mathbf{N}$ being unit normal from the surface (see § 131, Vol. I.).

This equation means that the moving force on the electrification is perpendicular to the surface. The other moving force, $p\mathrm{V}\mathbf{D}\mathbf{B}$ per unit volume (§ 85, Vol. I., equation (80)) on the medium is inoperative, because by assumption the medium is fixed. So, by using the expression for $\mathbf{H}$, we get

$$-\mathrm{V}\mathbf{N}\mathbf{E} = \mathrm{V}\mathbf{N}\mathrm{V}\mathbf{u}\mathbf{B} = \mathbf{u}\,.\,\mathbf{N}\mathbf{B} - \mathbf{N}\mathbf{u}\,.\,\mathbf{B}.$$

Or, since $\mathbf{N}\mathbf{B} = 0$,

$$-\mathrm{V}\mathbf{N}\mathbf{E} = -\mathbf{N}\mathbf{u}\,.\,\mathbf{B}. \tag{6}$$

This expresses the same as (2), when that equation is applied to a unit square circuit in the plane of the paper fixed in the ether and traversed by the electrified cone. For $+\mathbf{N}\mathbf{u}$ is the speed of the cone normal to itself, and $-\mathbf{N}\mathbf{u}\,.\,\mathbf{B}$ is the rate of increase of induction through the circuit.

Similarly equation (1) is the same as

$$\mathrm{V}\mathbf{N}\mathbf{H} = \mathbf{u}\,.\,\mathbf{N}\mathbf{D} - \mathbf{N}\mathbf{u}\,.\,\mathbf{D}, \tag{7}$$

by turning $\rho$ to $\mathbf{N}\mathbf{D}$, the surface density, and $p$ to $-\mathbf{N}\mathbf{u}$. This is an identity because $\mathbf{H} = \mathrm{V}\mathbf{u}\mathbf{D}$. Therefore both circuital laws are satisfied at the moving electrified cone. Its situation may be anywhere between the axial line and the limiting cone, which is the seat of a free wave. I give these details of transformation in order to encourage timid readers to study the Vector Analysis in Vol. I. of this work. I repeat that there are no quaternions in it, so there is nothing to be afraid of.

The formula for the electric force is (18), § 465, or

$$\mathbf{E} = \frac{\sigma}{2\pi ch\tan\theta}\,\frac{z\tan^2\theta\,.\,\mathbf{h}_1 + h\mathbf{k}}{(z^2\tan^2\theta - h^2)^{\frac{1}{2}}}, \tag{8}$$

and from this is derived

$$\mathrm{V}\mathbf{u}\mathbf{B} = -\frac{1}{\sin^2\theta}\,\frac{\sigma}{2\pi ch\tan\theta}\,\frac{z\tan^2\theta\,.\,\mathbf{h}_1}{(z^2\tan^2\theta - h^2)^{\frac{1}{2}}}. \tag{9}$$

Therefore, by addition,

$$\mathbf{E} + \mathrm{V}\mathbf{u}\mathbf{B} = \frac{\sigma}{2\pi ch\tan\theta}\,\frac{h\mathbf{k} - z\mathbf{h}_1}{(z^2\tan^2\theta - h^2)^{\frac{1}{2}}}. \tag{10}$$

Here $\sigma$ is not the surface density, but the linear density when the electrification is on the axis of the cone. The size of $\mathbf{E}$ is

$$E = \frac{\sigma}{2\pi ch\tan\theta}\,\frac{(z^2\tan^4\theta + h^2)^{\frac{1}{2}}}{(z^2\tan^2\theta - h^2)^{\frac{1}{2}}}, \tag{11}$$

and the angle between $\mathbf{E}$ and $\mathbf{N}$ is given by

$$\cos\widehat{\mathbf{E}\mathbf{N}} = \frac{z^2\tan^2\theta - h^2}{(z^2\tan^4\theta + h^2)^{\frac{1}{2}}(z^2 + h^2)^{\frac{1}{2}}}; \tag{12}$$

so, by (11) and (12),

$$\mathbf{N}\mathbf{D} = \frac{\sigma}{2\pi h\tan\theta}\,\frac{(z^2\tan^2\theta - h^2)^{\frac{1}{2}}}{(z^2 + h^2)^{\frac{1}{2}}}. \tag{13}$$

This being the surface density, the moving force on it is, by (10) and (13),

$$\mathbf{N}\mathbf{D}(\mathbf{E} + \mathrm{V}\mathbf{u}\mathbf{B}) = c\left(\frac{\sigma}{2\pi ch\tan\theta}\right)^2\frac{h\mathbf{k} - \mathbf{h}_1 z}{(z^2 + h^2)^{\frac{1}{2}}}, \tag{14}$$

of which the size is

$$\frac{1}{c}\left(\frac{\sigma}{2\pi h\tan\theta}\right)^2. \tag{15}$$

This is the normal pressure per unit area of cone. Multiply it by $h/r$ to get the $z$-component, and then by $2\pi h$ to get the total for a circular hoop round the cone. The result is

$$F = \frac{\sigma^2}{2\pi cr\tan^2\theta}, \tag{16}$$

where $F$ is the size of the resultant moving force of the electromagnetic field on the circular hoop. The direction of this force is from left to right, or against the motion. So $F$ measures the applied force required to maintain the motion, acting in the direction of $\mathbf{u}$. It varies inversely as the distance $r$ of the hoop from the apex. It is always finite, save at the apex, which is a point where some modification of the shape of the V surfaces is required to produce finiteness, by rounding off the sharpness.

Finally, we come to the initial question of the moving force on the electrified line. $F$ remains finite (save at the

apex again) when $h$ is reduced to zero, which makes $r$ become $z$. Then

$$F = \frac{\sigma^2}{2\pi c z \tan^2\theta} \tag{17}$$

is the force required to maintain the state, per unit length of the electrified line. If the linear density be reduced from $\sigma$ to zero gradually, instead of suddenly at the apex, it will do away with the difficulty there, I think.

The flux of energy VEH is perpendicular to the hyperboloidal surfaces of D. This requires special interpretation as the electrified line, like the above. Substitute the electrified cone, and it is all right. The work done by the applied force is accounted for.

Suppose we have a second electrified cone outside the first. Referring to the figure again, abolish the E and H disturbances outside the second cone as well as inside the first. The second cone is then negatively electrified. Its theory is just like that above given for the first cone. There is no free extreme conical wave now, of course. The moving force due to the field on the second or outer cone is with the motion, and the applied force must be against it. So now energy goes from the inner cone to the outer through VEH. External work is done on the inner cone, and is returned to externality at the outer one.

§ 478. Now consider the theory of an electrified line moving transversely to itself, not when of infinite length, as done in § 464, and previously, but of finite length. When of infinite length, the effect is to produce a pair of divergent plane waves, and there are only two forms of solutions, $V=0$ in one region, and $V=$ constant in the rest of space. But when the electrified line is of finite length, there are five formulæ for the potential. To see this, from the two ends of the line as apexes construct cones of angle $2\theta$, given by $u \sin\theta = v$, whose axes are in the

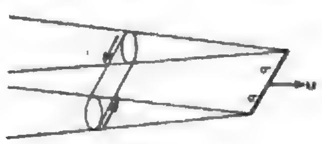


Fig. 31.

direction of u reversed. Join these cones together by a pair of planes touching them at opposite ends of diameters. These planes diverge from the electrified line and are inclined at angle $2\theta$. The Fig. 31 will give an idea of what is meant. The thick line $\sigma\sigma$ is the electrified line moving from left to right. The two planes are plain enough. The ovals are supposed to represent the circular sections of the two cones at a certain distance, seen sideways.

The formula for V is (9), § 464; that is, when integrated, (11), with proper limits, or

$$V = \frac{\sigma}{2\pi c}\tan\theta\left[\sin^{-1}\frac{x}{\sqrt{z^2\tan^2\theta - y^2}}\right]. \tag{1}$$

The only trouble is to find the limits properly, to be done by consideration of the geometry of the wedge and two cones in Fig. 31. Let for convenience

$$V = \frac{\sigma\tan\theta}{2\pi c}W, \tag{2}$$

and consider the values of W, the potential measured in special units.

(1). Outside the planes and cones, $W=0$. (3)

(2). Between the planes, but outside the cones, $W=\pi$. (4)

(3). Inside the left cone, but not also inside the right cone,

$$W = \tfrac{1}{2}\pi + \sin^{-1}\frac{a-x}{h}. \tag{5}$$

(4). Inside the right cone, but not also inside the left cone,

$$W = \tfrac{1}{2}\pi + \sin^{-1}\frac{a+x}{h}. \tag{6}$$

(5). Inside both cones at once

$$W = \sin^{-1}\frac{a-x}{h} + \sin^{-1}\frac{a+x}{h}. \tag{7}$$

Understand that $2a$ is the length of the electrified line, and that $x$ is measured along or parallel to that line, with origin at its middle point. Also

$$h = \sqrt{z^2\tan^2\theta - y^2}, \tag{8}$$

where $z$ is measured against u, or to the left, and $y$ upwards from the median plane in which the electrified line is moving.

The single formula (8) will cover the whole on certain understandings common in the mathematics of waves—viz., the three geometrical variables $x$, $y$, $z$ are to receive all values which allow W to be real; and then when, for instance, $x$ or $y$ passes out of these bounds, and makes one of the inverse sine functions impossible, the value of W is to be considered to remain what it was at the moment of leaving bounds. In this way the first four cases are derivable from the fifth. The displacement from the electrification divides equally between the two planes, just as if the line were infinitely long, but there is an auxiliary system of displacement in the two cones, to be mentioned presently. The induction in the planes, too, is the same as if they did not terminate—namely, parallel to the electrified line, from the top of the right to the top of the left cone in the upper plane, and from the bottom of the left to the bottom of the right cone in the lower plane. The question now is, how the induction gets across from one plane to the other, and back again to complete its circuit. Fig. 32 is a section of the wedge in the plane of the induction, as seen from the electrified line, whose position is vertically above the dotted line at distance $z$. The radius of the circles is $z\tan\theta$. If now we measure $x$ in left circle from its centre to the right, and $y$ upwards on the paper, the formula for W becomes

$$W = \tfrac{1}{2}\pi + \sin^{-1}\frac{x}{(z^2\tan^2\theta - y^2)^{\frac{1}{2}}} \tag{9}$$

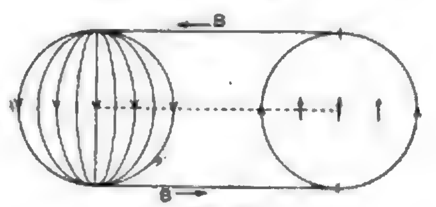


Fig. 32.

inside the left circle. W falls from $\pi$ on the right semicircle to 0 on the left semicircle, being $\frac{1}{2}\pi$ on the vertical diameter. The equipotential lines are semi-ellipses with a common major axis.

Now $H = VuD$. The $z$-component of D is here inoperative, so H is perpendicular to the lines of D in the plane of the paper (ignoring the $z$-component). But these are given by the slope of the potential in the plane, so they are properpendicular to the lines of V. It is only the $z$-component of D that follows a different law. Therefore the lines of H are the equipotential lines themselves. The flux of induction is therefore from the effective point source at the top of the circle to the effective sink at the bottom along the semi-elliptic paths. This applies to all planes parallel to the paper, from the electrified line itself to any distance beyond. As regards the intensity of H, it is smallest along the central vertical diameter and increases to infinity on the two extreme semicircles. This infinity is empty, of course, the total induction passing from one plane to the other (per unit distance along $z$) being finite. It is easy to see that if the electrified line be turned into a rod of finite size, carrying the same amount of electrification, the sheets of induction will become of finite depth, and then the density of the induction will be finite everywhere.

As regards the electric displacement in the cones, that is more difficult to follow, because it is in three dimensions instead of two. The transverse displacement in the plane of the paper, Fig. 32, goes perpendicularly across the lines of V; but the $z$-component, which is differently reckoned, and varies as $+\nabla V$ instead of $-\nabla V$, is very important. It is down through the paper in the outer half of the left one, and up in the inner. The full formula for the electric force is

$$\mathbf{E} = -\frac{(z^2\tan^2\theta - x^2 - y^2)^{\frac{1}{2}}}{z^2\tan^2\theta - y^2}\mathbf{i} - \frac{x\mathbf{r}}{(z^2\tan^2\theta - y^2)(z^2\tan^2\theta - x^2 - y^2)^{\frac{1}{2}}} \tag{10}$$

where r is the vector from the origin at the end of the electrified line.

The cones overlap one another at some finite distance depending upon the length of the electrified line and the ratio $u/v$ settling the angle $\theta$. In the overlap the E and H are the resultants of those for the two cones. Go far enough away from the electrified line and the circles in a plane section as in Fig. 32 tend to coincide, when viewed through a diminishing glass; or, viewed from the line, by natural perspective. Then the left crescent in Fig. 33 is all that is left of the left circle, and the induction is down in it from top to bottom in nearly circular paths. The right crescent shows what is left of the right circle, and the induction is up in it. The resultant H in the overlap, which is nearly a circle, is nearly circular, oppositely directed to that in the two crescents. It is intense at the boundary, and falls off towards the centre. The short horizontal line in the middle is the projection of the electrified line. We approximate in this way to the conical wave with reversed internal E and H due to a moving point-charge.

The voltages employed by Trowbridge are so greatly in excess of those which give estimated European speeds to electrons comparable with the speed of light, that it seems very probable that in his experiments electrons do have speeds given to them exceeding that of light. They cannot maintain them. That is one thing. The other principal peculiarity is the reversal of their action upon other electrification. Thus an electron moving much faster than light does will draw after it other slowly-moving electrons of the same sign,

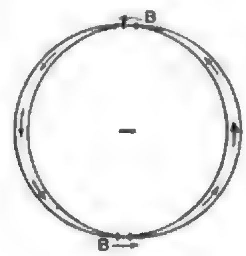


FIG. 33.

instead of repelling them, unless they get into the conical sheet, or rather, into the more diffused real disturbance corresponding to the conical sheet of the abstract theory.

It is to be noted that, by the theory of § 465, to which Fig. 27 refers, the inward displacement does not go to the point-charge first, and then come out again along the conical sheet, when the point-charge is enlarged to finite dimensions. It turns round into the conical sheet all the way along it; that is, forcing an electron along faster than light goes produces a sort of vortex of displacement in its wake.

*(To be continued.)*

## THE THEORY OF COMMUTATION.*

BY C. C. HAWKINS, M.A., M.I.E.E.

*(Concluded from page 21.)*

Next let there be no initial current or J = 0, and let a steady E.M.F. of value $E_0$ act throughout the period of commutation, H being = 0; then

$$i = E_0 \cdot \frac{T}{L} \cdot f_2(x), \text{ and } b_0 = 0.$$

Equation (15) becomes

$$-E_0 \cdot \frac{T}{L} \cdot \frac{df_2}{dx} + E_0 \cdot \frac{T}{L} - E_0 \cdot \frac{T}{L} f_2 \cdot \tau' - E_0 \cdot \frac{T}{L} \cdot \frac{f_2 \cdot \tau}{x}$$
$$- E_0 \cdot \frac{T}{L} \cdot \frac{f_2 \cdot \tau}{1-x} = 0$$

* From a brochure on the same subject, published by *The Electrician* Printing and Publishing Co.

or $$\frac{df_2}{dx} - 1 + f_2 \cdot \tau' + \frac{f_2 \cdot \tau}{x} + \frac{f_2 \cdot \tau}{1-x} = 0$$

$$\frac{df_2}{dx} = b_1 + 2b_2 x + 3b_3 x^2 + 4 \cdot b_4 x^3 + \ldots$$
$$f_2\tau' = b_0\tau' + b_1\tau' x + b_2\tau' x^2 + b_3\tau' x^3 + \ldots$$
$$= 0 + b_1\tau' x + b_2\tau' x^2 + b_3\tau' x^3 + \ldots$$
$$\frac{f_2\tau}{x} = b_1\tau + b_2\tau x + b_3\tau x^2 + b_4\tau x^3 + \ldots$$
$$\frac{f_2\tau}{1-x} = b_1\tau x + (b_1+b_2)\tau x^2 + (b_1+b_2+b_3)\tau x^3 + \ldots$$

Thence,
$$b_1(1+\tau) = 1$$
$$b_2(2+\tau) = -b_1(\tau'+\tau)$$
$$b_3(3+\tau) = -b_2(\tau'+\tau) - b_1\tau$$
$$b_4(4+\tau) = -b_3(\tau'+\tau) - b_2\tau - b_1\tau.$$

Lastly, let J = 0 and $E_0$ 0, an E.M.F. H$t$ gradually rising from zero alone being present, so that $i = H \cdot \frac{T^2}{L} \cdot f_3(x)$, and $c_0 = 0$.

Then
$$\frac{df_3}{dx} - x + f_3\tau' + \frac{f_3\tau}{x} + \frac{f_3\tau}{1-x} = 0$$

$$\frac{df_3}{dx} = c_1 + 2c_2 x + 3c_3 x^2 + 4c_4 x^3 + \ldots\ldots$$
$$-x = -x$$
$$f_3\tau' = c_0\tau' + c_1\tau' x + c_2\tau' x^2 + c_3\tau' x^3 + \ldots\ldots$$
$$= 0 + c_1\tau' x + c_2\tau' x^2 + c_3\tau' x^3 + \ldots\ldots$$
$$\frac{f_3\tau}{x} = c_1\tau + c_2\tau x + c_3\tau x^2 + c_4 \cdot \tau \cdot x^3 + \ldots\ldots$$
$$\frac{f_3\tau}{1-x} = c_1\tau x + (c_1+c_2)\tau x^2 + (c_1+c_2+c_3)\tau x^3$$

whence
$$c_1 = 0$$
$$c_2(2+\tau) = 1$$
$$c_3(3+\tau) = -c_2(\tau+\tau') - c_1\tau$$
$$c_4(4+\tau) = -c_3(\tau+\tau') - c_2\tau.$$

From the above the following table can be constructed:—

$$\left.\begin{array}{lll}
a_0 = 1 & b_0 = 0 & c_0 = 0 \\
a_1 = -\dfrac{2\tau+\tau'}{1+\tau} & b_1 = \dfrac{1}{1+\tau} & c_1 = 0 \\
a_2 = \dfrac{a_1(1-\tau')+\tau'}{2+\tau} & b_2 = -\dfrac{b_1(\tau+\tau')}{2+\tau} & c_2 = \dfrac{1}{2+\tau} \\
a_3 = \dfrac{a_2(2-\tau')+a_1\tau'}{3+\tau} & b_3 = \dfrac{b_2(2-\tau')+b_1\tau'}{3+\tau} & c_3 = -\dfrac{c_2(\tau+\tau')}{3+\tau} \\
a_4 = \dfrac{a_3(3-\tau')+a_2\tau'}{4+\tau} & b_4 = \dfrac{b_3(3-\tau')+b_2\tau'}{4+\tau} & c_4 = \dfrac{c_3(3-\tau')+c_2\tau'}{4+\tau} \\
a_n = \dfrac{a_{n-1}(n-1-\tau')+a_{n-2}\cdot\tau'}{n+\tau} & b_n = \dfrac{b_{n-1}(n-1-\tau')+b_{n-2}\cdot\tau'}{n+\tau} & \\
 & & c_n = \dfrac{c_{n-1}(n-1-\tau')+c_{n-2}\tau'}{n+\tau}
\end{array}\right\} \quad (20)$$

When different values for $x$ are inserted in $f_1(x)$, $f_2(x)$ and $f_3(x)$, the value for $i$ can be calculated; as $x$ increases, the series converge more and more slowly, until finally for $x = 1$, *i.e.*, $t = T$, the series becomes divergent. It is, however, especially important to be able to determine the final value of $i$, so that a different development by a series of powers must be adopted.

Let $y = 1 - x$; then equation (15) becomes

$$\frac{di}{dy} + E_0 \cdot \frac{T}{L} + H \cdot \frac{T^2}{L}(1-y) - i\tau' - i\tau\left(\frac{1}{1-y} + \frac{1}{y}\right)$$
$$- J\tau \cdot \left(\frac{1}{y} - \frac{1}{1-y}\right) = 0 \quad . \quad . \quad (21)$$

To solve this equation by a series of powers just as equation (15) was solved, is only possible in one way, viz., by assuming in the new series that $a'_0 = 1$, $b'_0 = 0$, $c'_0 = 0$. In other words,

commutation must be assumed to be always exactly performed, so that

$$i = -J \, . \, f_1(y) + E_0 \, . \, \frac{T}{L} \, . \, f_2(y) + H \, . \, \frac{T^2}{L} \, . \, f_3(y).$$

If this assumption be not made, expressions are obtained which become infinite when $y$ is made $=0$. One part of the integral can now be determined by means of a system of coefficients exactly analogous to that of (20), but another part must be added in order to correct the results if our assumptions are not correct, and this part cannot be developed in powers of $y$. The solution of equation (21) must therefore be expressible as the sum of two items in the form

$$i = z_1 + A \, . \, z_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

where $z_1$ is a solution of equation (21) in the form of a series of powers, A is an arbitrary constant dependent on the assumptions under which the series is formed, and $z_2$ is a solution of the equation

$$\frac{dz_2}{dy} - z_2 \, . \, \tau' - z_2 \, . \, \tau \, . \left( \frac{1}{1-y} + \frac{1}{y} \right) = 0 \quad . \quad . \quad . \quad (21a)$$

In order to determine $z_1$ on the assumption that $a'_0 = 1$, $b'_0 = 0$ and $c'_0 = 0$, the series of coefficients may be obtained from equation (21) just as from equation (15).

The solution of equation (21a) is $z_2 = \frac{y^\tau}{1-y^\tau} \, . \, \epsilon^{\tau' y}$, but it remains to determine the constant A which must be such that the value of $i$ as deduced from (22) for every value of $y = 1 - x$ may agree with the value for $i$ as calculated from formulæ (16), (17), and (20). This determination of A is only possible by means of hypergeometrical series and leads to the result that

$$A = J(k_1(2-\tau') + k_2 \, . \, 2\tau') + E_0 \, . \, \frac{T}{L} \, . \, k_1 + H \, . \, \frac{T^2}{L} \, . \, k_2$$

so that

$$A \, . \, z_2 = \Big\{ J \, . \, (k_1(2-\tau') + k_2 \, . \, 2\tau') + E_0 \, . \, \frac{T}{L} \, . \, k_1 + H \, . \, \frac{T^2}{L} k_2 \Big\} \, . \, \frac{y^\tau}{1-y^\tau} \, . \, \epsilon^{\tau' y}. \quad (23)$$

$$\left.\begin{aligned} \text{where } k_1 &= \epsilon^{-\tau'} \, . \, \frac{\pi}{\sin \tau\pi} \sum_{n=0}^{\infty} \frac{\tau'^n}{n!} \, . \, \frac{\tau(\tau+1) \ldots . (\tau+n)}{(n+1)!} \\ \text{and} \quad k_2 &= \epsilon^{-\tau'} \, . \, \frac{\pi}{\sin \tau\pi} \, . \sum_{n=0}^{\infty} . \, \frac{\tau'^n}{n!} \, . \, \frac{\tau(\tau+1) \ldots . (\tau+n+1)}{(n+2)!} \end{aligned}\right\} (23a)$$

Equation (23) now shows an important fact; in it the factor A remains finite and unchanged, and when $\tau > 0$, $(y^\tau)_{y=o} = 0$, so that $(z_2)_{y=o} = 0$, and there only remains $(z_1)_{y=o} = -J$. That the current must be exactly commuted when $\tau > 0$, is evident from the consideration that before the toe of the brush entirely leaves sector 1, the contact resistance between the two, and, therefore, also the resistance of the short-circuit, becomes infinite.

A further important conclusion is also to be drawn from the above. $z_2$ yields to the differential coefficient $\frac{di}{dt}$ a term with the power $y^{\tau-1}$, of which the exponent when $\tau < 1$ is negative, so that in this case for $y=0$, $\frac{di}{dt}$ becomes infinite. But if $\tau > 1$, this exponent is positive, and the term for $y=0$ becomes 0. Evidently, then, $z_2$ is the sum which causes $\left(\frac{di}{dt}\right)_T$ to become infinite so long as $\tau \leqq 1$, and A has som evalue other than nought. If the sum $A \, . \, z_2$ disappears, then and then only does $\left(\frac{di}{dt}\right)_T$ become finite under all circumstances. The complete disappearance of $A \, . \, z_2$ not only at the last moment but throughout is only obtained when

$$A = J(k_1(2-\tau') + k_2 \, . \, 2\tau') + E_0 \, . \, \frac{T}{L} k_1 + H \, . \, \frac{T^2}{L} \, . \, k_2 = 0 \quad . \quad (25)$$

and it will now be seen that this expression for A is also the quantity A in the equations (8) to (13). When $\tau > 0$, $\left(\frac{\epsilon^{\tau' y}}{1-y^\tau}\right)_{y=0} = 1$, and the remaining coefficient of $y^\tau$ is then the A of these equations.

If $\tau > 0$, *i.e.*, the brushes have some contact resistance, the condition $A=0$ can only be fulfilled when the brushes are set at one exact point on the commutator, and under ordinary conditions of working the probability of this exact point being always found for each current is so unlikely that it may be regarded as a special case having little practical bearing.* The further probability that the brushes would be set at the particular point in the reversing field, and that the speed would be such that in combination with this particular adjustment a straight line of change would be obtained is even more remote; for then not only must $A=0$, but this must be due to the particular relation between $E_0$ and H being such that

$$E_0 \, . \, \frac{T}{L} = -J \, . \, (2 - \tau'),$$

$$H \, . \, \frac{T^2}{L} = -J \, . \, 2\tau'.$$

To sum up, when $\tau > 0$, as in practice must be the case, commutation is always exactly performed, and our assumption in the "$y$" system that $a'_0 = 1$, $b'_0 = 0$ and $c'_0 = 0$ is correct. $A=0$ is a special case which makes $\left(\frac{di}{dt}\right)_{t=T}$ finite whatever the value of $\tau$; it requires, however, such nicety of adjustment of the brush position that it is unlikely to occur in practice. Putting on one side this special case, the important point is that when $\tau \leqq 1$, though the current is exactly commuted, $\left(\frac{di}{dt}\right)_{t=T}$ is infinite or the slope of the last point of the curve is vertical, and the final current-density in the brush-toe is infinite, so that sparking must take place; when $\tau > 1$, the current-density may be very high but is finite, $\tau = 1$ being the last value for which $\left(\frac{di}{dt}\right)_{t=T} = \infty$.

An indispensable condition, then, for sparkless runnning is that $\frac{R_1 T}{L}$ should be greater than 1.† If the brush contact surface be so great that this condition is not fulfilled, and A is $\neq 0$, *i.e.*, the brushes cannot be so set that commutation is of itself perfect, then either sparking takes place or the current-density towards the end of the time of short-circuit reaches such a high value that the copper brush-tip is momentarily overheated, and its resistance rises above the normal, so that in effect $R_1$ does become $> \frac{L}{T}$. The two possibilities are in reality the same, and are equally disastrous in their effect on the commutator.

§ 2. The Conditions of Sparklessness: (1) $\frac{R_1 T}{L} > 1$.—Finally, it may be asked what practical conclusions can be drawn as to the conditions of sparklessness. There are, in fact, three conditions, viz., (1) $R_1 T/L$ must be $>1$; (2) the transition at the last moment from the varying to the steady state must not be too abrupt; and (3) at no time must the current-density in the brush, toe or heel, be so high as to melt off particles of the brush or of the sectors under them. These conditions are to a certain extent inconsistent, and in this inconsistency lies much of the difficulty of securing sparklessness.

Taking the first condition,

$$L = k \, . \left( \frac{\tau}{N_2} \right)^{2} \frac{p}{p_1} \, . \, l \, . \, 10^{-9} \text{ henrys}‡$$

---

* If $\tau = 1$, $k'_1 = -1$ and $k'_2 = -1$, so that the condition $A' = 0$ becomes

$$J(2 + \tau') + E_0 \, . \, \frac{T}{L} + H \, . \, \frac{T^2}{L} = 0,$$

and in equation (13) the condition $C=0$ or $J(2R_1 + R) + E_0 + HT = 0$ may also be reduced to the same expression, viz.:

$$J(2 + \tau') + E_0 \, . \, \frac{T}{L} + H \, . \, \frac{T^2}{L} = 0.$$

Thus, if $\left(\frac{di}{dt}\right)_T$ is finite when $\tau = 1$, C in equation (13, simply takes the place of the quantity elsewhere distinguished as A; and $C = A = 0$.

† The first statement of this important fact must be credited to P. Girault "Sur la commutation dans les dynamos à courant continu." *Bull.* de la Soc. Internationale des Electriciens, May 4, 1898, Vol. XV., p. 183.

‡ In this equation $\tau$ = the total number of inductors on the armature, $N_2$ = the number of commutator sectors, $p$ = the number of pairs of poles, and $l$ = the length of the armature core.

where $k$ is a constant depending upon the relative arrangement of wires which are undergoing commutation, and upon the permeance which surrounds them as affected by the question of whether they are wound on the surface of a smooth armature or are embedded in the slots of a toothed core, and by the shape of the interpolar gap within which commutation is to be effected. The variation that may be obtained in the value of $k$ is here not discussed. The time of short-circuit if the armature is not multiple-wound is

$$T = \frac{60 \cdot b}{N \cdot N_1 \cdot \beta}, \text{ and } R_1 = \frac{R_2}{b \cdot b_1}.$$

where $R_2$ is the resistance of the brush contact per unit of surface, $\beta =$ the width of a sector, and $b_1$ and $b$ are the dimensions of the brushes parallel and at right angles to the axis of rotation.

Hence
$$\frac{R_1 T}{L} = \frac{60 \cdot 10^9 \cdot p_1 \cdot N_2 \cdot R_2}{N \cdot \beta \cdot b_1 p \cdot \tau^2 \cdot l \cdot k}$$

is to be greater than 1, from which the advantage of making $N_2$ as large as possible for a given value of $\tau$ is obvious, as also the disadvantage of a toothed armature owing to the increased value of its $k$. The difficulty of securing sparkless collection in low-voltage dynamos for electrolytic work probably lies in the fact that their very large currents necessitate the employment of copper brushes of large area and of very low resistance, and with these $RT_1/L$ is less than or but little more than 1. In such cases a given brush surface $= bb_1$ being necessary to collect the current, it would appear advisable to make $b_1$ small, or, in other words, to employ a commutator of large diameter with broad brushes bearing on sectors as wide as possible, rather than to make the length of the brush surface at right angles to the direction of rotation great. As a matter of fact, with copper brushes $R_1T/L$ is very frequently less than 1, and reliance must then be placed upon the rapid rise of resistance of the brushes when even a small amount of sparking takes place.

(2) $\left(\frac{di}{dt}\right)_T$ as small as possible.—Taking the second point, it is evident that if there be any slight dissymmetry between the various coils of the armature in either angular position, inductance, or resistance (and such must in practice occur), it will be less likely to produce sparking the more gradual the transition at the last moment from the varying to the steady state. The most favourable condition would therefore be that $\left(\frac{di}{dt}\right)_{t=T}$ should be $=0$, and the higher the speed the more important becomes this second condition, since the machine is rendered less sensitive by its observance.

On the other hand, this condition may imply such a large angle of lead or such a high current-density at some other period, that it becomes impracticable to secure it. We can, however, be certain of one fact, viz., that a curve which is throughout convex is worse than a straight line on both scores—not only will the machine be sensitive to any slight differences between the several coils, but the current-density is higher than the normal. Suppose, therefore, that a given dynamo has to run with a very small angle of lead, such as 6deg., and the curve of change has been found to be convex, experience must then decide whether the abnormal current-density or the abruptness of the final transition are sufficient to cause sparking. If they are, two courses are open, viz., either (1) increase the total resistance $R = r + 2r_c$, or (2) increase the brush contact-resistance so as to obtain a more nearly linear change. We are thus brought to the consideration of the third condition enumerated above.

(3) High Brush-Contact Resistance.—An increased R is naturally best obtained by the adoption of high-resistance commutator connectors, and an increase of $r_c$ until R has double its original value may nearly straighten the curve. At a still higher speed, when the curve is still more convex, doubling the resistance actually reduces the required angle of lead. This third advantage however only comes into play at very high speeds which are out of the range of practice, and cannot therefore be [illegible]. But if the higher-resistance commutator connectors be now tried with an average value for the angle of lead such as 10deg., they will be found of little use, while, lastly, if the current-curve is already concave as at lower speeds, they are positively disadvantageous, since they interfere with the normal current-density, and can only be useful if the current is over-reversed. Thus they are only to be recommended when the position of the brushes has to be considerably behind or ahead of the correct position, in which case they will check the production of large short-circuit currents.

Better results are obtained from the second remedy, which resolves itself in practice into the employment of carbon as the material of the brushes. Whether the curve of change is concave or convex, they always more or less straighten it. The distinction between resistance in the brush contact and resistance in the commutator connectors lies in the fact that the former varies after a linear law, while the latter is fixed; hence the former produces the required effect in exact proportion to the need for it. Being non-metallic, the carbon brush possesses the power of deadening the effect on the commutator if sparking does take place, since there can be no fusion or welding of the two touching surfaces. Even, however, with carbon brushes it is not possible to employ a very high current-density; not only would the normal loss of volts be large, but disintegration of the carbon is set up, so that the contact-surface becomes eaten away. If the very high current-density is localised in one part of the brush, *i.e.*, occurs in the brush tip or heel, then this part becomes red-hot, and its resistance actually falls. The equalising action of the contact-area is then defeated, and the carbon brush may be regarded as having failed to serve the purpose for which it was introduced. The two considerations of a reasonable loss of volts and avoidance of such a high density as may seriously heat the brush have led in practice to the adoption of a normal current-density not exceeding some 35 amperes per square inch. If the contact resistance of carbon is taken as 15 times that of copper brushes and the necessary surface to collect the current be five times that of copper, the $R_1$ of the carbon brushes is three times that of the copper, and this figure may be taken as a rough measure of the extent to which the superiority of the former can be utilised in practice.

## THE COMMERCIAL ELECTROLYSIS OF WATER.

A highly interesting Paper on this subject has been prepared by M. Buffa, whose results have recently been published. The electrolysis of water, though simple enough in the laboratory, presents certain difficulties when carried out on an industrial scale. It is necessary in the first place to avoid mixture of the oxygen and hydrogen given off at the two electrodes. The introduction of a diaphragm for this purpose so increases the resistance of the cell that the efficiency of the apparatus is seriously reduced. Taking the critical pressure necessary for the decomposition of water at 1·49 volts, it follows that when, on account of the diaphragm, 5 volts are requisite, the energy efficiency (even with theoretical current efficiency) falls to 29 per cent. A more economical procedure is to use metallic septa. These separate the two gases perfectly, and act as intermediate electrodes. The drop of voltage from the anode to one side of the septum is insufficient to decompose water and the drop of voltage from the other side of the septum to the cathode is likewise insufficient. Therefore, no liberation of the products of electrolysis occurs at either surface of the metallic septum, but is confined to the electrodes proper. It is obvious that if by some accident the voltage rises there is a risk of the septum acting as an electrode, and the products of electrolysis become mingled. It has been found that in practice iron electrodes in an alkaline bath are most convenient; caustic soda is preferable to caustic potash on account of its cheapness; it is used as a 14 per cent. solution. A difficulty in working may be caused by the deposition of a layer of alkaline carbonate on the electrodes due to the absorption by the electrolyte of $CO_2$ from the air. This is avoided by covering the aqueous liquid with a film of mineral oil. Apropos of this, it is interesting to note that the

same protective action is afforded by a film of water vapour, which obtains when the temperature of the electrolyte is fairly high. When, however, it drops to 10°C. or under, absorption of $CO_2$ takes place rapidly.

One of the chief uses to which the electrolysis of water can be adopted is the preparation of hydrogen for balloons. For military purposes it is essential that the gas shall be approximately pure so as to reduce the size of the balloon needed to lift a given weight and to diminish the number of cylinders of gas required to inflate the balloon. The hydrogen obtained by the action of sulphuric acid on iron weighs nearly twice as much as does pure hydrogen, viz., 160 grammes per cubic metre instead of 89 grammes; electrolytic hydrogen may be obtained in ordinary working weighing not more than 107 grammes per cubic metre. To electrolyse water on a large scale, taking current from a distant water power, it is generally necessary to convert an alternating current into a uni-direction current. Motor transformers are preferable to any electrolytic one direction device, because these latter yield a current whose mean pressure is built up of a pressure below and a pressure above that which is critical. That which is below does not suffice for electrolysis; that which is above destroys the proper function of the intermediate conducting diaphragms and yields mixed gases.

There are numerous neat little devices serving to make the running of the installation smooth and certain. Thus the specific gravity of the gases is measured by an instrument designed by Bassani, consisting of a gasholder which delivers the gas at a fixed pressure through a standard orifice. The rate of flow is proportional to the square root of the density and thereby affords a measurement of the quality of the gas. The apparatus is rendered practically automatic by an electrical arrangement which registers the time occupied by the efflux of the gas. The purity of the hydrogen is also controlled by passing it over heated spongy platinum, which determines an explosion if a notable quantity of oxygen is present. When especially pure gases are needed the crude products from the voltmeter can be purified by passage through a red hot tube and condensation of the water formed from the surplus O or H (as the case may be).

There is a works at Rome for the electrolysis of water which is capable of producing 0·086 cubic metre of hydrogen per horse-power-hour; a factory at Brussels turns out 0·12 cubic metre for the same expenditure of energy. At Rome, where the kilowatt-year costs 96·60fr., the cost of 1 cubic metre of hydrogen and ½ cubic metre of oxygen is 20c., neglecting interest and depreciation on plant. The capital cost of an installation of 100 H.P., taking its current from a central station, is 110,000fr.

Possible applications of the products of the electrolysis of water are numerous. In particular it is well adapted for oxyhydrogen blowpipe work, which has now various industrial uses. The autogenous soldering of the electrodes of accumulators and, indeed, of lead generally; the autogenous soldering of aluminium, which can be conducted in a reducing atmosphere by using a large proportion of hydrogen in the blowpipe flame, are instances.

It is stated that aluminium surfaces can be run together as easily as ordinary tinned goods. Water-tube boilers can be repaired *in situ* by means of the oxyhydrogen blowpipe, and trolley wires are equally amenable to this form of localised heating. For military balloons, electrolytic hydrogen is indispensable, and it is not too much to say that the chemical process for producing the gas is obsolete for this purpose. A singular defect of this pure hydrogen lies in the fact that it is odourless, and therefore does not advertise a leak: the addition of mercaptan remedies this defect. The cost of oxyhydrogen lighting is not excessive, and indeed compares favourably with other systems using compressed gas. The true oxyhydrogen light may be used, but the provision of a refractory material to be heated is a difficulty; hydrogen may be burned beneath a Welsbach mantle; oxygen may be carburetted with petrol, and burned in an ordinary small-jet burner.

The application of electrolytic oxygen and hydrogen for heating glass furnaces gives promise of success; for those high temperature sources of heat that are ordinarily too expensive begin to compete successfully with more ordinary methods of heating. It is even suggested that calcium carbide may be prepared—and economically prepared—by use of the oxyhydrogen blowpipe, but assent to this proposition must wait on experiment. The whole Paper is interesting and suggestive and may usefully serve to direct attention to one of the minor branches of electrochemistry which presents considerable possibilities of development.

## PHYSICAL SOCIETY.

At an ordinary meeting held October 26, 1900, Dr. O. J. LODGE, President, in the chair,

The CHAIRMAN read a letter from Prof. Cleveland Abbe, of the United States Coast and Geodetic Survey, stating that the *Monthly Weather Review* would be sent regularly to any member of the Physical Society expressing a wish to receive it. On the other hand the Chief of the Weather Bureau would, at any time, be glad to receive communications referring to the physics of the atmosphere.

Dr. SHELFORD BIDWELL then exhibited some

### Experiments Illustrating Phenomena of Vision.

The first phenomenon illustrated was that known as "Recurrent Vision." A vacuum tube illuminated by an induction coil, was made to rotate about a horizontal axis, and was seen to be followed at an angle of about 40deg. by a feebly luminous reproduction of itself. A spot of white light, projected upon a screen, and caused to move slowly in a circular path, was also followed by a less luminous spot. The same effect was shown by spots of green and yellow light, but in the case of red light no ghost was visible. The phenomena of recurrent vision are due principally, if not entirely, to the action of violet nerve fibres. The next experiments related to the non-achromatism of the eye. The lenses of the eye do not constitute an achromatic combination, although under ordinary conditions a bright object is not surrounded by fringes of colour. The effects of chromatic aberration are disguised by the luminous haze which surrounds the object, produced by a defect in the eye regarded as an optical instrument. A six-rayed star, formed by cutting a hole in an opaque screen, was illuminated by a gauze-covered condenser containing an incandescent lamp. The star was fairly clearly defined, and there were no fringes. More attentive observation showed a luminous haze. This haze is formed in consequence of the cellular structure of the eye, and the brightest rays—orange, yellow, and green—are chiefly instrumental in forming it. If therefore these rays are obstructed the conditions are more favourable for the observation of chromatic aberration. The rays were consequently cut off by means of coloured glasses and the general hue of the star was purple: to some it appeared bordered with dark blue, while to others (long-sighted) it appeared bordered with red.

Two oblong patches, one red and the other blue-violet, and of approximately the same intensity, were then produced, side by side, upon a screen. An observer with very good eye-sight was able at a distance of 10ft. to focus the patches alternately with perfect distinctness. In general, the blue patch was said to be more or less blurred. With an achromatic eye it should be possible to focus both together.

Dr. Bidwell then showed some lantern slides, illustrating the complex form seen when viewing a small luminous spot through a gauze-covered lens placed so as not to be in exact focus.

Some experiments were performed illustrating the principle of the colour top. When a bright image is formed on the retina after a period of darkness it has, in general, a red border which lasts for a fraction of a second. A dark patch suddenly formed on a bright ground has a blue border which lasts for a similar time. These effects were attributed by Dr. Bidwell to a sympathetic action of the red nerve fibres. When the various nerve fibres occupying a limited portion of the retina are stimulated by ordinary white or yellow light the immediately surrounding red nerve fibres are for a short period excited sympathetically, while the violet or blue-and-green fibres are not so excited, or in a much less degree. Again, when light is suddenly cut off from a patch in a bright field there occurs a sympathetic insensitive reaction in the red fibres just outside the darkened patch, in virtue of which they cease for a moment to respond to the luminous stimulus; the green and violet fibres, by continuing to respond uninterruptedly, give rise to the sensation of a blue border. By a simple experiment it was shown that the explanation of the colour-top depending upon changes in the convexity of the eye and non-achromatism was untenable. By the use of a strong light it is possible to get negative after-images after looking at a brightly-coloured object. These images are complimentary in colour to the object, and are formed even if the object is only viewed for a fraction of a second. By means of proper illumination and a disc rotating at the proper speed a red wafer was so arranged that, upon looking at it,

it was impossible to recognise the wafer itself, but only the continuous green after-image.

The CHAIRMAN expressed his interest in the last experiment in which it was possible to see the negative after-image of an object and not the object itself.

Prof. S. P. THOMPSON said these experiments threw a doubt on some of the accepted notions about the properties of the eye. Dr. Bidwell asks us to believe that the yellow haze is due to a cellular structure in the eye. Is there such a structure, can it be observed with a microscope, and do its meshes correspond in magnitude with those necessary to produce the effects? By diminishing the size of the pupil the haze is diminished and the sharpness of the image is increased. The effects seem to be due to ordinary aberration. Prof. Thompson said that the achromatism of the eye was simply shown by covering half the object glass of a telescope and viewing a bright object with it. The object then seems bordered with coloured fringes.

Mr. T. H. BLAKESLEY, referring to the colour patches used by Dr. Bidwell, pointed out that although the patches were the same distance from the lens yet they did not possess the same magnification. The last experiment shown did away with the theory of persistence of vision because the space between the object and the negative after-image was evidently not illuminated.

Mr. A. P. TROTTER asked if red and green were the only colours which gave complimentary negative after-images.

Dr. BIDWELL, in reply, said the effect was obtainable throughout the length of the spectrum.

A Paper

**"On the Concentration at the Electrodes in a Solution, with Special Reference to the Liberation of Hydrogen by Electrolysis of a Mixture of Copper Sulphate and Sulphuric Acid"**

was read by Dr. H. J. S. SAND. In this Paper an equation has been derived for calculating the concentration at the electrode of a solution of a single salt, from which the metal is being deposited under the conditions (1) that the solution is contained in a cylindrical vessel bounded by the electrodes, (2) that no convection currents occur, and (3) that the diffusion of the salt obeys Fick's laws and its transport values are constant. This formula can be made the basis for roughly determining diffusion coefficients. In the case of mixtures it is possible to arrive at limits for the concentration; and it has been experimentally proved that hydrogen always appears at the electrodes of an acid solution of copper sulphate, in which no currents of liquid are taking place, between the limits of time for the concentration to go down to zero. The time which it takes for the hydrogen to appear can be calculated from an empirical formula, which is similar in form to the one used for a single salt. The great part played by convection-currents in determining the ratio of the two constituents given off at the electrode of an acid copper sulphate solution, has been shown by proving experimentally that artificial stirring causes hydrogen to disappear altogether in cases where it would otherwise have presented over 60 per cent. of the equivalents carrying the current from the solution to the electrode.

The CHAIRMAN drew attention to the fact that no hydrogen was liberated until all the copper had gone, and said the formula for the concentration might be used again in further investigations.

Dr. DONNAN asked if the time at which hydrogen was liberated had been taken as the time at which hydrogen actually made its appearance in the form of bubbles, or whether any allowance had been made for saturation.

Dr. SAND said the time was taken up to the appearance of bubbles.

A Paper by Dr. R. A. LEHFELDT on

**"Electromotive Force and Osmotic Pressure"**

was postponed until the next meeting.

The meeting then adjourned until Nov. 9.

## ELECTRICITY WORKS ACCOUNTS.

### Dundee Municipal Electric Supply Works.

So far as increased business is concerned, good progress continues to characterise this undertaking. The output for 1899 exceeded that of the preceding year by 36·8 per cent., while the equivalent lamp connections rose nearly 29 per cent. The load factor of 9·47 per cent. is also a great improvement on the values for this factor which has obtained in the last two or three years.

Unfortunately, there has occurred a decided rise in the costs due to increases in the repairs and maintenance items. All the other items of cost have either remained constant or have dropped, and without exception indicate excellent results.

As for the repairs at the station, this item has advanced from the very average figure of 0·226d. per unit it held in 1898 to 0·824d., which is decidedly too high. The cause, however, of the considerable rise shown in the works and total costs is the charge of £1,500 which appears in the original accounts under distribution costs in respect of repairs and renewals of mains.

Although not stated as such in the official accounts, this sum appears to correspond with the £1,500 deducted from the total capital expenditure as "charged to revenue." Another charge, this time on the net revenue account is one of £1,982, being one-third of the expenditure on the extension of the power station. In our analysis we have included this with the sinking fund charge.

As a result of the increased costs and slightly diminished receipts the working profit has fallen from 8·12 per cent. to 5·66 per cent. on the mean capital. As in 1898, £700 was placed in the sinking fund, but last year £1,000 was also put aside to a reserve fund.

### Ayr Municipal Electric Supply Works.

The results of the working of the Ayr undertaking during the past year are in many respects most gratifying. It is true that, as the ultimate result, there was a deficit of £696, but an average price for supply of only 2·85d. per unit at an output of little more than 400,000 units for the year, are extenuating circumstances.

Ayr furnishes an interesting comparison with Dundee. In both places the ratio of the output to the plant capacity is high, but for different reasons. At the latter place the value of this ratio, last year, was 28·6 per cent., the load factor being only 9·47 per cent.—pointing to the influence of the battery installed. At Ayr the units sold per 8 c.p. lamp capacity were nearly 22, the load factor, however, being no less than 19 per cent., owing probably to the large proportion (60·5 per cent. of the total output) of arc lighting carried on.

The cost sheet at Ayr last year was very satisfactory, showing that in every item full advantage was taken of the high load factor which prevailed. The fuel charge is the only one which has increased and looks high, but in the circumstances of the coal trade this is only natural. In any case both the aggregate works and total costs are well under the values indicated by a consideration of the output and load factor.

Out of the working profit of £1,765, £1,531 was absorbed in interest and £930 represented the contribution to the sinking fund.

---

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)......Oct. 12, 1900
Ayr (Municipal)..........Sept. 22, 1899
Bath (Municipal) ..........April 20, 1900
Bedford (Municipal) ......Aug. 3, 1900
Belfast (Municipal) ........July 6, 1900
Birmingham (Company)....Sept. 15, 1899
Blackburn (Municipal) ....Jan. 19, 1900
Blackpool (Municipal) ....Oct. 5, 1900
Bournemouth (Company) ..Sept. 7, 1900
Bolton (Municipal) ........Nov. 24, 1899
Bradford (Municipal) ......June 22, 1900
Brighton (Municipal) ......May 4, 1900
Bristol (Municipal) ........Aug. 24, 1900
Bromley (Kent) (Co.) ......June 15, 1900
Brompton & Kensington (Co.) Mar. 23, 1900
Burnley (Municipal) .......Aug. 25, 1899
Burton-upon-Trent (Mun.) April 21, 1899
Bury (Municipal) ..........Sept. 28, 1900
Cambridge (Company)......April 13, 1900
Canterbury (Municipal) ....Oct. 26, 1900
Cardiff (Municipal) .........Dec. 15, 1899
Charing Cross (Municipal)..Mar. 9, 1900
Chelsea (London) (Co.)......Mar. 23, 1900
Cheltenham (Municipal)....Nov. 10, 1899
Chester (Municipal)..........Aug. 3, 1900
City of London (Company)..June 15, 1900
Clerkenwell (Company) ....May 18, 1900
Coventry (Municipal) .......Feb. 23, 1900
Croydon (Municipal).........July 20, 1900
Derby (Municipal) ..........Jan. 26, 1900
Dewsbury (Municipal).......Nov. 24, 1899
Dover (Company) ...........April 27, 1900
Dundee (Municipal)..........Jan. 12, 1900
Eastbourne (Company) ......May 4, 1900
Edinburgh (Municipal) .....Nov. 17, 1899
Exeter (Municipal) ..........Aug. 5, 1898
Folkestone (Company) .....April 27, 1900
Glasgow (Municipal) ........Sept. 14, 1900
Guildford (Company) ........Oct. 19, 1900
Halifax (Municipal)..........Sept. 21, 1900
Hammersmith (Vestry) ......June 29, 1900
Hampstead (Vestry) .........Oct. 12, 1900
Hanley (Municipal) ..........July 27, 1900
Harrogate (Municipal) ......Oct. 20, 1899
Harrow (Company) ..........June 16, 1899
Hast'gs & St. Leonards (Mun.) Sept. 7, 1900
Hove (Company) ............July 6, 1900
Huddersfield (Municipal) ...Aug. 17, 1900
Islington (Vestry)...........Oct. 27, 1899
Kensi'gton & Knightsbr'(Co.) Mar. 16, 1900
Kingston-upon-Hull (Mun.) July 13, 1900
Kingston-on-Thames (Mun.) July 10, 1900
Lancaster (Municipal).......Jan. 19, 1900
Leeds (Municipal)...........Dec. 1, 1899
Leicester (Municipal) .......Jan. 26, 1900
Leyton (Municipal) .........Sept. 8, 1899
Liverpool (Municipal).......June 22, 1900
London (Company) ..........June 8, 1900
Londonderry (Municipal) ..Feb. 16, 1900
Manchester (Municipal)....Sept. 14, 1900
Newcastle and District (Co.) Oct. 6, 1899
Newcastle-upon-Tyne (Co.) Oct. 12, 1900
Newport (Mon.) (Municipal) Dec. 15, 1899
Northampton (Company) ..Oct. 20, 1899
Norwich (Company).........Nov. 17, 1899
Notting Hill (Company) ....Mar. 16, 1900
Nottingham (Municipal) ..Sept 21, 1900
Oldham (Municipal) .........Dec. 1, 1899
Oxford (Company) ..........April 13, 1900
Pontypool (Company).......Sept. 28, 1900
Portsmouth (Municipal)....Aug. 21, 1900
Prescot (Company) .........Dec. 8, 1899
Preston (Company) .........Sept. 29, 1899
Reading (Company) .........Oct. 13, 1899
Richmond (Company) .......June 29, 1900
Salford (Municipal) ........Feb. 23, 1900
Scarborough (Company) ....July 13, 1900
St. Helens (Municipal) ....Dec. 8, 1899
St. James' & Pall Mall (Co.)..Feb. 16, 1900
St. Pancras (Vestry).........June 8, 1900
Sheffield (Municipal) .......Dec. 29, 1899
Shoreditch (Vestry) .........Oct. 27, 1899
Southampton (Municipal) ..Nov. 10, 1899
Southport (Municipal).......July 7, 1899
South Shields (Municipal)..July 7, 1899
Stafford (Municipal).........Aug. 17, 1900
Sunderland (Municipal).....July 28, 1899
Taunton (Municipal) ........June 16, 1899
Tunbridge Wells (Mun.) ..Sept. 1, 1899
Wakefield (Municipal) ......Dec. 1, 1899
Walsall (Municipal)..........June 23, 1899
Wandsworth (Company) ....May 18, 1900
Westminster (Municipal) ..Mar. 9, 1900
Whitehaven (Municipal) ...July 21, 1899
Winchester (Company) .....Oct. 26, 1900
Windsor (Company)..........Dec. 22, 1899
Woking (Company) ..........Dec. 22, 1899
Wolverhampton (Municipal) July 27, 1900
Woolwich (Company) ........Jan. 12, 1900
Worcester (Municipal) .....April 20, 1900
Yarmouth (Municipal) ......Nov. 3, 1899

| | DUNDEE. | | | | AYR. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Dundee Corporation. | | | | Ayr Corporation. | | | |
| *Date of Commencement of Supply* | March, 1893. | | | | January, 1896. | | | |
| *System of Supply* | 3 wire continuous current, with batteries. | | | | Alternate current transformer sub-stations. | | | |
| *Chief Engineer* | W. H. Tittensor. | | | | Arthur J. Fuller. | | | |
| **YEAR ENDED** | DEC. 31, **1898.** | | DEC. 31, **1899.** | | MAY 31, **1899.** | | MAY 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 557,900 | | 736,242 | | 366 784 | | 499,355 | |
| „ **SOLD (TOTAL)** | 451.942 | | 618.352 | | 297,420 | | 425 639 | |
| „ sold to consumers | 407,339 | | 530,271 | | 113,854 | | [illegible] | |
| „ sold for public lighting, &c. | 44,603 | | 88,061 | | 183 566 | | 257,600 | |
| „ used on works | 37.818 | | 50,947 | | 9,201 | | 12,0[illegible]0 | |
| **UNITS SOLD PER 8 C.P. LAMP CAPACITY** | 24·2 | | 28·6 | | 15 3 | | 21·8 | |
| Maximum supply demanded | 625 kilowatts | | 746 kilowatts | | 210 kilowatts | | 256 kilowatts | |
| Number of public lamps | 44 | | 49 | | 73 arc, 65 16 c.p. glow | | 32 arc, 117 32 c.p. glow | |
| Number of consumers | 400 | | 503 | | 501 | | 356 | |
| Connections to mains in 8 c.p. lamps | 28,341 | | 36,543 | | 12,645 | | 17,912 | |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 18 700 | | 21.630 | | 19.500 | | 19,500 | |
| **CAPACITY OF PLANT IN KILOWATTS** | 683 | | 693 | | 625 | | 625 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £96,000 | £141 | £96.000 | £138 | £50,000 | £80 | £50,000 | £80 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 96 000 | 141 | 96,000 | 138 | 50,000 | 80 | 50 000 | 80 |
| **RECEIVED (TOTAL)** | 41 450 | 60 7 | 61 450 | 88·7 | 47,977 | 76·8 | 48.377 | 77·4 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 41,450 | 60·7 | 61,450 | 88·7 | 47,977 | 76 8 | 48,377 | 77·4 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 67 300 | 98 5 | 50,300 | 72 6 | 2,023 | 3·24 | 1 623 | 2 60 |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | 67 300 | 98·5 | 50,300 | 72·6 | 2 023 | 3 24 | 1,623 | 2·60 |
| **REPAID (TOTAL)** | 12.750 | 18 7 | 15.750 | 22 7 | 2 725 | 4 36 | 5.700 | 9 12 |
| **RESERVE OR SINKING FUND** | 903 | 1 32 | 1.630 | 2·35 | 2,010 | 3·22 | 993 | 1 59 |
| **DEPRECIATION FUND** | — | — | 1.000 | 1·44 | — | — | — | — |
| **EXPENDED (TOTAL)** | 45.409 | 66 6 | 50,475 | 72 9 | 43.897 | 70 3 | 46,865 | 75·0 |
| Lands and buildings | 4,634 | 6·79 | 4.736 | 6·84 | — | — | — | — |
| Plant | 21,071 | 30 9 | 24,438 | 35·3 | — | — | — | — |
| Mains | 16,688 | 24·5 | 19,734 | 28·5 | — | — | — | — |
| Miscellaneous | 3,016 | 4·42 | 3 016 | 4 35 | — | — | — | — |
| **BALANCE OF CAPITAL ACCOUNT** | 3,959[a] | – 5·80 | 10.975 | 15·8 | 4 080 | 6 54 | 1,512 | 2 42 |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold | Total. | Per unit sold. | Total. | Per unit sold. |
| **TOTAL** | £7,267 | 3 860d. | £9 044 | 3·511d. | £3.901 | 3·150d. | £5,200 | 2·933d. |
| Revenue from supply | 6,774 | 3·595d. | 8,204 | 3 185d. | 2,289 | 1·8[illegible]d. | 3,125 | 1·762d. |
| „ meters, &c. | — | — | — | — | — | — | — | — |
| „ public lighting | 495 | 0·262d. | 640 | 0·325d. | 1,523 | 1 229d. | 1,933 | 1·091d. |
| „ sale of lamps, &c. | — | — | — | — | 2 | 0·002d. | — | — |
| „ miscellaneous sources | — | — | — | — | 87 | 0·070d. | 144 | 0·081d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| **TOTAL COSTS** | £3.809 | 2 024d. | £6 330 | 2 455d. | £2 621 | 2 114d. | £3 435 | 1·938d. |
| **WORKS COSTS** | 2.460 | 1·307d. | 4 697 | 1·822d. | 2.041 | 1 646d. | 2,610 | 1 472d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 1,061 | 0·554d. | 1,342 | 0·521d. | 347 | 0·080d. | 1,288 | 0·727d. |
| Oil, waste, water, stores | 219 | 0·116d. | 300 | 0·116d. | 59 | 0·048d. | 63 | 0 035d. |
| Wages at station | [illegible] | 0·288d. | 650 | 0·252d. | 719 | 0 580d. | 637 | 0 359d. |
| Repairs and maintenance at station | 485 | 0 261d. | 955 | 0·3[illegible]d. | 155 | 0 125d. | 220 | 0·124d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 94 | 0 050d. | 55 | 0·022d. | 120 | 0·097d. | 165 | 0·093d. |
| Repairs, renewals of mains, &c. | | | 1 509 | 0·582d. | 25 | 0 020d. | 52 | 0·029d. |
| *Public lighting* | 119 | 0·063d. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Attendance | | | | | | | | |
| Renewals | 119 | 0·063d. | 13 | 0 005d. | 85 | 0 064d. | 171 | 0·096d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 1 349 | 0 717d. | 1 633 | 0·634d. | 580 | 0 468d. | 825 | 0 465d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | 0·25[illegible]d. | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | [illegible] | 0 255d. | [illegible] | 0 211d. | 299 | 0·241d. | 417[a] | 0 235d. |
| Stationery, &c. | 73 | 0·038d. | 123 | 0·013d. | 26 | 0·021d. | 59 | 0 028d. |
| Establishment charges | 34 | 0·018d. | 58 | 0·023d. | 23 | 0 018d. | 35 | 0 020d. |
| Law charges, &c. | 17[b] | 0·009d. | 19[b] | 0·007d. | 125[a] | 0 101d. | 177[c] | 0 100d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap exp'nded | Total. | % to mean cap exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap exp'nded |
| **WORKING PROFIT FOR YEAR** | £3.459 | 8 12% | £2.714 | 5 66% | £1 279 | 3 20% | £1 765 | 3 89% |
| Sum carried to Depreciation Fund | | | 1,000 | 2·08% | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 700 | 1·64% | 2,532[c] | 5·19% | 879 | 2 18% | 930 | 2·05% |
| Net interest on loans (incl. Debenture charges) | 818 | 1·92% | 973 | 0·204% | 1,178 | 2·95% | 1,631 | 3 57% |
| **BALANCE FROM LAST ACCOUNT** | 1.714 | 4 03% | 3 273 | 6 83% | — | — | — | — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 3.273[c] | 7 70% | 1 376 | 2·87% | — | — | — | — |
| *Deficit* | — | — | — | — | [illegible] | [illegible] | [illegible] | [illegible] |
| **ORDINARY DIVIDEND PAID** | — | — | — | — | — | | | |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 52 4% | | 70% | | 67 2% | | 66 1% | |
| Expenditure per kilowatt capacity | £5 11s. 7d. | | £9. 2s. 10d. | | £4 4s. [illegible]d. | | £5 5s. 11d. | |
| **REVENUE PER KILOWATT CAPACITY** | £10. 12s. 10d. | | £13 1s. 0d. | | £6. 4s. 11d. | | £8 6s. 5d. | |
| Expenditure per 8 c.p. lamp capacity | [illegible] | | [illegible] | | 2s. [illegible] | | 3s. 6d. | |
| **REVENUE PER 8 C P LAMP CAPACITY** | 7s. 9½d. | | 8s. 4½d. | | 4s. 0d. | | 5s. 4d. | |
| **REVENUE PER 8-C P. LAMP CONNECTED** | 5s. 1½d. | | 4s. 11½d. | | 6s. 2d. | | 5s. 9½d. | |
| Price charged for lighting, per unit | 4d. to 3d. | | 4d. to 3d.[d] | | 5d. to 4d. | | 4d. | |
| Price charged for power, per unit | [illegible] | | 2d. [illegible] | | 3d. | | 3d. | |
| Price charged for public lighting | £16. 10s. per lamp per [illegible] | | £16 10s. per lamp per [illegible] | | £20 per arc per annum | | £20 per arc per annum | |

DUNDEE.—[illegible] After deducting [illegible] repaid to gas department [illegible] per cent. [illegible] After deducting [illegible] charged to revenue [illegible] amount expended [illegible] electrical power station.

AYR.—[illegible] Includes [illegible] £18 to repairs and £45 expenses [illegible] Includes [illegible] £117 and [illegible]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| **United Kingdom** | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| **Postal Union** | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## AN INTERNATIONAL TECHNICAL DICTIONARY.

At the first meeting of the Institution of Mechanical Engineers this session, the President, Sir WILLIAM WHITE, read a letter from the Verein Deutscher Ingénieure on the subject of a proposed English, French, and German technical dictionary. This Association, which holds a position in Germany almost equivalent to that of the Institution of Civil Engineers in Great Britain, proposes to compile a dictionary of technical terms, and suggests that scientific and technical societies in England, the United States, and France should assist by selecting members who would furnish gratuitously lists of the technical expressions employed in their special branches. The Council of the Institution of Mechanical Engineers has decided that it was not considered desirable that the Institution, as a body, should be committed to undertake a part of the work, but the co-operation of individual members was invited. Presumably, the same invitation of the German society will have been made to the Institution of Electrical Engineers, and it is of interest to consider in how far such a dictionary would benefit members of the electrical engineering profession, and to what extent assistance should be lent by them towards furthering the present scheme. As to the former of these two questions, there can be little difference of opinion. It may be argued that each of the four countries in question already possesses in itself an abundance of excellent scientific and technical literature, and that a great many of the best technical and scientific works are translated. Yet an engineer, and also a student of pure science, who desires to keep abreast of the advance in his profession should make himself acquainted with the work being done in other countries than his own. This he can only do completely by acquiring, a reading knowledge at any rate, of French and German, and by reading the articles which concern him most intimately in the various foreign technical journals. True there are English journals, which—like ourselves in the electrical branch of the technical professions—endeavour to publish translations or abstracts of the cream of the foreign articles, but the amount of excellent work now being done abroad precludes an absolutely complete record of all its details in the columns of an English journal. *Science Abstracts*, *Wiedemann's Beiblätter*, and similar publications furnish abstracts—especially of the more purely scientific articles—but excellent as they are, these publications must necessarily constitute rather an amplified index than a complete *résumé* of contemporary work. To assist in reading the original articles,

therefore, a good technical dictionary would be invaluable, and it is safe to assert that no dictionary exists at present embracing all the scientific and technical terms relating even to electrical and mechanical engineering only. It is of course with these two branches of technics that we are chiefly concerned, and strange as it may appear, less with the former than the latter. Electricity being a modern science has always developed in a more cosmopolitan manner than mechanical engineering, and in consequence a great number of electrotechnical terms are expressed in a nearly similar manner in the three languages, while for a proportion of the remainder, ordinary words are endowed with technical significance, and their meaning can often be traced with the help of a dictionary of the usual kind. In the case of mechanical engineering terms, on the other hand, a large number of those which are now actually written and printed were originally merely shop terms and have frequently sprung from workmen's slang, so that the dissection of them to seek their meaning through their derivation is fruitless. Not only for the purpose of reading foreign languages, but also when travelling abroad and in his conversations with colleagues thereon, is a knowledge of foreign technical terms needful to the engineer. It may be confidently asserted therefore that from every point of view a good dictionary of technical terms is a positive desideratum.

Next we have to consider whether the present scheme is likely to produce the best dictionary, for if the leading scientific and technical societies of the four great nations are to co-operate in its production no effort should be spared to make it as perfect as possible, and everything depends on the original groundwork of the scheme. Eighteen months ago (*The Electrician*, Vol. XLII., p. 783) we considered this general question of technical dictionaries. We then pointed out that the reason for the inadequacy of technical dictionaries was purely a commercial one, for even if an editor could be found to devote himself to the compilation of a standard work of the kind—which would be a labour of many years—a publisher would hardly be found to guarantee proper remuneration to him and the army of skilled workers which it would be necessary to engage for his assistance. We therefore suggested then that a representative scientific or engineering society, or several of such societies in conjunction, should undertake the work, and mentioned in this connection the Royal Society and the Institution of Civil Engineers. We are still of opinion that a good dictionary of the kind required could and should be compiled in this manner, but the lines suggested by the German Institution of Engineers are not the correct ones. If the dictionary is to be compiled by volunteer workers it will be fore-doomed to failure. To be properly carried out, the undertaking must employ a large number of engineers with knowledge of foreign languages, and it is unreasonable to expect these collaborators or the editor of the work to devote sufficient time to it without adequate remuneration. The making of a dictionary cannot be carried out in occasional leisure moments; it is actual hard work—and for the most part uninteresting work. Not only would it be badly and incompletely done if the German Institution's scheme were put into operation, but it would never be ready. By the time an edition had been finished it would already be out of date and the work would have to be begun anew. We have an example of such wasted labour in a quarterly, *Fortschritte der Elektrotechnik* (Progress of Electrotechnics), still being published in Germany. This is a fairly complete index of English, French, German and American electrotechnical articles published during the quarter, giving in a few words the gist of the more important ones. But each number is published not months after but from one to four years after the quarter it reviews has expired, and although an immense amount of good work has been put into it, the utility of the publication is small. The same would be the case of a technical dictionary supported by voluntary contributions. If such a work is to be produced, as it undoubtedly should be, let the leading scientific and engineering societies of the countries interested make grants towards expenses, appoint a committee, and engage an editor and staff on such conditions that they are not too much hampered in their duties by being under the control of a Concert of Powers. The ground to be covered having been clearly defined by the Committee, such a staff of compilers, with every inducement to perform their task thoroughly well, and possessing the mandate of the societies, would be able to compile exactly the kind of technical dictionary that has so long been needed.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

**Electric Wiring, Fittings, Switches and Lamps.** A Practical Handbook for Electric Light Engineers, Wiring and Fitting Contractors, Consulting Engineers, Architects, Builders, Wiremen and Students. By W. Perren Maycock, M.I.E.E. (London and New York: Whittaker & Co. 1899.) 6s.

By the sub-title to this book it will be seen that Mr. Maycock, experienced and prolific writer as he is, has undertaken a difficult task. And as if it were not in itself hard enough to cater in one small volume for such a variety of readers, the book is also intended, when taken in conjunction with another of the author's productions, to coach for the preliminary or ordinary grade examinations of the City and Guilds of London Institute. Thus it happens that, although on the whole of an elementary character, the work would not in itself serve as a first text-book for the student. On page 46 we read that the candle-power of a glow-lamp does not depend solely upon its voltage, and other statements of a like character which are merely truisms even to those but slightly initiated in the general principles of the theory or practice of electricity; and only five pages later the abbreviation "P.D." is employed for the first time without any explanation of its meaning, and that in a section instructing the reader how to connect lamps in parallel. In some parts, however, the book is decidedly worthy of commendation, especially in the section on arc lamps. If this portion of the book were taken by itself, enlarged, and re-written in a more technical and less elementary style, it would go far towards filling a gap in current technical literature.

**Eléments du Calcul et de la Mesure des Courants Alternatif.** By Omer de Bast. (Paris: Libraire Polytechnique. 1900).

This book, virtually a selection from the published course in electricity at the Technical College of Liège, is intended especially for electricians not possessing sufficient mathematical knowledge to follow the application of the methods of the calculus to alternating-current theory. So many books with precisely the same aim have been published of recent years, that a treatise on this theme must be indeed excellent in order to deserve and obtain special attention. We cannot say that M. de Bast's work possesses any features which entitle it to such special attention; yet the volume will prove to have for the reader already partially acquainted with the subjects treated a charm lacking in many of its predecessors. One point at least which compels for it favourable notice is the strictness with which the author confines himself to the subject in hand, and avoids those side issues which swell the pages of so many of our text-books on the alternating current. Another excellent characteristic is the weighed accuracy which marks every statement. The book will prove useful to students attending the writer's course on its subject matter, but to electricians in England, at any rate, its existence is of little importance.

## PARLIAMENTARY RECORD FOR 1900.

(*Concluded from page 18.*)

The interesting contest for the electric lighting of Dublin has already been pretty fully considered in these columns. The electric lighting company in promoting their bill proved that the Dublin Corporation had failed to give an adequate supply of electric light in the city, in spite of huge outlays of capital. Yet the Corporation brought forward an opposing scheme to cover the whole city at an estimated cost of £254,000. The company's bill, after passing the Committee stage triumphantly, was rejected by the House of Commons on third reading by six votes, and the Corporation remains the sole distributor of current for lighting purposes. It is of interest to note that in the speeches on the motion for third reading the chief argument against the bill was that there is no precedent for allowing a company to come in and compete with a local authority already supplying current. This argument will, however, have less weight with Parliament in future in the light of the declaration of Sir J. Kitson's Committee, made on the day after the defeat of this Dublin company's bill, and finally set out in the second clause of the section we have already alluded to in the power bills, giving the Board of Trade power to authorise supply of electricity by a company where the local authority unreasonably withholds its consent. Although the Dublin company was unsuccessful in attaining its object, one point has been gained by the promotion of this bill. It was the direct cause of the promotion of the Dublin Corporation's scheme; and dread of the competition which that body has so narrowly escaped will act as a wholesome stimulant in the provision of a good electrical supply for the city.

A bill promoted by the Brighton Corporation presented one novel point—the proposal to lead the high-pressure mains from a new generating station 8½ miles from Brighton to the present station in North-street, where the transformers will be placed, through the district of the Hove Corporation, this being the first instance before Parliament of one corporation seeking powers to go through another corporation's area. The objection raised by Hove was not to the laying of the cables so much as to the particular system proposed (the solid system), it being urged that this would involve the re-opening of the roads and streets if any of the cables should become defective, or if the demand should increase and render necessary the laying of more cables. Sir Wm. Preece strongly advocated, on behalf of Hove, that the cables should be laid in conduits with manholes, so that additional cables could be drawn in without re-opening the streets, and so that faults could be detected between manholes. In the result, however, the Brighton scheme was passed and the clauses submitted by Hove rejected.

Points of the greatest electrical and legal interest arose in connection with some of the bills for powers to construct electric tramways. The number of these bills this year has been very great, and it is quite evident that before long electric traction will be practically universal on the tramways of this country. The schemes in themselves, as engineering enterprises, did not, as a rule, present any exceptional features. Their chief interest lies in the fact that some of them have led to the formation of precedents in Parliament on the much-debated question of the proper limits to be put upon ownership of tramways by municipalities. On this question the Huddersfield Corporation Tramways Bill is of importance. The powers sought under this bill were powers to convert the present steam tramway system into a system with electric traction, and to extend the system both within the borough and *in adjacent districts*. When this scheme was argued first before the House of Commons Committee, that body decided that, while passing that part of the bill relating to alteration of the system to electric traction, they could not, in view of the appointment of the Parliamentary Committee on Municipal Trading, grant the principle of these large extensions outside the borough boundaries. Later, however, in the House of Commons it was stated that the appointment of the Committee on Municipal Trading was not intended to have any bearing upon this point, and the bill was again remitted to the House of Commons Committee, presided over by Mr. Jeffreys, with the result that the clauses dealing with these outside extensions were re inserted.

The Huddersfield Corporation Tramway Bill, then, forms a precedent, and may be taken as some indication that Parliament in future may not refuse to give powers to municipalities to construct and operate lines reaching to long distances outside their own boundaries, provided the outside authorities consent. The effect that this would have in discouraging private enterprise would be serious. We cannot persuade ourselves that it is within the proper scope of municipal work to conduct these great business enterprises outside their own boundaries. The same problem appeared in the Manchester Corporation Tramways Bill. That Corporation has made arrangements with all the surrounding local authorities (except Salford, with which negotiations are proceeding) to run electric cars through all the districts as one uniform system, Manchester providing the cars and supplying electric current for all places except Salford and Stockport. Now, if we desire an argument to show that this state of affairs is not a right one, we may find it in the decision of Parliament itself in the case of the Rochdale Corporation Bill, which sought powers to purchase the existing tramway system, convert it to electric traction, and extend it beyond the boundaries. The discussion on that bill before the House of Lords Committee was on the question whether a corporation trading as owner of tramways outside its own area should not be prevented from making a loss on the system. The Committee eventually adopted the principle and drafted a clause to incorporate it in the bill. The text of the clause, which is similar to that in the Dundee and Aberdeen Bills, will be found on p. 528 of *The Electrician* for July 27. Now, if it is wrong for a corporation to be allowed to run its tramways outside its own boundaries at a loss because its ratepayers would suffer, it seems equally wrong that these ratepayers should be allowed to derive a profit from that outside source. Altogether it seems very regretable that these extensions of the sphere of municipal enterprise should be approved by Parliament.

Another point of interest is that in some of the tramway schemes Parliament has granted a company a longer period than the 21 years allowed by the Tramways Act, 1870, before the local authority can enforce compulsory purchase. In the case of the Glasgow District Tramways, the chairman of the House of Lords Committee expressly laid this principle down. The promoter of that scheme showed in his evidence how the conditions of tramway enterprise at the present time made it impossible in most cases to accept the terms of the 1870 Act, and therefore it became necessary to arrange for special terms, particularly as to wayleaves and conditions of purchase.

So far as regards questions of engineering, the only discussion of special interest that arose during the consideration of electric tramway measures was on the London Tramways Bill (No. 2), promoted by the London County Council. This discussion was on the relative merits of the conduit system with insulated returns and the surface-contact system using rails as a return. The system recommended by Prof. Kennedy is the conduit system with insulated return, as by this means, he urged, electrolysis of gas and water pipes in the vicinity will be avoided. An experimental line from Westminster Bridge to Tooting is to be made, half on the surface-contact system and half on the conduit system. Of course, the gas and water companies made the most of the possibility of electrolysis in their pipes, and were successful in getting protecting clauses inserted in the bill by the House of Lords. These clauses (1) make the County Council responsible for injury to pipes and mains proved to arise from electrolysis caused by leakage from their system, and (2) give the gas and water companies power to carry out for themselves, at the expense of the County Council, any alterations in mains or pipes rendered necessary by the Council's undertaking. In the interests of the gas and water companies such provisions are but just: but it is noteworthy that in the case of the South Eastern Metropolitan Tramways Bill, when the South Metropolitan Gas Co. applied for the insertion of similar clauses, the House of Commons Committee granted the

second only, refusing the first, but inserting a proviso as to arbitration; and again in the case of the Croydon Tramways Bill the Committee refused to insert a clause asked for by the Lambeth Gas Co. throwing the cost of any accidents through electrolysis upon the Corporation.

The Glasgow Tramways Bill produced a splendid object-lesson in the art of obstruction of useful measures by local authorities. The Chairman of the House of Commons Committee, in declaring the decision of Committee that the preamble of the bill was not proved, commented in the strongest terms on the action of the opponents of the scheme. The Committee put on record that in their opinion the original scheme was a good one and calculated to be of much use to the district; but it had been so mutilated and loaded with conditions by conflicting interests and the excessive demands of several local bodies, that it now appeared to the Committee to be wholly unworkable. "This," said the chairman, "was the result of a system of blackmail on the part of the local bodies." We trust these remarks by Sir Lewis McIver may receive the attention they deserve. The fact that it was necessary to make them points to a serious evil; for surely it is a scandal that it is possible for a scheme recognised by a Parliamentary Committee to be valuable and useful to the people to be killed by blackmail on the part of municipal bodies.

A curious decision, and one that stands out for special comment, was that given by the House of Commons Committee presided over by Mr. W. H. Holland. A company and a corporation each sought powers to construct electric tramways in part over the same area; and instead of, as has usually been done, giving the corporation alone powers to make tramways within its boundaries, the Parliamentary Committee passed both schemes, giving each of the parties running powers over the system of the other. The result will be watched with interest. These schemes came up under the Christchurch, Bournemouth, and Winton Tramways Bill. The Poole and District Electric Traction Co. desired to construct electric tramways from Christchurch into Bournemouth, connecting with their line to Poole. The Bournemouth Corporation had always opposed the introduction of tramways into the borough on the plea that it would drive away the wealthier class of visitors who brought their own carriages. But on the hearing of this bill they brought forward a scheme of their own for tramways inside the borough, and the Traction Company, therefore, sought, if the Corporation bill should be passed, to have running powers over the lines. In the end, both bills passed, and a clause was inserted that if the Corporation did not construct this particular Christchurch line between the borough boundary and the centre of the town within two years the company should have power to carry out the work. Reciprocal running powers were granted to the Company and to the Corporation over each other's lines. Strenuous efforts were made by the Corporation to get the Committee to reconsider the clauses giving mutual running powers, but without success.

One further bill remains to be mentioned—the Weston-super-Mare Tramways Bill, which presents the first case of a tramway company seeking powers to work their system electrically in a district where an important main line submarine telegraph cable was already laid. The tramways at Weston are to be worked on the overhead system, and the Commercial Cable Company, whose cable comes ashore at Weston, sought a provision reserving to them all their common law rights, giving them powers to do such work as might be necessary to prevent their lines being interrupted by the tramway currents, and asking that the tramway promoters should reimburse them for the expense of this and compensate them for any loss or damage. The Cape Town case (Eastern and South African Telegraph Co. *v.* Cape Town Tramways Co. (Ltd.), reported in *The Electrician* for March 16, April 6 and 13, 1900) was freely referred to in the discussion. Ultimately the House of Lords Committee refused to grant any protection clause to the Commercial Company. On the other hand, the House of Commons Committee, which had first considered the measure, was much impressed by the importance of the question raised, and, besides inserting a clause the text of which is given in *The Electrician* for July 6, p. 414, joined to their report to the House a recommendation that the position of cable companies in relation to other electrical undertakings should, with other matters involving electrical interests, be considered by a joint committee such as that which reported on the telephone question in 1898.

A proposal of some novelty, at least in this country, was included in three separate measures before Parliament this year, namely, the construction of an electric conveyor bridge across a river. All these proposals have received the sanction of Parliament. One bridge is to be constructed over the Mersey at Runcorn, a second over the Ribble, and the third over the Usk at Newport (Mon.). The bridge consists of a high girder, with a cradle platform suspended from it, worked electrically. In the case of the bridge across the Ribble, to be built in connection with the Southport and Lytham tramroad scheme, the girder of the bridge will be 177ft. high, so as to allow for the highest masts of vessels navigating the river. This is 36ft. higher than the Tower Bridge across the Thames. The cradle will be from 50ft. to 60ft. long, and will be capable of carrying an electric car and trailer, or a waggon load of hay or other produce, with two horses, to the total weight of 25 tons. The rods suspending the cradle from the girder will be from 150ft. to 160ft. long. The success of such transporter bridges on the Continent was brought forward as an argument in their favour, and probably helped to convince the Committees.

In the matter of electric railways little calling for especial mention has arisen. The Baker-street and Waterloo Railway will undoubtedly have its usefulness greatly increased by the further extensions from the terminus of the Great Central Railway at Marylebone to the terminus of the Great Western Railway at Paddington, and on the south side from Waterloo to the Elephant and Castle. Then the Metropolitan and Metropolitan and District Railway Companies have now obtained the sanction of Parliament to construct works at Chelsea and lead high-pressure mains to their line at Earl's Court, and to distribute the power along the route of their lines, transforming down at sub-stations.

From the digest here presented of the electrical measures before Parliament in 1900 it will be seen that there has been very considerable progress made in the general introduction of electricity, especially as a source of mechanical power. While congratulating the industry generally and the promoters of the successful schemes in particular, we would add a word of praise to those on whose shoulders fell the labour of prosecuting the schemes before Parliament, especially the parliamentary agents and counsel. Such learned counsel as Mr. Balfour Browne, Mr. Littler, Mr. Pember, Mr. Worsley Taylor, to name but a few of those who have been prominent in the cases with which we have dealt above, have by their sound technical knowledge coupled with great forensic skill made the rough places plain for the Committees, and have helped very considerably towards the satisfactory progress which the past session has brought about in the general introduction of electrical power.

Now that Parliament has indicated in the acts dealing with the great power schemes the lines on which it considers such legislation should run, we may confidently expect a large crop of similar schemes. The main result, as we may well hope, will be the growth of new industries in parts of the country where at present such industries would be impossible, leading eventually to a partial solution at any rate of the question of over-crowding in towns. On the whole, the result of the year's work is satisfactory, and gives promise of still greater progress in the immediate future.

St. Katherine's Docks.—An electric lighting plant has just been completed at the St. Katherine's Docks. The plant capacity is 4,000 8 c.p. lamps, the various stowages and show floors being adequately lighted throughout. The generating plant consists of three Galloway boilers, with mechanical stokers, and three 600kw. Belliss-Crompton sets. The docks are wired on the three-wire system, with a pressure of 220 volts on each side of the middle wire. Bare mains are employed of hard-drawn copper mounted on oil insulators.

## PROGRESS IN ELECTRIC LAMPS.*

BY PROF. ANDRÉ BLONDEL.

The object of this Paper is to pass in review the improvements realised up to the present, and those still to be hoped for, in arc and incandescent lamps.

*Progress in Arc Lamps.*—During the past 10 years great strides have been made both as regards the theory and the construction of arc lamps. Our theoretical knowledge of the properties of the arc has greatly increased. The measurements of M. Violle have shown that the maximum temperatures reached in the arc are 3,500°C. at the positive, 2,700 C. at the negative carbon, and also that in a closed space the brightness and the temperature of the crater are constant. Again, after a discussion, joined in by many authorities, it seems now settled in conformity with the present author's conclusions that the back E.M.F. in the arc exists only as arising from the arc's resistance, which can be considerably modified by the addition of salts to the crater. Mrs. Ayrton's experiments have connected by simple laws various phenomena of the arc; in particular they have shown that the energy consumed is a linear function for each diameter of the carbon. That the apparent resistance varies not only with the diameter of the carbons and the length of the arc, but also with the nature of the carbons and the surrounding gas has been shown by various experimenters. Mr. E. Wilson, repeating an experiment by M. Cailletet, has shown that the brightness of the positive carbon diminishes when the pressure is increased, and that by the withdrawal of gas a carbon mist is produced. M. Le Chatelier has attributed the constancy of the temperature of the crater to the presence of fusing carbon there. In addition, the author's experiments have shown that in free air the brilliancy of the arc increases with the current, and passes from 150 candles per square millimetre for small arcs to 220 candles per square millimetre for powerful arcs. Mrs. Ayrton, in her researches on the hissing of the arc, discovered that the hissing is caused by the advent of oxygen at the crater; and that the phenomenon does not occur below a certain current density, and is preceded by Trotter's phenomenon of the rotation of the arc on itself.

As regards the alternating-current arc the author has given a detailed analysis of its periods of lighting and extinction, and of its current and voltage curves; he has shown the parts played by the resistance and the self-induction of the circuit, the conductivity of the core, and the form of the E.M.F. curve of the generator.

The electric arc does not conform to Ohm's law, for increase of current produces widening of the arc, and consequently a diminution of the resistance. This leads to instability, which must be guarded against, on a constant-potential supply, by the inclusion of a resistance in series. This instability was studied by the author in 1891 by drawing "characteristic curves of extinction," in which the potential difference between the lamp terminals was plotted for various currents.

As regards the mode of regulation, the differential system seems now universally admitted to be the best. We may take with the minimum voltage of 30 volts for the arc a potential drop of 1·5 volts in the steadying resistance for alternating arcs, and with 33 volts a fall of 3·5 volts to 4 volts in the resistance for continuous-current arcs. The use of shunt-lamps presents some advantages over the differential system: the lamps are simpler; there is no risk of burning out by too strong a current; and they permit of easier regulation of the current within wide limits.

The oscillographic study of the extinction of the arc without additional resistance, shows it to take place slowly, the phenomenon requiring about $\frac{1}{10}$sec. or even more for its completion. This indicates that with quick-acting and sensitive mechanism the normal arc may be uninterruptedly maintained with only small steadying resistance in series. The inertia of the moving parts leads to hunting however, unless the vibrations set up are rapidly damped by a dash-pot. In the best modern lamps, air dash-pots are employed, and the adjusting mechanism has reached great perfection. Arc lamps have numerous constructional conditions to satisfy. They must be able to stand rough handling and every weather, and must be capable of easy and quick replenishment and repair. It is noticeable that of recent years there has been a tendency to revert to the use of clockwork mechanism on account of its great sensitiveness and small consumption of energy. As for motor mechanisms, they are rather complicated when continuous currents are used, but with alternating currents assume various elegant forms of the type of a metal disc embraced by electromagnets of suitably differing phases. With certain types of mechanism in alternating current lamps the self-induction of the regulating coils tends to reduce the sensitiveness. This self induction effect might be compensated, as M. Claude has suggested, by proper condensers. The self-induction, however, tends also to keep the impedance almost constant, in spite of variations of the resistance of the coils through temperature alterations, and so gives the alternating-current lamp some advantage over the continuous-current lamp. In the latter lamps ingenious temperature compensators have been adapted, but these unfortunately leave uncorrected the variations of the resistance produced by the shortening of the carbons. Improvements in mechanism have brought many good double carbon lamps into use; among these the Crompton Pochin, Brockie-Pell, and Korting and Mathiesen lamps may be mentioned. The author has for a long time considered that these lamps are very efficient as regards the utilisation of the energy supplied. Besides this they require little labour and are economical in carbons.

Modern methods of lamp grouping differ greatly from the old system, in which the employment of isolated lamps was necessary. One modern tendency is, however, to use high-voltage enclosed lamps working directly at 110 volts; another is to use, as of old, two lamps in series, each absorbing from 30 volts to 35 volts. In both these cases the steadying resistance is important. But by the construction of differential lamps the importance of the steadying resistance is minimised. Low voltage lamps have been in use since 1889, but it was not till after 1897, when the Hegner (Volta) lamp appeared, that the low-voltage lamp entered largely into industrial practice. Siemens and Halske, as also Korting and Mathiesen, in their low-voltage lamps use, at starting, a high resistance which is afterwards gradually removed. With these the fear arises that, in spite of the perfection of the mechanism, certain circumstances may lead to a dangerous increase of the current. Hegner, using also differential lamps, but without special mechanism, puts three in series with an automatic rheostat of four parts, which are removed successively as the lamps get started, thus securing a more stable and less dangerous arrangement than the former. Still more recently Vigreux and Brillé have proposed a special mechanism on the differential system which without springs, weights, or frictional appliances, can produce a very rapid recoil of the carbon if the arc becomes shorted. The advantages of these low-voltage lamps are that they enable a better distribution of illumination to be effected, and that they are more economical as regards consumption of energy. Against these advantages must be set, however, the heavy initial expense, the complication and delicacy of the mechanism, and the necessity for carbons of very special quality.

With these lamps, grouping by threes is called for only on short, small-resistance circuits. When large areas are being supplied the leads furnish sufficient steadying resistance for the usual arrangement of two arcs in series. In any case it is only on circuits at 110 volts and when sub-division of the illumination is desired, that low-resistance lamps are specially useful. When, however, the distribution is made at 220 volts, and especially when 220 volts is to be substituted for 110 volts in an existing circuit, a reduction of the number of lamps under a given voltage should rather be aimed at. The solution of this problem is afforded by the enclosed arc lamp.

Illumination by arc lamps in series, with both continuous and alternating currents, is still much in vogue in the United States, but has been almost completely abandoned in Europe on account of the lack of independence among the lamps, and the dangers accompanying the use of high-pressure currents. A recent application in this direction in England consists in the employment of constant-current transformers and Ferranti rectifiers, and thus allows the use of lamps giving a better light distribution than alternating-current arcs. The pulsating current produced is, however, as dangerous as alternating currents. On the Continent commutator transformation to continuous current, or the use of alternating-current lamps with reflectors, is preferred.

The enclosed arc lamp did not assume importance till 1894. It is characterised by having a very long arc using a tension of 75 volts to 80 volts. In the Marks (or Jandus) lamp the arc is surrounded by a double globe, the inner one of which possesses a valve (check-gas plug), which permits expansion of the contained air. The outer large globe is protective, and becomes filled with gas from the inner globe. In these circumstances the carbons are consumed very slowly, and the arc itself is modified in character—the upper positive carbon is, through rotation of the arc, scarcely hollowed, the lower negative carbon is plane, while their normal distance apart is 8mm. at 80 volts. The mechanism of all makes of these lamps is of the most rudimentary type. And since the carbon consumption is small the displacement of the luminous spot is very little. The advantages of these lamps are: Their independence of one another, the ease of their application in 110 volts or 220 volts systems, the extreme simplicity of their mechanism, the employment of cheap carbons, the small consumption of the carbons, and the reduction in the amount of attention necessary. Their disadvantages are, on the other hand, the blue tint in the light, the variations of brightness which render almost necessary the use of a diffusing globe, the fouling of this by a silicious deposit, and the mediocrity of the light from large carbons. The disadvantages attending the use of alternating-current enclosed lamps remain still so numerous that this type of enclosed lamp cannot yet be regarded as a success.

* Abstract of a Paper read at the International Congress of Electricity Paris.

The manufacture of arc lamp carbons has received, of course, much attention. The old method of baking several times a paste of carbon powder treated with certain syrups is quite discarded; its products were of the highest excellence, but were very expensive. Now, gas carbon, selected carefully and powdered, is mixed with various proportions of lamp-black and tar; and sometimes, with a view to increasing the luminosity or the durability, chemicals are added. The paste, well worked up, is squirted, and, finally, cookedat the highest possible temperature. Most European manufacturers give the positive carbon a core of carbon containing borates and silicates, and emitting into the arc a conducting vapour, which assists stability, lowers the hissing voltage, and gives a wide range of working tension.

In the United States, for home consumption only, an inferior kind of carbon is made from lampblack and petroleum purified by acid. Such carbons must be made very soft, and must be plated with copper if intended for low-voltage lamps. The coppering of carbons has been abandoned in Europe, chiefly because the drops of molten copper affected the steadiness of the arc.

The density of average carbons varies from 1·30 to 1·35; the specific resistance varies from 0·005 to 0·1 in ohms and centimetres, and is generally about 0·008 or 0·0095. The cores usually contain 80 per cent. to 85 per cent. of carbon, 5 per cent. to 6 per cent. of water, and the rest is made up of silicates and borates. There is, however, no good test for the quality of a carbon other than its actual use in a lamp.

The proper diffusion of the light is now effected more thoroughly than formerly by the use of reflectors, opaline globes, holophanes, diffusers, &c.; and also by the employment of inverted arcs whose light is reflected from a whitened ceiling or from special reflectors.

The photometry of the arc lamp has lapsed into confusion, for the horizontal candle-power, the maximum candle-powers, the mean spherical and the mean hemispherical candle-power are in common use, as well as a so-called "nominal" intensity. In any case, it is difficult to compare the results of two experimenters, on account of the insufficiency of definition of the arc. It is necessary to specify not only the current and terminal voltage, but also the diameter of the carbons, the voltage between their points, the length of the arc, and the kind of core in use. Moreover, to attain uniformity in results, it is necessary that the same standard of candle-power should be used by all the observers and that the tint of the light from the arc should be properly taken into account. The author and M. Jigouzo have found, by the aid of the lumenmeter, that the illumination produced is increased by a diminution of the diameter of the carbon following a law less simple, however, than that of Schreihage; and that it increases with the voltage up to a certain maximum depending on the current density, and then diminishes again. This maximum varies from 10 lumens to 25 lumens (0·8 candle to 2 candles) mean spherical per watt for the continuous current, and from 5 lumens to 17·5 lumens (0·4 candle to 1·4 candles) for the alternating current. Wedding's experiments, by other methods, showed, besides the influence of the diameter of the carbon on the photometric curve, the direction of the maximum candle-power is raised towards the horizon when the current density increases, and at the same time the ratio of the horizontal to the maximum intensity increases from one-fifth to one half. Finally, an all-round comparison shows that the consumption per Hefner candle of mean hemispherical candle-power is about 1·1 watts in 200-watt alternate-current lamps or in 60-watt continuous-current lamps, and is 0·68 watt in 1,100-watt alternating or 150-watt continuous-current lamps. This great difference is partially compensated by the replacement in alternate-current lamps of the steadying resistance by a self-induction coil.

In enclosed arc lamps, supplied with 75 volts to 80 volts, the arc is perpetually undergoing irregular displacements, but the total luminous flux varies little. The diffusing globe absorbs 30 per cent. to 40 per cent. of the light produced. The yield of an enclosed arc seems to be about two-thirds of that of a good open arc lamp of the same power. The measurements by Wedding, Gérard, and De Bast, have shown that the enclosed arc is not more economical than an incandescent lamp. Yet other experimenters, Friedman, Burrow, and Rapaport, by reducing the diameter of the carbons, have shown the reverse. Still, the enclosed arc seems notably inferior to the open arc with regard to the energy consumption. Undoubtedly, with alternating currents the enclosed arc is considerably inferior to the ordinary incandescent lamp.

*Progress in Incandescent Lamps.* The uniformity in the manufacture, the efficiency, the durability, and the price of incandescent lamps, have all altered for the better. The carbon filament lamp remains easily the most-used form of the incandescent lamp. It is usually employed in sizes of from 8 candles to 36 candles, exceptionally from 50 candles to 100 candles. The yellowish light it affords is rather in their favour than otherwise.

From the theoretical point of view it is regrettable that the rating of lamps by the method, proposed in 1890 by M. Crova, by defining their degree of incandescence, has not been applied in practice. This method makes easy the determination of the temperature of the filament. According to Weber this temperature reaches from 1,565°C. to 1,588°C. and even 40deg. higher for lamps with larger filaments. Le Chatelier finds the temperature to be about 1,800°C., while Janet deduced 1,610deg. to 1,720deg. for 16-candle lamps at 65 volts. Le Chatelier's method, in which the intrinsic brilliancy of the filament is assumed to depend only on the temperature and the condition of the surface of the filament, is open to objection on account of the evident transparency of the material of the filament. The increase of resistance with temperature is greatly concerned with the structure of the filament; for Howell has shown that the resistance of the core of a filament diminishes as the temperature increases, while the resistance of the layer of deposited carbon, like that of graphite, increases with the temperature. Hence it is possible that the resistance of a filament at some temperatures becomes stationary or possesses even a negative temperature coefficient.

On the whole the last 10 years have witnessed few changes of importance in the manufacture of incandescent lamps, but very great improvements in every detail of the complete lamp have taken place. The modern process of "squirting" cellulose dissolved in zinc chloride, alcohol-ether, sulphuric acid, &c., to form the filaments have almost completely replaced the old processes of Swan and Edison for ordinary filaments. For very large filaments a carbon paste similar to that used for arc lamp carbons is usually employed. The carbonisation of the raw filament by incandescence in hydrocarbon vapour remains still almost essential because it retards the blackening of the globe of the lamp, and permits of a great modification of the resistance of the filament, the conductivity of the deposited carbon being eight or 10 times that of the body of the filament. Unfortunately this change of resistance is still found to be difficult of regulation. Nowadays, also, the vacuum is much more nearly perfect. Powerful mercury pumps follow the application of mechanical air-pumps when these have reduced the pressure to half a millimetre of mercury; or, sometimes, a process of chemical exhaustion replaces the mercury pump. The attachment of the filament to the leads, too, has been changed, perhaps for the worse, by the adoption of a process which bakes on to the joint a paste of carbon and tar. Nickel and ferro-nickel leads have been tried, but it seems better instead of entirely replacing the platinum to make the platinum portion of the leads as short and thin as possible.

Least progress of all has been made in the light-yield, referred usually to the maximum horizontal candle-power. Normally, the mean consumption is 3·5 watts per *bougie décimale*, unless the lamp is used at higher pressure than its proper voltage. Weissmann and the author by the use of low-pressure lamps have reduced safely the consumpton to 2·5 watts per candle. The increase in the number of the 220-volt systems has caused manufacturers to develop a single-filament lamp working directly at 220 volts, but the construction of these lamps is more difficult, and variations of voltage have more effect than is the case with the lower-pressure lamps. These lamps, too, have proved less durable than the corresponding 110-volt lamp, they cannot be made to give satisfactorily low candle-powers, while their expenditure of energy per candle-power increases rather quickly with time. The future high-voltage lamp will probably employ a filament of higher resistance than the carbon filament.

Many experimenters have endeavoured to make filaments of other refractory substances than carbon, such as the carbides of boron, silicon, aluminium, calcium, &c., but have not attained complete success. Laughans uses a filament of cellulose mixed with powdered boron or silicon; Maxim uses a modified form of carbon filament which is made from a crystalline carbon powder made into a paste with tar. Welsbach makes filaments by heating a platinum wire in an atmosphere of hydrocarbons, water vapour, and osmium anhydride. The latter filaments though very efficient, are expensive and can be used only with pressures of from 20 volts to 30 volts. The use of the rare earths in this connection seems very promising. Various investigators have endeavoured to cover carbon filaments with these substances, both by electrochemical processes and by the application of pastes. The chief difficulty in the way seems to be the difference between the coefficients of expansion of the carbon core and the deposited oxides. Chromium, tungsten, platinum, iridium, &c., have all been used to replace carbon, but with small success. Welsbach, however, has made a filament of thoria, deposited on platinum or osmium, which consumes only 1·5 watt per candle, but the lamps so made are very expensive.

Jablochkoff, in 1877, and Nernst, in 1897, made use of the property, already described by M. Roux, which the oxides and analogous substances possess of becoming conductive at a fairly high temperature. Nernst has made the necessary preliminary heating automatic by placing a spiral platinum wire near the filament; he uses also oxides of greater conductivity than ever used before. These lamps give very white light, produced by the expenditure of energy, at the rate of 1·75 watts per candle in a 25-candle lamp, and 1·00 watts per candle in a 100 candle lamp. The presence of air or, at any rate, an oxidising atmosphere is necessary to prevent electrolytic decomposition of the filament. It is to be feared that variations of voltage may have rather a large effect, and, in any case, a steadying resistance is necessary. Lamps of less than 25 candles, or less than 110 volts have not yet been made, but high-voltage lamps are easily obtainable.

The rating of incandescent lamps varies from country to country. In France the "bougie décimale," and in Germany and America the Hefner, are the common units of illumination. In France the horizontal candle power perpendicular to the loop of the filament is measured; in other countries the mean of the candle powers in several directions is taken. The German Electrical Association lays down that lamps should bear an indication of the power and voltage to within 2 per cent., and that the life of a lamp be defined by the time in which the candle power falls 20 per cent.

## POWER GENERATION: COMPARATIVE COST BY THE STEAM ENGINE, WATER TURBINE, AND GAS ENGINE.*

BY J. B. C. KERSHAW, F.I.C.

(*Concluded from page 971, Vol. XLV.*)

II.—WATER POWER.

1. Details of estimated expenditure upon the Rheinfelden generating station and plant. 16,000 H.P. is expected to be developed with a capital expenditure of £225,000. This does not include dynamos. (*The Electrician*, March 26, 1897.)

2. Estimate by Minet of cost of 1,000 E.H.P. in France. Capital outlay £24,000. Cost of electrical horse-power-hour works out to 0·011f. = 0·105d.—(Minet's "Electro-Metallurgie," 1898, p. 30.)

3. Details of estimated expenditure upon Massena power development scheme. Power to be developed = 75,000 H.P. Capital outlay $1,833,000. Charges to be made vary from $12 per electrical horse-power-year upwards. (Prospectus of company issued July, 1897.)

4. Details of actual charges at Niagara $19.10 to $23.50 per electrical horse-power-year. (Private letters to writer.)

5. Prof. Forbes, in a letter to *The Times*, states that the Niagara Falls Co. are disposing of 34,590 H.P., and have a gross income of £150,000. This equals £4. 6s. 7d. per horse-power-year. (Aug. 19, 1899.)

6. Details of proposed charges to consumers of Niagara power in Buffalo. With meter and service rent, this works out to 1·4 cents per electrical horse-power-hour for small consumers, and to under 1·0 cent. per electrical horse-power-hour for large consumers of power.—(*Electricity* (New York), April 10, 1898.)

7. Statement by Wallace that at Foyers the *operating* costs of the power station equal 30s. per electrical horse-power-year.—(*Jour. Soc. Chem. Industry*, April, 1898.)

8. Prof. Forbes, in a letter to *The Times* (August 19, 1899), states that the operating expenses at Niagara for 34,590 H.P. are only £25,000 per annum. This equals 14s. 5d. per horse-power-year.

9. Detailed statement by Wallbank of cost of power development at Lachine Rapids. Present cost is $32.97 per kilowatt-year. This will be reduced to $8.14, when 20,000 H.P. is produced and sold.—(*Electrical World*, June 18, 1898.)

10. Archibald states that the charges for the Lachine Rapids power in Montreal are to small users $85, and to large users $32 per electrical horse-power-year.—(*Electrical World*, August 5, 1899.)

11. Notice of reduction of charges to $22.35 per electrical horse-power-year for Niagara power in Buffalo. This applies only to large consumers.—(*Electricity* (New York), December 21, 1898.)

12. Statement by Magee, that hydraulic power is the cheaper so long as the capital expenditure has not exceeded £28 per electrical horse-power developed. (*Cassier's Magazine*, January, 1899.)

13. Details of capital expenditure upon a scheme of water-power development at Zurich. Total expenditure upon hydraulic and dynamo plant will be 19,000,000fr. Total power to be developed equals 25,300 H. (gross).—(From *Le Genie Civil*, *Electricity* (New York), March 15, 1899.)

At Zurich, according to Levin, the charge for power to *large consumers* is £6 to £7 per brake horse-power-year. (*Electrical Review*, June 15, 1900.)

14. In Norway water-power can be developed in certain districts at a cost of only 17s. 9d.–22s. 3d. per electrical horse-power-year.—(*Jour. Soc. Chem. Industry*, p. 722, 1899.)

15. At the chlorate works at Vallorbes, the capital expenditure upon the development of 3,000 H.P. was £10,400, or £3·89 per horse power. (Lunge, "Sulphuric Acid and Alkali," Vol. III., 1896 edition.)

16. Details by Prof. Janet of actual expenditure upon water-power developments in France. This varies from £4·28 per horse-power to £30 per horse-power according to the head of water to be dealt with. The lowest expenditure was upon a fall of 140 metres in Haute-Savoie. The horse power is calculated at the turbine shaft, and the cost of dynamos is not included in these figures.—(*Electrical Review*, September 30, 1898.)

17. According to a writer in *The Electrician*, August 4, 1899, the total inclusive charges at Rheinfelden are as follows:—

(*a*) 365 × 24 hours...... £6 per electrical horse-power-year.

(*b*) 307 × 10 hours...... £5—£7 per electrical horse-power-year.

18. Details, by Prof. Crocker, of the cost of water-power in Japan. Power is sold in Kyoto at £6. 8s. per electrical horse-power-year for powers up to 100 H.P., and at £3. 6s. per electrical horse-power-year for powers above 100 H.P.—(*Electrical World* (New York), June, 1899.)

19. Details, by E. Bignami, of cost of water-power in Italy. Capital costs have averaged £12 per horse-power developed, and operating costs 56s. per electrical horse-power-year.—(*Engineering Magazine*, August, 1899.)

20. Details, by B. C. Washington, of cost of water-power in California. At Mecur (Utah) the Telluride Power Co. supply current over an 80-mile circuit and charge $60 per electrical horse-power at the mines.—(*Jour.* Franklin Institute, September, 1899.)

21. At Meran, in the Austrian Tyrol, 2,000 H.P. is sold to the local carbide company at 47s. 6d. per electrical horse-power-year.—(*Eclair Electrique*, May 9, 1899.)

22. In Switzerland the charges for power vary between £8 and £10 for small motors, and between £6 and £7. 5s. for large motors per brake horse-power-year. In one exceptional case the charge was only ¼d. per kilowatt-hour.—(*Electrical Review*, February 2, 1900.)

23. The capital outlay at Lyons has been £84 per horse-power developed. Over one-half of this total had been expended upon hydraulic engineering works. At Interlaken the capital outlay has been £34 per horse-power developed.—(J. W. Hall, in discussion upon Addenbrook's Paper upon "Electric Power Supply from Central Stations," read before South Staffordshire Iron and Steel Institute, 1898.)

24. According to B. Carlsen, water-power in Sweden costs between 13m. and 60m. per electrical horse-power-year.—(*Zeits. f. Elektrochemie*, VI., p. 471.)

25. At Sarpsfos, in Norway, power is being sold by the power company to the two carbide works at 46m.–50m. per electrical horse-power-year. (*Chem. Industrie*, April 1, 1900.)

26. Statement that lowest *charge* for water-power in Switzerland is £5 per brake horse-power-year at Schaffhausen. (*Electrical Review*, June 15, 1900.)

**Table III.**—*Capital Outlay upon Water-power Developments.*

| Place. | Gross H.P. | Capital outlay. | Outlay per H.P. | Authority. | Ref No. |
|---|---|---|---|---|---|
| Vallorbes ................ | 3,000 | £10 400 | £3 9 3 | Lunge | 15 |
| Haute-Savoie ........ | 8,500 | 36,400 | 4 5 7* | Janet | 16 |
| Massena.................... | 75,000 | 381,800 | 5 1 10 | ... | 3 |
| Haute-Savoie ............ | 4,000 | 28,000 | 7 0 0* | Janet | [illegible] |
| Italy ........................ | Average outlay | | 12 0 0 | Bignami | 19 |
| Rheinfelden ............ | 16,000 | 225,000 | 14 1 3* | | 1 |
| ... | ... | ... | 21 0 0 | Magee's max. limit | 12 |
| France .................... | 1,000 | 24,000 | 24 0 0 | Minet | 2 |
| Haute Savoie ............ | 300 | 9,000 | 30 0 0* | Janet | 19 |
| Zurich .................. | 25,300 | 760,000 | 30 0 9 | | 13 |
| Canada (Lachine Rapids) | 6 600 | ... | 30 0 10 | Wallbank | 9 |
| Interlacken ............ | | | 34 0 0 | J. W. Hall | 23 |
| Lyons .................... | 11 300 | 1,000,000 | 84 0 0 | do. | 23 |

**Table IV.**—*Estimated and Actual Costs and Charges for Water-Power per Electrical Horse-Power-Year of 8,760 Hours.*

| Country and place. | Cost or charge. | Remarks. | Ref. No. |
|---|---|---|---|
| Norway .............. | £1 0 0 | Average of actual costs at small power stations | 14 |
| Canada (Lachine Rapids) | 1 5 5 | Estimated cost when 20,000 H.P. is developed | 9 |
| Scotland (Foyers) .. | 1 10 0 | Operating costs only .................. | 7 |
| Switzerland ......... | 1 19 0 | Lowest charge recorded.............. | 22 |
| Austria (Meran) ... | 2 7 6 | Charge to Carbide Co. for 20,000 H.P. | 21 |
| Norway (Sarpsfos) | 2 7 6 | Average charge to carbide factories | 25 |
| Uni. States (Massena) | 2 10 0 | Lowest proposed charge ........... | 3 |
| Italy ................... | 2 16 0 | Average operating costs.............. | 19 |
| Sweden ........ | 13s. to £3 | Estimates by Carlsen.................. | 24 |
| Japan (Kyoto) .... | 3 6 0 | Charge to large users................. | 18 |
| Canada (Lachine Rapids) | 3 11 9 | Present cost of power ............. | 9 |
| France ......... | 3 16 7 | General estimate of cost ........... | 2 |
| United States (Niagara) | 3 19 7 | Charge to large consumers ........ | 4 |
| | 4 6 7 | Average charge for whole of power | 5 |
| | 4 13 1 | Charge for Niagara power in Buffalo | 11 |
| Switzerland (Schaffhausen) | 4 5 0 | ...... | 26 |
| Switzerland (Zurich) | 5 10 6 | Charge to large consumers ......... | 13 |
| Germany (Rheinfelden) | 6 0 0 | Charge to large consumers ....... | 17 |
| Japan (Kyoto) ...... | 6 8 0 | Charge to small consumers ....... | 18 |
| Canada (Montreal) .. | 6 13 2 | Charge to large consumers ....... | 10 |
| United States (Utah) | 12 10 0 | Charge over an 80-miles transmission line | 20 |
| Canada (Montreal) .. | 17 14 0 | Charge to small consumers ....... | 10 |
| United States (Buffalo) | 25 11 0 | Charge for Niagara power to small consumers in Buffalo | 6 |

* This does not include cost of the dynamos.

* Paper read before Section G of the British Association at Bradford.

In the preceding two tables (III. and IV.) these estimates and actual costs have been reduced to comparable form. The relation between the brake horse-power and the electrical horse-power has been taken as 85 : 100. One is again struck by the wide variation of the figures. The capital outlay per horse-power ranges between £3. 9s. 3d. at Vallorbes and £84 at Lyons. The estimated and actual charges per electrical horse-power-year show the still greater difference between £1 at a small unnamed power station in Norway and £25. 11s., the charge to small consumers in Buffalo.

The figures by Wallbank for the cost of power at the Lachine Rapids station in Canada, and by Janet for the capital outlay upon typical water-power development schemes in France, are sufficiently interesting to deserve further consideration, and they are reproduced below.

Details of capital expenditure and running expenses at Lachine Rapids Power Station, from Wallbank's Paper, before National Electric Lighting Association, Chicago, 1898 :—

Power at present developed is 4,000kw.
Power available is 15,000kw.

Allowing for 10 per cent. losses between turbines and dynamos, the capital expenditure has been $263.83 per kilowatt.

The annual costs per kilowatt at present are :—

| | |
|---|---|
| Interest at 6 per cent. | $15.95 |
| Depreciation of 5 per cent. (on one-third of capital outlay) | 4.17 |
| Operating expenses | 2.85 |
| Total | $22.97 |

$22.97 per kilowatt-year = £3. 11s. 9d. per electrical horse-power-year.

The annual costs per kilowatt when 15,000kw. is generated will be :—

| | |
|---|---|
| Interest at 6 per cent. | $4.95 |
| Depreciation at 5 per cent. (on one-third of capital outlay) | 1.68 |
| Operating expenses | 1.51 |
| Total | $8.14 |

$8.14 per kilowatt-year = £1. 6s. 5d. per electrical horse-power-year.—(*Electrical World*, June 18, 1898.)

DETAILS OF THREE WATER-POWER DEVELOPMENT SCHEMES IN FRANCE.

1. 6,000 H.P.—11,000 H.P. (mean 8,500 H.P.) in Upper Savoy. Fall 140 metres. Capital outlay £36,400 = £4. 5s. 7d. per horse-power at turbine shaft.

2. 4,000 H.P. in Department Isère. Fall 100 metres. Capital outlay £28,000 = £7 per horse-power at turbine shaft.

3. 300 H.P. in Upper Savoy. Fall 2 metres. Capital outlay £9,000 = £30 per horse-power at turbine shaft.—(*Electrical Review*, September 30, 1898.)

These figures illustrate well the effect of height of fall upon capital outlay, and show the great economy of utilising or creating high falls of water for industrial purposes. The difference in capital outlay between examples 1 and 3 represents an *addition* of £1. 6s. per horse-power per annum to the cost of power at the latter power station, *in interest charges alone*, and more than this if depreciation be taken into account. The figures showing the increase of charge due to transmission are also of striking interest. Niagara power at Buffalo costs £4. 13s. 1d. per electrical horse-power-year as compared with £3. 19s. 7d. at Niagara. The power from Lachine Rapids costs £6. 13s. 2d. per electrical horse-power-year in Montreal, whereas the present costs at the genereting station are only £3. 11s. 9d. In Utah the charge to mines on an 80-mile transmission line is £12. 10s. per electrical horse-power-year : the cost of generating this power at Provo is probably not one-fourth of this amount. These figures are worthy of close scrutiny by those interested in the power schemes which have lately been occupying the attention of our legislators, since they indicate that transmission costs and losses are capable of doubling or trebling the costs of electricity to the consumer.

III.—GAS POWER.

1. By use of gas engines and Mond's latest form of producer, 23·8 per cent. of the energy of bituminous coal can be converted into mechanical energy. The actual figures for a 25 H.P. Crossley gas engine, are 2,166 H.P.-hours per ton fuel.—(*Proc.* Inst. Civil Engineers, March, 1897.)

2. Statement by Dr. Bowman that with gas engines of best type, 1lb. of coal yields 1 H.P.-hour. With a 300 H.P. plant the horse-power-year (apparently of 2,825 hours) costs only 30s. The capital outlay per horse-power for producers and engines is £12, or 20 per cent higher than with a modern steam plant, but the therma, efficiency is 50 per cent. greater.—(*Jour.* Soc. Chem. Industry. December, 1897.)

3. At Lausanne, in Switzerland, a 390 H.P. gas engine plant has run satisfactorily for over two years for supply of the electric power to the tramway system. The plant consists of three 130 H.P. Crossley engines, working with an expenditure of 1·137lb. coal per horse-power-hour.—(*Electrical Review*, November 11, 1898.)

4. Statement by Dowson that at Halifax the consumption of fuel is 1·01lb per horse-power-hour.—(*Mech. Engineer*, 1898, p. 703.)

5. Statement that by Thwaite-Gardner system of utilising waste gases of blast furnaces, 1 I.H.P.-hour is obtained per 1·3lb. coke charged into furnace.—(*Electrical Review* (London), Dec. 30, 1898.)

6. Results of trials of above system at Wishaw Iron Works, Glasgow. 10 H.P. can be obtained per ton of fuel charged into furnaces per week (6 × 24 hours).—(*Electrical Review* (London), May 6, 1898.)

7. Results of tests by Prof. Meyer of 60 H.P. gas engine at Differdingen, run on blast-furnace gases. Thermal efficiency varied between 27·4 per cent. and 30·2 per cent.—(Abstracted, *Engineering Magazine*, July, 1899.)

8. A 1,500 H.P. Westinghouse gas engine, now building, is expected to develop a thermal efficiency of 30 per cent., or 1 B.H.P. per pound of coal charged into the producer.—(*Electrical Review* (London), July 28, 1899.)

9. At Northwich a 300 H.P. gas engine has been running on producer gas for a considerable period, and yielding 1 B.H.P. per pound coal charged.—*Jour.* Soc. Chem. Industry, July, 1899.)

10. Meyer has estimated that in Germany, using blast furnace gases, the horse-power-hour could be generated at a cost of 0·699pfg. —(*Rev. Universelle des Mines*, July, 1899.)

11. Lencauchez has estimated that using producer gas generated from French anthracite coal, 1 H.P.-hour would cost 0·0163fr.—(*Jour.* de Soc. des Ingenieurs de France, 1899.)

12. Estimate by Humphreys of cost of electrical horse-power-hour, using Mond producer gas, based upon a plant of 10,000 H.P. = 7,000 E.H.P. Capital expenditure estimated to be £140,000, and total running expenses, £35,000. Interest taken at 8 per cent.—(*Proc.* Inst. Civil Engineers, March, 1897.)

Converting these data into comparable form, and gathering the results together, we have the figures presented in Tables V. and VI.

**Table V.**—*Fuel Consumption of Gas Engine Plants.*

| Place. | Lbs. fuel per H.P.-hour. | Authority. | Ref. No. |
|---|---|---|---|
| Pittsburg | 1·00 | Westinghouse Engineers | 8 |
| ...... | 1·00 | Dr. Bowman | 2 |
| Northwich | 1·00 | Beilby | 9 |
| Halifax | 1·01 | Dowson | 4 |
| ...... | 1·03 | Humphreys | 1 |
| Lausanne | 1·137 | ...... | 3 |
| ...... | 1·300* | Thwaite | 5 |
| Glasgow | 1·555* | Booth | 6 |

* These refer to coke and blast furnace gases.

**Table VI.**—*Estimated Costs of the Electrical Horse-Power-Year of 8,760 Hours when Generated by Gas Power.*

| Authority. | Cost. | | | Remarks. | Ref. No. |
|---|---|---|---|---|---|
| Meyer | £4 | 1 | 7 | Blast furnace gases | 10 |
| Humphreys | 5 | 0 | 0 | Mond producer gas | 12 |
| Bowman | 6 | 2 | 0 | Mond producer gas | 2 |
| Lencauchez | 7 | 12 | 2 | French anthracite used in gas producer | 11 |

IV.—CONCLUSION.

Taking the best figures for each of the three sources of power dealt with above and bringing them all to a common basis of comparison, namely, the cost of the electrical horse-power-year of 8,760 hours, we obtain the figures given in Table VII.

**Table VII.**—*Comparative Costs of Electrical Power. Lowest recorded costs per Electrical Horse-Power-Year of 8,760 Hours.*

| Source of power. | Lowest estimated cost. | | | Country. | Lowest actual cost. | | | Country. |
|---|---|---|---|---|---|---|---|---|
| Water | £1 | 5 | 5 | Canada | £1 | 19 | 0 | Switzerland |
| Steam | 4 | 18 | 8 | England | 4 | 17 | 7 | U. States |
| Gas (blast furnace) | 4 | 1 | 7 | Germany | ... | | | ... |
| Gas (producer) | 5 | 0 | 0 | England | ... | | | ... |

The first cost for water-power given in Table IV. has not been used in Table VII. since it is evidently exceptional, and there is no probability of power being generated from water in large units at such a low cost.

The figures in Table VII. support the opinion, now generally held, that water, when developed without excessive capital expenditure, is the cheapest source of mechanical or electrical energy. When, however, the hydraulic engineering expenditure has been heavy, or when the power after generation has required to be transmitted over long distances, the margin between the relative costs of water and steam power is greatly narrowed, and in some cases disappears altogether.

*Electrical energy, generated by falling water, is costing more at Rheinfelden, at Zurich, and at Buffalo than it would cost in South*

*Lancashire if generated by steam-power in large units; and the margin between the actual charge for water-power at Niagara and the estimated cost of steam-power in large generating stations in South Lancashire is only 12s. 1d. per electrical horse-power-year.*

With regard to the influence of capital expenditure occasioned by heavy engineering work upon the final cost of water power, it is probable that the differences in the the charges for the electrical horse-power-year at Niagara, Rheinfelden, and Lachine Rapids are to be ascribed to this cause, though in the case of Niagara, heavy promotion expenses were no doubt incurred. The power at Lachine Rapids and Massena will be developed with a much lower capital per horse-power than has been the case at Niagara and Rheinfelden; but the figures for the two former stations are not yet complete, and possibly the estimates of the sale price of the power—namely £1. 5s. 5d., and £2. 10s. per electrical horse-power-year—will have to be revised.

Turning now to a consideration of the relative position of gas power, the question of the practicability of large engines may be taken as settled; but until further experience has been gained with these large engines under constant work, it is unsafe to prophesy upon the place they will occupy in the future industrial development of this and other countries. If they do not cost excessive sums for maintenance and repairs, large gas engines—in conjunction with coke ovens and blast furnaces—may entirely alter the present position of affairs; and new industries which at present are being established in the neighbourhood of water-power stations, may find themselves in severe competition with similar manufactures carried on in the coal and iron districts of the older manufacturing countries. It has been calculated that 2,000,000 H.P. is annually wasted in the gases issuing from the blast furnaces of the United Kingdom.* If these waste gases could be industrially utilised in the manner suggested, we should to a large extent be compensated for our lack of natural water-power. But blast furnaces demand coke, and coal beds are exhaustible; so that even if this source of mechanical and electrical energy be tapped, it can only postpone, but not avert, the final triumph of the waterfall and of the turbine.

* *Electrical Review*, May 6, 1898.

## ELECTRIC TRACTION ON MAIN RAILWAYS IN ITALY.

We have received from Messrs. Ganz & Co., through Mr. A. J. Lawson, some interesting notes of work which this firm is doing in connection with electric traction on main railways. In this application of electric traction, a difficulty was found in the heavy current required for railway traffic if a low pressure was used, and having regard to the construction of the various parts, such as commutators, &c., there was a difficulty in employing a higher continuous-current pressure than 750 volts for the motors. Difficulties on account of large currents are evident, for instance, in the increase in the cost of conductors, of bonding and of leading the current from the conductor to the motor. In the case of long lines, also, in which three-phase transmission will be required, the use of continuous currents for the trains would necessitate rotatory machinery in sub-stations. Messrs. Ganz & Co., and especially their assistant engineer, Mr. K. von Kando, therefore, turned their attention to the employment of high-pressure polyphase current for direct application to the motors.

A system worked out on these lines was submitted in 1898 by Messrs. Ganz & Co. to the board of directors of the Italian Adriatic Railway Co., as a substitute for the present steam locomotives working the Lecco-Colico-Sondrio-Chiavenna Railway, and with the approval of the Italian Government this firm was entrusted with the work. The total length of line being converted is 66 miles. The current is to be taken from an hydraulic station at Morbengo on the River Adda, some distance before the entrance of that river into the Lake of Como. The primary pressure of 20,000 volts will be generated by three-phase alternating-current machines, directly mounted on the turbine shafts, and three machines of 2,000 H.P. each will be put in. The frequency adopted is low—viz., 15 ∿ per sec. Transformers are placed along the line reducing the pressure from 20,000 to 3,000 volts, at which pressure the current is delivered to the trolley wires and taken from them by means of a trolley of special form through insulated cables direct to the motors. There are two 150 H.P. motors on each car, so connected that when coupled together the speed of the rotors is half that of the revolving field and consequently there are two speeds available—the so-called half-speed of 19 miles an hour, which is attained on series connection, and 38 miles an hour, which will be the normal speed for passenger trains on the level.

The greatest incline on the railway is about 2 per cent., and the sharpest curve is 980ft. radius. For the passenger traffic a motor car 62ft. long, with four pairs of wheels, will be employed, and two ordinary passenger cars as trailers. Each motor car complete weighs 50 tons. There will be 10 of these in all, of which five are to be "parlour cars." Freight trains will be composed of a locomotive having four 150 H.P. motors, weighing complete 45 tons, and freight cars of a total weight of 250 tons. These motors will be coupled two in series, and the speed of these trains will be 19 miles an hour. At present two such locomotives have been built. It is probable the line will be in working order by the end of the year.

Before taking this work in hand, Messrs. Ganz & Co. contructed in 1899, in one of the islands in the Danube, near East Buda, an experimental line about a mile long, on which a motor car having two 150 H.P. motors directly supplied with current at a pressure of 3,000 volts has been working continuously with most satisfactory results. The motors are inductor motors, and the parts to and through which this high-pressure is transmitted are completely protected by metal casing in contact with the rails.

Mr. Lawson also sends us the following interesting particulars of a projected line in Italy which, with two new sections, will be complete from Genoa to the south-eastern side of Mont Blanc. A fairly full description of one of these sections was published by Col. Alberto Ara, late of the Royal Italian Artillery, in the *Gazzetta del Popolo*, relating chiefly to a scheme of Engineer Rossi, of Genoa, who has projected a line of about 27 miles in length from Asti to Chivasso. This would form part of the main line from Genoa to the Val d'Aosta, and this section would be subsidised by the State to the extent of about £160 per mile per annum for a period of 70 years, and a lump sum of £20,000 from the town of Asti. This line would shorten the distance between Genoa and Aosta by about 20 miles. The second section referred to has been projected by Engineer Cedale, of Aosta, as an extension of the present Val d'Aosta line from Aosta to St. Didier, on the other side of Mont Blanc. This would be similarly subsidised, except that possibly the town of Aosta would not make such a large capital grant. In this case it is proposed to tunnel under Mont Blanc and make a junction with the extension of the Paris-Lyons-Mediterranean Railway now being carried up into the Chamounix Valley. The maximum elevation above sea level at any point in the line projected is only 8,280ft., while the distance from St. Didier to Chamonix is only 10 miles, of which about 8 miles are in tunnel. It is proposed to work these lines electrically, utilising water power to generate the current. It is expected that when these sections are completed the P.L.M. Railway will run through trains from Paris to Genoa, and possibly even through carriages may be run from Calais to the Mediterranean.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.

"Calendar of the University College of North Wales for the Session 1900–1." (Manchester: J. E. Cornish.)

"Alphabetical Lists of United States Patentees and Inventions for the Quarter ending March 31, 1900." Index to Vol. XC.

"The Practical Engineer" Pocket-Book for 1901. (Manchester: Technical Publishing Co.) 1s. 6d.

"An Elementary Treatise on the Calculus for Engineering Students," by John Graham. Second edition. (London: E. and F. N. Spon.) 7s. 6d.

"Theory and Calculation of Alternating-Current Phenomena," by C. P. Steinmetz, assisted by E. J. Berg. Third edition. (New York: *Electrical World and Engineer*.)

"The Official Gazette of the United States Patent Office." Nos. 1, 2, and 3, Vol. XCIII. (Washington: Government Printing Office.)

## CORRESPONDENCE.

### THE LIGHT EMITTED BY THE CONTINUOUS-CURRENT ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your leaderette on "The Light Emitted by the Continuous-Current Arc," in your issue of October 19th, you say:—"To explain the increase of this absorption with increased arc length obviously requires either that the thickness of the absorbing medium, or that its absorbing power increases with increase of arc length. We hardly think there is yet sufficient reason to choose the latter explanation in preference to the former." But the former explanation is exactly the one which I adopted, and not the latter as your leaderette would appear to imply.

For the argument given in my Paper which you have published recently, is this:—

In *all* arcs, both long and short, the carbon vapour emitted by the crater is turned to carbon *mist* at an almost infinitely short distance from the crater. This mist I suppose to consist, not of liquid drops like water-mist, but of tiny solid particles like smoke. In a short arc, a comparatively thin layer of these condensed solid particles has to be traversed by the crater light, and hence a comparatively small portion of that light is absorbed; but the longer the arc the thicker is the layer of mist, and the greater, therefore, is its absorbing power.

I may mention that my theory of the turning of the vapour from the crater into carbon *mist* was evolved at least four years ago, but that it is only since I have seen how completely it explains all the puzzling phenomena of the light of the arc that I have had the courage to publish a hypothesis so heterodox.—Yours, &c., HERTHA AYRTON.

[That our note should have borne such good fruit in the form of Mrs. Ayrton's letter is very gratifying. We are also glad to find that, to a certain extent, our view of the matter was the same as that of Mrs. Ayrton, and that, whatever the *mode* of absorption by the arc medium, it is chiefly its increased thickness and not its altered constitution in long arcs that is the cause of the increased absorption of the luminous rays emanating from the crater. The theory that the vapour arising from the crater cools down to the "dew point" of carbon in an almost infinitely short distance from the crater, and that practically the arc is largely constituted, not of carbon vapour but of carbon mist, is, we think, the most important suggestion in Mrs. Ayrton's valuable Paper. As she shows, this theory apparently accounts largely, if not entirely, for the peculiar distribution of fall of potential between the carbons of an arc and for the experimental fact that the large proportion of total electrical energy absorbed is transformed to heat in close proximity to the crater surface.—ED. *E.*]

### STROBOSCOPIC MEASUREMENTS OF FREQUENCY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to a paragraph in the current number of *The Electrician* ("Contemporary Electrical Science," p. 16), in which a stroboscopic disc method of measuring the frequency of an alternating current is described, it is interesting to note that the intermittent nature of the light from an alternate current arc may readily be observed whilst walking along a street lighted by such arcs. It is only necessary to swing an umbrella or walking stick, when the characteristic appearance of a moving object illuminated by an intermittent light is at once evident. I first noticed this effect about a year ago in Romford-road (West Ham) whilst walking along with a friend who happened to be carrying a stick.—Yours, &c.,

Municipal Electrical Institute, JOHN LISTER.
West Ham, E., Oct. 27.

[This phenomenon in connection with arc lamps is by no means new, and has frequently been made use of for the measurement of frequency. Mr. Samojloff's note, abstracted by Mr. Fournier d'Albe, is chiefly interesting from the fact that he had reproduced the phenomenon with an incandescent lamp.—Ed. *E.*]

## ROYAL SOCIETY.

The following is a list of those who have been recommended by the President and Council of the Royal Society for election into the Council for the year 1901 at the anniversary meeting on November 30th:—

PRESIDENT.
Sir WILLIAM HUGGINS, K.C.B., D.C.L., LL.D.

TREASURER.
Alfred Bray Kempe, M.A.

SECRETARIES.
Sir Michael Foster, K.C.B., D.C.L., LL.D.
Prof. Arthur William Rucker, M.A., D.Sc.

FOREIGN SECRETARY.
Thomas Edward Thorpe, C.B., Sc.D.

OTHER MEMBERS OF THE COUNCIL.

*Prof. Henry Edward Armstrong, V.P.C.S.*
*Sir John Wolfe Barry, K.C.B.*
*Charles Vernon Boys.*
Horace T. Brown, F.C.S.
William Henry Mahoney Christie, C.B.
Prof. Edwin Bailey Elliott, M.A.
Hans Friedrich Gadow, Ph.D.
*Prof. William Mitchinson Hicks, M.A.*
Lord Lister, F.R.C.S.
*Prof. William Carmichael McIntosh, F.L.S.*
*Ludwig Mond, Ph.D.*
Prof. Arnold William Reinold, M.A.
Prof. J. Emerson Reynolds, Sc.D.
*Robert Henry Scott, Sc.D.*
*Prof. Charles Scott Sherrington, M.D.*
J. J. H. Teall, M.A.

## LEGAL INTELLIGENCE.

### London Electrical Cab Co. (Ltd.).

Mr. Justice Wright on Wednesday delivered his reserved judgment in the matter of the petition of Col. C. E. Foster and others for the compulsory winding-up of this company. The previous hearing was reported last week.

His LORDSHIP, in the course of his judgment, said the company was formed some time ago for the purpose of working street cabs by electric power. All the money seemed now to have gone, and the company was in the position of being wound up. There were no unsecured creditors. The petitioners were secured shareholders and debenture-holders, and they were entitled to an order, if an order would do them any good. The only possible benefit his lordship could suggest was that there might be results arising from certain proceedings. If there were any they would, to the extent of £15,000, go to the debentureholders and not to the shareholders. If more than £15,000 was recovered, it would go to the benefit of the shareholders. It seemed that the company held patents or exclusive licences for patents, and that these might possibly be of some value. One of them was not assignable, and therefore could not be assigned to a new company. He did not doubt that the patents were of value, but no exact estimate was possible as to what that value would be. He did not think that the objections which had been made were substantial enough to prevent him from making an order. The petition, however, made a number of serious allegations, but they were supported by nothing in the way of evidence other than the statutory affidavit. He was satisfied, on the evidence, that the main grounds on which the petition rested was a misconception founded on no basis of fact. There was an allegation that the directors had not enforced certain contracts. He was satisfied that the directors thought those contracts were not satisfactory, or that the articles supplied under them were not satisfactory, or that they could have done better elsewhere. So there was no ground for proceeding against the directors on that score. It was also said that the directors put down a ridiculously low estimate of working capital, but he had no reason to doubt that the statements they made were honestly made. The petitioners might be right in saying that the company was crippled from the first by having to pay two-thirds in cash for the licences to the vendors, and the failure of the company was no doubt due to the fact that the management were persons who were not men of business. There was, however, no ground for making the order asked for. It might be that the companies concerned would give shares for the licences now held, but until it was ascertained that nothing could be done for the shareholders it would be wrong to terminate the existence of the company. Making an order, too, would destroy the value of at least one of the licences. In the circumstances his lordship thought it would be best to let the petition stand over generally, and if the parties desired it he might appoint an official independent liquidator to act in conjunction with the receiver in relation to the licences and other matters, and whose sole function would be to protect the interests of the licensees and shareholders. The receiver for the debenture holders was only concerned to get the debenture-holders satisfied, and he would accept any sum which would satisfy them. It might be that the real value of the licences would be sufficiently large to leave a considerable sum over for the shareholders. The order made by Mr. Justice Byrne might probably be rescinded.

Mr. CORNWELL, for the petitioners, said that all personal charges against the directors had been withdrawn.

His LORDSHIP remarked that the alleged secret agreements had not been supported by evidence, and there must be an order as to costs, either now or at a later date. The matter could be mentioned again next Wednesday.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Ashton-under-Lyne Electric Lighting committee require an electrical engineer to take charge of their electricity undertaking. Applications to the borough comptroller (Mr. John Neal), Town Hall, Ashton under-Lyne, by 10th inst. See advertisement.

British Electric Traction Co. require a resident engineer with experience in tramway permanent way construction. Applications to secretary, Donington House, Norfolk-street, London, W.C. See advertisement.

An electrical engineer is wanted, competent to supervise a staff of assistants and technical workshops, for Marconi's Wireless Telegraph Co., 18, Finch-lane, London, E.C., where applications are to be sent. See advertisement.

Farnworth District Council require a resident electrical engineer. Some further information is given in an advertisement, and applications must be sent to the clerk (Mr. W. Tyldsley) by Nov. 12.

Darlington Corporation require an assistant electrical engineer and a junior assistant engineer. Further particulars are given in an advertisement, and applications must be sent in to the town clerk (Mr. Hy. G. Steavenson), Boundgate, Darlington, by Nov. 15.

A mains superintendent for high-tension alternating work is required at Newport (Mon.). Applications to Mr. C. D. Copland, borough electrical engineer. See advertisement.

An assistant engineer is required for the Crewe Corporation electricity works. An advertisement gives some further particulars, and applications must be sent to the resident engineer (Mr. H. H. Denton) by 7th inst.

Wolverhampton Lighting committee invite applications for the position of chief clerk and canvasser in their electricity department. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. Horatio Brevitt) by noon of Nov. 12.

An assistant engineer is required for the Glasgow telephone department. Applications to Mr. A. R. Bennett. See advertisement.

A shift engineer is required at the Southampton electricity works. Applications to Mr. R. R. Linthorne, town clerk, Municipal Offices, Southampton, before Nov. 10. See advertisement.

A junior station assistant is required at the Aberdeen electricity works. Applications to city electrical engineer (Mr. J. Alex. Bell), Cotton-street, by Nov. 4. See advertisement.

Warrington Corporation require a resident electrical engineer. Applications to town clerk by noon Nov. 7.

Birkenhead Corporation require a tramway manager. Commencing salary £300 per annum. Applications by 13th inst.

---

Mr. W. J. Bache has been appointed borough electrical engineer by the Gloucester City Council. Since the starting of the works Mr. Bache has acted as resident engineer, previous to which period he was assistant at Leeds.

Mr. H. B. Maxwell, chief assistant at Worcester, has been appointed to the position of resident electrical engineer at Partick.

Mr. Thomas Tomlinson, B.E., has been elected electrical engineer to the Bray District Council in succession to Mr. G. M. Harries. The other five candidates selected to attend the special meeting of the Council at which the appointment was made were Messrs. H. T. Lee (Wakefield), H. Godfrey Nicholson (Southampton), J. Moss (Eccles), H. B. Price (Great Eastern Railway) and S. W. Martin (Rathmines).

Mr. G. L. Gomme, who has hitherto been statistical officer of the London County Council, has been appointed clerk to the Council, at a salary of £2,000 per annum.

---

**Aberdare.**—The Aberdare Electric Lighting Co. are applying for a provisional order, but there is a feeling in favour of municipalising the electricity undertaking and of opposing the company's application.

**Aberdeen.**—At the Council meeting last week the electrical engineer (Mr. J. Alex. Bell) submitted the tenders which had been received for the supply of two 200kw. generating sets and a balancing set in connection with the Corporation electricity works at Dee Village. The Gas and Electric Lighting committee had authorised Mr. Bell to accept the tender of Messrs. Mavor and Coulson at £5,144, being the lowest offer submitted. The committee had also before them tenders which had been received for a 420kw. generating set. The following paragraph was included in the conditions of contract:—

> The whole of the foregoing works to be undertaken by contractors who have carried out successfully at least one similar undertaking in Britain, and, if required, they must obtain for the engineers of the Aberdeen Corporation permission to see these undertakings under working conditions.

Treasurer Bisset moved that the lowest offer be accepted, but Councillor Esselmont moved that the conditions be amended by the deletion of the above condition, and that fresh tenders be invited. By the chairman's casting vote the amendment was carried.

**Batley.**—An inquiry was held here on Wednesday into the application of the Council to borrow £23,602 for electricity works. The consulting engineer, Mr. S. V. Clirehugh (Messrs. Lacey, Clirehugh, and Sillar), gave technical details, and the town clerk (Mr. J. H. Craik) gave particulars as to rating, value, &c. He said that it was the intention of the Corporation to construct electric tramways. There was no opposition.

**Belfast.**—The accounts of the Electricity department for the past quarter were submitted to the Gas and Electric committee last week. The receipts amounted to £2,302. 3s. 2d. against £1,941. 5s. 1d. in the corresponding quarter of 1899, an increase of £360. 18s. 1d. (18.5 per cent.). The receipts from meter and motor rents were £111. 6s., against £71. 18s. 1d., an increase of 55 per cent.; £10. 9s. 6d. was received for hire of fittings—an item which was nil last year. The units sold were as follows: For lighting 90,890, for motors 20,084 and for public lighting 764, against 65,765, and 17,355 in 1899. The lamps connected represented 67,000 8 c.p., in addition to which 9,600 more had been applied for, making 76,600. This included 383 H.P. in motors connected, and 144 H.P. in motors applied for.

**Blairgowrie.**—After investigation, the Police Commission have decided not to proceed with their proposed application for a provisional order. It is therefore probable that the North British Electric Supply Co.'s application will now be unopposed.

**Bolton.**—At a Council meeting on Wednesday the chairman of the Tramways committee (Ald. Nicholson) made a statement in regard to the working of the electric tramways for the six months ended Sept. 30. The income was £35,762 and the working expenses £23,610, leaving a balance to credit, after allowance for interest and sinking fund (£6,385) of £12,151. Parliamentary powers are to be obtained to extend the electric tramways to some of the outlying districts.

**Bradford.**—The Westgate electric tramway route was inspected on behalf of the Board of Trade yesterday (Thursday).

**Brighton.**—During the construction of the new electricity works at Aldrington, two-thirds of Mr. Arthur Wright's salary is to be charged to capital account.

**Cardiff.**—A meeting of the Tramways committee was held on Friday to consider the tenders for the supply of electric tramway plant, and some particulars of the accepted tenders are given in another column. At the outset Councillor Jenkins called attention to the contract which had been given for steel rails. In September Messrs. Dick, Kerr & Co. were given the tender for 1,000 tons of rails and 40 tons of fishplates. Everyone, he said, was under the impression they would be manufactured in this country, but it now turned out that the whole of the rails were of German make. It was unfair that the firm should be allowed to sublet. The contract provided that 500 tons of rails should be delivered in Cardiff at the end of October and the remainder at the end of the year. As a matter of fact, the contract had not been signed. He protested against the rails being made abroad, and the committee decided to wait until the end of the present month, and then take immediate action in the matter. At a committee meeting on Wednesday Councillor Veall said that only one British firm had quoted for the particular class of steel that Mr. Harpur wanted. Having regard to the difference in prices the Cardiff tramways would be burdened with an additional outlay of £30,000 if the Council insisted upon having the order executed in England. Councillor Andrews said that during the last four weeks steel had gone down from £1 to £1. 10s. per ton. Mr. Harpur said that it was a lamentable fact that the best railmakers in this country would not roll tramway rail sections, and if the Council tied themselves to English makers then he should be bound to alter his specifications for a milder and less durable form of steel. After discussion it was resolved that 2,000 tons of British-made rails according to the borough engineer's original specifications be advertised for, the town clerk meanwhile to communicate with Messrs. Dick, Kerr & Co.

A report of a sub-committee on the preparation of the existing tramlines for electric traction was also considered on Friday. The sub-committee asked Mr. Glenn, engineer of the Tramway Company, whether his company would permit the Corporation to go on with the work of preparation prior to the handing over of the lines. At first Mr. Glenn objected to this, but after discussion he agreed to advise his directors, if the parties could agree as to the present value of the lines, to construct and bond them, and have them ready at the end of 1901, when the Corporation take possession, the work to be done by contract under the supervision of the city electrical and borough engineers. The sub-committee reported in favour of this arrangement, and pointed out that if nothing was done with the existing lines until the Corporation took them over it would take six or nine months to electrically equip the lines, and during this time the tramways in the centre of the town, and consequently the most productive sections, would be idle. This report is to be considered at a special meeting of the committee.

**Croydon.**—Application is to be made for sanction to borrow £30,000 for electric lighting extensions, including £6,360 for the arc lighting of the tramway routes.

**Companies Struck off the Register.**—Notice is given that on Oct. 26 the following limited liability companies were struck off the register :—

| | |
|---|---|
| Armstrong-Dove Motor Syndicate. | European Electric Finance Co. |
| Battery and Motor Co. | Gravier Dynamo Syndicate. |
| Brit. and Continental Illuminating Co. | Improved Incan. Elec. Lamp Synd. |
| Brit. Assoc. of Medical Electricians. | Kerbey-Bowen. |
| Canton (Waipori) Mining and Electric Power Co. | Langhans - Berrenberg - Chaplin Patents |
| Capital and Counties Elec. Supply Co. | Light Railway Contract Co. |
| Corbridge Electric Lighting Co. | Llandudno Electric Supply Co. |
| Cruto Incandescent Lamp Agency. | London Electrical Carriage Co. |
| Elec. and Gen. Contract Corporation. | Ditto Coupé Co. |
| Electric Free Wiring Syndicate. | Ditto Van Co. |
| Electric Meter Co. | London Health Electrical Syndicate. |
| Electric Racing Horse Maze (Pioneer) Syndicate. | Maxim Motor Co. |
| | New Power Syndicate. |
| Electric Steam Syndicate. | North London Electric Supply Co. |
| Electrolytic Separation Syndicate. | Peerless Accumulator Syndicate. |
| Elieson Lamina Accumulator Co. | United Inventions Syndicate. |

The following are to be struck off in three months, unless cause is shown to the contrary :—

| | |
|---|---|
| Caoutchouc Co. | Penzance, Newlyn, and St. Just Light Railway Co. |
| Electric Horse Promotion Syndicate. | |
| Freudenberg's Multiple Telep. Synd. | Premier Electricity Meter Co. |
| Ditto Automatic ditto. | Vice Versa Electric Lamp Syndicate. |
| Improved Telephone Patents. | Whitstable Elec. Light and Power Co. |

**Darwen.**—The town clerk and borough engineer have been instructed to report upon the proposal to construct an electric tramway from Bolton to Cadshaw Bridge.

**Eastbourne.**—Application has been made for sanction to borrow £31,912 for the erection of a new electricity station at Roselands, the supply of new transformers, mains, &c., as set out in the report of the consulting engineer (Mr. W. C. C. Hawtayne) abstracted in our issue of May 4.

**Edmonton.**—The Council have served notice on the North Metropolitan Electric Power Supply Co. of their intention to apply for a provisional electric lighting order.

**Electric Organ.**—A Hope-Jones electric organ has been erected at the Victoria Rooms, Clifton.

**Electric Power Scheme for the Middlesbrough District.**—We are in a position to state that an important scheme for the electrical distribution of power for manufacturing and other purposes throughout the Middlesbrough, Stockton, Hartlepool and Cleveland district is being arranged, and that parliamentary powers will be applied for next session. The scheme, which is supported by many of the most influential manufacturers in the district, will be on similar lines to the Lancashire, South Wales and Durham District Power Bills passed last session. Mr. A. A. Campbell Swinton, 66, Victoria-street, Westminster, is consulting engineer, and Messrs. Jackson and Jackson, Middlesbrough, are solicitors to the project.

**Engineering Combination.**—Arrangements have been made for the amalgamation of the engineering and shipbuilding firms of Thomas Richardson & Sons (Hartlepool), Sir Christopher Furness, Westgarth & Co. (Middlesbrough) and William Allan & Co. (Sunderland). The capital of the new company, which will be styled Richardson, Westgarth & Co., will be £700,000, divided into an equal number of 6 per cent. preference and ordinary shares of £1 each. The debenture issue is to be £350,000, bearing interest at 4½ per cent. The directors include Sir C. Furness, M.P., Sir T. Richardson, Mr. W. Allan, M.P., and Mr. Tom Westgarth.

**Falkirk.**—The Council have unanimously resolved to apply for a provisional order.

**Fatality.**—On Wednesday, at St. Alfege Mission Room, Greenwich, the inquiry was resumed respecting the death of Arthur Robinson, who died from the effects of an electric shock received at the works of the Blackheath and Greenwich District Electric Lighting Co. (The case up to the adjournment was reported in our last issue, p. 25.)

Mr. E. J. Ford said deceased was in his employ. On the Saturday prior to the accident he gave the man Turner and deceased instructions to fix a handrail in front of a switchboard at the company's works. He considered it safe to send them, as it was understood that no one was allowed to go on the gallery where the switchboard was without being accompanied by one of the company's engineers. When he accepted the order, Mr. Constable, the company's engineer, told him that the bolts would be quite safe as they would be "dead."

Mr. W. Mebby, electrical engineer, employed at the company's works, deposed that it was his duty to supervise the deceased and Turner, and see that they did not get into danger. When they went to the switchboard he told them that they must not work on either hand rail without permission. He suggested that they should get on with the matchboard lining at the back of the switchboard, which they did. He left before the accident occurred, and passed on instructions to Mr. Patten, who relieved him. Witness, earlier in the day, had cautioned deceased not to go near the machine that was running at the time. Before witness left he gave Turner a glove and made deceased stand on two mats. He did not give deceased a glove because where he was working he was not liable to shock. Witness said that he had never worked on a more dangerous switch than the one at the company's works.

Mr. A. T. Gordon Smith, electrical engineer in the company's employ, said be was on duty with the last witness, and also warned deceased that the work was dangerous.

Mr. R. P. Wilson, 66, Victoria-street, consulting engineer to the company, said that after the last inquest he recommended the raising of the switches to such a height as to make it impossible for anyone to touch them by accident. That recommendation had been carried out, and the company had done their best in every possible way to render the switchboard safe. On the day of the last inquest he received instructions from the company to ensure the safety of the switchboard, and there had been no justifiable delay in carrying out the recommendation of the Home Office Dangerous Trades' Committee. Other improvements were in course of being made.

The jury (one member excepted) returned a verdict to the effect that "deceased died suddenly from having received an electric shock, which occurred through the absence of proper supervision on the part of his employers, the Blackheath and Greenwich District Electric Lighting Co."

**Fermoy (Cork).**—At last there seems to be a prospect of settling the electric lighting question. A communication was received last week from the electrical engineer (Mr. F. J. Warden-Stevens) in which he stated that he had got the matter well in hand, and had been in communication with several manufacturers of plant, including Messrs. B. R. Rowland & Co., Ashmore, Benson, Pease & Co., and Messrs. J. W. Manley & Co., who in part payment would take a large number of shares in the local company which is to be formed.

**Fire.**—A fire broke out on Monday night in the finishing shop at the works of the Premier Electric Lamp Works, Huyton Quarry, Liverpool. Beyond some damage to fittings and the destruction of a quantity of globes, ready for exportation, the loss was inconsiderable.

**Glasgow.**—The Corporation have decided to apply for power to borrow £1,250,000 additional, to cover the cost of constructing and electrically equipping the new and converting the existing tramways, including rolling stock, power stations, &c.

**Gloucester.**—Arc lighting is to be extended to several additional streets at an estimated cost of £3,000. The consulting engineer (Mr. Robert Hammond) has presented a report in which it is stated that the capital expenditure to date upon the undertaking amounts to £51,025. The available capacity was 300kw., and it was extremely fortunate that the Council had the foresight to put the new set of plant on order. This new plant would double their capacity. If electric traction for the tramways is adopted, additional plant will at once be needed.

**Gourock.**—As the Burgh Commissioners cannot obtain a supply of electric current from Greenock, the town clerk (Mr. James Glen) has been instructed to obtain particulars as to the cost of obtaining an order and the capital expenditure involved in a municipal electricity scheme.

**Honley (Huddersfield).**—The District Council had intended to apply for a provisional order to acquire the local gasworks and to establish electricity supply, but find that parliamentary procedure will not permit of this being done. The draft agreement for the acquisition of the gasworks has been approved by the Council.

**Hampstead-Charing Cross Electric Railway.**—According to Laffan, Mr. C. T. Yerkes, the American railway magnate, has stated that the syndicate with which he is associated is about to proceed with the electric railway from Charing Cross to Hampstead, with connections to Euston, Paddington and possibly Victoria. The construction and equipment of the line is to be to the general design of the Central London Railway, with which it is to have a connection.

**Light Railways in Middlesex.**—An agreement has been entered into between the North Metropolitan Tramways Co., the Middlesex County Council and the Metropolitan Tramways and Omnibus Co. in regard to the construction and working of light electric railways authorised by the Middlesex Light Railways Order.

The Middlesex County Council have given notice of intention to introduce a bill for powers to enable the Council to acquire tramways in the county.

**London County Council.**—At Tuesday's meeting it was agreed to grant a loan of £21,000 to Bermondsey for the erection of a dust destructor and laying electric lighting mains (electric lighting £11,920, destructor £9,080). £25,000 was loaned to Poplar for electric lighting.

It was also agreed, on the recommendation of the Highways committee, to apply for powers next session for the construction of electric tramways between the present terminus of the L.C.C. tramways at High-street, Tooting, to the county boundary at Waterfall Bridge, at an estimated cost of £11,250. Wimbledon District Council also proposes to seek powers for the construction of electric tramways from Wimbledon railway station to the county boundary at Waterfall Bridge, and the Wimbledon Council agrees, in the event of these necessary powers being obtained, to construct its tramways and cars for the same system of traction as that which the County Council may adopt, and to lease the tramways in Wimbledon to the County Council, or to enter into an agreement for mutual running powers, or for any other arrangement which may be agreed upon.

It was decided to renew the application to Parliament for powers to reconstruct as a double line for electric traction the existing single tramway line from Camberwell Green to Vauxhall.

A report has been issued by the Highways Committee giving a review of the past year in relation to the Council's tramways. Referring to the experimental line now being converted to electric traction, it is anticipated that this will be in working order by Easter, 1901.

The report also deals with the subject of Electric Lighting Acts and Orders, and in connection with the Council's electric meter testing station, it is pointed out that in most of the electric lighting orders under which electric energy is supplied in the Council's area, it is stipulated that the amount of energy supplied to any consumer is, unless otherwise agreed, to be ascertained by means of an appropriate meter of construction and pattern approved by the Board of Trade and certified to be correct and properly connected by an inspector appointed by the Council. This stipulation, however, is not included in the St. Pancras (Middlesex) Electric Light Order, 1883, or in the St. Luke's (Chelsea) Electric Lighting Order, 1891, under both of which application has to be made to a court of summary jurisdiction to appoint an inspector to settle any dispute. This is stated to have been the cause of some inconvenience to consumers in the districts covered by these orders, and the Council's inspectors have by consent of both parties been called in to adjudicate upon these disputes. During the past year 297 meters of various patterns, the accuracy of which was in dispute, have been tested at the Council's station and have also been examined on consumers' premises. 153 meters have been tested for supply companies, and 627 for meter manufacturers. The fees received by the testing station in 1899-1900 amounted to £478. 16s. 6d.

The Council, has, during the past year, sanctioned the laying of electric mains in about 91 miles of streets in addition to a large number of service lines to consumers' premises. Of these 1 mile of mains were power mains, 38 miles for high-tension cables and 52 miles for low-tension. The Council has, in all cases, required that these mains shall be laid under the footways wherever practicable, and that the covers of street boxes shall consist of iron frames, filled in with material to suit the paving. The Council also requires that where high tension mains other than concentric cables are used each of the street boxes shall be provided with an inner as well as an outer cover, the two being well insulated from each other and the outer cover efficiently connected to earth.

**Manchester.**—In view of the forthcoming municipal elections a lengthy address has been issued to the ratepayers by Mr. S. Norbury Williams, one of the elective auditors for Manchester, in which Ald. Higginbottom, chairman of the Electricity committee and Lord Mayor-elect, is charged with being connected with companies which have had trade dealings with the electricity department. The address is divided into two parts, in the first of which Mr. Williams accuses the Electricity committee of grossly mismanaging the department, and in the second he makes a personal attack upon Ald. Higginbottom. He asserts that though the committee consists of 17 members, a large part of its operations is known to two or three men only. He alleges that 70 orders, amounting to £9,500, have been placed without competition, that in 29 out of 37 cases increases of salaries or wages have been made without the knowledge of the committee, and also that appointments and promotions have been made in a similar manner. As illustrating what he terms the disgraceful laxity which has prevailed, he cites a case in which £54 was lost in discount owing to the bill not being paid within a specified time. He also quotes alleged instances in which extras upon contracts were allowed to mount up. These charges are based upon a report of a sub-committee recently appointed by the Electricity committee to make an investigation. [See abstract of this report below.] Trading through limited companies, urges Mr. Williams, "must be ruthlessly trampled upon and extinguished, and no quarter must be given to the trader." He then proceeds to associate Ald. Higginbottom with four firms which have had trading connections with the Electricity department of the Manchester Corporation. The firms mentioned are :—

(1) Messrs. S. Z. de Ferranti (Ltd.)
(2) The British Insulated Wire Co. (Ltd.).
(3) The British Electric Works Co. (Ltd.).
(4) The West Gorton Foundry Co. (Ltd.).

Details are given of the transactions of the committee with these various companies, the inter-connection of the directorates of the companies, and, finally, Ald. Higginbottom's association with them. It is not alleged that Ald. Higginbottom has any connection with Messrs. Ferranti, nor with the British Insulated Wire Co. He is, however, chairman of the British Electric Works Co. Certain charges are made in connection with the personnel of this company, and it is alleged that favouritism was shown by the Manchester Electricity committee to Mr. Walton, the representative in Manchester of the British Electric Works Co. The allegation in this case is that Mr. Walton was in the employ of the Electrical department of the Corporation for some time, became acquainted with the Corporation's requirements, and was in this way able to sell the fittings manufactured by the British Electric Works Co. (of which Ald. Higginbottom was chairman), and that these fittings were passed by the Corporation officials in order to please the chairman of the committee. A tender was sent in by this company to the Electricity committee on Sept. 10 last for the supply of fittings, and Mr. Williams regards this as a serious charge against Mr. Higginbottom. The report, however, states that "luckily for all concerned the tender was refused," but (says Mr. Williams) "the tender had no business to have been sent in," and "this sort of thing must be stamped out." With regard to the West Gorton Foundry Co. the charges are more pertinent and more fully elaborated, and Mr. Williams statements go to show that Ald. Higginbottom and his family are the principal owners of the capital of this company. Mr. Williams refers to tenders sent in by the company, some of which were, however, declined, and in some cases only partially accepted. It would appear that on Sept. 14 last the company succeeded in obtaining a contract, but apparently for a small sum only. In the succeeding portion of his statement, Mr. Williams attacks the Electricity committee, which he charges with selling electric current to users of motors at less than half the cost of generation. He contends that the cost of production and management, including interest and sinking fund, is 2·87d. per unit, while the sale price is 1¼d. only per unit. In other words, current which cost £100 to manufacture realised only £43 on sale. In the last financial year (continues Mr. Williams) 1,993,000 units of current for lighting produced an income of £41,500, whereas motor users consumed 479,000 units and paid only £2,500. A moral is pointed in this connection. The charge is that motor users are nursed in order that employment may be found for installation firms, and it is stated that the firm of Messrs. Higginbottom and Mannock figures against 23 installations of motors. Proceeding, Mr. Williams says, "Ald. Higginbottom is a member of both the Gas and Electricity committees, which use large and costly cranes in their works. Ald. Higginbottom's firm (Messrs. Higginbottom and Mannock) make cranes. He then proceeds to set out the minutes of the Gas committee in which a tender for the supply of hydraulic cranes is let to Messrs. F. Pearn & Co. (Ltd.) "who do not make cranes. Mr. Williams charges Ald. Higginbottom (through his firm of Higginbotton and Mannock) with supplying these cranes through Messrs. Pearn & Co. Cranes have also been supplied to the Electricity committee for the Dickenson-street works, and Mr. Williams states that most of these cranes have been erected by Higginbottom's firm, but were "invoiced in other names." The purport of these charges is that Ald. Higginbottom, by his association with the trading companies and firms referred to, is unfitted for the position of Lord Mayor of Manchester. Mr. Williams concludes by stating that "no man ought to be a penny the gainer through his membership of a representative and trading body like the Manchester City Council."

Ald. Higginbottom has lost no time in replying to these charges. At the Manchester City Council meeting on Wednesday he was permitted to make a personal statement, and prefaced his remarks by observing that so far as the charges were against the Electricity committee as a whole he would leave them for the committee to answer as a body. He would remind the Council that the electricity undertaking had grown from a very small one to a very large one, in fact, the largest in the country, in a very short time, and it had been a difficult task for the Electricity committee and the officials of the department to keep pace with the demand. This fact accounted for certain irregularities which had led, as Mr. Williams had pointed out, to the appointment of a sub-committee to inquire into the best steps to be taken to make the system and administration of the Electricity department a more perfect one. With regard to his (Ald. Higginbottom's) dealings with the manufacturing companies mentioned by Mr. Williams, and taking them in their order, he would say that he had no interest whatever in Messrs. S. Z. de Ferranti (Ltd.) He was not a shareholder, and no member of his family, either near or remote, held any shares in the company, nor was Mr. Ferranti himself a director of any company in which he (Ald. Higginbottom) had any interest. He would point out that at the time when electricity meters were first ordered from Messrs. Ferranti that firm was acknowledged to be pre eminent in the manufacture of such apparatus, and the instruments supplied by them were the best and most reliable for measuring current supplied to consumers which could then be obtained. Since that time others meters had been perfected, and, as a matter of fact, no meters had been ordered from Messrs. Ferranti since Oct. 1897. It was, therefore, untrue to say that continuous orders had been sent to that firm since 1893. The order for two 1,000 H.P. generating sets supplied by Messrs. Ferranti was on the basis of the lowest tender, and the committee's action in placing the order had been fully endorsed by the Council. With regard to the British Insulated Wire Co., he had personally no interest in this concern, and as far as he was aware (without an inspection of the list of shareholders) no relative of his held any shares in the company. Two directors of that company were co-directors with him in the British Electric Works Co., but the latter concern had never done any business with the Manchester Electricity committee. As to the cable supplied by the British Insulated Wire Co. to the Corporation the following were the true facts: The total capital expenditure on mains (including cost of laying up to June, 1900) was £359,857 ; the total amount paid to the British Insulated Wire Co. was £44,957. The cost of laying was only a small proportion of the

cost of the cables, so they could judge for themselves as to the small proportion of orders which had gone to the company. He would ask the Council to clearly understand the conditions under which the British Insulated Wire Co. obtained their orders. First, tenders were invited; second all the tenders were carefully examined by the electrical engineer and the committee; third, the company's tender was the lowest of five tenders for the high-tension cables which conformed to the specification of the Corporation's engineer; fourth, when tenders were invited for the cables for this year's requirements (amounting to about £60,000 worth) the tender of the British Insulated Wire Co. was not accepted, the prices being too high, and the orders went to five other firms, some of whom had not previously supplied them with cable. With regard to the British Electric Works Co., he was a director and chairman of that company, and, as he had mentioned, two of his co-directors were directors of the British Insulated Wire Co. Mr. Williams had referred in great detail to the starting of a Manchester depot by the Works Company and the engagement of Mr. Walton, who had been in the employ of the Electricity department of the Corporation. Mr. Williams stated that it was a move of his (Ald. Higginbottom) to enable the Works Company to do business with the Electricity committee. This was a shameful imputation. The appointment of Mr. Walton came about in this way. For several months the British Electric Works Co. had been seeking premises in Manchester to open a depot, and were looking out for a suitable man to take charge of that depot, and act as agent for the whole of Lancashire. Various persons had been seen, but none were suitable. He mentioned the matter to several people who were most likely to know of a suitable man, and he was told that Mr. Walton, at the electricity works, was thinking of leaving and starting in business for himself. He saw Mr. Walton, and ascertained that this was quite correct. He had reached the limit of salary to which he was entitled in the post he held, and as the engineer was not prepared to advance his salary he had told the engineer that, at an early date, he should leave the service of the Corporation. He reported these circumstances to the British Electric Works Co., and they offered him the appointment and he accepted it. The imputation was that "free competition was not now possible." With whom was the competition? The Electricity department did not buy electrical fittings of the type manufactured by the Works Company in any appreciable quantity. With regard to the allegation that Corporation officials would be ready to pass the fittings of the company, he must point out that these officials had no discretion whatever. There were certain fixed rules which were published and certain definite tests that all fittings had to conform to. The right was expressly reserved to any representative of a firm sending fittings to be tested to be present during such tests, and there was no room for favouritism, even though it were desired to be shown. To say that "Mr. Higginbottom's fittings are publicly exhibited at Dickenson-street station" was a wilful attempt to mislead. All registered fittings were exhibited at Dickenson-street, and there was a published list of those firms whose fittings had been tested and which had conformed to the Corporation requirements. There were in all 36 firms, and the total number of fittings exhibited was 407. The number of fittings exhibited that had been made by the Works Company was twelve out of a total of 407; 23 fittings had been submitted for registration by the company, and of these 12 had been passed as being suitable for consumers to use and 11 had been rejected as not conforming to the Corporation requirements. In this paragraph there was the statement that the Works Company had sent in one tender to the Electricity committee. That was done without his knowledge. The tenders were opened by the committee and initialled, and, as usual, were passed on to the chairman to read out the prices. Upon seeing that the Works Company had sent in a tender he (Ald. Higginbottom) immediately turned to the electrical engineer, who had to examine the sketches sent in to see if they conformed to his specification, and told him that that tender must not be considered. It was not considered and not accepted. The result, therefore, was that that company had not sold any goods or received any orders from the Electricity department of the Manchester Corporation. In regard to the West Gorton Foundry Co., about two years ago a firm of gas-engine builders were wishful to build a foundry. They arranged with his firm that they (Higginbottom and Mannock) should build a foundry next to their own works, and they should pay his firm a certain rent for same on a five years' lease. They built the foundry, and started as a private firm. After working for some months they found themselves short of capital, and were going to shut down. They appealed to his firm to take the business off their hands, and it was finally decided to form a small limited company, and the private company sold all their plant, taking payment part in cash and part in shares. The partners in his firm and members of his family, as well as several gentlemen outside, and including a well-known ironfounder in Manchester, who is manager and director of the West Gorton Foundry Co., took shares and found the capital. Mr. Williams' accusation in connection with that company was entirely false. Mr. Williams stated that after two unsuccessful attempts at tendering the West Gorton Company again sent in a tender on Sept. 14, which was successful. What was that tender which was accepted? The Electricity department had a lot of old cast-iron scrap to sell, which was bought by ironfounders and metal brokers. The secretary to the Electricity department was instructed to invite tenders from several firms for this scrap, and he did so. The manager of the West Gorton Foundry Co., who has also a foundry of his own in Ancoats, applied for a tender form. He sent in his tender to the committee. These tenders were opened by the committee, were initialled and passed down to him as chairman to read out the offers. To his surprise there was a tender from the West Gorton Foundry Co., and it was the best offer for the old metal. He immediately told the committee that he was a director of this company, and that the tender must not be accepted. Several members of the committee, however, insisted on the offer being accepted, as it was the highest, and said that the committee had a perfect right to sell in the highest market, or they would not be doing their duty to the ratepayers, and although he distinctly again said he would rather they would not accept the offer, the committee accepted the tender—£24 odd. Was he to blame for this? The whole, therefore, of Mr. Williams' accusations and allegations against himself came to this: He was a director in two companies—the British Electric Works (Ltd.) and the West Gorton Foundry Co. (Ltd.)—neither of which companies had ever sold one pennyworth of goods to the Electricity department, and in only the one instance of the West Gorton Foundry Co. buying some old scrap metal from the department, and sold to them against my wish, and for which the Corporation received more money than any other person would pay. Alderman Higginbottom concludes by saying that Mr. Williams "displays crass ignorance of the most elementary facts of the cost of electricity supply" in dealing with the question of the charge made to consumers for power. He would remind the Council that even with all the bad management and gross carelessness of which the committee and himself and the engineer-in-chief were accused, the Electricity department had been made to pay, and was not the bankrupt concern which Mr. Williams alleged it to be. From 1893 to 1900 they had made a net profit of £73,926. 10s. 6d., had paid the city fund in aid of rates £48,963. 14s. 9d. after paying interest on money and sinking fund, and had a reserve fund of £13,695. 19. 7d. But the statements as to selling current for motive power at a low price and at a dead loss were made by Mr. Williams with a view of showing that he fixed this price of 1½d. per unit to encourage the use of motors, so that he could supply motors to the citizens of Manchester. But he did not fix the price at all. The committee fixed the price at 1½d. per unit, after several long reports from the engineer-in-chief, and if it had encouraged the use of motors so much the better for the Electricity department and the Corporation, as the current supplied to motors was supplied at a profit. Mr. Williams charged against him that his firm's name stood opposite 23 motors, as having fitted them up in Manchester—23 motors out of 500, three of which were in his own premises. Fitted them up, whom for? Why, for the citizens of Manchester, who had asked his firm as hoist makers and who had made a special study of electric hoists to put electric hoists in their premises, and of which the electric motor forms a part. What nonsense this all was. Was his firm to be debarred from doing business with the citizens of Manchester because he was a member of the Manchester Corporation and the chairman of the Electricity committee? As to the "cranes" incident. Messrs. Pearn had for years made hydraulic pumps, &c., for the Gas department, and had done a very large business in hydraulic jib cranes for other firms in this country. They, amongst other firms, received inquiries for hydraulic cranes from the Gas department, and asked his firm for tenders in the ordinary course of business. Messrs. Pearn received the order, and were at liberty to make the cranes themselves. They called, however, upon his firm to make the cranes at the price they had quoted. Mr. Williams's statement that his firm had invoiced cranes to the Corporation in other names was quite untrue. In conclusion, Mr. Higginbottom said he had given the Council a clear, unvarnished and truthful statement of all the facts in relation to the allegation brought against him by Mr. Norbury Williams, and he asked them, as a matter of right and justice, to at once let him know if he retained their confidence.

After some discussion, a resolution was proposed and seconded that the charges in Mr. Williams's statement should be left for discussion by special meeting of the Council to be held on Monday next. This was met by an amendment, that the Council, having heard the explanation of Ald. Higginbottom, were of opinion that the explanation was perfectly satisfactory. Ald. Southern asked Ald. Higginbottom whether, before Mr. Norbury Williams had published the statement which they were discussing, he had submitted it to him for his explanation, and was answered in the negative. No communication had passed between Mr. Williams and Ald. Higginbottom. A very lengthy discussion ensued, and it was ultimately agreed that a small committee, consisting of the Lord Mayor of Manchester, Alds. Copeland and McDougall, and Councillors Edwin Holt, Shann, Plummer, and Vaudrey, be appointed to consider the charges made, and to bring up a report on Monday next.

A report has been issued by the special sub-committee recently appointed to inquire into the administration of the Electricity department (referred to above). The report states that :—

The engineer acknowledged that various goods had been ordered, in many instances without being passed through the requisition book, or being reported to the committee. He had always had the impression that he was at liberty to order all such goods as were required for repairs and maintaining the plant in efficient working order, whether the goods were under contract or not. The returns show that in a number of instances the salaries of draughtsmen, inspectors, clerks, &c., have been increased without such increases coming before the committee. The returns further show that numerous appointments have been made from time to time without the consent of the committee, and at salaries varying from 20s. to 50s. per week. The engineer stated that he understood that in these cases also he had the power to make these appointments and promotions. A return of discount lost on accounts through delay in payment shows that during a period of 12 months there has been a loss of £54. (The report goes on to state:) The committee are of opinion that the returns above referred to, and the observations thereon, indicate that during the past few years there has been a laxity in bringing many matters of importance to the notice of the committee, which is not in keeping with the general practice obtaining in other departments of the Corporation, and the observance of which tend to keep the committee fully informed of all the business of the department. The sub-committee submit that the present system of ordering goods under "quotation" has had the effect in many instances of not complying with the Standing Orders of the Council, and they recommend the desirability of discontinuing this method in the future. The total value of the goods obtained under "quotation" during 18 months exceeded £9,000.

This report was embodied in the minutes of the Electricity committee presented at Wednesdays meeting of the Council, which were approved and adopted.

**Merthyr.**—The various points of difference between the District Council and the British Electric Traction Co. in regard to the construction of electric tramways has been referred to arbitration. The proceedings in connection with the arbitration will commence in London on Monday.

**Municipal Telephony.**—Messrs. Bennett and Ward-Thomas, consulting engineers, Manchester, have been instructed to report on the question of establishing a municipal telephone exchange for West Hartlepool.

**Northern London.**—An agreement has been drawn up, signed and sealed by the representatives of the District Councils of Enfield, Southgate, Edmonton, and Tottenham, by the terms of which it is proposed to make a joint application to Parliament for powers to generate and supply electric energy for lighting, power, and traction in these districts of Northern London. Wood Green was to have been included, but at a meeting of the Council, presided over by Mr. Littler, C.B., Q.C., the chairman, he refused to seal the agreement on the ground of its illegality. Mr. Littler described the scheme set out in the agreement as a "wild cat" one, and said it was his duty to prevent the sealing of an agreement which, if acted upon, would render each member of the Council liable to be surcharged. A warm debate followed this expression of opinion, and ultimately a resolution approving the first four clauses of the agreement was agreed to. The matter has been referred back to the Councils of Enfield, Southgate, Edmonton, and Tottenham, who are holding special meetings to consider Mr. Littler's views.

**Paisley.**—At the special meeting of the Council on Monday, it was decided to apply for powers to borrow £25,000, additional for electric lighting.

**Pontypridd.**—Mr. R. P. Wilson has been appointed consulting electrical engineer to the Council, which has decided to apply for a provisional order.

**Poplar (London).**—A recommendation was made by the Electrical committee at the last meeting of the District Board of Works to increase the salary of Mr. Blackman, the electrical engineer, from £300 to £500 per annum, and also that he be strongly recommended to the new Borough Council. An amendment that the question be left over for the new Council was carried, but a further amendment to the effect that Mr. Blackman receive a gratuity of 250 guineas, and that the new council be strongly recommended to increase his salary to £500 per annum was carried by the casting vote of the chairman.

**Portsmouth.**—The foundation stone of the electric tramway power station was laid by the Mayor on Monday. The amount of the purchase price to be paid by the Corporation for the local tramways is to be fixed by the arbitrator (Sir F. Bramwell).

**Presentations.**—On 26th ult. the staff and employés of the Huddersfield electricity works met to present Mr. J. R. P. Lunn, mains superintendent, who is leaving to take the position of borough electrical engineer at Darlington, with a timepiece and ornamental figures. Ald. Calvert, chairman of the Electric Light committee, made the presentation.

Mr. Andrew S. Dunn, the retiring telegraph superintendent and electrical engineer of the Caledonian Railway Co., has been presented by the staff of his department with a gold lever watch.

**Redditch.**—The Council have taken up a new loan of £8,000 for electric lighting extensions.

**Provisional Order Notices.**—Ripon Corporation and Atherton and Standish-with-Langtree District Councils give notice of intention to apply for provisional electric lighting orders.

**Rhyl.**—Application has been made for sanction to borrow £15,000 for electricity works. At the Council meeting on Tuesday a discussion took place on the proposed agreement between the Council and the local tramway company as to the supply of current to the latter. The Council had insisted upon a guarantee that the company would take 150,000 units per annum, and in turn the company required the payment of a penalty in the event of the Council failing to give a regular supply. The agreement was referred back to the Electric Light committee, with a proviso that the penalty should not exceed £2 per hour, and that the Board of Trade be asked to withhold confirmation of the tramways order until the Council had completed the agreement.

**Rochdale.**—The formal opening of the electricity works took place on Thursday last. A full and illustrated description of these works appeared in our issue of Oct. 19.

**St. Helens.**—Up to Sept. 30 the equivalent number of 8 c.p. lamps connected was 15,727, against 9,093 last year.

**Sheffield.**—The Heeley electric tramway route was formally opened yesterday (Thursday). The cars used on this route are of the double deck type and have been supplied by the Brush Company.

**Southampton.**—The Electricity committee have offered to supply electric current for power to the Ordnance and Survey Department at 2½d. per unit for the first 100,000 units per annum and 2¼d. after. The charges for lighting have been fixed at 6d. per unit up to 10,000 units and 5d. if the consumption exceeds this figure. After March 31 these charges will apply to general consumers. Application has been made for sanction to borrow £12,000 additional for electric lighting extensions.

**Theft.**—At Birmingham the men Frazer and Smith, charged with stealing and receiving a quantity of copper wire, the property of the National Telephone Co., were sentenced to six weeks' hard labour and three years' penal servitude respectively.

**Warrington.**—Application has been made to the Board of Trade to sanction the construction of an electric tramway over the level crossing at Wilderspool. Major Cardew (Messrs. Preece and Cardew) has been instructed to prepare specifications for obtaining tenders for the construction of five further sections of tramways. The chairman of the Electric Lighting committee (Mr. Monks) anticipates that electric current will be available by Christmas.

**West Ham.**—The consulting engineer (Mr. J. E. Waller) has been instructed to proceed with the plans of the proposed municipal tramways, and the electrical engineer (Mr. J. K. Bock) and the consulting electrical engineer (Mr. J. J. Steinitz) have been authorised to proceed with the plans for the electrical equipment. At the same time plans of the generating station are to be got out.

**Windsor.**—A cable for the lighting of some of the Royal apartments at Windsor Castle has been laid by the Windsor and Eton Electric Power Installation Co.

**Wolverhampton.**—In a report presented to the Corporation on Wednesday the Lighting committee state that, in order to meet the increasing demand for electricity for lighting and power, it would be necessary to put down extra plant, and recommended that application be made to the Local Government Board for permission to borrow £58,942 on the security of Corporation stock. The amount would include £4,620 for buildings and foundations, £18,140 for boiler-house equipment, £19,580 for engine house equipment, £15,000 for feeders, &c., and £1,602 to cover the amount overspent on a previous loan. The report was unanimously adopted. The new loan will make the expenditure on electricity supply £149,000.

# TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]*

## TENDERS INVITED.

*Shoreditch (London)*: Vestry invite tenders for steam feed, blow-off and drain pipes, feed-pump and water storage tank and sundry iron work; two slow-speed Corliss engines, direct-connected current generators (output about 800kw. each set), condensing apparatus, pipes and sundry iron work. Specifications may be obtained after 29th inst. at the offices of the Vestry's electrical engineer (Mr. C. Newton Russell), Coronet-street, Hoxton, N., and specifications may also be inspected, but not obtained, at the offices of the consulting electrical engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders must be forwarded to Dr. H. Mansfield Robinson, Vestry clerk and solicitor, Town Hall, Old-street, E.C., before noon, Nov. 20. An advertisement contains further particulars.

The directors of the *Midland Railway Co.* invite tenders for various stores, including telegraph instruments, stay rods, bolts, &c. (galvanised), telegraph and signal wire, castings, brass engine fittings, copper and brass tubes, lamps, fog signals, &c. An advertisement gives further particulars, and patterns will be ready for inspection at the General Stores Department, Derby, after Nov. 5. Forms of tender may be obtained from Mr. G. Morrall, stores superintendent, and tenders (addressed General Stores committee, Midland Railway Co., Derby) must be in by 9 a.m. Nov. 18. Mr. Alexis L. Charles is secretary of the company.

*Newcastle-upon-Tyne* New Tramways committee invite tenders for arc lamps and accessories. Tenders (addressed to committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, by 21st inst. An advertisement contains additional particulars, and conditions of contract, &c., may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 29, Princess-street, Manchester, and 26, Victoria-station, London, S.W.

*Farnworth* District Council require tenders for wiring premises on the deferred payment system. An advertisement gives further particulars, and tenders must be sent to the clerk (Mr. W. Tyldsley), Council Offices, Farnworth, by noon of Nov. 12.

*Londonderry* Corporation require tenders for the supply of carbons for one year from Jan. 1 next. Schedules of quantities and further particulars may be obtained from the the city electrical engineer (Mr. R. V. Macrory), and tenders must be lodged with the town clerk (Sir R. Newman Chambers), Guildhall, Londonderry, by Dec. 1. See advertisement.

Tenders are invited for the supply of lead-covered, concentric cable, cast-iron conduit and watertight junction boxes for the District Asylum, *Mullingar* (Ireland). Specifications may be obtained from the resident medical superintendent, and tenders must be sent to the joint committee of management, District Asylum, Mullingar, before Dec. 1. An advertisement gives additional particulars.

Tenders are invited for the supply and erection of electricity generating plant at *Harwich*. Further particulars are set out in an advertisement, and tenders must be lodged with the consulting engineers (Messrs. Bennett and Ward-Thomas), 11-13, Victoria-buildings, Manchester, by noon of 17th inst.

*Manchester* Tramways committee invite tenders for cast-iron bases for tramway poles. An advertisement gives further particulars, and specifications may be obtained from the general manager (Mr. J. M. McElroy). Tenders to chairman of committee by Nov. 9.

*Greenwich* Guardians require tenders for an electric lighting installation at their new workhouse, Grove Park, S.E. Specifications may be had from the architect (Mr. Thomas Dinwiddy, F.R.I.B.A.), and tenders must be delivered at the Union Offices, East Greenwich, S.E., before 22nd inst. An advertisement gives further particulars.

The joint committee of the Metropolitan and Metropolitan District Railway Companies (London) invite tenders for the electrical equipment of the Inner Circle Railway. The specification has been sent to only a few of the leading firms and is not a detailed one, the companies' desire being to give the tenderers a certain latitude, especially in regard to making suggestions as to the best means of getting the electrical system installed without stopping the ordinary traffic. Tenders are to be in by Dec. 1.

*London County Council* invite tenders for the supply of about 150 arc lamps for the electric lighting of Victoria Embankment and Westminster Bridge. Tenders by Nov. 13.

*Stockport* Tramways committee invite tenders for overhead equipment and rail bonds; also for steel girder tram rails, fish plates, &c., and for laying permanent way. Tenders by 24th inst.

*Belfast* Gas and Electric committee invite tenders for steam pipes, pumps, &c., condensing plant, boilers, mechanical stokers and superheaters, coal and ash-conveying plant, and switchboard extensions. Tenders to town clerk (Sir Samuel Black) by noon of Nov. 23.

Tenders are invited by the *Nottingham* Guardians for an electric lighting installation at the new workhouse. Particulars from the architect (Mr. Arthur Marshall, A.R.I.B.A.).

*City of London* Corporation Streets committee invite tenders for a mechanically-driven dust cart. Tenders to town clerk before Nov. 10.

*Walker* Council require tenders for dust destructor, boilers, &c. Tenders to 5, St. Nicholas-buildings, Newcastle-on-Tyne, by Nov. 12.

*Kendal* Corporation invite tenders for electricity generating plant. Tenders by 25th inst.

*Spanish* Ministry of Public Works, Madrid, invite tenders until Dec. 7 for the concession for constructing and working an electric tramway between Aravoca and Pozuelo de Alarcon.

*Cuevas* Municipality (Almeria, Spain) invite tenders for electric lighting for 20 years.

The *Spanish Post and Telegraph Administration* require tenders for tape paper for the telegraph service for five years, beginning with 1901.

## TENDERS RECEIVED AND ACCEPTED.

Cardiff Town Council have accepted the following tenders for the supply of electric tramway plant. The figures in parenthesis indicate "guaranteed efficiency":—

*Section No. 1 (Engines).*

| | | | |
|---|---|---|---|
| John Musgrave & Co. (*accepted*) (91%) | **£14,608** | British Thomson-Houston Co. (92%) | £13,303½ |
| F. Nell & Co. (91) | 20,964 | Dutilh-Smith & Co. (90) | 12,900 |
| R. W. Blackwell & Co. (92) | 18,205½ | Galloways Limited (88) | 12,754 |
| Hick, Hargreaves & Co. (90) | 16,178 | Yates and Thom (92) | 12,670 |
| Pollit and Wigzell (90) | 15,906 | Cole, Marchent and Morley (90) | 12,408 |
| S. Z. de Ferranti (Ltd.) (91) | 15,191½ | Victor Coates & Co. (88) | 12,400 |
| Caledon Shipbldg. Co. (88) | 15,137 | British Schuckert Co. (93) | 12,018 |
| D. Stewart & Co. (88) | 14,786 | Metcalf & Co. (90) | 11,205 |
| Robey & Co. (90) | 13,682 | Ashton, Frost & Co. (91) | 10,324 |

*Section No. 2 (Generators).*

| | | | |
|---|---|---|---|
| British Westinghouse Co. (*accepted*) (93) | **£7,467½** | Brush Co. (94) | [illegible] |
| Sunderland Forge Co. (90) | 12,458 | Lancashire Dynamo Co. | 7,663 |
| Siemens Bros. & Co. (91) | 10,213 | D. Bruce Peebles & Co. (93) | 7,627½ |
| P. R. Jackson & Co. | 9,914 | Dick, Kerr & Co. (94) | 7,600 |
| Crompton & Co. (92) | 9,015 | Bergtheil and Young (94) | 7,315½ |
| Thames Ironwks. Co. (93·5) | 8,874 | British Schuckert Co. (92) | 7,242 |
| Elec. Construction Co. (93) | 8,810 | Dutilh-Smith & Co. (94) | 6,830 |
| Mather and Platt (93) | 8,715 | Ashton, Frost & Co. (93·5) | 6,799 |
| British Thomson-Houston Co. (93) | 8,568½ | Anchor Electric Co. (93) | 6,400 |
| | | Frank Suter & Co. (93) | 6,378½ |
| | | Witting Bros. (91) | 6,300 |

*Section No. 3 (Boilers, &c.).*

The tender of Messrs. John Musgrave & Sons was accepted for boilers at £2,952, economisers £512, superheaters £558, water tank £698, pumps £385; and that of Messrs. T. and T. Vicars was accepted for stokers at £694. 19s., conveyer £159. 10s., elevator £131, bunkers £917.

Also tendered: Messrs. Victor Coates & Co., Evans & Co., Galloways Limited, Meldrum Bros., Tinkers Limited, Yates & Thom, and E. Danks & Co.

Eastbourne Town Council have accepted the following tenders for plant for their electricity generating station:—

| | |
|---|---|
| Stirling Boiler Co. (two water-tube boilers, with fittings, feed pump, &c.) | £2,033 |
| S. Z. de Ferranti (Ltd.) (400kw. steam alternator with exciter) | 7,850 |
| Ditto (main switchboard and connections) | 982 |

Brighton Corporation have accepted the tender of the Electric Construction Co. for a balancer for the working of the 400 volt supply system at £260.

Eccles Corporation have accepted the tender of the British Insulated Wire Co. for the supply of a feeder cable at £515.

Wrexham Town Council have accepted the tender of Mr. E. M. Evans, for wiring the electricity buildings, at £75. 10s.

## BUSINESS NOTICES.

Messrs. Wheatley Kirk, Price & Co. have now removed from 49, Queen Victoria-street, E.C., to larger premises a few doors nearer the Mansion House. In future this firm's address will be 46, Watling-street, Queen Victoria-street, London, E.C.

Messrs. F. C. Smith and J. W. Roberts (trading as Smith, Roberts & Co.), electrical engineers, 27, Chapel-street, Southport, and 1, Silk-street, Leigh, Lancs., have dissolved partnership. Debts by Mr. F. C. Smith, who continues as the Southport Electric Light Co.

Messrs. Geipel and Lange have been appointed sole agents for the United Kingdom for the Ward-Leonard system of operating electric motors for the driving of printing machinery of all kinds. Information regarding this system can be obtained from Parliament Mansions, Westminster, S.W.

The Sturtevant Engineering Co. (Ltd.) have removed from 75 to 147, Queen Victoria-street, London, E.C.

Messrs. Browett, Lindley & Co. (1899) (Ltd.) inform us that their London offices are now on the National Telephone Co.'s system, No. 2427 Gerrard.

**Plant for Sale.**—Leeds Corporation invite tenders for the purchase of plant at present in use in connection with their system of electric tramways. Further particulars are set out in an advertisement. The plant, which is in excellent condition, can be inspected on application to the engineer-in-charge at the Corporation generating station. The consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., will supply additional information; and tenders (addressed to Tramways Committee) should be sent to town clerk's office, Town Hall, Leeds.

Leeds Lighting committee invite tenders for the purchase of rope-driven electric generating plant about to be replaced by plant of larger capacity. Particulars are given in an advertisement, and conditions, &c., may be obtained from the manager of the Electric Lighting Department (Mr. H. Dickinson), 1, Whitehall-road, Leeds. Tenders, addressed to town clerk (Mr. W. J. Jeeves), by Nov. 18.

The West Ham Corporation have for sale two 24 B.H.P. Crossley gas engines. Particulars from borough electrical engineer (Mr. J. K. Bock), Electricity Station, Abbey Mills, West Ham. See advertisement.

**Correction.**—In the note which appeared in our last issue on the new continuous-current transformer manufactured by Messrs. Isenthal & Co. it was stated that the transformer will deliver 20 amperes at 4 volts, when supplied with half an ampere at 20 volts. This latter figure should have been 200. The primary voltage may be 100-250 volts, according to the circuit for which the instrument is intended.

**"Henley's" Cables.**—We have received from Messrs. W. T. Henley's Telegraph Works Co. a book giving an account of some of the work carried out at the extensive North Woolwich works of the company during the past 50 years. The history of these works commences with the beginning of submarine telegraph enterprise, and up to 1882 were devoted almost exclusively to the construction of submarine telegraph cables and underground telegraph lines. A list is given of a large number of cables turned out at these works, the earliest of any importance being that laid between Australia and Tasmania in 1858. Reference is made to the submarine and telegraph cable contracts executed by the company from 1860 to 1899. After the year 1882 Henley's Company extended its sphere of operations to telephone, electric light and electric power work, and a long list of supply undertakings (light and power), to which cables have been supplied is given. The works, which 20 year ago employed about 100 hands, now find work for over 1,000, altogether apart from a large staff employed outside the works at home and abroad. Several excellent photographs accompany the text.

**Westinghouse Plant.**—Circular No. 1,033, issued by the British Westinghouse Co., deals with direct-current engine-type generators.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 24 to Oct. 30, with the ports of destination:—

*Africa*—Cape Town, £502; Durban, £188 (including £87 telegraph material). *Argentina*—Buenos Ayres, £150 (telegraph material). *Australasia*—Adelaide, £2,087; Brisbane, £63; Lyttleton, £44; Melbourne, £883; Sydney, £1,748. *Belgium*—Ostend, £17. *Brazil*—Rio Janeiro, £306 (including £185 telegraph material). *Ceylon*—Colombo, £548. *China*—Shanghai, £2,305 (including £2,090 telegraph cable). *Denmark*—Copenhagen, £32 (including £17 telegraph wire). *Germany*—Hamburg, £300 (telegraph material). *Gibraltar*, £20. *Hong Kong*, £171. *India*—Bombay, £75; Calcutta, £804; Madras, £100 (telegraph material). *Malta*, £153. *Norway*—Christiania, £44 telegraph material). *Russia*—Libau, £140. *Straits Settlements*—Singapore, £474 (including £147 telegraph cable). *Sweden*—Gothenburg, £35 (including £16 telegraph wire); Stockholm, £65 (telegraph material). Total £10,804, against £14,480 in the corresponding week last year (Oct. 25 to Oct. 31).

# COMPANIES' MEETINGS AND REPORTS.

## The Western Telegraph Co. (Ltd.).

The fifty-fourth ordinary general meeting of the shareholders of this Company was held on Tuesday at Winchester House, Old Broad-street, Mr. W. S. ANDREWS in the chair.

The SECRETARY (Mr. E. Steer Hodson) having read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, we are pretty much in the same position, only more so, as that we have had to report to you for the last two or three general meetings—that is, that the even course of our prosperity appears to be continued, and that circumstances have only gone to confirm the wisdom of the arrangements we made to bring the two companies together. The joint working of the companies has proved to be more advantageous and satisfactory than the separate working of the two undertakings used to be. I will just touch, first of all, upon the receipts, which is the usual course we pursue. For the first time, I should say, the accounts for the half year contain the receipts and the expenses of the united system, and where comparisons are made they are made with the totals of the two systems worked into the present accounts. I ought to preface my remarks by stating that it has been a work of very great difficulty to get all these returns ready for this meeting in October. We have had the Western and Brazilian liquidation going on, and we have had all the arrangemen consequent upon the consolidation of the interests of the two companies and of the working arrangements necessary to be made owing to our having one undertaking instead of two to provide for. Therefore it has been rather a rush to get our accounts ready. I will now read the figures. The income for the half-year ended June 30, 1900, including dividends from other telegraph companies, amounted to £230,435; for the previous half-year it was £226,217. This shows a net increase of £4,218. That, however, boldly stated, would be rather misleading, because, as a fact, the income derived from messages and registrations, &c., amounted to an increase of £17,374, the difference between these two sums being occasioned by the amounts of dividends we received from other companies, which vary, as I have previously had to tell the shareholders, from half-year to half-year. Then, if we compare our revenues with the June half-year—that is to say, with the corresponding half-year—omitting the question of dividends, we had a net increase of some £36,000. Consequently, you see, we are progressing in a very satisfactory manner indeed in our income; and I may add that up to the present time, in the current half year, the revenues promise to be more encouraging than those I have just enumerated. I therefore think, as far as we can see, that there is every cause for satisfaction. The expenses are not so pleasing. The total expenditure for the half year was £80,000, and that for the previous half year was £71,000—I omit odd figures—showing an increase of £9,000; but there again, I am pleased to say, that does not look very formidable when it is examined. The increase is chiefly due to expenditure falling upon the current year which is not of a permanent character. For instance, the company's ship "Norseman" has been home. We reported to you that she was coming home, and she has been home, and is going out again at an early date, the purpose of bringing her here being for repairs and certain alterations in her machinery, which we believe will result in more economical working. The addition in repairs of cables account comes to £3,000, the London expenses are the same, salaries and wages and traveling expenses offer nothing to remark upon; there is an addition of £300 in the latter. We had to expend something on account of electrical stores, &c., for working the new cables; that came to just £2,500. That accounts for £5,800. Then we had to execute considerable repairs at some six of our stations at a cost of something like £1,400. The directors' remuneration for the half-year is £500 more than for the previous half year; and pension and staff assurance funds amount to an increase of £656. There are also several increases and decreases of a minor character; but these are, practically, I think, all that I need draw your attention to. But there you see more than £8,000 accounted for out of this total increase of £9,000, so that there is practically very little to think about. After payment of £11,032 for debenture interest and sinking fund, and providing for the payment of income-tax, there is a credit balance on the half year's business of £135,613. To this is added £6,791, the balance brought forward from June, making together £142,404. We have to deduct from this £651 for expenses on the issue of debenture stock as well as the interim dividend for the March quarter, amounting to £31,189, leaving a balance of £110,554. After transferring £50,000 to the reserve fund, a balance of £60,554 is left. The Board recommend the payment of a final dividend of 3s. per share, making, with the interim dividends, 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £51,982. 10s., leaving a balance of £8,571 to be carried forward. I think you will agree with me that the operations of the half-year have had a very satisfactory result. There is a large amount put to the reserve fund, but, as you all know, we are making large demands on the reserve fund, and we are fortunate in our traffic receipts, which enable us so to reinforce the reserve fund that we hope to complete our line of new cables without impinging very greatly upon that fund. We are putting all that we can, as prudent men and as guardians of your interests, to the reserve fund, so that we may keep it up as far as we possibly can. There has been at present, you will observe, no increase in the share capital on account of the laying of these new cables, our funds enabling us to go on to their completion—in fact, the last section has gone out; and we shall have laid down altogether, for the better accommodation of Brazilian and other interest in South America 1,275 knots, 1,438 knots, and 1,219 knots, making a total of 3,932 knots. With that final cargo the ship sailed on October 28. Now, these cables are of the very best and most modern construction, and they are calculated to give a high speed and to provide direct circuits, which will transmit a larger number of messages than the ordinary circuits we had before. We shall, of course, have to draw upon the reserve fund to the extent that is necessary for this. The s.s. "Norseman" is expected to go out very soon—certainly, I should hope, before Christmas. The effect of that will be that when the "Norseman" is on the station those larger expenses which we have had to incur on account of the hiring of ships to replace the "Norseman" during her absence will cease, and your outlay will go back to your normal expenditure for shipping purposes. I now move that the report and accounts be adopted, and that the dividends and bonus therein set out be approved.

Mr. FREDERICK YOULE seconded the motion.

The CHAIRMAN, in answer to Mr. George Ennis and Mr. Betts, stated that it would be necessary to a certain extent to draw upon the reserve fund to pay for the new cables. In regard to the shares, respecting the issue of which Mr. Betts had asked a question, they were simply shares that had been allotted to the shareholders of the Western and Brazilian Telegraph Co. in exchange for their shares.

The resolution was then unanimously adopted, and Messrs. Deloitte, Dever, Griffiths & Co., and Messrs. Gane, Jackson, Jefferys and Wells were afterwards re-elected auditors for the ensuing year.

---

An extraordinary general meeting was held subsequently to consider a resolution for adding to clause 110 of the Articles of Association the following words: "Every past, present and future Director who has been or is or shall become a Director of any other Company as the nominee of this Company may, in addition to any remuneration received by him under the preceding provisions of this article, also retain for his own benefit any remuneration to which he has become or may hereafter become entitled as a Director of such other Company, whether his qualification for such Directorship shall or shall not be held by him in trust for this Company."

The CHAIRMAN: This is simply an enabling resolution, and it is in pursuance of the views and the policy recently enunciated—namely, at our meeting in October, 1899. The River Plate line that we tell you in our report we have acquired an interest in is one connecting Uruguay with Argentina, and it links up the important lines to the Pacific—that is to say, to the West coast of South America—with the lines of this Company to and through Brazil. This line is a very short one, and it has been hitherto worked by an independent company, with separate maintenance, separate staffs, with its own tariffs, and with its own rules and regulations—working as a separate

local section, with its own independent transmissions, but interposed, so to say, in our through connections. This, of course, was manifestly detrimental to the telegraph service, and in the interests of direct and speedy communication, homogeneous management, and the furtherance of the public interests, it certainly called for improvement and alteration. In fact, it was a repetition on a small scale of the intolerable evils that existed before the establishment of the International Telegraph Convention, when all State lines worked within limited confines—namely, in their own territories only—had their own special rules, service regulations, and tariffs. This obstructive condition of things was only terminated by the Telegraph Convention, which combined and assimilated the rules and regulations of the different States, adopted common logical bases for reduced tariffs, and introduced that priceless boon—as it has turned out to be—of direct telegraphic communication between common centres and capitals of distant countries. The Convention swept away for this purpose the geographical boundaries which existed before. This is practically the policy we have been pursuing with the Western and Brazilian Telegraph Co., and which we are now pursuing with the River Plate Company, only we have gone a step further, and have actually now incorporated the Brazilian Submarine and the Western and Brazilian undertakings into one company: in fact, by a complete amalgamation. We began, as you know, by an exchange of shares with the Western Company, keeping that company alive, with a separate management, but under one control, such as now exists with the Platino Company, which it is proposed to extend identically and immediately to the River Plate Company, and eventually, perhaps, to other undertakings (in fact, this is a part of what I may call a general measure, although that general measure is not ripe to-day, and cannot be described to-day), so that we shall obtain simplicity and unity of management, and ultimately be enabled to assimilate the concern. This River Plate business is a small affair. The amount we pay for it is about £66,000, and upon that £66,000 there is a very excellent return; in other words, we are making an arrangement that will pay. We are obtaining important objects by it in the shape of improved working, and we are securing a remunerative investment for our capital and, we think, affording a very good step onwards in respect of future movements. I now move the resolution.

Mr. J. DENISON-PENDER seconded the motion.

The CHAIRMAN, in answer to questions, stated that it was proposed eventually to amalgamate the River Plate Company with the Western Company.

The resolution was carried unanimously.

Mr. G. DANNATT proposed a vote of thanks to the Chairman and Directors for their able and satisfactory management of the Company's affairs.

The resolution was carried unanimously.

The CHAIRMAN cordially acknowledged the vote, and afterwards referred in warm terms to the indefatigable services of the officers of the Company.

The proceedings then terminated.

## Monte Video Telephone Co. (Ltd.).

The annual meeting of this Company was held on Wednesday, Mr. FRANK W. JONES (Chairman and Managing Director) presiding.

The SECRETARY (Mr. E. M. Reiss) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN then said: Gentlemen, the results for the period under review at our last meeting were the best that had ever been laid before you and we are very pleased to state that those for the past year are still better. While the immediate prospects are not in favour of any great increase of business during the present year, I may say that so far there is promise of an improved revenue. The more distant future is of much greater promise. Monte Video is not a city of rapid growth, but a steady increase in population and business goes on and seems likely to continue, and in the opinion of many, a much greater improvement than ever will before very long be shown. The new port works are now believed to be assured and must have an exceedingly favourable effect upon the whole of Uruguay and more particularly upon Monte Video. While it would be difficult to estimate with any degree of exactness the extent of this benefit, it is believed that its effect in Monte Video will be very great indeed, and will turn what has hitherto been considered a not particularly active locality into a busy seaport, equalling, if not surpassing, any in South America, excepting Buenos Ayres. The town possesses certain advantages over Buenos Ayres which ought, and undoubtedly will, become of more decided moment once the port works are completed. Beyond question it will then be one of the best ports in the world, possibly the very best in point of health of location and natural facilities for drainage. It must remain the one port for Uruguay; there hardly can be another of any importance comparatively, and from that port the large and constantly increasing exports of wool, hides, sheep and cattle must be made, and the heavy imports of most necessities and luxuries of life for the whole republic, as there is practically no manufacturing in the country, must come. Aside from this assured business there should be a great and constantly increasing advantage in trade with the upper waters of the Parana and Uruguay rivers, and with Paraguay and the southern portion of Brazil. All this should be kept in mind, and we should be prepared to cope with whatever demands the prospective increase in population and business may make upon us. In reviewing the accounts, commencing with the balance-sheet, the first item in which there is any change from the one of last year is "Sundry creditors," the increase of which, £1,553, is attributable to the purchase of a new property for the Cordon office, one-half of the cost of which is still owing, but will be paid during the coming month. Depreciation fund (£8,000) remains the same. Reserve fund was increased last year by £2,700, £200 more than appeared in the accounts for the year, this sum having been transferred from the amount written off account of bad debts, as it subsequently appeared that such portion was an excessive writing off. The reserve fund, now standing at £13,000, it is proposed to increase by £3,500. The final item on the side of liabilities—profit for the year £9,269—is very satisfactory. The corresponding figures for the preceding four years were: 1895, £5,727; 1897, £6,237; 1898, £6,826; and 1899, £8,227. It will be seen that the business has been steadily progressing. On the assets side the ordinary capital expenditure shows an increase of £217 over the previous year, the stock of materials an increase of £204, and sundry debtors £204. Under the heading of "Investments," real estate in Monte Video is increased £2,915. We now own, as freehold, our central and the two chief sub-office properties, and are no longer at the mercy of landlords and at the risk of exorbitant rents on their account. Our sub-office properties, "Paso" and "Cordon" are believed to be fairly valued in the accounts, but the central property, purchased in 1892, it is thought may stand at a high figure. It was under rental, and the Company was forced to purchase, or remove, which would have been disastrous. The Board have doubt as to whether there ought not to be some writing off upon this account, and it is intended to have this property re-valued and written down to such an amount as will fairly represent its value. The amount written off would be taken from depreciation fund and would therefore make no difference in the relative assets and liabilities in the next balance-sheet. Investments aside from real estate, £8,698, remain at cost price, as last year, and represent marketable securities at the middle price of yesterday's Stock Exchange quotations of £10,352. Turning to profit and loss account we find that working expenses at Monte Video increased £684, attributable to an increase in the maintenance charges through a greater number of subscribers. London office expenses decreased £223, mainly through the reduction in the number of Directors. The item in accounts of previous years "Amounts written off subscriptions for bad debts, &c.," has been eliminated from the debtor side of the profit and loss account, it being considered that "Subscriptions, &c.," on the credit side should show actual values rather than, as heretofore, a sum which included an amount not considered collectable. In continuation of the policy of the Board to write down the assets to actual values, we have again written off £300 from stock of materials, bringing this item on the balance-sheet to what the Board believe is now a thoroughly reliable figure. On the credit side of the profit and loss account we note the sum £19,446 for "Subscriptions, &c.," an increase over the previous year of £1,138. The result on balance, as before stated, shows a profit of £9,269, as against £8,227, or something more than a 10 per cent. increase of profit for the year. The appropriation of the profit and the balance from the previous year, a total of £11,527, has received the very careful consideration of the Board. Had we capital at command for anticipated expenditure in improving and extending the business, there would have been no hesitation in recommending a higher dividend on the ordinary shares; but such a course could not be recommended without reliable reserves for future capital expenditure. We cannot tell when, or how soon, demands for such expenditure may be made upon us that will tax our efforts to the utmost. We cannot lose sight of the fact that improvements in telephony are likely to require new instruments, switchboards and other appliances, that extensions must constantly be made, and that an underground plant is to be looked forward to. Our ordinary capital expenditure last year, it will be noticed, amounted to £2,465 and with the Cordon office property to over £5,000. It would have been unwise to have taken any portion of that amount from our investments in securities, and the only other source from which it could be taken was revenue. Leaving out the extra amount in the balance-sheet to sundry creditors of £1,500 over last year, which is what we have still to pay on the Cordon property, there remains from the £5,000 capital charge for the year exactly the sum we have carried to reserve, £3,500, which represents the cash expenditure for the year on capital account. I go into this matter somewhat at length for the reason that some shareholder, closely examining the accounts, may have thought that while we show earnings for the past year of over 6 per cent. on the ordinary shares, we recommend the payment of only 2½ per cent. We all know that earning a dividend and having the amount intact at the end of the year are not the same thing, and I think that our accounts, when considered with care, show conclusively that your Directors have recommended all the dividend on the ordinary shares that the circumstances warrant. We hope in time to pay larger dividends, but we shall not feel deserving of severe criticism if they are maintained at their present figure. If the business progresses, as we hope, and its demands for extensions above and below ground and for improved plant are what may be anticipated, we may be obliged to curtail the present rate of dividends, or suspend them altogether, unless we can arrange to secure fresh capital. The business shows that it can sustain a fair amount of debentures without trespassing upon the present rate of dividends, and, in fact, it appears that with such issue larger dividends than as yet have been paid upon the ordinary shares would be warranted. It is thought that before long the Directors may consider it advisable to exercise their powers in this respect and offer a debenture issue for subscription. In the meantime, we shall be glad to have the assurance of the shareholders that the policy of building up a strong reserve is approved. With the addition recommended in the accounts the reserve fund will amount to £16,500, built up entirely from surplus earnings. I now move the adoption of the report and accounts.

The resolution was carried unanimously, as were also resolutions approving the dividends at the rate of 5 per cent. on the preference and 2½ per cent. on the ordinary shares.

The retiring director, Mr. F. W. Jones, having been re-elected, and the auditors reappointed, a vote of thanks to the chairman and directors terminated the proceedings.

## Eastern Extension, Australasia and China Telegraph Co. (Ltd.).

The report of the directors of this company for the half year ended June 30, states that the gross receipts amounted to £313,226. 17s. 11d., against £324,361. 6s. 2d. for the corresponding half year of 1899. Working expenses (including £28,260. 16s. 6d. for maintenance of cables) absorb £108,660. 1s. 2d., against £107,266. 10s. 1d. for the corresponding period of 1899, leaving £204,566. 16s. 9d. From this is deducted £5,630. 7s. 8d. for income tax, £13,983. 12s. 11d. for interest on debentures, debenture stock, and contribution to sinking fund, £5,000 for reserve in connection with the proposed removal of head offices, and £500 towards the Indian Famine fund, leaving £179,452. 16s. 2d. as the net profit for the half-year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £62,500, have been paid for the half year, leaving £116,952. 16s. 2d., from which £120 has been deducted for dividend on new shares, and £100,000 transferred to the general reserve. The balance (£16,832. 16s. 2d.) is carried forward.

During the half-year the unissued balance of 50,000 shares of the company's share capital was issued to the shareholders at a premium of £3 per share (or £13 each), and an official quotation has since been obtained. The balance of 5 per cent. Australian Government Subsidy Debentures has been paid off with the exception of 18 debentures not yet presented for payment. Interest on these ceased from July 1 last. (The numbers of these 18 debentures are set out in the report).

The duplicate cable between Victoria and Tasmania has been partially renewed at a cost of £13,239. 5s. 7d., which has been debited to general reserve. The necessity for improved telegraphic communication with the north of China having been demonstrated by the recent deplorable occurrences in that country, the company, in conjunction with the Great Northern Telegraph Co., have been able to meet international requirements by providing, at short notice, from their stocks of material in the Far East, cables between Shanghai, Chefoo, and Taku, with branch lines from Chefoo to Wei-hai-Wei, Port Arthur, and Kiaochau. These cables have been opened to the public without any additional charge being levied on traffic exchanged between China and Europe.

The report refers to the resignation of the Most Hon. the Marquis of Tweeddale, K.T., of the chairmanship of the company, and to the election of Sir John Wolfe Barry, K.C.B., to fill the chair.

## Cape Electric Tramways (Ltd.).

The directors' report for the year ended June 30 states that the profit and loss account after provision for debenture interest shows a net balance to credit of £65,294. 4s. 5d., which, added to £15,615. 6s. 9d. from last year, makes a gross available profit of £80,819. 11s. 2d. The directors have paid 9 per cent. by two interim dividends, the first at the rate of 4 per cent. paid on Feb. 26 (£16,000), and the second at the rate of 5 per cent. on Aug. 22 (£20,000). They have also placed to credit of reserve £8,000 further, and have created a special reserve, to credit of which they have placed £12,000. These sums aggregate £56,000, and leave a balance of £24,819. 11s. 2d. still to be dealt with, and out of which they now recommend that a bonus of 3 per cent. upon the capital should now be paid, which will absorb £12,000.

During the twelve months' working the Cape Town system has carried 11,332,627 passengers, against 8,489,490 passengers, and the Port Elizabeth system has carried 2,967,420 passengers, against 2,563,259 passengers in the preceding year. The total of passengers carried on both systems is 14,300,047, against 11,052,749, an increase in the preceding year of 3,247,298. The number of passengers carried during the year was exceptionally high, and exceeded their anticipations as regards the natural increase of traffic consequent on the great influx of strangers into Cape Town, which resulted from the declaration of war. It may, however, be regarded as certain that the business of the company continues steadily to increase, and to meet this increase the directors are making arrangements for providing additional power, and enlarging the power station, and are also increasing the rolling stock. The decisions in these important matters were arrived at after consideration of an exhaustive report of the chief consulting engineer to the company (Mr. F. Irvine), who was sent out to the Cape by the board at beginning of the year. During the past year the Hanover-street line has been opened, and latest advices informed them of the completion of the line to Tamboers Kloof. These extensions will, it is hoped, add considerably to the returns of the company. The extension to the dock gates is still under negotiation, and the line to Camps Bay is being energetically constructed. An extension of the tramway system of Port Elizabeth to Humewood has also been sanctioned, and will shortly be proceeded with.

The action in Cape Town entered into by the Eastern Telegraph Co. against the company for damages of £50,000, was tried before the judges of the Supreme Court of Cape Colony in February last, and resulted in an unanimous verdict in favour of your company by a full bench of judges. An appeal has been lodged before the Supreme Court of Judicature in this country, and the matter is still *sub judice*.

**W. R. SYKES' INTER LOCKING SIGNAL CO. (LTD.)**—Major Gen. C. S. Hutchinson, C.B., presided over the second meeting of this company on Tuesday. He said the reason why the meeting had been so long delayed was due to the trouble in making the audit, which was only completed a short time since. The result of the trading for the 12 months ended June 30 was not so satisfactory as had been expected, and this was due to the considerable increase in the price of raw material, and to the reorganisation that necessarily followed on the business being taken over by the company. With regard to the reorganisation of the company, the extra charges involved were due to the fact that, in addition to the salaries of the managers, which were very nearly the same as when the undertaking was a private concern—Mr. Sykes and his family, who were employed for a number of years before the company was made into a public one, and drew salaries to the amount of £1,404 a year, now drew a slight increase on that, the amount being £1,550, an increase of £146—there were now a board of directors to be paid, and also a secretary, the whole of which was previously included in the private family arrangement. Another cause was the indisposition of the railway companies to enter into arrangements for the introduction of Sykes' block system. Many orders had been received, the execution of which the companies had asked to be put off until more prosperous times. The vendors had, therefore, entered into an arrangement not to receive the same amount of dividend as the subscribed shareholders until the latter had been paid a dividend at the rate of 6 per cent. That enabled shareholders to receive 6 per cent. this year, while the vendors would only receive 1 per cent. The profit for the six months (amounting to £4,023) had been carried to special reserve. The auditors thought this should have been used in reducing capital account, but the directors were advised by their solicitor that it was preferable to keep it in the form adopted in the balance-sheet. Orders were coming in fairly well, but not so fast as the directors had hoped. They had orders in hand at the present time to the extent of £14,000. Mr. Sykes was now engaged in the completion and erection of what they believed would prove a very valuable part of his inventions. He referred to a machine for use in railway stations, whereby the number of levers in a cabin would be very materially reduced. There was one being put up now in Glasgow in connection with very large works they were carrying on there, and the machine, which combined electrical working with mechanical working, would enable an apparatus of 65 levers to do the work of an apparatus which would contain, in the ordinary mode of dealing with signals and points, some 325. The apparatus would thus require only about one-fifth of the levers that would otherwise be necessary, and this, of course, if it proved successful, which they had every reason to suppose it would, would no doubt be a very valuable addition to the company's business. There had been a great many inquiries from railway companies with regard to the progress it was making, and as soon as it was in operation (which he believed would be six months hence)—its value would be fully tested. Mr. Sykes' new invention would become part of the company's assets in the ordinary course of things. Any invention made by Mr. Sykes necessarily came to the company without charge. The report was adopted.

**ST. HELENS CABLE CO. LTD.**—The first annual meeting of this company was held at St. Helens on Oct. 31. The chairman (Mr. G. E. Heyl-Dia) gave an account of the progress made during the past 13 months, which he said was so satisfactory that although the Warrington electric cable works had only been working for the past six months the board were in a position to recommend a dividend of 6 per cent. on the ordinary shares. The prospects of the company were as bright as could be wished, as the works were going night and day, and the continued addition of new plant was being fully occupied as it was put down. The report was adopted unanimously, and a hearty vote of thanks to the chairman and directors terminated the proceedings.

**SWANSEA IMPROVEMENTS AND TRAMWAYS CO.** A meeting of this company was held on Tuesday, when the report of the directors for the half year ended June 30 was submitted. It stated that the tramways have been worked electrically since June 30. The rapid and frequent service now provided is much appreciated by the public, and the traffic receipts show an increase of more than 60 per cent. over those of last year, when working by horses. The Swansea Corporation had applied for an order under the Light Railways Act to construct extensions, for some of which the company sought powers last year, but did not succeed owing to the opposition of the local authorities. The directors were taking steps to protect the company's interests. As stated in our last issue, this order has been granted, the parties having come to an amicable arrangement.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation | Oct. 27 | 612 | + 116 | [illegible] | 15,721 | – 2,079 |
| *Birmingham Tramways | „ 27 | 4,564 | + 273 | 16 | 73,410 | + 3,363 |
| Blackpool Corporation... | „ 25 | 314 | + 105 | 30 | 26,261 | + 6,864 |
| Blackpool and Fleetwood | „ 27 | 217 | – 21 | 17 | 18,831 | + 10 |
| Bolton Corporation ...... | „ 28 | 1,254 | ... | 31 | 42,294 | ... |
| Bradford Corporation... | „ 28 | 544 | + 164 | 30 | 15,637 | + 3,530 |
| Brisbane Trams ......... | Sept. 12 | 1,913 | + 363 | 10 | 18,600 | + 3,782 |
| *Bristol Trams & Carriage | Oct. 26 | 2,973 | + 68 | 17 | 58,872 | + 743 |
| *Buenos Ayres & Belgrano | Sept. 30 | 2,355 | + 533 | 13 | 29,121 | + 252 |
| Central London Railway | Oct. 27 | 6,102 | ... | 13 | 64,498 | ... |
| City & South London Ry. | „ 23 | 1,866 | + 821 | 17 | 26,458 | +10,159 |
| Cork Elec. Trams ........ | „ 25 | 414 | + 10 | 43 | 17,877 | + 1,464 |
| Dover Corporation ...... | „ 27 | 181 | + [illegible] | 30 | 7,187 | + 383 |
| Dublin & Lucan Rly. | „ 27 | 71 | + 5 | 17 | 1,827 | + 325 |
| Dublin United ........... | „ 26 | 3,429 | + 401 | 17 | 64,859 | + 8598 |
| Dublin Southern Dist.... | „ 26 | 741 | + 1 | 17 | 17,861 | |
| *Glasgow Corporation ... | „ 27 | 8,402 | + 253 | ... | ... | ... |
| Hull Corporation ......... | „ 27 | 1,330 | + 692 | 17 | 23,557 | +12,554 |
| *Liverpool Corporation... | „ [illegible] | 8,349 | + 1,306 | 42 | 330,681 | +41,963 |
| Liverpool Overhead Rly. | „ 28 | 1,518 | – 112 | 17 | 23,894 | + 1,090 |
| *Sheffield Tramways ...... | „ 24 | 2,473 | + 625 | 43 | 96,286 | +33,962 |

* Partly electrical.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29⅞d. per oz. (Oct. 31). Consols (2¾ per cent.) 98¼—98½ for money, 98¼—98½ for account; 2½ per cent. 97½—98 (Oct. 31). Stocks and Shares Continuation Days, Nov. 12 and 27; Ticket Days, Nov. 13 and 28; Pay Days, Nov. 14 and 29; Mining Share Carry-over Days, Nov. 9 and 26.

**BRISBANE ELECTRIC SUPPLY CO. LTD.**—The half-yearly report presented at the meeting on Sept. 20 stated that the business of the company continued to expand, and that fresh customers were being connected every week, so that the new 50kw. Parker set, which was due at the end of the month would be at work none too soon to cope with the increased load. The output for the half-year was 125,000 units, and the revenue for the same period £2,933.

**MUNICIPAL LOAN.**—The Hoylake and West Kirby Council invite applications for a loan of £7,000 for electric lighting. Applications by 14th inst.

**NEW ZEALAND ELECTRICAL SYNDICATE (LTD.)**—Warrants for the half-year's interest on the 6 per cent. first mortgage debentures, and for the half-year's dividend on the 7 per cent. cumulative preference shares have been posted.

**SIAM ELECTRICITY CO. (LTD.)**—The report for the half-year ended June 30 was recently issued, and recommended the payment of a 4 per cent. dividend. Satisfactory progress has been made during the period, 38 new customers having been connected.

**STOCK EXCHANGE NOTICES.**—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to the further issue of 150,000 £1 shares of the *Castner-Kellner Alkali Co. (Ltd.)*, and the ordinary and 7 per cent. cumulative preference £1 shares of the *Electrolytic Alkali Co. (Ltd.)*. The committee has also been asked to allow the further issue of 30,000 4½ per cent. cumulative £5 preference shares of the *Charing Cross and Strand Electricity Supply Corporation (Ltd.)*, and 11,000 fully-paid £5 shares (Nos. 1 to 11,000) of the *Hove Electric Lighting Co. (Ltd.)*, to be quoted in the official list. The last is a renewed application. The committee has also ordered the undermentioned securities to be quoted in the official list:—60,000 £10 fully-paid ordinary shares (Nos. 1 to 60,000), 59,987 6 per cent. £10 fully-paid preference shares (within Nos. 1 to 60,000), and £300,000 3½ per cent. mortgage debentures of £100 each (Nos. 1 to 3,000), of *The Dublin United Tramways (1896) Co. (Ltd.)*.

**WEST INDIA AND PANAMA TELEGRAPH CO. (LTD.)**—The profit of this company for the half-year ended June 30 being insufficient to provide the preference dividends, the directors have decided to take the sum required from reserve, and recommend the payment of the usual dividends on the cumulative preference shares and 6d. per share on the ordinary shares.

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 24. | | Price Wednesday, Oct. 31. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Oct. 31. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch Dist'ct Elec. Lt. Ord. (fully pd.) | ⅝ | ⅞ | ⅝ | ⅞ | ... | | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 10/8 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | ... | Calcutta Elec. Supply Ordinary (fully paid) | 5½ | 6½ | 6½ | 6½ | ... | ... | 6½ | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9½ | 10½ | 4 5 9 | February and August | 9½ | 9½ |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary ... & new | 6½ | 7½ | 6 | 6½ | 4 11 4 | March | 6⅛ | 6½ |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December | ... | ... |
| $1,000,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yrs. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,879 | 10 | 8/0 | City of London Electric Lighting Ord. | 8 | 9 | 8½ | 9½ | 4 6 3 | February and August | 9 | 8½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 12½ | 13½ | 4 9 0 | January and July | 13¼ | 13⅛ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 5 0 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ Deb. Stock (issue allotted) (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | 110 | 109½ |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 3 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2½ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 45,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 13½ | 14½ | 13½ | 14½ | 3 15 10 | April and October | 13½ | ... |
| £240,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 13 7 | June and December | ... | ... |
| £150,000 | Stock | 3½ | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 7 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 15½ | 15½ | 15 | 16 | 4 7 7 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6½ | 6½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/0 | Rand Electric | ⅝ | ⅞ | ⅝ | ⅞ | 12 15 0 | ... | ... | ... |
| £130,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 76 | 85 | 75 | 85 | 5 18 0 | January and July | ... | ... |
| 15,000 | $100 | $1 | Royal Electric Company of Montreal Shares | 165 | 175 | 165 | 175 | 4 8 6 | April and October | ... | ... |
| £115,800 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 19 8 | February and August | 15½ | ... |
| 30,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | " " | ... | ... |
| £150,000 | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 97 | 100 | 98 | 101 | ... | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 29,437 | 5 | ... | Do. Do. | 11 | 12 | 11 | 12 | ... | ... | 11½ | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 18 | 14 | 18 | 3 15 0 | ... | ... | ... |
| £157,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 101 | 103 | 103 | 105 | 4 17 1 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 23 | 24 | 23 | 24 | 3 8 11 | February and August | ... | ... |
| 25,000 | 10 | 6% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £150,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 15,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 10 | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10½ | ... |
| 45,000 | 10 | 11/0 | British Elec. Trac. Ord. | 13½ | 14½ | 13 | 14 | 7 3 1 | ... | 14½ | 13 |
| 50,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 13 4 | February and August | 12½ | 12½ |
| £250,000 | Stock | 6% | Do. 6 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 121½ | 121½ |
| 40,000 | 5 | 1/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 3 16 5 | ... | 5 | ... |
| 27,500 | 5 | ... | Do. "B" | 3½ | 4½ | 3½ | 4½ | ... | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 6 per Cent. Debentures | 104 | 107 | 104 | 108 | 4 11 4 | ... | 105½ | ... |
| £120,000 | Stock | 13/4 | Do. 5% 2nd Deb. Stock Prov. Certs. (a.l.p.d.) | 96 | 99 | 96 | 99 | 5 1 0 | ... | ... | ... |
| 300,297 | 10 | 3/0 | Central London Ordinary | 10 | 10½ | 10 | 10½ | 2 17 1 | June and December | 10⅛ | 10⅛ |
| £366,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 58 | 61 | 58 | 61 | 2 5 2 | February and August | ... | ... |
| 37,500 | 10 | 1/7½ | Do. Ordinary (Nos. 22,501 to 60,000) | 6 | 6 | 5 | 6 | 3 9 4 | ... | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 139 | 143 | 139 | 143 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | " " | ... | ... |
| £244,315 | Stock | ... | Do. 4 per Cent. Perpetual Debenture | 120 | 123 | 118 | 123 | 3 5 0 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896) Ltd., Ordinary | | | 17½ | 18 | ... | | ... | ... |
| 59,987 | 10 | ... | Do. 6 per Cent. Preference | ... | | 15½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | 4% | Do. 3½ per Cent. Mortgage Debs. (red.) | ... | | 112 | 115 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 20½ | 21½ | 21 | 22 | 3 12 6 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 13 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | 9½ | 10½ | | | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 8% | Liverpool Overhead Railway Ordinary | 8½ | 9 | 8½ | 9½ | 4 8 6 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 15 6 | " " | ... | ... |
| £415,000 | Stock | 4% | Do. 4 per Cent. Debenture | 104 | 106 | 104 | 106 | 3 15 0 | January and July | ... | ... |
| £170,000 | 100 | 5 | Montreal Street Railway Sterling 5% Mort. Bonds (1908) | 104 | 105 | 104 | 106 | 4 15 0 | ... | ... | ... |
| £140,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 4 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 3½ | 3½ | 3½ | ... | ... | ... | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 17 | 19 | | | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | 10½ | 10½ | ... | | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 6 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10½ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 104 | 107 | 104 | 107 | ... | ... | 105½ | ... |
| £40,000 | Stock | 4% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 3 3 | June and December | 96 | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

## TELEGRAPHS.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 24. | | Price Wednesday, Oct. 31. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Oct. 31 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| £96,200 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 103 | 3 17 6 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £110,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 85 | 90 | 5 11 1 | ... | ... | ... |
| £323,720 | Stock | 15/0 | Anglo-American | 53 | 57 | 52 | 54 | 5 10 6 | Feb., May, Aug., Nov. | 53⅛ | 51⅞ |
| £5,098,640 | Stock | 20/0 | Do. Preferred | 98½ | 100½ | 98 | 99 | 5 9 1 | „ „ | 100¼ | 9[illegible] |
| £3,048,610 | Stock | 27/0 | Do. Deferred | 10⅜ | 10⅝ | 10½ | 10⅝ | 12 11 2 | „ „ | 10⅝ | 10 5/16 |
| 13,333,300 | $100 | $1¾ | Commercial Cable Capital Stock | 168 | 173 | 165 | 176 | 4 11 5 | Jan., Apr., July, Oct. | ... | ... |
| £1,349,496 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 17 10 | „ „ | 102½ | 102¼ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary x.d. | 6½ | 7½ | 6½ | 7¼ | 7 17 0 | February and August | 6⅝ | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. x.d. | 15 | 16 | 14½ | 15½ | 6 9 0 | „ „ | 15 | ... |
| 12,981 | 5 | 2/0 | Direct Spanish Ordinary | 4 | 5 | 3½ | 4½ | 4 9 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | „ „ | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10¾ | 10½ | 11¼ | 5 10 0 | Jan., Apr., July, Oct. | 10⅝ | ... |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 101 | 99 | 101 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary | 148 | 151 | 149 | 151 | 4 10 11 | Jan., Apr., July, Oct. | 150½ | 149¼ |
| £1,936,488 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 99 | 102 | 99 | 102 | 3 9 0 | „ „ | 100¼ | 99¾ |
| £1,432,288 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) x.i. | 117 | 120 | 117 | 119 | 3 8 4 | May and November | ... | ... |
| 250,000 | 10 | 2/6 | Eastern Extension | 14⅜ | 15⅛ | 14⅞ | 15¼ | 4 11 10 | Jan., Apr., July, Oct. | 14⅞ | ... |
| 50,000 | 10 | | Do. (Nos. 250,001 to 300,000) iss'd at £3 (prem. all pd.) | 6¾ | 7½ | 6¾ | 7¼ | ... | ... | ... | ... |
| £330,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 115 | 119 | 115 | 118 | 3 7 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 | 102 | 99 | 103 | 3 18 6 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100% | 103% | 100% | 103% | 3 17 9 | May and November | ... | ... |
| 101,237 | 10 | 1/9 | Globe Telegraph and Trust x.d. | 10⅜ | 11⅛ | 10⅝ | 11 | ... | Jan., Apr., July, Oct. | 11 | 10¾ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference x.d. | 15 | 15½ | 15 | 15½ | 3 17 6 | „ „ | 15 | ... |
| 160,000 | 10 | 6/0 | Great Northern of Copenhagen | 31 | 34 | 31 | 33 | 3 15 7 | January and July | 31¼ | ... |
| £94,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 98 | 101 | 98 | 101 | 4 9 1 | June and December | 99⅞ | ... |
| 17,000 | 25 | 12/6 | Indo-European x.i. | 49 | 51 | 49 | 52 | ... | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 17 8 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 125 | 130 | 4 12 5 | „ „ | 125 | ... |
| 16,000 | 10 | ... | West African Telegraph | 3¼ | 3¾ | 3¼ | 3¾ | 4 9 8 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 0 | March and September | ... | ... |
| 30,006 | 2½ | ... | West Coast of America | ¼ | 1 | ½ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 14 4 | January and July | ... | ... |
| 88,321 | 10 | 1/0 | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | ⅞ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ | 7½ | 6½ | 7½ | 8 0 0 | „ „ | 7 1/16 | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 6 | 7 | 6 | 7 | 8 11 6 | „ „ | ... | ... |
| £290,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 109 | 4 13 6 | January and July | ... | ... |
| 337,930 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 14½ | 15 | 14½ | 15 | 4 11 4 | Mar., June, Oct., Dec. | 14⅞ | 14⅝ |
| £275,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 | 106 | 103 | 106 | 4 14 4 | June and December | ... | ... |
| £311,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | 103½ | ... |

## TELEPHONES.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 24. | | Price Wednesday, Oct. 31. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Oct. 31 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 2¾ | 3¼ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 321,950 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | ... | | ... | | ... | July | ... | ... |
| 172,600 | 1 | 3½% | Monte Video Telephone Ordinary | ⅝ | ⅞ | ⅝ | ⅞ | 5 0 0 | November | ... | ... |
| 66,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | „ | ... | ... |
| 530,000 | 5 | 2/0 | National | 4⅛ | 4½ | 4⅛ | 4½ | 6 16 5 | February and August | 4 7/16 | 4¼ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 15 | 13 | 15 | 4 0 0 | „ „ | 13 | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 13 | 15 | 13 | 15 | 4 0 0 | „ „ | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | „ „ | 5 1/16 | 5 |
| 2,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 91 | 93 | 91 | 93 | 3 11 5 | June and December | 91¾ | 91 |
| £[illegible] | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | ... | ... | 101½ | ... |
| 171,504 | 1 | 0/6 | Oriental x.d. | ½ | 1¼ | ½ | 1¼ | 4 8 11 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 4⅞ | 5⅜ | 4⅞ | 5⅜ | 6 13 4 | July | ... | ... |
| 16,620 | 5 | 2/6 | Do. 5% Cumulative Preference | 4½ | 5⅜ | 4½ | 5⅜ | 4 15 3 | June and December | ... | ... |
| £179,987 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | „ „ | ... | ... |

## ELECTRIC MANUFACTURING &c. COMPANIES.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 24. | | Price Wednesday, Oct. 31. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Oct. 31 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70,000 | 1 | 3d. | Alliance Electrical Co. 5% Cum. Pref. | 1 | 1¼ | 1 | 1¼ | 4 8 11 | ... | ... | ... |
| 145,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ⅞ | 1 | ⅞ | 1 | 7 7 4 | March and September | ⅞ | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ⅛ | ⅜ | ⅛ | ⅜ | ... | ... | ... | ... |
| 80,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 99 | 97 | 99 | 4 4 2 | ... | ... | ... |
| 40,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 4 13 11 | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 4 10 0 | ... | ... | ... |
| 100,000 | 5 | 1/6¾ | British Westinghouse 6% Preference | 4⅞ | 5⅜ | 4⅞ | 5⅜ | ... | ... | ... | ... |
| 90,060 | 2 | 1/3½ | Brush Electrical Engineering | 1⅝ | 1⅞ | 1⅝ | 1⅞ | 0 9 4 | September | ... | ... |
| 16,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2¼ | 2 | 2¼ | 5 6 8 | „ | ... | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 108 | 111 | 108 | 111 | 4 0 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 104 | 101 | 104 | 4 7 2 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. x.d. | 12½ | 13½ | 12½ | 13½ | 5 11 1 | „ „ | 13⅛ | 12¾ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 | 5½ | 5 | 5½ | 4 10 11 | „ „ | 5⅜ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 19 11 | November and May | ... | ... |
| 300,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1¼ | 1 | 1¼ | 6 0 0 | ... | 1⅛ | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) x.i. & rights | 97 | 100 | 97 | 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ⅞ | 1 | ⅞ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | 1 | 1¼ | 1 | 1¼ | 5 6 8 | ... | ... | ... |
| 84,000 | 3 | 2/4½ | Crompton and Co. (Nos. 1 to 32,098) | 3⅞ | 4⅛ | 3⅞ | 4⅛ | 5 5 10 | January and July | 3⅞ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 18 0 | „ „ | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ⅞ | 1⅛ | ⅞ | 1⅛ | 5 6 8 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 3 | 2/9½ | Do. (£5 paid) | 3¾ | 4¼ | 3¾ | 4¼ | 5 13 4 | „ „ | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 0 | June and December | ... | ... |
| £100,000 | Stock | 2% 4½% | Do. 3% 2nd Deb. Standing Pres. Certs (all pd.) | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 35,600 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half yearly | 4½ | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 104 | 101 | 104 | 4 7 0 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co., Limited | 2 | 2¼ | 2 | 2¼ | 5 6 8 | January and July | 2⅛ | ... |
| 25,000 | 2 | 2/9 | Do. 7 per Cent. Cumulative Preference | 2¼ | 2½ | 2¼ | 2½ | 6 6 8 | July | 2 5/16 | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 16 2 | January and July | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 12½ | 13½ | 12½ | 13½ | 5 11 1 | February and August | 13⅛ | 12⅞ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 | 5½ | 5 | 5½ | 4 1 10 | „ „ | 5 1/16 | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 | 112 | 104 | 112 | 4 0 4 | „ „ | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 20 | 21 | 20 | 21 | 3 11 5 | „ „ | 20 15/16 | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | March and September | ... | ... |
| 37,350 | 12 | 11/0 | Telegraph Construction and Maintenance | [illegible] | [illegible] | 36 | [illegible] | 4 10 0 | March and July | 3[illegible] | 3[illegible] |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 20,000 | 5 | 9/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 10½ | 11½ | 8 4 4 | ... | 11 | 10¾ |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 | 5½ | 5 | 5½ | 4 6 11 | ... | 5 5/16 | ... |
| 30,000 | 5 | 2/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | 11 | ... |
| 30,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 0 | „ „ | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 4 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# PARIS EXHIBITION.

## ELECTRIC INSTALLATION

## ON SALE

CONSISTING of Mather & Platt Multipolar Shunt Wound Dynamo having an output of 220 to 250 volts and 1,400 amperes at 105 revolutions per minute, driven by one of Galloways' 600 H.P. vertical compound engine, cylinders 18in. and 34in., stroke 3ft. 0in., Corliss valves, forced lubrication, ejector condenser, and centrifugal pumps. In daily operation at the Exhibition.

***FOR FULL DETAILS AND PRICE, APPLY***

**GALLOWAYS Ltd., Manchester.**

---

## CHEAP PREPAID ADVERTISEMENTS

*relating to* **SITUATIONS VACANT AND WANTED, MISCELLANEOUS PLANT WANTED, FOR SALE, AND FOR EXCHANGE,** *are inserted in* "**THE ELECTRICIAN**" *at the following special low rates:*

| | |
|---|---|
| *Three Lines and under* — — — — | 1s. 6d. |
| *Per Line after* — — — — — | 6d. |

**Nine Words to the Line.**

*Cash must accompany all orders for advertisements inserted at these rates if inserted "to account," they will be charged full scale rate.*

## SITUATIONS VACANT AND WANTED, &c.

WANTED, for Colombo, Ceylon, an outside ELECTRICAL ENGINEER, thoroughly experienced in the laying and maintenance of high and low-tension mains, solid and conduit systems, must be a fully qualified electrician, unmarried, and not less than 25 years old. Salary £30 a month.—Apply, by letter, stating age and qualifications, to THE SECRETARY, United Planters' Co. of Ceylon, Ltd., 11, St. Benet Place, Gracechurch-street, E.C.

ASSISTANT MANAGER.—WANTED, by a Publishing Company, an Assistant Manager for the Commercial Department having a good knowledge of the Electrical and Allied trades throughout the Country. A good opening for a competent man.—Apply, by letter, stating salary required, to "ASSISTANT," care of Hart's Advertising Offices, Maltravers House, Arundle-street, Strand, W.C.

WANTED, a young TELEPHONE ENGINEER (single) to go abroad, with good technical education, thoroughly experienced in inside and outside telephone work, and capable of taking charge of the staff and working of a telephone exchange. Apply, by letter, stating age, experience and salary expected.—Address, Box 1,617, Willing, Royal Exchange, London, E.C.

DRAUGHTSMAN, used to Switchboard work, must be smart and reliable, one with workshop experience preferred.—Apply, stating age, experience and wages required, to Box No. 3,814, *Electrician* Office, Salisbury-court, Fleet-street, London.

PUPIL.—The Engineer of a large system of Electric Tramways has a VACANCY for a PREMIUM PUPIL.—Apply, 3,817, *Electrician* Office, Salisbury-court, Fleet street, London.

PREMIUM PUPIL WANTED by Engineer of an Electric Light and Power Station.—For particulars apply to "W. C. S." *Electrician* Office, Salisbury-court, Fleet-street, London.

ELECTRICAL ENGINEER, (Stud.Inst.E.E.) young, desires EMPLOYMENT with firm of Manufacturing or Consulting Electricians, to supervise erection and testing of lighting and power plants; seven years' varied practical and college theoretical training. Highest references.—Apply, RUPERT WAITE, 47, East Mount-road, York.

ELECTRIC WIRES and CABLES.—Specialist with over twenty years' experience in all branches of cable manufacture as Engineer and Manager of large cable works at home and abroad, desires suitable position in existing concern, or would be willing to design, erect and manage new cable factory. Address, "SPECIALIST," *Electrician* Office, Salisbury-court, Fleet-street, London.

RELIABLE steady BRASS TURNER (non-society) good vice hand, wants job. Capable of taking charge; worked Cooper's Lathe.—TURNER, 17A, Churton-street, S.W.

TO ELECTRICIANS, BRASS FINISHERS and OTHERS. Send for circulars of our milling machines, lathes, &c. Several good second-hand for sale, also several engines.—Call 100, Houndsditch, London, or write to BRITANNIA TOOL FACTORY, Colchester.

For good SOUND CASTINGS apply BRITANNIA Co., Colchester.

ACCUMULATOR CHARGING.—C. H. CATHCART and CO., having plant specially adapted for this purpose, Charge Cells of all sizes promptly, thoroughly and cheaply. Terms on application. Accumulators on Hire for temporary lighting, experimental uses, &c.—3, Dorset-buildings, Salisbury-square, Fleet-street, E.C. (Telephone No. 266.)

TO MECHANICS' INSTITUTES, Public Libraries and other Institutions.—Messrs. Harry South & Co., Limited, 10 and 12, Garrick-street, London, W.C., have several years' numbers of *The Electrician* and *Electrical Review* to be given away free on application.

## SECONDHAND

## ELECTRICAL MACHINERY.

Messrs. THOMPSON, SON & CO., of New York, have
a LARGE QUANTITY of

***DYNAMOS, MOTORS, SWITCHES, ARC LAMPS, ENGINES, BOILERS, &c., &c.,***

in Stock, of Standard makes, for Immediate Delivery.

***COMPLETE EQUIPMENT FOR ELECTRIC LIGHTING PLANTS OR STREET RAILWAY SERVICE.***

Write for Catalogue and particulars to—

**W. H. MERRIMAN,** 30, Victoria St.,
LONDON, S.W.

## NOW READY.

With Numerous Illustrations. Demy 8vo. Paper Covers. Price **2/6** net, post free.

## THE THEORY OF COMMUTATION.

By C. C. HAWKINS, M.A., M.I.E.E.

"THE THEORY OF COMMUTATION" deals with commutation in the continuous-current dynamo, and has special reference to Prof. Arnold and Dr. Mie's method of taking into account the contact resistance of the copper or carbon brushes in the mathematical equation of the short-circuit current.

LONDON—"THE ELECTRICIAN" PRINTING & PUBLISHING CO., LTD.,
1, 2 & 3, Salisbury-court, Fleet-street.

*Large Stocks kept for Immediate Delivery*

**"Blackley Tape"**

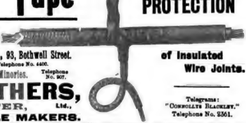
FOR THE "EFFICIENT" PROTECTION of Insulated Wire Joints.

**LONDON:** Francis & Spilsbury 20, Bucklersbury, E.C.
Telegraphic Address, "AGENCIES LONDON." Telephone No. 5583 Bank.
**GLASGOW:** The United Asbestos Co., Ltd., 93, Bothwell Street.
Telegraphic Address, "SALAMANDER GLASGOW." Telephone No. 4400.
**BIRMINGHAM:** S. Jevons, The Minories. Telephone No. 907.

**CONNOLLY BROTHERS,** Ltd.,
Blackley, MANCHESTER,
INSULATED WIRE and CABLE MAKERS.

Telegrams: "CONNOLLYS BLACKLEY." Telephone No. 2361.

London Agents: G. F. QUICKE & CO., 301 & 303, Euston Road, London, N.W. Teleg. Address, "Qincongo London." Telephone No. 443 King's Cross



**THAMES** DYNAMOS MOTORS ELEC. DRILLS

The THAMES IRONWORKS, SHIPBUILDING & ENGINEERING CO., Ltd.,
THAMES ELECTRICAL ENGINEERING WORKS,
BLACKWALL, LONDON.

**"Bar-Lock"**

The ROYAL BAR-LOCK TYPEWRITER, with its writing in plain sight, constitutes supreme excellence in Typewriters. It is the most perfect expression of mechanical skill that has yet been produced in the form of a Writing Machine.

Full particulars and New Art Catalogue post free on application to Her Majesty's Typewriter Makers,
THE TYPEWRITER CO., LTD., 12, 14 & 16, QUEEN VICTORIA STREET, LONDON, E.C.

**DAVEY, PAXMAN & CO., L<sup></sup>D. COLCHESTER,**

Engineers and Boilermakers.

**Speciality:** STEADY RUNNING ENGINES FOR ELECTRIC LIGHT INSTALLATIONS.

MAKERS OF
Portable and Semi-Portable Engines
Semi-Fixed Engines and Boilers.
Horizontal Engines.
Vertical Engines and Boilers.
Tandem Engines, Simple and Compound.
Triple-Expansion Engines.
Corliss and Trip Gear Engines.
Horizontal Winding Engines.
Air Compressors.
Compound Portable & Semi-Portable Engines
Vertical Hoisting Engines and Boilers.
Compound Semi-Fixed Engines and Boilers
Compound Horizontal Fixed Engines.

Engines of all Sizes up to 1,500 h.p.

Paxman's Patent "Economic" Steam Boiler.

The "ECONOMIC" Boiler is one of the best Steam generators before the public not only for efficiency, but for Economy and Durability This Boiler contains particularly good features and high qualities, and is BEING ADOPTED VERY LARGELY FOR CENTRAL ELECTRIC LIGHTING STATIONS, MILLS, and FACTORIES, &c., WITH GREAT SUCCESS

Cornish, Lancashire, "Essex," Vertical, Locomotive, "Economic," Safety, Water-Tube, Marine, and other Boilers.

D. P. & CO. ARE MAKERS OF HIGH-CLASS STEAM BOILERS OF EVERY DESCRIPTION.

*ALL RIVET HOLES DRILLED.*

*Telegraph Address: "PAXMAN, COLCHESTER.* BOILERS MADE UP TO 200lb WORKING PRESSURE.

Catalogue and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ld., Engineers, COLCHESTER.**

London Office: 78, QUEEN VICTORIA STREET, E.C.

Digitized by Google

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED. First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,173. [No. 2. Vol. XLVI.] FRIDAY, NOVEMBER 9, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Ministerial changes are almost always attended with risk, and invariably give rise to misgivings when new appointments are made, as in the present readjustment of officials, for purely political or party reasons. We cannot but regret Mr. Ritchie's withdrawal from the Board of Trade for the higher duties of the Home Office. His successor, Mr. Gerald Balfour, however, is said to be a good business man, and, like the rest of the distinguished family to which he belongs, a zealous public servant and hard worker. At the Local Government Board the new president, Mr. Walter Long, may have opportunities of directing municipal trading into sound and legitimate channels, without exactly muzzling it as he did the canine community. Mr. Austen Chamberlain as Financial Secretary to the Treasury, if he is to represent Post Office affairs in the House of Commons, will have a hard task, following in the wake of such a man as Mr. Hanbury. As to the Post Office itself, the parliamentary chief remains as before in the Upper Chamber—and Mr. Henniker Heaton has not yet been found a place there.

The Committee appointed by the Manchester Corporation to enquire into the charges made against Alderman Higginbottom by Mr. S. Norbury Williams, while fully exonerating him in their report from the more serious charges, stigmatise his action in tendering as a sub-contractor for cranes for Corporation contracts as "altogether improper." (A long *précis* of the report will be found in another column.) As a result, Mr. Higginbottom has not only resigned his position as Chairman of the Electricity Committee, but has also declined the Lord Mayoralty, to which he had been nominated, retiring in fact altogether from civic life. In spite of his indiscretion in the matter investigated by the Committee, the good wishes of the electrical profession go with him. He has certainly contributed largely to the signal success of the Manchester electricity undertaking.

In spite of guard wires and devices which are constantly being patented for automatically switching off an overhead traction wire when it breaks or another wire comes in contact with it, accidents are being continually reported owing to such causes. In most cases they are of a slight nature, since the pressure is limited to 500 volts, but they are most regrettable as likely to produce a scare similar to the famous overhead wire scare in America a few years ago, and to prejudice the public against the most practical and economical form of electric traction. Recently accidents of this nature have occurred in Carlisle and Plymouth in this country, and great prominence has been given to one which occurred in Vienna last Friday. In the latter case two people coming into contact with a telephone wire which had fallen across the trolley wire were severely burned, and doubts were entertained as to the recovery of one of them. We think that traction engineers should experiment more than they do, and on a large scale, with protective devices, and not confine themselves merely to those insisted upon by the Board of Trade and similar authorities.

In another column we give a short notice of some experiments by M. Guarini on the propagation of Hertzian waves along wires and through air. They are chiefly interesting in that their results agree very perfectly with what might have been expected under the conditions imposed. Of course, confirmatory experiments in any not thoroughly explored department of science are always welcome and, indeed, necessary; and in any department such as this with which M. Guarini deals, and in which our experimental knowledge is yet rather vague and uncoordinated, such observations are especially important. But these particular experiments would have been much more valuable had M. Guarini taken more completely into consideration the

numerical values of those electrodynamical quantities, such as the inductances of the secondary coil and of the single wire, which govern the behaviour of the apparatus in any given case. The conscientious quantitative comparison of observations and calculations could not fail, we consider, to lead to discoveries of importance in this fecund branch of science. And, in general, if more of published researches were undertaken rather with a view to unveiling disparities than with the aim of merely confirming what can easily be foreseen, not only would much labour be saved, but, besides, science would benefit more appreciably. This applies not only to the work of young investigators who, like M. GUARINI, are just feeling their way, but also to many more able and experienced men who are too prone to make use of the experimental facilities at their disposal rather to demonstrate scientific truisms than to pursue useful research.

**Electro-Harmonic Society.**—Major R. E. B. Crompton will preside at the concert of the Electro-Harmonic Society on Friday, November 16th.

**"The Last Signs of Life."**—We are informed that the Mons. A. D. Waller, mentioned in the note under this title in our last issue, is Dr. Augustus D. Waller, F.R.S., who is well known as the author of "Waller's Physiology," &c.

**Personal.**—It is currently reported that Mr. R. E. B. Crompton, Major Commanding the Electrical Engineers (R.E.) Volunteers, has been retained by the War Office to draw up a scheme for a more extensive and better organised employment of traction engines for war purposes.

**Cable Interruptions.**

| | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Tangier—Tarifa | Jan. 3, 1900 |
| Ceara—Maranham | Feb. 20, 1900 |
| Pará—Maranham | Mar. 2, 1900 |
| Môle St. Nicolas—Cap Haitien | Mar. 7, 1900 |
| Zanzibar—Mombasa | Sept. 20, 1900 |
| Paramaribo—Cayenne | Oct. 6, 1900 |

**New Anglo-Dutch Cable.**—In consequence of the growth of telegraphic correspondence between Great Britain and Holland, a new jointly-owned cable connecting the two countries has just been submerged by the former administration. The cable was manufactured by W. T. Henley's Telegraph Works Co., has a length of 111·68 nauts, and contains four conductors. It duplicates the Benacre-Zandvoort line, completed in 1884, and has been laid to the south of that section.

**Municipal Electrical Association.**—We have received copies of the *Proceedings* of the Municipal Electrical Association for 1899 and 1900, containing reprints of the Papers read at the fourth and fifth general meetings at Bristol, Huddersfield, and Leeds, with abstracts of the discussions. The volumes also contain the annual reports of the Council of the Association, the balance-sheets, and give an account of the proceedings at the Saturday business meetings. Copies may be obtained from Mr. A. B. Mountain, Corporation Electricity Supply Station, Huddersfield, at 8s. 6d. each.

**Maps of Telegraphic Communications.**—It is officially announced that corrections are necessary to the latest maps of telegraphic communications published by the International Telegraph Bureau, Berne. The map of the European system, published in 1898, incorrectly shows two cables from Prevesa (Corfu) to Vallona. These have never been laid, and should be erased. The map, in four sheets, of the extra-European system, published in 1899, indicates a land line connecting the offices of Kotonou (Porto-Novo) and Lagos. This does not exist; the land line shown as connecting Quetta-Lome-Klein Popo to Whyda and Kotonou stops at the latter station.

**Institution of Civil Engineers.**—The eighty-second session of the Institution of Civil Engineers was opened on Tuesday last, when the new president, Mr. James Mansergh, delivered his presidential address. The medals and premiums awarded last session having been delivered to the recipients, a reception was held in the library of the Institution. The company included Lord Kelvin, Sir Frederick Bramwell, Sir Benjamin Baker, Sir John Wolfe Barry, Sir Douglas Fox, Sir William Preece, Sir Frederick Abel, Sir Alexander Binnie, and Mr. Alexander Siemens.

**A Cross-Channel Elevated Railway.**—It frequently happens that New York daily papers receive highly interesting pieces of news from England long before they have been published in this country, but these are not always so exciting as the following item in a New York daily paper: A certain "Count Bompio Pieri" is said to have designed an electric overhead railway across the English Channel. He proposes, our contemporary says, to stretch two cables across the Straits of Dover and hold them aloft by means of captive balloons. The cables are to support the car, and also to serve as conductors for the current. Captive balloons are to be employed, also, to convey the passengers to the line at the terminal stations.

**Fast-Speed v. Slow-Speed Engines.**—In the course of his presidential address to the Liverpool Engineering Society on Wednesday, Mr. J. A. F. Aspinall (who succeeds Mr. Bromley-Holmes as President) referred to the question of fast versus slow-speed engines in traction power houses. He considered that the Liverpool tramways might be said to have clearly demonstrated that the British form of high-speed engine, with direct driving, was eminently suited to work of this kind. The apostles of the widespread theory that slow-speed engines produced elsewhere were alone capable of dealing with electric traction "could hardly be considered to have kept a judicial balance between their engineering knowledge and their commercial desires."

**Royal Society Medals.**—Among those to whom the Council of the Royal Society have adjudicated medals are Prof. Marcellin Berthelot, foreign member of the Royal Society, to whom the Copley Medal is to be awarded for his brilliant services to chemical science; Prof. Antoine Henri Becquerel, who receives the Romford Medal for his discoveries in radiation proceeding from uranium; and Major Percy Alexander MacMahon, F.R.S., the recipient of a Royal Medal for the number and range of his contributions to mathematical science. The medals will, according to the usual custom, be presented at the anniversary meeting on November 30th, and the Society's dinner is announced to take place at the Whitehall Rooms on the evening of the same day.

**Röntgen Society.**—On Thursday, November 2nd, the Röntgen Society held its first meeting of the session, and Dr. J. B. Macintyre delivered his inaugural address. He reviewed the progress that has been made in the design and construction of apparatus and methods of employing it, but dealt chiefly with the medical and surgical aspect, *i.e.*, rather with results than means. Referring to a statement made in one of the leading medical journals that the importance of the X-rays had been over-estimated, he said that it was difficult to see what could give rise to extreme disappointment unless too high expectations were formed at the beginning of this new and progressive science. At the conclusion of his address Dr. Macintyre announced that he had been permitted by the Council to offer a gold medal for the best X-ray tube for practical purposes submitted to the Society during the year 1901.

**Royal Institution.**—A general monthly meeting of the members of the Royal Institution was held on Monday, the 5th inst, Sir James Crichton-Browne, treasurer and vice-president, in the chair. The special thanks of the members were returned to Dr. Frank McClean, F.R.S., for his donation of £50 to the fund for the promotion of experimental research at low temperatures, and to Dr. Rudolph Messel for his present of a bronze bust of Sir Humphry Davy.——The annual course of Christmas lectures, specially adapted to young people, will be delivered by Sir Robert S. Ball, F.R.S., Lowndean Professor of Astronomy in the University of Cambridge, the subject being "Great Chapters in the Book of Nature." The first lecture will take place on Thursday, December 27, at

8 o'clock, and the remaining lectures will be delivered on December 29, 1900, and on January 1, 3, 5, and 8, 1901.

**Accident at the Lyons Tramway Power-House.**—On Monday morning a disastrous boiler explosion occurred at one of the power-houses which furnishes current to the Lyons tramways. The boilers are arranged in one row, divided into three sections, the two external sections containing five boilers each, and the middle one six. It appears that a boiler in the centre of these three sections had been slightly cracked close to the furnace door, and it is assumed that in giving way it produced explosions as well in the two boilers adjoining it. Happily the effects did not extend to the whole row. The escaping steam severely scalded all the workmen on the shift. Two were killed, and six burned or bruised more or less dangerously. The tramway traffic in Lyons is totally interrupted, as the remaining power-house can only supply sufficient current to work the line between Lyons and Ouillins.

**Wireless Telegraphy.**—We announced last week that the fitting of the Ostend-Dover mail boats with Marconi's apparatus was then actively progressing. On Sunday last the installation which has been placed on the "Princess Clementine" was practically tested. The apparatus was accommodated in one of the starboard deck cabins, and the corresponding air-wire ran to an extension of the foremast; the land apparatus is situated at La Panne, between Ostend and Dunkirk, 61 miles from Dover. Messages were exchanged continuously from the time of leaving Ostend till Dover was reached, the rate of transmission being about 20 words per minute. The apparatus employed is similar to that made use of for previous experiments of a like nature, and does not include the syntonous or selective devices, the construction of which has recently been announced. Later this week the vessel was placed in communication with the English coast while on her journey, the consent of the English authorities having been obtained, it is said, after some difficulty.

**The London Technical Education Gazette.**—The current double number of the *London Technical Education Gazette*, a journal which is the official publication of the Technical Education Board of the London County Council, consists of a detailed list of evening classes that are being conducted in London during the session 1900-1, and contains 127 pages. A rapid glance through the long list shows that in every branch in which tuition is given—that is to say, in nearly every branch of learning—a very large increase in the number of classes has taken place during the last few years. Whether the supply is exceeding the demand cannot be seen, of course, till a similarly detailed list of attendances be published. Engineering and trade classes have multiplied in a gratifying manner, and now with commercial subjects bulk largely in the list. The number of classes preparing for the London University degrees has also undergone considerable increase, and now, apparently, form a not unimportant part of the whole. On turning to certain pages on which are given the details of some of the classes, we regret to find certain inaccuracies which ought not to occur in an official publication.

**Manchester Association of Engineers.**—At a meeting on Saturday last a discussion was held on "The Paris Exhibition and its Lessons and Suggestions for Engineers." Mr. F. Ashbury opened the discussion and reviewed all the architectural features. Mr. Hans Renold followed, and referred chiefly to metallurgical subjects. Mr. C. Day described the engines at the exhibition. He considered other countries were specially behind England in high-speed engines, and he wondered why French engineers had not devoted more attention to these types. In the case of slow-speed engines Continental nations ran us close and in some cases surpassed us. He thought English manufacturers had much to learn with regard to putting a good appearance on everything, and showing their plant to its best advantage. Mr. Saxon, while agreeing that English manufacturers should pay more attention to design and finish, argued that many foreign designs which had been much admired were adapted from English engines. Mr. J. Nasmith said that finish was not the most important thing. German, French, and Swiss engines were holding their own against English competition owing to the closer attention which was given to details.

**Electrical Power from Windmills.**—In an article in a recent number of the *Elektrotechnischer Anzeiger* an electrical installation whose motive power is the wind is described by Herr Gustav Conz, who designed and erected it. The author, after some considerable experience of the winds of the northern coasts of Germany, concluded that power for continuous lighting, &c., was available in abundance provided that a large battery of accumulators formed part of the installation. At Kappeln, in Schleswig-Holstein, a Neumann wind turbine has been erected. Its diameter is 36ft. and its effective surface about 900 sq. ft. Its speed is regulated, by the automatic turning of its vanes, to about 11 revs. per min.; and at this speed in a wind of velocity 7½ft. per sec. the turbine yields about 30 H.P. This power is transmitted to a 30 H.P. shunt-wound dynamo running at 700 revs. per min. and giving 120 amperes at 160 volts. The battery has a capacity of 66,000 watt hours. The author states that as soon as the wind attains a velocity of 7½ft. per sec. the dynamo can be given its full load, and, also, that while the wind is rising to the velocity mentioned the charging of the cells may be proceeded with. It is not found necessary when charging the accumulators to use any automatic cutout, because whenever the wind falls temporarily the battery is usually drawn upon to only a trifling extent to keep up the speed of the turbine. We are not told how sparking is obviated when the dynamo is running as a motor with a forward lead to the brushes. The positive pole of the dynamo is connected permanently to one terminal of the battery and the negative pole to a charging switch. The pressure of the lighting circuit is, however, kept constant at 110 volts by means of an automatic cell switch. In order to charge large batteries for district lighting, the author recommends that a number of wind turbines be erected with dynamos in parallel delivering their currents to a common central battery.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY,) November 9th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Chemical Society's Rooms, Burlington House. Agenda: (1) "Electromotive Force and Osmotic Pressure," by Dr. R. A. Lehfeldt; (2) "On Astigmatic Lenses," by R. J. Sowter; (3) *a*, "On a Phase-Turning Apparatus for Use with Electrostatic Voltmeters"; *b*, "On a Method of Measuring Power in Alternate-Current Circuits"; *c*, "Note on Obtaining Alternating Currents and Voltages in the Same Phase for Fictitious Loads," by A. Campbell; (4) "On the Refraction of Sound by Wind," by Dr. E. H. Barton.

FARADIAN CLUB.

*8 p.m.* Club Smoking Concert at the St. James' Restaurant (Regent Saloon).

**MONDAY, November 12th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

Meeting of the Newcastle-on-Tyne local section at the College of Science, Newcastle-on-Tyne.

**TUESDAY, November 13th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

Meeting of the Manchester local section at Owen's College, Manchester.

**WEDNESDAY, November 14th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*7.30 p.m.* Students' Meeting in the Library, 28, Victoria-street, Westminster, S.W. Paper to be read: "Overhead Line Material," by A. J. Le Hurst.

*8 p.m.* Meeting of Glasgow local section at the Institution of Engineers and Shipbuilders, 207, Bath-street, when Mr. W. A. Chamen will read a Paper on "Electrical Supply."

**FRIDAY, November 16th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Paper to be read and discussed: "Capacity of Railway Waggons as affecting Cost of Transport," by J. D. Twinberrow.

ELECTRO-HARMONIC SOCIETY.

*8 p.m.* Concert (Ladies' Night) at the St. James' Hall Restaurant (Banqueting Hall), Regent-street, W.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Metastability of the Cadmium Cell.*—W. Jaeger and S. Lindeck make a somewhat indignant reply to E. Cohen's indictment of the Weston cadmium cell, or rather to his unusual manner of preferring it. They acknowledge that the cadmium cell is untrustworthy at lower than ordinary temperatures, though hardly up to 23deg. They claim, however, that the Reichsanstalt cells maintain their E.M.F. within 0·01 per cent. for years, and that 80 per cent. of the 150 commercial cells tested maintain it within 0·02 per cent. As an additional precaution, they recommend the employment of a cadmium amalgam rather more dilute than that of 14·3 per cent.

[JAEGER and LINDECK, *Ann. Physik*, No. 10, 1900.]

*Diffusion of Ions in Air.*—J. S. Townsend has continued his interesting researches on the rate of diffusion of ions in various circumstances. His latest investigations concern ions produced at various pressures by the action of a radio-active substance, and also determinations of the rate of diffusion of ions produced in air at atmospheric pressure by the action of ultra-violet light and point discharges. The principle of the method consisted in calculating the coefficient of diffusion from observations on the loss of conductivity of a gas as it passed along metal tubing. The experiments were so arranged that in all cases the loss of conductivity due to diffusion should be much greater than the loss due to other causes, so that it was not necessary to apply any corrections for losses arising from recombination or from the mutual repulsion of the ions. It appears that in every case the rate of diffusion of ions into a gas is inversely proportional to the pressure. The negative ions which are produced when ultra-violet light falls on a zinc plate diffuse into air at nearly the same rate as the negative ions produced by a radio-active substance. The values of the coefficients of diffusion for dry and moist air are 0·0485 and 0·0375 respectively. The rates of diffusion of ions produced by a point discharge have coefficients varying between 0·021 and 0·039, being highest for negative ions in moist air.

[J. S. TOWNSEND, *Proc. Roy. Soc.*, October 26, 1900.]

*Positive and Negative Hall Effects.*—E. van Everdingen describes a novel effect obtained with a prism of bismuth cut by Perrot, of Geneva, from a block of the slowly-cooled metal. The effect is described as follows: A bar of bismuth cut at right angles to the principal crystallographic axis shows, in a magnetic field of about 5,000 C.G.S. units, when placed with the principal axis normal to the lines of force, a Hall effect of normal magnitude and normal (negative) sign; when placed with the principal axis parallel to the lines of force, it shows a small, positive Hall effect. Hence the same bar of bismuth which in one position shows a Hall effect similar to, say, that of nickel, on being turned through 90deg. shows a Hall effect similar to tellurium and antimony. With regard to the effect this discovery will have upon the electron theory, the author thinks that the reversal of sign need not present a very formidable difficulty, particularly as the theory has already to reckon with reversals. The Hall effect is supposed to be proportional to the difference of migration velocities. Since $v$, the velocity of the negative ions, is more susceptible to change than $u$, the velocity of the positive ions, the cause of the reversal observed must be sought for in a large alteration of $v$, which reverses the sign of $u - v$.

[E. VAN EVERDINGEN, *Proc. Akademie Amsterdam*, October 24, 1900.]

*Diffraction of Rontgen Rays.*—To discriminate between actual and apparent diffraction of Röntgen rays, it is necessary to have some theoretical notion as to the probable character of a diffraction phenomenon produced by a succession of irregular impulses such as Rontgen rays are at present thought to consist of. The mathematical treatment of the problem presents great difficulties, but A. Sommerfeld has simplified it by means of Huygen's principle, which, though only approximately correct, yields results well within observational limits. He shows that if the sensitive plate is not too far from the slit, the impression produced is sharp and well-marked, the best result being obtained when the distance $x = \frac{k^2}{8\lambda}$, where $k$ is the width of slit and $\lambda$ the "breadth of impulse," corresponding to the wave-length in periodic disturbances. At greater distances the edges of the image become broad and washy. According to Haga and Wind's much-discussed experiment on "the wave-length of Rontgen rays" the dark centre disappears when the slit has a width of $9\mu$. Since $x$ in the experiment was 75cm., the breadth of impulse comes out as $0{\cdot}13\mu\mu$. That is somewhat larger than the value derived by J. J. Thomson from the size of the molecules. It is well within molecular dimensions, and that fact may shed some light on the slight absorption of Rontgen rays and upon the absence of regular reflection.

[A. SOMMERFELD, *Physikal Zeitschr.*, October 27, 1900.]

*Energy of Becquerel Radiation.*—To obtain some idea of the amount of energy involved in Becquerel rays, E. Rutherford and R. K. McKling have studied them in conjunction with Röntgen rays, and compared the thermal and electrical effects produced by the two kinds of radiation. The discharge producing the Röntgen rays had a frequency of 57 per second, and assuming that the duration of each impulse was $10^{-5}$sec., the bolometer readings indicated a maximum energy of 10·5 calories per second from each square centimetre. This is 560 times the heating effect of the sun's rays per square centimetre at the earth's surface. The intensity of the Röntgen rays falling on a fluorescent screen is easily obtained by multiplying the luminous intensity of the screen by 28, that being the proportion in which the incident energy stands to the radiant energy of the screen. The amount of energy required for producing a single ion is about $1{\cdot}9 \times 10^{-10}$ ergs, which is considerably above that required for the electrolysis of water. As the ions produced by some Becquerel rays are probably the same as those produced by Röntgen rays, the energy of the former may be deduced from that of the latter. For uranium oxide the value obtained is $10^{-11}$ gramme-calories per second. In radium, whose energy is 100,000 times greater, the energy radiated per gramme of the substance is not less than 3,000 calories per annum.

[E. RUTHERFORD and R. K. MCKLING, Communication to Royal Society.]

*Law of Radiation.*—Thiesen's equation for the energy of radiation as dependent upon temperature and wave-length says that for any given wave-length the energy increases indefinitely with the temperature, or in other words, that there is no limit to the amplitude of the vibration which gives rise to that particular ray. The same view is taken by Michelson, whereas W. Wien considers that with rising temperature the energy of every wave-length approaches a finite limit, such as in the case of sound would be prescribed by the breaking strength of the vibrating material. O. Lummer and E. Jahncke have endeavoured to throw some light on this matter by obtaining a general formula from which the two contending formulæ could be deduced by altering the constants The equation so obtained is

$$E = cT(\lambda T)^{-\mu} e^{-\frac{c}{\lambda T}}$$

Wien's equation is obtained from it by putting $\mu = 5$, Thiesen's by putting $\mu = 4{\cdot}5$, and Rayleigh's by putting $\mu = 4$. It is only in the first case that E may have a finite limit. Apart from the intrinsic improbability of just that case occurring, $\mu < 5$ is most in accordance with Maxwell's law of distribution; and if Lummer and Pringsheim's figures really represent the intensity of black radiation, the value $\mu = 4{\cdot}5$ is the only admissible one.

[LUMMER and JAHNCKE, *Ann. Physik*, No. 10, 1900.]

*Ionisation by Ultra-Violet Light.*—P. Lenard measures the velocity of ions produced by ultra violet light by forcing a current of air through two flat nets in succession. The nets are made of linen threads rendered conducting by means of soap solution. The space between them is illuminated by

ultra-violet light, taking care, however, that the limit of the illuminated space is 2cm. away from the first net, which is positively charged. The second net is put to earth. When the blast is working without the rays, there is no loss of charge, but when the rays are turned on, with or without the blast, there is a loss of charge due to the ionisation of the air. As the blast increases in strength the negative ions which seek to approach the positively-charged screen are blown back, and when the velocity of the air is 1·8m. per second there is no more loss. That, therefore, is the velocity of the negative ions. With the E.M.F. used this gives 3·18cm. per second for a potential gradient of 1 volt per centimetre. The corresponding value for the positive ions is 0·0015cm. per second. The author obtains for $s$, the sum of the radii of the molecule and positive electron, the value $56 \times 10^{-6}$ mm., or about 70 times the diameter of a molecule. This means that the positive electron consists of a large number of atoms, even if it only carries one elementary charge, *e*.

[P. LENARD, *Ann. Physik*, No. 10, 1900.]

## THE LEGAL RECORD OF ELECTRICITY FOR 1900.

The commencement of the legal session 1900-1901 is a suitable occasion for a cursory review of the legal work of the session which ended in August last. As the application of electricity becomes more general, it is to be expected that we shall find an increasing number of actions of an electrical nature before the courts. Such litigation will probably increase, notwithstanding the reforms made, and possibly to be made, in the laws relating to letters patent; for competition is now so keen that wherever one firm possesses a valuable commercial asset in the form of a patent, rivals in trade will be found ready to risk the charge of infringement in order that the opinion of the Courts on the validity of the claims of the patent may be secured. During the past session several actions of first consequence to the electrical industry were before the Courts, and a brief digest of the questions of fact and of law which have come up for decision may therefore be interesting. The actions have been of varied character, and have covered a large range of technical subjects, providing discussions on intricate points of both patent law and electrotechnics. The actions decided have raised questions on systems of distribution, on meters, on motors for traction, on arc lamps, and on applications to the chemical industries. All these cases have demanded the utmost skill on the part of counsel and witnesses to enable the presiding judge to arrive at a decision. Fortunately, we have at the Bar counsel competent to deal with the most complicated technical questions, so that where a litigant fails to obtain what he considers to be justice, it need never be from inability to secure the service of counsel to put his case clearly before the judge.

Perhaps the most important case—its effects would have been far-reaching had the decision been the other way—was the action "Rucker *v.* London Electric Supply Corporation (Ltd.)," which raised the point of the validity of the well-known Zipernowski-Deri patent. This patent was taken out by Zipernowski and Deri in 1885, and was, at later periods, the subject of litigation in some of the foreign courts. It seems to have occurred to some one that this patent was a master-patent covering the system of distribution in use by many of the chief electric supply undertakings, and it appears to have been purchased some years ago as a speculation by Mr. Martin D. Rucker. Before commencing an action against any of the companies for infringement, Mr. Rucker had the patent amended, the objectors to the amendment being pacified by the gift of a free licence. The amendment was skilfully made, and the old-established London Electric Supply Corporation was selected as the body with whom to begin the fight. The importance of successfully contesting the claims of Mr. Rucker was fully recognised by users of this system of distribution, and a defence fund and committee was formed to support the defendants in the action. The case was very fully reported in our issues of Jan. 26, Feb. 2 and Feb. 16.

The main discussion centred round the question whether in 1885 it was a new thing to connect the primaries of transformers in parallel to the main line. The case for the plaintiff depended largely on the fact that the Gaulard and Gibbs installation, the first serious attempt at distribution by transformers in this country, was a system in which the primaries were connected in series; but the defendants were able to call M. Fesquet, who was in charge of the Gaulard and Gibbs exhibit at the Royal Aquarium, Westminster, in 1883, and he was able to prove that although the system was a series system it was possible to connect the primaries of the transformers in parallel as well as in series, and that, in fact, he had so connected them on many occasions. The questions to be decided in this case were largely questions of fact—as, for example, the extent of knowledge of the parallel system of distribution in 1885—but there were also questions of law. On practically every point the learned judge found for defendants, so that when the case comes on in the Appeal Court in the present session the respondents have a considerable margin on which to win. One legal point was in itself sufficient to overthrow the plaintiff's case—viz., the fact that an article in the *Zeitschrift für Electrotechnik*, which contained in the judge's opinion a sufficiently full disclosure of the Zipernowski-Deri arrangement, was laid on the table of the public reading-room in the Patent Office Library in London two days before the date of plaintiff's patent.

This was the first case dealing with electrical problems which fell to Mr. Justice Farwell, the new Chancery judge, and the manner in which he dealt with each point raised during the hearing, and the thorough grasp he seemed to have on all the points at issue, demand our admiration. We shall be surprised if the Appeal Court decides differently from Mr. Justice Farwell.

The case of "Chamberlain and Hookham *v.* Bradford Corporation" presented for decision the very interesting question whether the Thomson energy meter, when used on constant-pressure mains, infringes the Hookham current-meter patent. (The case was fully reported in our issues of May 11, May 18 and June 1.) Both are motor meters with Foucault brakes, but the arrangements for flow of current in the armature and for the field magnets are different. The point of greatest interest was the ingenious argument for plaintiffs by Mr. Fletcher Moulton, that, although defendants' meter was an energy meter, yet when used on constant-pressure mains it became practically a current meter, and that the Bradford Corporation kept their pressure practically constant, as required by the Board of Trade, and really used this meter to measure current. But this argument, although ingenious, was set aside by Mr. Justice Farwell as fallacious.

In our leading article for June 1 we emphasised the importance of studying the technical journals. Both in this and the Rucker case we find articles from the technical press of earlier dates than the patents under discussion put in to prove want of novelty in the patents, and Mr. Ferranti in this action asserted that, had he read Marcel Deprez's article in *La Lumière Electrique* in January, 1884, he could have constructed a properly working motor meter resembling the Thomson meter. In spite of this, however, the Hookham meter did not appear till 1887—three years later.

In his judgment Mr. Justice Farwell did not give any decision on the validity of the Hookham patent, as this was rendered unnecessary when he had convinced himself that the defendants did not infringe; but in the light of his judgment the scope of that patent will probably be held to be narrowed down considerably. That is, of course, provided the Court of Appeal, which is to be called upon to revise this decision, and perhaps also the House of Lords finally, do not reverse it.

The only other action of primary importance heard last session, in a Court of first instance, was "Jandus Arc Lamp and Electric Co. (Ltd.) *v.* Johnson," and this case was somewhat of a disappointment. It is well known that members of the trade are keenly interested in the question of validity of the patents under which enclosed arc lamps are made. Here, then, seemed the occasion for having that question decided in the Courts. But the defendant was a licensee of the plaintiff

company, and therefore could not attack the validity of the patents in virtue of which the licence was granted. It was a disappointment to many that the validity or non-validity of the Howard, Barton and Jandus patents could not be tested. Very recently another opportunity to solve this question seemed to present itself, when the Jandus Company began an action against Mr. W. J. Davy, but this action has been discontinued.

The action under notice was soon disposed of. Besides the substantial defence, which, however, proved untenable, that the goods produced by defendant were not made under the licence, and would not, in the absence of a licence, be infringements of the patents, the defendant set up a counterclaim for misrepresentation at the time the licence was granted. To succeed on such a claim as this it would be necessary to give very clear statements to the Court as to the representations that had been made, and how far these were misrepresentations. Mr. Johnson's memory of these transactions proved to be "very weak and feeble," and his last chance of success vanished. Mr. Johnson was further interested in the case "Brockie-Pell Arc Lamp (Ltd.) v. Johnson," a motion for committal to prison for breach of an injunction previously made by the Court. Mr. Justice Kekewich made an order for committal as asked, but notice of appeal was given, and during the intervening week before the date of re-hearing an arrangement was come to between the parties, and proceedings were abandoned. In this case we venture to disagree with the finding of Mr. Justice Kekewich. The lamps sold by defendant, and complained of by plaintiffs, were not identical with the Victoria lamp. The learned judge held that there was "substantial identity," that the differences were only "differences in detail." But these difference were sufficient to make the lamps other than Victoria lamps, and it was the sale and manufacture of Victoria lamps which was forbidden by the order of April, 1899 (see *The Electrician*, July 27, p. 530). As soon as *exact* identity disappears, then, in our view, the question becomes one of infringement, and ought to be so tried, and not brought as an order for committal.

Passing now to the Court of Appeal, we find that the Lords Justices were occupied with an action decided by Mr. Justice Cozens-Hardy last year, which aroused considerable interest. This was the Sprague motor suspension case, or to give it its proper name, "The Electric Construction Co. (Ltd.) v. Imperial Tramways Co. (Ltd.) and British Thomson-Houston Co. (Ltd.) (third parties)." The first hearing was reported in our columns of November 10 and 17, 1899. On that occasion the question to be decided was simply the validity of the Sprague patent—taken out in England in the name of Handford, and numbered 9,527, 1885. As the patent had expired no injunction could of course be given, but in its place the plaintiffs sought damages. Mr. Justice Cozens-Hardy found then that the patent was invalid by reason of the wideness of the first claim, and the wide range of this claim wrecked the plaintiffs' case both before Mr. Justice Cozens-Hardy and again on appeal before the Master of the Rolls and Lords Justices Rigby and Collins. In this action only questions of construction and of law occur; no evidence was given as to the state of knowledge at the date of the patent, so that in this respect this caes differs from the Rucker and the Chamberlain and Hookham cases. This case gives an instructive lesson as to the drafting of a specification for letters patent. For example, the following sentence occurs in Handford's specification: "The yoke or back-piece of the field magnet is hung from a cross piece of the truck by heavy springs, or from the car body itself in case of a street car or other vehicle having no truck." Mr. Justice Cozens-Hardy decided that that meant that the yoke is hung *not* by springs in the case of a car having no truck, and therefore that it was not intended to include springs in claim 1. Mr. Moulton, for the appellants, argued that this interpretation was quite wrong, and in our opinion was successful in proving his point by reference to another sentence, "These springs extend to cross bars on the truck frame, or to the car body in case no truck is used." This instance will suffice to show how very careful a patentee should be to avoid all ambiguity. Of course it is just possible that the ambiguity of phraseology throughout this specification is intentional in order to make sure that the claims are sufficiently wide, and, if so, then the result of this litigation will be a wholesome lesson; but, on the other hand, if it is unintentional, then the patentee or his agents have, by want of sufficient exactness of expression on the part of the person responsible for drafting the specification, been deprived of the benefits of a really good invention.

It was mentioned in our columns of June 22 that a decision in the reverse direction as to the validity of the Sprague motor suspension patent was upheld in May last in the United States Circuit Court of Appeals. But, lest this difference between the judges of the two courts should cause surprise, we may point out that in Sprague's American patent the claims are not worded exactly as in his English patent, and further, that in deciding the English case the judges had also to recognise the fact that another American patent by Sprague, which contained a drawing showing the invention claimed in Handford's specification, was published in England before the date of Handford's application for a patent. This was a further ground on which the judges declared the plaintiffs' patent to be invalid. In this matter we think all will feel, with the Master of the Rolls, "very considerable sympathy" for the patentee and for his assignees.

We come now to a case dealing with the application of electricity to a chemical industry—the manufacture of causticsoda. The decision in "Castner Kellner Alkali Co. v. Commercial Development Corporation" was given by the House of Lords, and so is the final law on the points at issue. The action was originally tried before Mr. Justice Bigham, and was the first electrical, and, we believe, the first patent case with which he had to deal. The questions to be decided were purely those of law, and the case is instructive on the point of the validity of a patent. (A report of the hearing by the House of Lords was given in our issues of May 18 and May 25, and the judgment in the issue of Aug. 3.) In one respect the case was a curious one. The plaintiff company carries on its manufacture of alkali by the process invented in the Castner patents, but also possesses the Kellner patent, and it was on the Kellner patent that this action was brought. On the other hand the defendant company had not commenced work, but was only *proposing* to do so, using the Rhodin patent. The appellants' patent had never been put into practice at all, and the defendants' patent had never been used commercially. The rival inventions were, therefore, little more than paper inventions. But the real question to be decided was not the question of infringement, but the validity or non-validity of the Kellner patent. On May 18 (pp. 142 and 143), we gave the text of this specification, and it will be seen that the gist of Kellner's invention is the use of a "stationary mercury cathode." But in his complete specification Kellner described and illustrated by drawings a modification of his apparatus, in which the bells and mercury trough were mounted on a vertical spindle, so that a rotary motion might be given to the bells, radially arranged round the shaft; or the bells might be kept fixed *and the trough rotated*. The introduction of this modification of the original apparatus, as described in the provisional specification, was held to render the patent invalid; for, in spite of the ingenious argument of counsel for plaintiffs that by "stationary mercury cathode" was meant "stationary relatively to the containing vessel," and that even in this modification of the apparatus the mercury was practically at rest in its containing vessel, the Lord Chancellor and Lord Macnaghten, who gave the decision of the House of Lords, both maintained that the introduction of a rotating trough was an entire departure from the essential features of the invention as described in the provisional specification, and that therefore the patent was bad from disconformity. The judgment in the House of Lords was a unanimous one. In the Appeal Court two Lords Justices (the Master of the Rolls and Lord Justice Rigby) held the patent invalid from disconformity, while Lord Justice Vaughan Williams held it to be valid and that defendants had infringed.

This completes our survey of what we may perhaps call the great "trade cases" of 1899-1900, but it often happens that the most important questions as to the rights of individuals turn up in what appear at first quite minor actions, and in

the present instance a scrutiny of all the cases of the year has presented some interesting points which may well be mentioned.

Perhaps the most important point raised was the question whether an undertaker having powers to use the *streets* for tramways, under the Tramways Act of 1870, has thereby powers also, in using electricity for traction, to turn up the *pavements* to lay feeders. This question was raised directly in the hearing before the Appeal Court of "Corporation of Hyde *v.* Oldham, Ashton, and Hyde Electric Tramway (Ltd.)," and was raised indirectly as a side issue, though not under the Tramways Act, 1870, in "Goldberg and Sons *v.* Liverpool Corporation," also in the Appeal Court; and we may compare the *dicta* of the Bench in the two cases. In the latter the real point at issue was whether the Liverpool Corporation had a right to place a pole for overhead tram wires and a fuse box on the footpath only 2½ft. away from the door of Goldbergs' premises, after Goldbergs' refusal to allow a rosette to be fastened to their premises had been made. In short, the action was one for damages for nuisance, and malice on the part of the Corporation was alleged. It should be mentioned at the outset that the powers of the Corporation are given under the Liverpool Corporation Tramways Act, 1897, by which they have authority to adapt the tramways and streets for the purposes of mechanical traction. In the argument for Goldbergs in the Appeal Court counsel did not dispute that the Corporation had full power to use the carriageway for the purpose of constructing their tramway, but contended that they had no power to use the pavement. His contention was that the word "street" in sec. 36 of the Corporation's Act of 1897 comprised the carriageway only. The Master of the Rolls, in his judgment, said he could not assent to this contention. "There could be no doubt that the powers conferred by sec. 36 were applicable to any street, and that the pavement was part of the street for the purposes of constructing, erecting, laying down and maintaining in, over, or under its surface such works as might be necessary or expedient for the purpose of adapting the tramway to the use of mechanical power."

Here, then, the Master of the Rolls unhesitatingly declared that, although not expressly mentioned, the pavement is included under the word "street" in the Liverpool Tramways Act of 1897. But when we turn to the Tramways Act, 1870, we find a different state of affairs. In the Corporation of Hyde case, mentioned above, the Corporation was willing to allow the Tramway Company to put feeders under the pavements on a payment of £500. The Tramway Company refused to make any such payment, and asserted their legal right to use the footpath. The Corporation applied for an injunction, and Mr. Justice Grantham granted the injunction last year. In July last the case came on for hearing in the Appeal Court. The Electric Tramway Company based their rights on the powers they held under the Tramways Act, 1870, and under an Order in Council of 1896. Lord Justice Smith held that "the Tramways Act of 1870 only applied to laying down tramlines in roadways." He could not see "that it had any application to laying down electric feeders under the footpath." And as to the paragraph relied on in the Order of Council, he could "not find any justification for what the defendants had done against the will of the plaintiffs." In this judgment Lord Justices Vaughan Williams and Romer concurred.

In the light of the view taken by the Master of the Rolls in the earlier case as to what is included in the words "any street," the decision of Lord Justice Smith seems quite open to criticism. But accepting the two decisions, what does an examination of these two cases teach us? Surely that the time is more than ripe for new legislation on tramways. It is obvious that an act drafted in 1870, long before electric traction was introduced, and having in view only horse or steam trams, which required no disturbance of the streets except in the middle of the road, is altogether inadequate to deal with the various and wholly different problems which arise under schemes for electric tramways. Would it not therefore be well, without further delay, to overhaul the acts and orders on the subject at present in force and pass a new and really adequate Tramways Act?

Another case, and a very curious one in some respects, dealing with the duties of a company under these Tramway Act of 1870, was heard in the Irish Courts in June, and was an appeal to the Queen's Bench Division against the decision of a magistrate in an action brought by the Dublin Corporation against the Dublin United Tramways Co. for failing to maintain and keep in good condition and repair with such materials as the Corporation directed, the tramway tracks within the city, as required by sec. 28 of the 1870 Act, taken in conjunction with sec. 37 of the Dublin United Tramways (Electrical Power) Act, 1897. The curious point in the case was that it was found that the Tramway Company had made reasonable efforts to keep the fabric of the tracks—the stone setts, &c.—in good order, and that the structural condition of the tracks was fairly satisfactory; but that the tracks were rendered exceedingly slippery through failure of the company to "sand" them. The draught made as the cars pass "swishes" off all gravel from the track, causing them to become slippery for horses' feet. So long as the trams were drawn by horses the company, of course, sanded the track, but ceased to do so when electric traction was introduced. The Irish Queen's Bench has now decided that the sanding of the track is necessary "for the protection of the public." "So long," said Mr. Justice Madden, "as the roadway was a danger to themselves the tramway company sanded it, but when it only became a danger to the public they cease to sand. The sections seem to be for the protection of the public." Under the course which was pursued in this action no further appeal is possible, but it will be interesting to have the question discussed in the English courts and possibly in the House of Lords. We cannot help agreeing with Mr. Justice Boyd, who gave a dissenting judgment in this Irish case, that "the obligations cast on the company by these acts had reference only to the fabric of the roads," and that the work which the Corporation could compel the company to do should be constructive work and nothing else.

This completes our summary of points arising in this year's legal actions of general interest to electricians. There have, of course, been many cases where the points at issue were ordinary points of common law, such as breach of contract or the interpretation of documents. One case which was looked forward to with great interest was that of "Attorney-General *v.* National Telephone Co.," but when the case did at last, after numerous delays, come on, intimation was made that the parties had come to an agreement, the Telephone Company agreeing that it is *ultra vires* for them to lay underground wires in London unless by licence of the Postmaster-General. Nothing was said in Court to enable us to learn whether the Telephone Company entirely threw up its case, or whether the agreement gave the company something in return.

The next session of the Law Courts promises to present many cases of interest. Some of the cases with which we have dealt above will appear again for revision in a higher court, while the Judicial Committee of the Privy Council will have to consider the appeal in the important case from Capetown dealing with the disturbance to the Eastern and South African Telegraph Co.'s cables from the Capetown electric tramways. A full report of the proceedings at Capetown in this matter appeared in our issues for March 16 and April 6 and 13, 1900. The promised test action on the Jandus patents may probably also be expected, and some further actions on the chemical industries are spoken of, so that there is every prospect that the legal work of the new session will present ample food for discussion.

## BOOKS RECEIVED.

"Directory of Electric Lighting and Electric Traction, 1900-1." Edited by C. S. Vesey Brown. (London: Hazell, Watson and Viney.) 6s. net.

"Exercises in Natural Philosophy, with Indications how to Answer Them." By Magnus Maclean. (London: Longmans, Green & Co.) 4s. 6d.

"The Construction of Large Induction Coils." By A. T. Hare. (London: Methuen & Co.). 6s.

## PROF. PERRY'S PRESIDENTIAL ADDRESS TO THE INSTITUTION OF ELECTRICAL ENGINEERS.

I do not intend to make this in any sense a report of the progress of our Institution during the last or any number of years. I shall not, therefore, give any account of the exceedingly good work done by Colonel Crompton and the active service corps of our Electrical Engineer Volunteers in South Africa. I shall not describe how we fêted our American cousins in England and France, nor how they fêted us; nor what a wonderful success accompanied all that was attempted by us or by them or by M. Mascart and our French colleagues, although I cannot refrain from bearing my testimony to the great kindness of the Prince of Wales and the British Commission in so generously lending us the British Pavilion for our great reception, and giving us the use of one of its rooms for our office all the time of our visit to Paris.

My brother has tried to get me to introduce to your notice some novel ideas which have come to us during the last 10 years in our business of lighting the city of Galway from a fairly constant water-power using accumulators with a gas plant stand-by. It has almost come to be a practical idea to produce carbide of calcium in wet seasons, and utilise it through the gas engine in dry seasons. I was also tempted to discuss the use of large engine plant at central stations; and another of several subjects in which I have been recently engaged has been the magnetic effect produced by systems of electric traction. But I have resisted temptation, and have chosen a subject which seems to me much more important.

Your president's address is followed by no discussion. He is, therefore, privileged, but his very privileges cause him to address you with a greater sense of responsibility: he may say what he pleases, but he must be very sure that he has the best interests of the Institution at heart; the interests of the Institution as a whole, not the interests merely of a few members, and least of all ought he to think of his own interests. Nevertheless, your president speaks not as an omniscient judge, but rather as a very fallible, very prejudiced, one-sided man who, because he has devoted himself to one part of the work of this Institution, is certain to be unfair in his comments upon other parts of the work.

Your past presidents represent in this way all classes of members of this Institution. You have had scientific men, given, some of them to calculation and some to experiment, and some to both—men who have advanced the study of pure science. You have had practical telegraph men, civil and military, men cunning in land and deep-sea telegraphy and telephony; men cunning in railway signalling. You have had electrical chemists. You have had manufacturers and users of all kinds of electrical appliances. You have had men who devote themselves to the teaching of electrical engineers, and who fully appreciate the fact that no good teacher ought to be out of practical touch with the profession. And nearly all of your past presidents have invented things which are now in practical use. As each of these men has given you at least one address written from his own peculiar point of view, his prejudices are not likely to have done any harm to members who read the other addresses. I know, therefore, that you are good-naturedly prepared to give me plenty of rope. I can predict the twinkle of amusement in the faces of some of my friends when they learn that I am about to take up a subject on which we have had many debates.

In this address I mean to put before you this simple question: Is electrical engineering to remain a profession or is it to become a trade? Is this Institution to continue to be a society for the advancement of knowledge in the application of scientific principles to electrical industries, or is it to become a mere trades union?

Of course, at the present time the outside public are willing to regard membership of this Institution as a symbol of something more than the membership of a mere trades union. During the early growth of any trade, even such a trade as that of the plumber, it was really a profession. And a common trade may suddenly become a profession, if it suddenly begins to develop, as, for example, stone-masonry of a hundred years ago suddenly developed into civil engineering. Electrical engineering has been developed rapidly, so that in the past it has certainly been a profession and not a trade.

Again, we are an institution of engineers, and the general public are willing to class us with other engineering institutions—for example, the Institution of Civil Engineers. Now the title M.Inst.C.E. is a professional distinction which represents in civil engineering what F.R.C.S. does in surgery, or M.R.C.P. in medicine. We owe a great deal to our association with, and recognition by, the Institution of Civil Engineers: our meetings are held in its rooms; many of our members are also its members; our proceedings are modelled on its proceedings. Now this older Institution, governed by the best thoughts of the best British engineers, has laid it down that its associate members, that important class from which the higher class is mainly fed, shall have passed certain specified examinations in pure and applied science.

I am not now suggesting that we ought to adopt this science examination method of admitting any kind of members to our Institution. I do not believe in the wholesale adoption of methods of working from another society. I am asking you early in my address to remember that this greatest of all professional engineering institutions, governed by practical men full of common sense, knowing the wants of their profession well, insists upon a knowledge of science in its new members. If this recognition of science did not exist anywhere else in the whole world, I say that its recognition by such a thoroughly good professional society as that of the Civil Engineers ought to recommend it to all professional societies.

In Germany an enormous stride has recently been made in the raising of engineering degrees to rank with the highest university honours. There is hardly one engineer of eminence in Switzerland, France, or Germany who has not passed with honour through the classes of one of their great science universities.* In Great Britain within the last 15 years not only have great engineering schools been established in all the manufacturing towns, but even in Cambridge University there is one of the best schools of civil, mechanical, and electrical engineering of which I know anything.

Before we think of imitating the Institution of Civil Engineers, we ought to reflect on certain fundamental distinctions between that Institution and our own which at first sight seem to make us less professional. There is a well-known unwritten rule of the Civil Engineers to which there are only a few exceptions, that no contracting railway or harbour engineer can acquire the title of M.Inst.C.E. I think myself that it is a pity to draw a hard and fast line between consulting engineers and contractors. No doubt it simplifies the labour of the Council in its selection of candidates, but it gives rise to anomalies.

A man who was once a civil engineer because he served a pupilage under his clever father, and who now is nominally at the head of his father's large practice, the real engineering work being done by many clever employés, this man may be a member. A contracting engineer who shows marvellous ability not only in rectifying the mistakes of the designer of a large bridge or tunnel or reservoir embankment, but shows the power of Lord Kitchener in directing the work of thousands of men so that no man need be idle, and the whole contract goes on like clockwork, and is finished well in the minimum of time, this man is ineligible. Now in our Institution it has been recognised from the very first that manufacturers and contractors and their employés may belong to the very highest ranks of their profession. Of course, I do not mean men who simply receive the profits of businesses, or even men who merely work to obtain orders for themselves. I mean men who are not merely formally but in reality manufacturing or contracting engineers. I mean men who, in dealing with standardised things, design new methods for quick, good, cheap production of such things. I mean men who improve old forms of things, possibly through their paid subordinates. I mean by a manufacturer fit to be a M.I.E.E., a man who might act as his own manager, and who, perhaps, has a wider outlook than on mere managerial duties. So long as a contractor or manufacturer is really an engineer, we know that we add to our strength with the addition of every such member.

But consider a contractor who only uses ordinary types of machines or electrical plant in well-known ways, surely he can hardly be said to be in the profession at all. Surely the one thing that differentiates us from mere tradesmen is that we do not follow mere rule of thumb methods; we think for ourselves, we weigh advantages and disadvantages. If every new installation required the same treatment as existing ones, the engineer would degenerate into a tradesman, and it seems to me that the electrical engineer ought to have a special fear of such degeneration.

In railway and harbour and river and sanitary engineering, in every new job there are new difficulties to be dealt with. An engineer who designs many undertakings and sees them carried out must be a thoughtful man; he cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires a somewhat different treatment from any old case. Every case brought before a barrister requires the exercise of all his past experience. In every case a *profession* implies the necessity for the exercise of all one's past experience; because the work one has to do is never the same as any work one has ever done before. And when I say past experience I really mean certain general principles which one has always in one's mind, principles derived from all that one has done or seen or read about.

Electrical engineering is in a curious position. It owes its being altogether to scientific men, to the laboratory and desk work of a long line of experimenters and philosophers. Even now the work going on in a laboratory to-day becomes the much larger work of the

* I understand also that the great unions of manufacturers in Germany are about to make facilities for giving a year of real factory work to the polytechnic students, thus perfecting the German system. In Japan we found great success in requiring students to spend their summer in real shops, their winters at college. In England it may be that we shall prefer to let apprentices have shorter factory hours than workmen, their masters being responsible for instruction being given in theory.

engineer to-morrow. When at length the laboratory experiment is utilised in engineering, we see that there is no other kind of engineering which so lends itself to mathematical treatment and exact measurement. Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made exact measurements may be made to test the accuracy of our theory. For a completed machine or any of its parts can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested.

Contrast this with the calculations it is possible to make in other kinds of engineering. The pressure of earth against a revetement wall is possibly 200 per cent. or 300 per cent. greater, or 50 per cent. to 70 per cent. less than what we imagined it to be in what some limited men call theory. We use factors of safety 5 or 10 or more on all kinds of iron structure calculations, because we are aware of our ignorance of a correct method of dealing with the problems. The civil engineer never has exactly the same problem as has already been solved. In tunnelling, earthwork, building, &c., in making railways and canals, he is supremely dependent on the natural conditions provided for him: the configuration of the surface of the ground, the geological formation, the structural materials available in the neighbourhood. The story of how the engineer has to study the endlessly different ways of interaction of water and sand and gravel is told by the troublesome bars at the mouths of rivers all over the world, by the difficulties of coast and river-bank protection, by the failure of sea walls and piers. But why should I make a catalogue of the different kinds of work done by civil engineers? Every one of them needs the exercise of general scientific principles due to much experience.

Now of all such natural difficulties the consulting or contracting electrical engineer is greatly independent. Give him a source of power and tell him what is to be done; whether he is to light a town or a building, whether with arc or incandescent lights; whether he drives a stamp mill near a mine or a pump, or a machine tool, or a spinning frame, the electrical part of the work is carried out in much the same way. Natural conditions affect him mainly in the cost of transport of his materials and the cost of labour. He can make in an easy way the most careful calculations as to the best arrangement of his conductors and machines to give maximum economy, and except for this easy calculation his work is that of a mere tradesman. He is practically independent even of the weather. There are, indeed, some of us who grumble that this easy calculation is not made easier still, who prefer to make arithmetical guesses rather than exact calculation, because, perhaps, we like to see a little uncertainty introduced into the problem to make it more like a problem in civil engineering. I want members to see clearly that as time goes on, as our electrical engineering work gets more and more cut and dried, the man who loses the power to calculate, who loses his grip of the simple theory underlying our work, must sink more and more into the position of a mere tradesman who has no longer the right to call himself an engineer.

An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things. It has become the custom to call this theory, and I suppose I must follow the custom. I should prefer to call it science* or knowledge. Do you remember Huxley's definition of science? "Science," he said, "is organised common sense"; and this is really what I mean. Well, calling it theory, the man who is permeated by theory, whose theory is so much a part of his mental machinery that it is always ready for practical application to any problem, he is the real engineer. But you must not mistake me in this matter. Eighty per cent. of the men who pass examinations in mathematics, mechanics, and electricity have very little of this theory. Fifty per cent of the writers of letters in the engineering journals in which mathematical expressions occur have almost nothing of this theory in their possession. It is unknown to foolish men. Books alone, lectures alone, experiments alone, workshop experience alone cannot teach this theory. The acumen of a Q.C. may actually prevent a man from acquiring it. A man may have much of this theory, although he may never have listened to lectures, although he may dislike the sight of a mathematical expression. I have known men who might be called illiterate to possess much theory. I have known many men who might be called good electricians who are almost wanting in the theory necessary for the electrical engineer.

* What Falstaff said of the word "Occupy" we have to say of the word "Science." It is used by many people out of its proper meaning and then condemned, so that one is getting afraid to use it. In Prof. Fitzgerald's splendid inaugural address to the Dublin Section of this Institution he says: "As has recently been pointed out to me by Dr. Trouton, it would be impossible to say the same contemptuous things of knowledge as are said of science. In Germany the word used, 'Wissenschaft,' is the one corresponding to our word 'knowledge,' and there nobody of any sense could say that 'knowledge is all humbug,' as is here often said, and still oftener thought, of 'science.'"

I am speaking only of theory. Of the other qualifications for an engineer I need not here speak; they are present to the minds of all of us. A man may have any amount of knowledge; he may know how to apply his knowledge, and yet he may not be able to apply the knowledge from a want of engineering character. The engineer must be a real man; he must possess individuality, the power to think for himself. He must not be like a sheep, knowing only enough to follow the bell-wether. Over and over again in the last 30 years have some of us given our students much the same sort of advice that Baden-Powell gives to scouts in that excellent little book of his. If any of you have not read that book you ought to buy it at once, and you will there find that if a man is to think for himself he must possess all kinds of knowledge, he must be constantly picking up new kinds of knowledge.

Nobody can limit the value of any kind of knowledge, but still one may say that certain things are probably more important than others. To gain what we call "theory" a good general education is most helpful—mathematical knowledge is very helpful; laboratory and workshop experience are extremely helpful. There is one qualification which the electrical engineer must have and without which all other qualifications are useless, and if a man has it no other qualification is supremely important, and this absolutely indispensable qualification is that a man shall love to think about and work with electrical things. He must like these not because of the money he can make through electrical contrivances, nor even, I think, because of the name he may make before the world—this would be mere liking or cupboard love, which has no lasting quality. So long as we have men in this country who have the true love for scientific work of which I speak, so long shall we have a real profession of electrical engineering, for such men are always scheming new contrivances and improving old ones and utilising the services of all helpful people, and especially of capitalists. When we have reached a state in which nobody schemes new things because the existing things are perfect there will no longer be a profession of electrical engineering. Of all ideas surely that of having reached perfection is most hateful; the idea of exact knowledge, that nothing is unknown, that there is no need for thought and therefore that to think for oneself is a sin.

And so, although we are all agreed that much standardisation in our contrivances and methods is absolutely necessary for our competition with other nations, we must follow the Americans in this matter and take care that it does not destroy invention. Of course when things are really standardised, when we have our perfect Mauser rifle or dynamo or locomotive or traction engine or electrically driven stamp mill, a Boer can buy or even manufacture them if he has money, and he can use them as well as, or possibly better than we can. But he is not an engineer. He uses things after the engineer has done his work upon them. A stoker, a common engine driver, the guard of a train, these are not engineers. You must have noticed that the American engineers, who surely deserve the character of being practical idealists above all other engineers, are the men who are most imbued with notions of standardisation which lead to cheapness of manufacture, and they are also the men most alive to the necessity for occasional extensive scrapping of types of machinery when they become even a little antiquated.

Our chiefs, the men who run us all, our real men at this Institution, may be called practical idealists. They have imagination, and judgment, and individuality. They have the imagination and enthusiasm of inventors, and yet they are more than inventors, for they can estimate the worth of their own inventions and control their imaginations. They are ready to receive all new ideas, they welcome all new things, and yet they are not carried away. They are radicals and yet they are conservatives. They have what Mrs. Beecher Stowe called *faculty*. A strong imagination well under control, surely it is the greatest of mental gifts. I look round me and wonder how many of us really have it; and how many of us are only dull music-hall loving men, who scorn novels and poetry, who live utilitarian, material lives, whose aim is merely to make money through electricity, who love it not for its own self, who cherish their "tuppeny-ha'penny-worth" of theory because it is sufficient for their immediate wants. Why, even the writers of leading articles in the daily papers can talk of the wonders of electricity and what may yet come to pass; and yet we who make machines and use them and switch the marvellous thing on and off and take all sorts of liberties with it—we are like Calibans oblivious of the wonders of the fairy isle—like soulless priests making a living in the temple of Isis—like Aladdins who rub our lamp only to get the necessaries of life.

Twenty years ago some of us were laughed at for our optimism, and yet everything that we declared then to be do-able has now actually been done by engineers, except the thing which was then and is now declared to be the supremely important thing, namely, the electric consumption of coal. We say now, as we said then, "The applied science of the future lies invisible and small in the operations of the men who work at pure chemistry and physics." And think of the wonderfully rapid rate at which laboratory dis-

coveries have been made in the last 11 years, and how as the years go on they become more and more numerous; and yet many of us plod along with our work seeing no farther than our noses. A year is now more pregnant with discovery than a hundred years used to be, and yet the protective stolidity of our ancestors is upon us, and we think of the latest discovery as if it were really the very last that can be made. A thousand men are measuring and trying new things in laboratories all over the world. Some of them plodding and soulless; others of them with imagination and clearness of vision. Do you think that nothing is to come from all that work?

And is it not one of the most important functions of the engineer to do as Mr. Marconi has done, to convince capitalists ignorant of science that if the successful laboratory experiment is tried on the large scale it must also be successful? And are we going to leave all this pioneering work, with all its possibilities of great gain, albeit with possible loss, to foreign engineers, when in most cases the scientific discovery has been made in England? Are we so lacking in the hope and faith which are born of imagination and science? And must we in the future, as in the past, have to rely upon the influx of the clever foreigner like Sir William Siemens? Must we, Boer-like, always depend upon our Uitlander population, Fleming and German, Hollander, Huguenot and Hebrew, for the development of our natural resources?

Some of the best engineers I know are so exceptional that one must class them with geniuses; they have faculty and character, and so they have become engineers even under the most unfavourable circumstances. They have passed through ordinary schools, and yet developed common sense. They were pitchforked into practical work, and their liking for the work, as well as some curious kind of instinct, led them to pick up all sorts of knowledge which have become part of their mental machinery. They continue to pick up new kinds of knowledge when these become necessary for their professional work. Unfortunately these men do not realise how exceptional they are, and they advise boys to go direct from school into works. They forget that the other 99 per cent. of men treated in the same way as themselves can only become hewers of wood and drawers of water to real engineers. Treated in this way average boys are just like so many sheep; they learn just what seems absolutely necessary and no more; their acquaintance with the scientific principles underlying their trade is a hand-to-mouth knowledge which becomes useless when their trade undergoes development.

In 1867 I was an apprentice, and when in the drawing office and pattern shop I remember well how I was chaffed for studying such a non-paying, non-practical subject as electricity. When I published my first electrical paper in 1874 before the Royal Society, and even for some years afterwards, the real students of electricity in England could be counted on the fingers of one's hands. Many of us remember the first Gramme magneto machine that came to this country, a scientific toy, in 1874. How many engineers dreamt that a great new branch of engineering had been started? Even in 1878 engineers were, as a rule, quite ignorant of electricity, and since then every year, although newspaper writers have talked largely of the age of electricity, the men actually engaged in electrical industries have acted as if the greatest of changes were not perpetually going on in it. To be left behind, or to become camp followers, children of Gibeon, this is the usual fate of the men who scorn theory. In 1882-4 we used to have to pay men £200 and £300 a-year because they had a slight knowledge of electrical matters. In 1884-6 these very men were not worth 20s. a week, they were weeded out of the profession and their places were taken by men of better knowledge. Two or three years after, these better men were again found to have been weeded out, because men of still better knowledge were available. And so it has gone on ever since. Men learn just enough to get posts; they settle down in these posts, and scorn theory. They actually forget what little theory they once did possess. They know a great deal about existing machines, but presently they discover that improvements have been going on, and that they no longer have a right to say that they belong to the engineering profession. In every year one has told men, "You will be left behind. See A and B and C. I told them three years ago, when their names were in everybody's mouths, that they would be left behind like their predecessors, and they laughed. Now I tell you, and you laugh, and you also will be left behind. Yes, I know that you get a good salary, or large fees, and your head touches the sky. Nevertheless because you neglect theory and the simple mathematics, by means of which theory is made available in practical problems, you will have to take a back seat presently, for our profession is in its early youth, and is growing rapidly."

Remember that I do not now refer to the few exceptional heaven-born engineers who, in spite of bad training, do manage somehow to pick up the necessary knowledge. I speak of the average men, many of whom are now living in the same old fool's paradise. They know enough for present needs; they scorn the simple principles which underlie all our work; they scorn the easy mathematics by which these principles are most readily employed in practical problems: they will have their reward.

Just think of what is occurring at the present time. In England we have cheap coal, and it can be carried easily. In Switzerland and other countries where there is no cheap coal the water-power had to be utilised and power had to be transmitted great distances electrically. This needed high voltage, and as it is difficult to get high voltage with direct-current machines, alternating currents were used, and on account of motor troubles multiphase working has been introduced. What a revelation it was to almost all of us, that visit of a year ago to Switzerland! We saw enormous schemes of lighting and traction and power. We saw electric trains driven by distant waterfalls sandwiched in among ordinary trains keeping proper time on working railways. We had known that there were great schemes carried out in Germany and America and other countries, and yet all the machines were quite unfamiliar to us. We were very much like what engineers of 1870 would have been if suddenly brought into a generating station. Is it not a fact that some of us, said to be eminent and thought to be practical, asked questions and made remarks which showed that we did not know the most elementary principles of three-phase working? Is it, then, any wonder that the traction schemes now being developed in England, on lines that are certainly not the best for this country of their adoption, are altogether dependent on the use of foreign electrical machinery and employ foreign electrical engineers? I am not putting this altogether fairly, for municipal procrastination has prevented our development, and yet I am not putting it altogether unfairly. We know too little theory.

I am afraid that just now we are in a rather tight place. I would give something to know how we in this room are going to get acquainted with modern electrical engineering. Our usual way of learning is by actual handling of things. But if the millions of pounds' worth of machinery coming to England every year is all foreign and is used mainly under foreign superintendence, our usual method of study is made very difficult. True there are American and German, and, indeed, English publications which would give a knowledge of the theory, but not, I think, to the average English electrical engineer. I know of many men 25 years to 40 years of age who seldom come to our meetings, and who say they are silent in discussions because they cannot be understood; perhaps these men will find a way to save us all from being left behind. There is much more that I might say in this connection. An individual Englishman may be left behind other Englishmen, and all English electrical engineers may be left behind the rest of the world, but all electrical engineers of the world may even be left behind other appliers of science. It is not merely that the incandescent mantle of the gas engineer is improving and necessitates improvements in our filaments, but in spite of the flourishing conditions of our factories just now, I could give many other illustrations of how we shall all suffer if we do not keep adding to our knowledge. Twenty years ago, when giving some lectures in Clerkenwell to workers in the then flourishing watch trade, I ventured to prophesy the decay of that trade. But I am afraid that the case of Jonah and Nineveh is the only one in which prediction of disaster led to reform. I venture on no prophesy therefore, because it might harden your hearts.

Much of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters could be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science, and he learns what is called mathematics in such a fashion that he hates the sight of a mathematical expression all his life after.

And what is the result? English engineers do make a wonderfully intimate acquaintance with the machines and tools that they work with, but when it comes to the manufacture of new things they do it by fitting and trying, by quite unnecessary expenditure of money through trial and error. A machine is made and tried and then another better one, until a good result is arrived at. And this method did well enough in the past and would do well enough in the future if only we had not to compete with foreigners who can really calculate. It is not all smoke; there is a real danger in this foreign competition unless we mend our ways. There is an absolute necessity for great change in English ways; but there are so many people interested in the maintenance of old methods of working; so many people who think they will lose their bread and butter if a change takes place; so much capital, scholastic and other, invested in our old machinery, that it takes a catastrophe to produce changes. Much of the strength and weakness of England has always lain in her conservatism. We have been talking of standardisation of machinery lately, so I may say that things have been standardised in England for a long time. Now to get all the good effect of standardisation it is occasionally necessary to go in for wholesale scrapping, and it is this scrapping part of the business that we dislike in England. We

here all know that the District and Metropolitan Railways might have been worked electrically years ago just as easily as they will be when we are allowed to begin upon them, but of course the scrapping of a lot of steam locomotives was a serious thing. The loss of experience to English electrical engineers, because of this hatred of scrapping, is leading to other incalculable losses. I understand that the whole generating and line plant—the whole machinery of the Boston tramways—has been scrapped several times since they first were driven electrically. Japan has scrapped all her old civilisation just as France did. During the century now dying Germany has made the most sweeping changes in her law and school legislation, and, indeed, in everything. England, and Spain, and China, how they differ in this respect even from England's own colonies.

Of course it may be said that English customs have grown during centuries; they are well tried and there is no pressing need for sudden alteration. I quite agree, but unfortunately this very perfection and fitness of our customs have bred in us a want of flexibility, so that in cases where a sudden change is really necessary, we are disinclined to make the change merely because it is a change and for no other reason.

No one has ever heard me speak of the decadence of England. When the greatness and the wealth, the manliness and the strength, the healthiness and good life of England are shown forth to the as yet ignorant world in all their magnitude there will be some astonishment. But it is our duty to keep up our high standards. We must change what is bad when we know it to be bad, and not let bad things* continue to exist, parasitic growths, maintained because on the whole we are strong and healthy. You will, perhaps think that this is a very serious exordium when I tell you that I have introduced it all on account of the state of mathematics in our profession. I feel a sort of degradation every time that I hear a successful, clever, old member of this Institution sneering at mathematics. There is a plausibility about his statements; he himself has been very successful in life without much help from mathematics; but indeed, his sneer is doing a great deal of harm to the younger members who admire his success, who forget that he has succeded in spite of, and not because of, his neglect of mathematics.

Our knowledge of electrical phenomena must be quantitative to be of practical use; we must be able to calculate. Mathematics is the science of calculation, and we must therefore be able to employ, and we all do necessarily employ, less or more mathematics every hour of our professional lives. The draper and the grocer and the housekeeper merely need arithmetic. Everybody now knows some arithmetic. Everybody can add and subtract and multiply and divide, and keep accounts in some simple sort of way. This is due to the fact that arithmetic is no longer taught in the old Greek method with its 27 independent characters (for our 10 figures), the study of which required a lifetime, so that only old men could do multiplication, and they not only needed many hours to do one easy bit of multiplication, but declared that if the art were not practised every day it could not be remembered. Reading and writing and ciphering are now taught to everybody. It used to be that only learned men and philosophers could read, write, and compute. You will remember the charge that was brought against one of Shakespeare's characters, who was said to possess mere bookish theory without practical knowledge. "And what was he?" "Forsooth a great arithmetician." Nowadays, when everybody can compute, we should say of the possessor of mere bookish theory, "Forsooth he knows the calculus."

For in mediæval times things were taught in such a way that only a few men had a chance of knowing how to read, write, and cipher. We have been compelled to change all that, the pedagogue has by compulsion given up his mediæval methods of teaching in these things, although in all other matters he retains them. But a time has come when we see that ciphering is not enough mathematics for us to be familiar with, we need a little algebra, we need co-ordinate geometry, we need the differential and integral calculus. The pedagogue tells us that we must follow the orthodox course of study, which takes many years; and some of us, many of us, who have followed the orthodox method find that we have spent so much time and mental power upon it and its thousands of unnecessary tricks and contrivance and philosophy, that we can take in no more ideas. We cannot utilise our mathematics on engineering problems because we are too old and tired and *blasé* to comprehend these problems. Nevertheless we are the only people who know mathematics, and so we publish volumes of unmeaning and useless disquisitions on problems that we do not understand. Or we know just enough mathematics to be able to show our ignorance to experts, but quite enough to impress engineers with our knowledge; and we know just enough about engineering problems to show our ignorance to engineers, but quite enough to impress mathematicians, and what we publish is merely as the crackling of thorns under a pot. As for the man who does understand electrical problems, he remembers that there was a something called a study of mathematics at his school, that he did pass certain examinations with much difficulty and tribulation, that the subject had no real meaning to him even when he was supposed to know it, and he now hates the sight of anything that looks like mathematics.

I tell you, gentlemen, that there is only one remedy for this sort of thing. Just as the antiquated method of studying arithmetic has been given up, so the antiquated method of studying other parts of mathematics must be given up. The practical engineer needs to use squared paper. What is the use of telling him that he has taken an unauthorised way to the study of co-ordinate geometry, that he cannot approach it except through Euclid and modern geometry and geometrical conics and algebra and trigonometry. He says the youngest child can be made to understand diagrams on squared paper. So again the idea underlying the calculus is one that every child, every boy, every man possesses and uses every day of his life, and there are useful methods of the calculus that might be taught quite quickly to boys, and which it would be a pleasure to boys and men to use continually in all sorts of practical problems, but of course the subject of the differential and integral calculus is one that must come at the end of a long course of what is to the average boy utterly uninteresting and unmeaning mathematics. Indeed, the average boy never reaches the subject, whose very names, differential and integral calculus, are enough to drive him frantic.

Yes, the schoolmasters say that we must follow the mediæval rules of the game, and all sorts of fine things are said about them, but as a matter of fact we only need to bring a little common sense to bear upon schoolmasters. At present most of us stick to our arithmetic as a safe and well-tried friend. We compute after the manner of the draper and grocer and housekeeper. In finding out what is the best size of conductor, or armature winding or core, or iron and winding of a field-magnet, we calculate by mere arithmetic for one size, and then for another; perhaps we have weeks of arithmetical computation before we find the right size of thing to use, and we cannot frame general rules. And some foolish person who knows a little mathematics works at the problem (as we ought to be able to do, but are not), and he frames a general rule and we laugh at it, and sneer at mathematics because he has probably left out of account the most important consideration. We know that the result is wrong, but we cannot say why it is wrong.

Then there are some far-reaching, labour-saving ideas that we simply cannot get into our heads at all, we cannot comprehend them. Am I sinning against the rule as to good comradeship which exists here if I say that some of us are ignorant of the most fundamental fact regulating economy in arranging sizes of conductors? Suppose we find the total cost of installing a conductor of a certain length, using 1 sq. in. section of copper. We do the same thing for other sizes, and we plot total cost and weight of mere copper on squared paper. I do not care what system we adopt if it is the same system for all sizes, and if we buy our materials from the same manufacturers and use the same kind of labour, our points will lie very nearly in a straight line on the squared paper. Hence increased cost will be proportioned to increased weight of copper, and, indeed, increased total cost will be like the mere increase in the cost of copper, taking a slightly higher price of copper per ton. Some of us, ignorant of the elementary mathematics involved in the problem, think that the mistake has been made of assuming that the cost of an installed conductor is merely the cost of the copper in it, and of course he must feel that it is too absurd a mistake not to be laughed over. With an elementary knowledge of mathematics, his mistake would be impossible, and without such a knowledge the clever electrical engineer is constantly discovering mare's nests in the investigations which he criticises.

I know of long misleading accounts of the results of good experimental observations which might have been described in a few clear words by the aid of elementary mathematics. I know men who spend on a particular problem ten times the amount of worrying thought that would enable them to master the easy mathematics that includes all such problems. Quite recently one of our most eminent members declared to me that he had not really grasped the reason for small economy at a power station when there is a small load factor until he studied the common sense mathematical form which has been given in a recent publication. And yet he is a man who has heard much, and read much, and talked much on this subject.

Every electrical engineer has a correct idea of how a transformer acts, or how the E.M.F. in one of the coils of an armature of a direct current or other generator, or, let us say, a rotary transformer, changes during a revolution, and how the E.M.F.s of all the coils are combined to produce currents in the external circuits. But through how much mathematical tribulation must most of us have passed from our state of ignorance to our present state of knowledge! It is no wonder that we are disinclined to the

* Such as our wretched system of weights and measures. Oh, young America and Australia, is it wise to waste a year of every child's life, and years of the life of every business man, merely because we do it in England! You get many of your pedagogues from us, and of course they say that without cwts., qrs. and lbs., and Latin declensions and Euclid, the mind cannot be trained. Do you believe them, or are you with open eyes making a great sentimental sacrifice!

study of a new phenomenon which seems as if it might lead us through the like tribulation. The tribulation is least because it is suffered only once if we first learn the calculus method which underlies all our work; it is greatest if we get it up in a completely new-looking form in every new problem. I speak now of what is most difficult in our study, for there is thought required in applying the calculus method. Thus, for example in multiphase work at the present time the best mathematicians wonder how it is possible for easy calculation to be made in such a subject. What we want just now is that an electrical engineer acquainted with three-phase current phenomena should be so much a master of ordinary easy mathematics that he has a chance of discovering a very simple way of putting the matter before us. At present calculation is easy but tedious, and, indeed, repellant; but I am perfectly certain that a competent man might quickly invent methods of calculation which are not only easy, but short and thinkable. Mathematicians with the requisite electrical knowledge, again, may be lacking in sympathy and humour. I know a book of more than three hundred large pages on ordinary alternating currents, and all the information in it is given far more simply in two pages of another book with which some of you are acquainted. Possibly, just now, mathematicians who are electrical and who have common sense have too much other work to do, and we must wait their leisure.

The fact is, mathematics ought to be the natural language of the electrical engineer, and at present it is a foreign language; we cannot read or write or think in it. We are at the beginning of our development, like monkeys whose necessities have increased faster than their powers of speech.

Some of you are aware that a new method of teaching mathematics has recently been introduced in nearly all evening classes in science schools throughout the country.* I wish I could say that there was a prospect of its being introduced in all schools, for it seems to me that this would lead to the result that all young men entering works would be masters of that kind of calculation which is most important in electrical engineering; not merely a few men having this power, but the average men, just as the average men can read and write.

I am addressing engineers, men who utilise the results arrived at by scientific workers, men whose profession is applied science. But surely if we are to apply the results arrived at by scientific men, if the laboratory experiment of to-day is the engineering achievement of to-morrow, we ought to be very much alive to all that is going on in the scientific world.

All men ought to be far more alive to the importance of scientific work. On the psychological side, it is perfectly exasperating to me to see how few are the men who know that Darwin has given a key to almost all the great philosophical problems of antiquity, and that there is a great mental development accompanying the more evident engineering development now going on in the world. Again, it is the fault of our methods of education that all our great men, our most important, most brilliant, best educated men, our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, should remain so ignorant of physical science, the application of which by a few men not ignorant is transforming all the conditions of civilisation.† But of all men just think what it means for engineers to be ignorant of science, or neglectful of its new developments, and of all engineers think what it would mean if electrical engineers sinned in this way.

Except ours, all other branches of industry have taken thousands of years to grow. There were bridge and hydraulic and sanitary and harbour and river engineers in ancient Rome, and such engineers existed thousands of years before the first papyrus was written in Egypt. But no Assyrian tile or Egyptian hieroglyphic or relic from a tomb indicates that telephones or electric motors or electric lights existed before our time. No gradual improvement in our methods of conquering nature led up from small beginnings in our electrical engineering. Our profession has not grown during thousands of years of time like other professions. It has sprung suddenly, full grown, from the new spirit which is going to rule the souls and bodies of men, the spirit of research in pure science. The new spirit puts knowledge, mere knowledge of nature, as its highest aim. The scientific student knows that all sorts of good must come to mankind from his studies; all sorts of scientific knowledge are sure to be utilised by engineers, but in the pursuit of science the usefulness and utility of the result are of no importance. And are we—we who have received the first-fruits of the labours of scientific men, we, the first-born spoilt children of the great parent of all that is to come, we who form the foremost files of the present time—are we going to turn upon our beautiful young mother and say she is useless and ugly, and she hinders our money-making, and that we are willing to kill her for the sake of the burial fee? Thank God that is the spirit of only a few of us. Have we not as an Institution gone to great expense in the publication of *Science Abstracts* in partnership with the Physical Society? That publication has been and continues to be of the very greatest value to all students of pure and applied science who read our language, for it tells them the results of all the scientific work now being done in all parts of the world. And even if some of us do not read that useful publication, do we not know that it is there to read if we like? Do we not know that it is a symbol of our redemption from the yoke of the Philistine? It is one of many signs that, in answer to the question which I have asked in this address, we can truthfully say that we are professional men, that our profession has promise of enormous expansion and improvement, and that we are not mere tradesmen.

I am afraid that you will think that I have a personal interest in putting before you the claims for consideration of the pursuit of pure science, because you know that I am trying to defend Kew Observatory from imminent danger. In truth, I have no interest in this matter unbecoming a president of this Institution. For two years I have been trying to reason with traction engineers. Like many other electrical engineers, these gentlemen desire to use uninsulated return conductors. If they do so near a magnetic observatory certain records of terrestrial magnetic disturbances are quite spoilt. At Potsdam this sacrilege has been forbidden. At Washington, Toronto, Cape Town, and most other important places the magnetic records have already been rendered useless. Prof. Rücker and I were asked by the other members of the committee of the Royal Society which was in charge of the Kew Observatory to defend Kew, and with the help of Her Majesty's Treasury we thought we were able to insist upon the use of insulated returns in all undertakings authorised by Parliament where harm was likely to be inflicted on Government observatories. I may say that the scheme designed by Mr. Clifton Robinson for using an insulated return conductor in the working of the tramways of the London United Tramways Co., in consequence of our action, was a thoroughly good scheme which it gave one satisfaction to look at, not ugly and not expensive. It seemed to me a fit scheme for any tramway system, however complex, in which overhead conductors are used. You are aware that for an electric railway or for a tramway where a conduit is employed, it is in every way better, and is in a large scheme actually cheaper to use an insulated return. We felt therefore very happy, for magnetic observatories seemed quite safe from interference. We were, however, mistaken, for the only clause which we have been able to get inserted in all Parliamentary authorisations of undertakings, leaves it to the Board of Trade to substitute other methods of protection than the insulation of the return conductors in cases where these other methods seem to be sufficiently good for the protection of laboratories and observatories, and this is why the Board of Trade appointed the committee which met on October 31 probably for the last time.

Prof. Rücker, Prof. Ayrton, and I have made many tests on the magnetic disturbances produced by tramways and railways, particularly by the Stockton tramways and by the Waterloo and City Railway, and we have had many meetings with the traction engineers, but nothing has yet been decided.

I mention this matter, which has given great anxiety to scientific men, because I am afraid that some of you may think when you hear of it that I have been acting against the interests of the electrical industry. I beg to assure you that I have been acting in your best interests. As an electrical engineer I ought surely to regret the use of uninsulated returns even if we leave Kew Observatory out of account. Suppose we do not now insulate our returns. Electricity will certainly return by gas and water pipes, and the amount of harm done to those pipes is merely a question of time. Because of the ignorance of legislators and gas and water companies, nothing is said just now, but will nothing be said at the end of 10 years or 20 years when pipes are found to be eaten away everywhere? And if by a slight increase of expense, or rather, as I think, actually no increase of expense, but merely a little increase in inventiveness and common sense on the part of electrical engineers, this evil may be entirely prevented, surely it is in the interests of all of us that insulated returns should be insisted upon. But even if we do not insist on insulating the returns in all systems, surely something may be said for the giving of this protection on lines near such a magnetic observatory as Kew. Even the magnetograph records now being made have been continuous for 45 years, and if Kew is interfered with no sum of money can compensate for the interference; for if the observatory were removed the future observations would have no link with the past.

An engineer declared in this room that it seemed to him an injustice to hamper the progress of electric tramways "for the sake of making observations that never have given, and never may give, to the world any important results." Now, it is not so much on account of Kew that I object to this sort of observation, as to its general spirit of antagonism to scientific research. There is

* See summary of Lectures on Practical Mathematics; also the Science and Art Directory, and the Reports of Examiners on the Science Examinations of 1899 and 1900, all published by the Education Department, South Kensington, S.W. The reforms now advocated in mathematical and science teaching are all clearly described in a Paper read before the Society of Arts in January, 1880.

† See articles in *Nature* of July 5 and August 2.

no doubt that the answer to the old question which Gilbert might have asked three hundred years ago, "What is the cause of terrestrial magnetism?" is very jealously hidden from us by Nature. The earth probably contains much iron, but its great internal heat seems to forbid our imagining the iron to be magnetic. The assumption that a negative electric charge on the rotating earth will explain things, requires such an enormous charge that this assumption has been discarded. There are annual and diurnal variations of a fairly regular kind; there are storms which have some relation to the aurora borealis, to sun spots and to earth currents. There are small sudden changes which seem to occur almost instantaneously all over the earth. Observations of these things may be useless from some points of view, but scientific men have been and continue to be willing to give up time and much money for this object. Utilitarians had to be cajoled through superstition to allow observations of the stars to be carried on in ancient times, and we have no such cajolery to offer. We simply say that it has been through this sort of useless-looking method of working that all our progress in science has come.

Engineers descended from men who sneered at Cavendish and Franklin and Volta and Oersted and Ohm and Faraday are you who utilise the results of the work so sneered at and pile up fortunes in consequence of it; are you the men to sneer at and ridicule the scientific work of the present day because it seems to you useless? Tell us a better method of observation; give us better suggestions as to what these magnetic phenomena may mean; but the past record of scientific observation enables us to laugh at you when you say that magnetic observations may never give the world any important results. Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much? How very little we know of electricity and magnetism! Does the mere motion of the earth, taking no account of electric charges at all, cause it to be magnetic? Almost anything is on the cards. Surely I need not appeal to your cupidity, but it is quite possible that our knowledge of this secret may enable us to tap a tremendous store of Nature's energy.

Gentlemen, this is not a trades union, and it is not a society for the furtherance of pure scientific research, but it is a society of professional men who recognise the past services of scientific observers with gratitude and respect, and hope for greater ones in the future. And shall it be said of us that our gratitude is not greater than that of Judas, to whom indeed 30 pieces of silver was doubtless a large sum; that "we have given our hearts away a sordid boon;" and that as to our future hopes we are willing to sell our birthright for a mess of pottage.

## OBSERVATIONS ON AN IMPROVED GLASS REVEALER, FOR STUDYING CONDENSATION IN STEAM-ENGINE CYLINDERS, AND RENDERING THE EFFECTS VISIBLE.*

BY MR. BRYAN DONKIN.

Some years ago the writer introduced a small glass instrument named by Hirn a "Revealer," for studying the condensation of steam in an engine cylinder. Since then some improvements have been made, and the following results obtained: A revealer was placed on the top of both the high and the low pressure cylinders of a compound steam-jacketed vertical condensing beam engine, working in a factory at a speed of about 35 revs. per min. The diameter of the low-pressure cylinder is 26in. with 3ft. stroke, and that of the high-pressure cylinder $7\frac{3}{16}$in. with 14in. stroke.

*General Description.*—Each revealer has two cylindrical glasses (Figs 1 and 2) fixed concentrically one inside the other, thus forming a hot-air jacket for the inner glass, with an annular space of 10mm. (0·4in.) between them. The inner glass cylinder is smaller in diameter than formerly, the connecting pipe to the motor cylinder is straight, and the cock and pipe much larger, so that the connection is more direct. Inside the inner glass is a small cast-iron cylinder. All the external metal and glass surfaces are well covered with removable thick non-conducting material to diminish radiation. The object of the instrument is to reproduce as nearly as possible, and render visible, what takes place inside the steam cylinder, and is necessarily concealed. No vessel, such as a revealer, exterior to the cylinder, can be under exactly the same conditions as the internal parts, because the cylindrical portion of the latter is cleaned by the piston at every half revolution, and the clearance surfaces are greasy. Nevertheless, the effects of condensation, as shown by the revealer, may be within 85 per cent. to 95 per cent. of the truth, and all results can be accurately seen, magnified and studied. In all steam cylinders, condensation takes place on the internal walls when working with saturated steam. In this revealer, under the above conditions, very fine globules of water, the results of condensation, will be seen close together, the appearance of which the author will first endeavour to describe for the low-pressure cylinder.

*Revealer on the Low-Pressure Cylinder.*—The modifications of the improved revealer have caused a great reduction in the size of the minute globules on the glass walls, as compared with those shown in former experiments. After the revealer has become comparatively warm, and when the steam is first admitted into it from the low-pressure cylinder, the globules, from 1mm. to 2mm. (0·04in. to 0·08in) in size, are much larger than those seen after working about 10min. or 15min., when all the parts have had time to acquire a normal temperature. Commencing with the steam stroke, the first result observed, when the steam is admitted to the revealer, is a light and not very dense cloud or white fog coming up from the engine cylinder. This is precipitated upon the hot internal glass and cast-iron walls, and is seen as very fine globules or particles of moisture or condensation. This cloud is sufficient to obscure a light placed on the opposite side of the revealer. Re-evaporation then rapidly follows before the end of the steam stroke. On the opening of the exhaust-valve the cloud passes quickly off into the cylinder, and the glasses become quite transparent. A good illumination renders the incoming and outgoing clouds of mist quite visible. Each time the steam enters a large number of very small globules, at about equal distances from each other, are immediately seen upon the glass walls. These are from one-twentieth to one-twenty-fifth of a millimetre (0·002in. to 0·0016in.) in diameter, or less, and are distributed in a fairly uniform manner over the surfaces. The time occupied by the deposition of the globules and their re-evaporation is perhaps a tenth of a second. Before the end of the steam stroke, the duration of which is about half a second, and before the exhaust valve opens, the smaller globules, one-twenty-fifth of a millimetre in diameter, are all evaporated. During the exhaust stroke, the larger globules are also re-evaporated, but not so quickly. The internal surfaces are sometimes quite dry, and at other times a few drops of moisture remain on them.

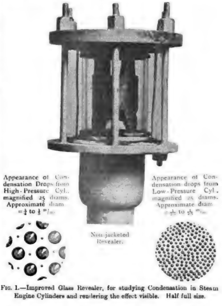


FIG. 1.—Improved Glass Revealer, for studying Condensation in Steam Engine Cylinders and rendering the effect visible. Half full size.

To facilitate the study of these minute condensed globules or wet particles on the inside of the inner glass, a microscope is used, and the glass and iron walls well illuminated. It is interesting to watch not only the formation of the globules, but also their rapid disappearance by evaporation. Any change in the working conditions of the engine, by altering the expansion or speed, is at once detected. The globules change in diameter, becoming larger or smaller than before, probably as the difference of temperature between the walls and the steam is increased or diminished. Very soon however the glass walls take up a certain temperature, and constant conditions

---

* Paper read before the Institution of Mechanical Engineers, Oct. 19.

again prevail, differing only in the size of the globules from those previously seen. By artificially cooling the outside of the short iron connecting pipe between the glass revealer and the cylinder with cold water and a sponge, the fog or cloud on admission of the steam at the commencement of the steam stroke is much increased, as is also the diameter of the globules on the internal glass walls. The steam seems to be chilled. Two other revealers with single glasses, and longer and uncovered connecting pipes fixed on the same end of the same low-pressure cylinder, gave, during the same stroke, greater condensation and larger globules, with thicker fog inside. This was a result which might be expected.

*Condensation on the Cast-Iron from the Low-Pressure Cylinder.*—Inside the inner glass cylinder or revealer a small cast-iron cylinder was placed to observe the condensation produced on this metal and to measure the size of the globules. Vertical and horizontal cross lines a millimetre apart were marked on this cylinder, forming small areas of 1 sq. mm. (Fig. 2). These squares, being visible under the microscope, afford a useful means of estimating the size of the minute globules. The condensation observed was practically the same on the cast-iron as on the inner glass cylinder, both being probably at the same temperature and touched by the same steam. The various phenomena may be summarised as follows, after the normal conditions are established, for the low-pressure cylinder :—

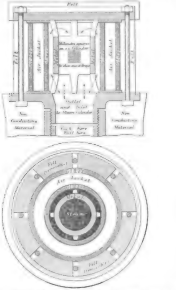


FIG. 2.—Improved Glass Revealer fixed on Steam Engine Cylinder for showing effects of Condensation, Re-evaporation, &c. Half full size.

| | | |
|---|---|---|
| One revolution | 1. Fog rising from cylinder into revealer ......... | Steam stroke duration about ½ second. |
| | 2. Deposition of moisture and water on glass and metal surfaces ............................ | |
| | 3. Rapid re-evaporation during expansion ......... | |
| | 4. Exhaust opens. Fog sinking back to cylinder | Exhaust stroke duration ½ second. |
| | 5. Glasses quite clear. Surface nearly dry ...... | |

Internal diameter of glasses, 67mm. and 44mm. (2·64in. and 1·73in.). External diameter of cast-iron cylinder, 35mm. (1·38in.). Height of glasses and cylinder, 57mm. (2·24in.). The pressure in the low-pressure cylinder varies a little at different times of the day ; the maximum initial is generally about at atmospheric pressure (see Average Diagram, Fig. 4). At times, in the revealer, no condensation is visible and no re-evaporation, only very slight fog in and out.

*Revealer on the High-Pressure Cylinder*—A second revealer, with double glasses and a small cast-iron cylinder in the centre, was placed on the top of the high-pressure cylinder, and well protected from heat losses. All the general series of effects were the same as those on the low-pressure cylinder during one revolution. The only marked difference between the two cylinders was in the size of the condensed globules on the glass and cast-iron surfaces. These were about ¼mm. to ⅕mm. (0·01in. to 0·008in.), some few being ½mm. (0·02in.) in diameter. This means more condensation in this cylinder than in the low-pressure, which agrees with calculation and experiment. This cylinder is jacketed with live steam at a pressure of 60lb., or about 4 atmospheres. With the low-pressure cylinder the pressure is the same in the jackets, namely 4 atmospheres, and as the mean working pressure is much lower than in the first high-pressure cylinder, there is a much greater difference of pressure and temperature between cylinder and jacket to keep the low-pressure cylinder walls hot. The jacket is more efficient on the low-pressure cylinder, and less condensation is to be expected. This agrees with experimental results. In this plan the two revealers can be seen and compared, both working at the same time on the top of each cylinder. To make sure that the varying pressures of steam in the revealer were really the same as in the engine cylinder, two indicators were fixed, one on the top of the revealer and the other on the top of the cylinder, and diagrams taken during the same stroke. The diagrams were exactly the same from the revealer as from the cylinder. The range of temperature in the high-pressure cylinder is generally about 101°F., or about 56°C., and that in the low-pressure cylinder some 85°F. or 47°C. ; but the pressures and temperatures vary somewhat with the work. This double-glass revealer forms a kind of transparent prolongation of the steam-engine cylinder (Figs. 1 and 2).

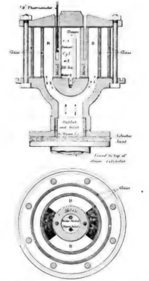


FIG. 3.—Improved Glass Revealer with two Glass Cylinders and Internal Steam or Water-jacketed Cylinder. One-third full size.

One result of these observations is to prove that there cannot be any thin film of condensation water on the internal surfaces of steam-engine cylinders, whether the cylinder is relatively hot or cold, as there has so often been supposed to be. The difference of temperature between the walls and the working steam seems to affect only the size of the globules of water. It is very difficult for the eye to follow the rapid and violent movements of fog and small globules of water in all directions on the internal surfaces, and also their very quick and violent disappearance by re-evaporation at exhaust. It is now generally admitted that condensation of steam in engine cylinders is caused chiefly by the difference of temperature between the internal surfaces and the steam in contact with them, which it should be the object of engineers to minimise. Condensation is reduced in quick-revolution engines, and where dry or superheated steam is used. It assumes various forms—water particles, fog, or globules of different diameters. These seem always to be in rapid motion, and not stagnant. On

admission, the internal metal walls are heated by the steam. Other heat changes occur in each revolution, tending to equalise the temperature between the solid iron, the liquid water, and the gaseous steam. The temperatures of the 1mm. and 2mm. drops of water have not yet been measured, existing only during, say, one-tenth of the stroke. Wall temperatures have been taken; and the varying steam temperatures, deduced from the indicator diagram of pressure, are known fairly well during a revolution. Rotary engines should give less condensation on admission, as compared with the reciprocating types, both working with steam-jackets and with superheated steam.

*Steam Revealer with Two Cylindrical Glasses, and Internal Steam or Water-jacketed Cast-iron Cylinder in centre.*—The following further experiments have been made. A small cast-iron cylinder (Fig. 3) is fixed in the centre of the revealer, and so arranged that boiler steam can be introduced inside it to raise its temperature, provision being made to drain the water away. Cold water can also be passed through it continuously to reduce its temperature. The mean temperature of this inner cylinder is taken by means of a mercurial

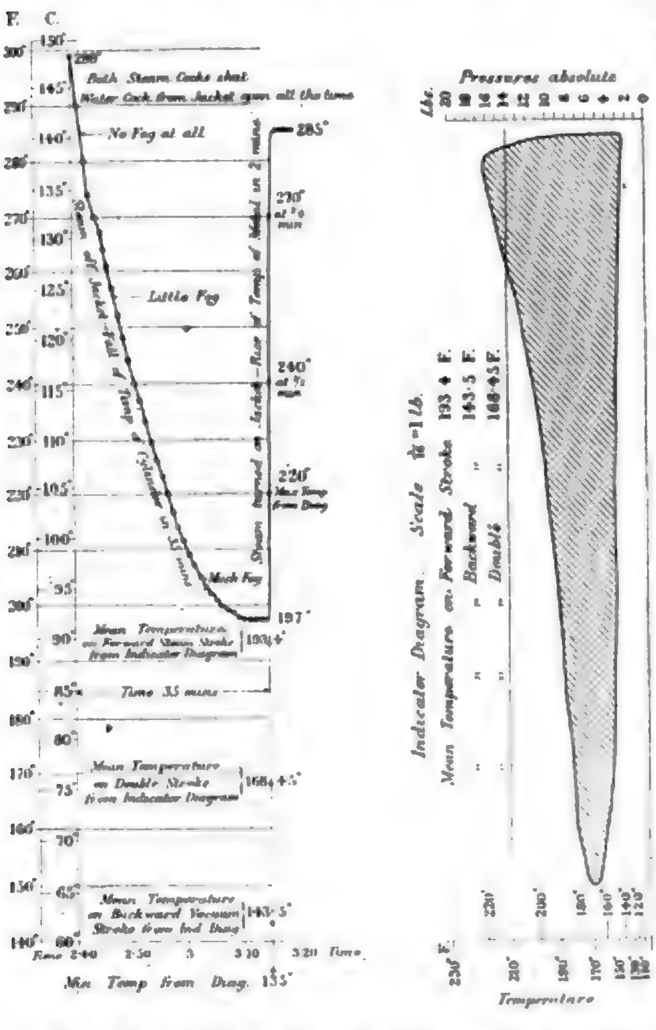


FIG. 4.—Improved Glass Revealer. Curve showing Fall of Temperature of Cylinder shown in Fig. 3 exposed to Exhaust Stroke, &c., and so made as to be jacketed or not at pleasure, fixed on Low-pressure Cylinder of Factory Engine; speed about 35 revs. per minute.

thermometer about $2\frac{1}{2}$mm. (0·1in.) in diameter, placed in a hole in the centre of the wall. The steam from the engine cylinder passes at each stroke into and out of the annular space BB, between the cylinder and the inner glass. The fog or condensation on the walls can be observed through the glass cylinder by the eye or a microscope. In this way the cylinder can be either heated by steam or cooled by water, and the fog effects noted for different temperatures of the small cylinder inside the revealer. To get the mean temperature of steam in the steam-engine cylinder, indicator diagrams are taken, and the mean temperature calculated from the pressures. Thus, when all the conditions are constant, the temperature attained by the inner cylinder can at any time be compared with the mean temperature of the steam touching its walls.

*Experiment.* (December, 1899. Figs. 3 and 4.)—The revealer shown in Fig. 3 was fixed on the top of the low-pressure jacketed cylinder of the engine, and placed in communication with it. The speed of the engine was about 35 revs. per min. Boiler steam was admitted into the inside of the small central cylinder, and the revealer was kept going with the power on the engine constant for a given time until all the working conditions were normal. At a given moment, with the wall at 299°F. or 148°C., the steam was shut off from the jacket, and notes were made of the gradual decrease of the wall temperature, arising doubtless from the exposure of the hotter walls to the cooler steam-stroke, and to the still cooler exhaust-stroke to condenser. This had already been noticed in a preliminary experiment. For copy of indicator diagram see Fig. 4. The wall-temperature was read every minute until a minimum of 197°F. or 92°C. was reached and maintained. The steam was then turned again into the jacket, and the rapid rise of the wall-temperature noted up to 285°F. or 140°C. in about one minute. The wall-temperatures are plotted in Fig. 4. In 35 minutes the temperature of the cylinder decreased from 299deg. to 197deg. = 102°F. or about 2·9°F. or 1·6°C. per minute. The mean temperature of the diagram was 320°F. or 160°C. cooler than the mean temperature of the small cylinder walls. From the weight of the small cylinder, 1·06lb., its loss in thermal units per minute can be calculated. This amounts to 0·384 thermal units per minute, and for 0·095 sq. ft. is equal to 4 thermal units per square foot per minute, lost by the walls to the condenser. In the above experiment there was very little radiation from the revealer, as it was just above a steam-jacketed and hot cylinder; and also very little conduction of heat along the connecting pipe, which is well covered, as is also the revealer.

*Condensation of Fog in the Revealer.*—With steam in the jacket no fog is visible, nor can any condensation on the walls be detected by the eye. They are much hotter than the incoming steam. About a quarter of an hour after shutting off the steam in the jacket a little fog is visible, and at the end of 35 minutes much fog is seen, and slight condensation on the walls; in other words, as the temperature of the walls was gradually reduced, the amount of fog and condensation increased.

*(To be concluded.)*

## HADFIELD'S NICKEL-MANGANESE STEEL.

BY PROF. ERNEST WILSON.

The chemical analysis of the principal constituents of this steel, as given to me by Mr. Hadfield, is Ni 25, Mn 5·04, C 0·8 per cent. It is marked 1,414B, and is in the form of (1) a forged ring of rectangular cross-section having internal and external diameters of 3·31cm. and 4·93 cm. respectively, with a length of 2·64cm.; (2) a wire about 200cm. long and of diameter 0·0912cm.

*The Ring.*

This specimen was covered with primary and secondary asbestos-covered copper wire for ballistic galvanometer experiments. It was then enclosed in an iron box, the whole being placed in a Fletcher gas furnace ready for heating. After heating it was re-wound with cotton-covered wire for the cooling experiments. Table I. gives particulars of the experiments and shows the order in which they were carried out.

The results show that within the limits of temperature, and with the rates of heating and cooling set forth, the specimen remains practically non-magnetic.

The density is constant.

The temperatures calculated from the variation in electrical resistance of the secondary coil, using the temperature coefficient 0·388 per cent. per 1°C., agree very well with those set forth in the table.

*The Wire.*

Table II. gives particulars of the experiments and shows the order in which they were made.

The variation of specific resistance with temperature does not follow the straight-line law; the rate of diminution of specific resistance decreases with diminution of temperature.

The temperature coefficients based on the determination of electrical resistance at −80°C. and −182°C. (assuming a straight-line law) are 0·088 and 0·089 per cent. per 1°C.

Messrs. Barrett, Brown and Hadfield* find the temperature coefficient for a sample containing Ni 25, Mn 5·04, C 1·18 per cent. to be 0·085 per cent. per 1°C. between 0°C. and 250°C.,

* See "Science Abstracts," Vol. III., p. 639; also *Trans.* (not *Proc.* as quoted in "Science Abstracts") Roy. Dublin Soc. 7, pp. 67—126, Jan., 1900.

**Table I.**

| Quantity measured. | Tested as received at atmospheric temperature. | | | Heating from atmospheric temperature. 182°C. | 421°C. | 836°C. | Atmospheric temperature 14°C. | | Cooled to − 80°C. with carbonic acid snow in ether. Time taken to cool from 14°C. = 1½ hrs | | Atmospheric temperature. Left all night in beaker to heat up to this temperature | | Cooled to − 80°C. with carbonic acid snow in ether, and then with liquid air to − 182°C. 17min = total time taken to cool. | | | Atmospheric temperature. Removed from liquid air and allowed to heat in atmosphere. | | | After heating to 900°C.; 1 hr. taken to heat, 2 hrs. taken to cool. Atmos. temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Permeability μ ............ | 2·11 | 2·01 | 1·81 | 2·04 | 1·83 | | 2·3 | 2·09 | 2·23 | 2·08 | 2·59 | 2·10 | 2·61 | 2·6 | 2·55 | 2·97 | 2·56 | 2·23 | |
| Magnetising force H ... | 9·66 | 37·7 | 57·9 | 49·4 | 47·7 | * | 29·7 | 57·4 | 12·5 | 58·8 | 12·5 | 58·6 | 10·5 | 30·3 | 59·4 | 9·9 | 33·5 | 53 | |
| Induction per sq. cm. B | 20·4 | 75·8 | 105 | 101 | 87·2 | | 69 | 120 | 28 | 122·5 | 32·5 | 123 | 26·4 | 78·9 | 151·4 | 29·4 | 85·8 | 118 | |
| Density, gms. per c. cm | Not taken | | | ..... | | | 7·93 | | ..... | | Not taken | | ..... | | | 7·93 | | | 7·90 |

* Time taken to heat from 20°C. = 1 hour. Left all night in furnace to cool.

**Table II.**

| — | Tested as received at atmospheric temp. 20°C. | In liquid air. Temp. − 182°C., about 7min. to cool from 20°C. | At atmospheric temp. next morning, after being left all night to heat in beaker. | In carbonic acid snow and ether − 80°C. a few minutes taken to cool. | At atmospheric temp. 20°C. allowed to heat in air from − 80°C. | Heated to 900°C. | At atmospheric temperature 21°C. |
|---|---|---|---|---|---|---|---|
| Specific resistance in $10^{-6}$ ohms per c. cm. | 88·3 | 71·6 | Not taken. | 79·7 | 88·7 | † | 88·2 |
| Density in gms. per c.cm...................... | Not taken | ... | Not taken. | ... | 7·87 | † | 7·89 |

† Time taken to heat, 1 hour; to cool, 2 hours.

the specific resistance being $97·52 \times 10^{-6}$ ohms per c.cm. at 15°C. A specimen containing 0·6 per cent. C., and the same percentages of Ni and Mn, had a specific resistance 89·2, which is in fair agreement with the author's results.

**Tensile Strength.**—No general conclusions can be drawn from the following isolated tests made on this wire, but the results are worth noting. After being cooled in carbonic acid snow, and ether (see Table II.), the wire broke at 49 tons per square inch, and was practically elastic up to the breaking point. The reduction in area at fracture was 2 per cent.

After being heated to 900°C. (see Table II.) the wire was more ductile than in the first test, and had not broken after suffering a 9 per cent. elongation on 27cm.; the reduction of area being 7 per cent. The wire just supported 33 tons per square inch, which indicates its elastic limit.

*Conclusion.*

This material, provided it does not seriously deteriorate by exposure to the air, is admirably suited for the construction of spiral resistance coils in which a high specific resistance is required. The specific resistance is nearly four and a-half times, and the temperature coefficient a little more than double the corresponding figures for German silver. If heated with excessive current, the material, when again cool, is more ductile. Its specific resistance is practically unaltered, but this might not be the case with a large number of heatings and coolings.

[NOTE.—A specimen of Hadfield's manganese steel in the form of a ring, having the following analysis: C 0·73, Si 0·55, S 0·06, P 0·09, Mn 12·06 per cent., was experimented upon at the temperature of liquid air, and gave the following results:—

| | | | |
|---|---|---|---|
| μ ......... | 2·02 ...... | 1·86 ...... | 1·87 |
| H ......... | 13 ...... | 38·1 ...... | 72·6 |
| B ......... | 26·3 ...... | 71 ...... | 136 |

The ring is still non-magnetic on returning to atmospheric temperature.]

I wish to express my thanks to Dr. Hampson, of the Brin's Oxygen Co., for manipulating the liquid air used in these experiments. My thanks are also due to Mr. F. S. Robertson and Messrs. W. Marden and L. G. Nunes for the assistance these gentlemen have given me.

## ELECTRICITY WORKS ACCOUNTS.

### Sunderland Municipal Electric Supply Works.

While the aggregate costs figures for the year 1899-1900 of this undertaking mark a distinct retrogression in comparison with the 1898-9 results, yet the cause is easily recognisable. The concern, like the majority of undertakings in this country, has suffered and is still suffering from the high cost of coal. We learn from the engineer of the Sunderland station that the increase in the price of coal last year was from 8s. 9d. to 12s. 6d. per ton, while this year the same quality has risen to 15s. per ton.

With this in mind, the rise in the fuel item at Sunderland from 0·53d., at which it stood in 1898, to 0·76d. this last year, is seen to be natural and inevitable. The latter figure is really an excellent result in the circumstances, and it will be observed that all the other items of generating costs as well as the management and property charges, have been reduced.

We regret to note that the load-factor has fallen from the 12·7 per cent. of 1898 to 10·7 per cent. last year. In other respects the business shows a most flourishing rate of advance. The lamp connections increased by 34·7 per cent., and the output by 85·5 per cent.

In addition to plant extensions an important change has been effected in the transformation, in the residential district, from alternating-current supply to the continuous current system, thereby making one uniform system throughout the town. Extensions are proceeding at Dunning-street which, when completed, will use up the whole of that site, increasing the kilowatts installed to 1,980. Four 420 I.H.P. steam dynamos for lighting and traction with surface condensers, and four Galloway boilers, with economisers, &c., including induced-draught fans, are being installed.

### South Shields Municipal Electric Supply Works.

The accounts of this undertaking show that a splendid improvement has been effected in its general prosperity.

As the net result of last year's operations this concern has, after satisfying the capital charges, cleared itself—a result in striking contrast with the £882 deficit which marked the working of 1898-9.

A study of the costs column of our table will show that the works costs of 1898-9 were already excellent, although the management and property charges were a little high. This last year all the various items, with the exception of the unimportant distribution charges, have very materially been improved upon. This achievement effected in conjunction with the large increase of nearly 68 per cent. in the output is of course the secret of the better financial results attained.

It is interesting to note the diminished and very low fuel charge which obtained at South Shields last year. At 0·44d. it is quite 0·3d. below the average fuel charge in municipal stations of similar output and load factor in 1898. Like the output, the lamp connections exhibit the promising advance of 51·6 per cent., while the load factor has risen from 10·9 per cent. to 11·5 per cent.

| | SUNDERLAND. | SOUTH SHIELDS. |
|---|---|---|
| *Undertaking Worked by* | Sunderland Corporation. | South Shields Corporation. |
| *Date of Commencement of Supply* | March, 1895. | September, 1895. |
| *System of Supply* | 3-w. con. curr., with batts., alt. H.T. for out[l]ying districts. | Alt. curr. trans. sub-stations, with 2 wire dis[t]ribution. |
| *Chief Engineer* | John F. C. Snell. | Joseph A. Jeckell. |

| YEAR ENDED | SUNDERLAND MAR. 31, 1899. | SUNDERLAND MAR. 31, 1900. | SOUTH SHIELDS MAR. 31, 1899. | SOUTH SHIELDS MAR. 31, 1900. |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 558,832 | 746,753 | 391,637 | 634,464 |
| „ SOLD (TOTAL) | 472,240 | 640,079 | 308,108 | 501,839 |
| „ sold to consumers | 394,883 | 559,897 | 200,808 | 394,039 |
| „ sold for public lighting, &c. | 77,357 | 80,182 | 107,300 | 107,800 |
| „ used on works | 59,646 | 31,730 | 11,268 | 16,417 |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 16 | 18 3 | 16 0 | 14 6 |
| Maximum supply demanded | 424 kilowatts | 682 kilowatts | 325 kilowatts | 500 kilowatts |
| Number of public lamps | 50 arc | 50 arc | 63 arc, 243 glow[a] | 63 arc, 256 glow[f] |
| Number of consumers | 340 | 448 | 277 | 475 |
| Connections to mains in 8-c.p. lamps | 25,000 | 35,024 | 17,151 | 26,004 |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 29 500 | 35.000 | 19,250 | 34,400 |
| CAPACITY OF PLANT IN KILOWATTS | 946 | 1.120 | 615 | 1.100 |

| | Sunderland 1899 Total. | Per kilowatt capacity. | Sunderland 1900 Total. | Per kilowatt capacity. | South Shields 1899 Total. | Per kilowatt capacity. | South Shields 1900 Total. | Per kilowatt capacity |
|---|---|---|---|---|---|---|---|---|
| **CAPITAL—** | | | | | | | | |
| AUTHORISED (TOTAL) | — | — | — | — | £58.323 | £94 8 | £99,037 | £90 1 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | — | — | — | — | 58,323 | 94·8 | 99,037 | 90 1 |
| RECEIVED (TOTAL) | £61 350[a] | £64·9 | £88 315[a] | £78 8 | 57,175 | 93·0 | 74.102 | 67·4 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 58,850 | 62 3 | 88.315 | 78·8 | 57,175 | 93·0 | 74.102 | 67·4 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | 1 148 | 1 87 | 25.873 | 23 5 |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | 1 148 | 1 87 | 25.873 | 23 5 |
| REPAID (TOTAL) | 1,340[b] | 1·42 | 1 830[b] | 1·63 | 25 | 0·04 | 447 | 0 406 |
| RESERVE OR SINKING FUND | 34 | 0 036 | 28 | 0·025 | 2,971 | 4·83 | 4.680 | 4·25 |
| DEPRECIATION FUND | — | — | — | — | — | — | — | — |
| EXPENDED (TOTAL) | 61.931 | 65 5 | 82.159 | 73·4 | 58 699 | 95·4 | 88.657 | 89·6 |
| Lands and buildings | 11,035 | 11·7 | 12 829 | 11 5 | 10,090 | 16·4 | 12,218 | 11 . |
| Plant | 31 074 | 32 9 | 34,675 | 31·0 | 30 883 | 50·2 | 44,109 | 46 2 |
| Mains | 18,066 | 19 1 | 29,705 | 25 5 | 17,404 | 28·3 | 30,793 | 23 0 |
| Miscellaneous | 1,756 | 1·86 | 4,950 | 4·42 | 321 | 0·522 | 1.502 | 1·37 |
| BALANCE OF CAPITAL ACCOUNT | – 581[c] | –0·81 | + 6.156 | + 5·49 | – 1,524[b] | 2·48 | – 14.584 | – 13 3 |

| | Sunderland 1899 Total. | Per unit sold. | Sunderland 1900 Total. | Per unit sold | South Shields 1899 Total. | Per unit sold. | South Shields 1900 Total. | Per unit sold |
|---|---|---|---|---|---|---|---|---|
| **REVENUE—** | | | | | | | | |
| TOTAL | £6 959 | 3·537d. | £9.805 | 3 676d. | £5.231 | 4·075d. | £7.973 | 3·813d. |
| Revenue from supply | 6,016 | 3·056d. | 8,641 | 3·210d. | 3,740 | 2 913d. | 6,312 | 3·020d. |
| „ meters, &c. | 187 | 0 095d. | 273 | 0·102d. | 100 | 0·078d. | 203 | 0 097d. |
| „ public lighting | 697 | 0·354d. | 697 | 0·261d. | 1,386 | 1·080d. | 1,454 | 0·696d. |
| „ sale of lamps, &c. | 20 | 0·010d. | 162 | 0·061d. | — | — | — | — |
| „ miscellaneous sources | 39 | 0 020d. | 32 | 0 012d. | 6 | 0·005d. | 4 | 0·002d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £4 105 | 2 086d. | £5 757 | 2·158d. | £3.081 | 2·400d. | £3 952 | 1 890d. |
| WORKS COSTS | 2.783 | 1·414d. | 4.095 | 1·535d. | 2 075 | 1 616d. | 2.661 | 1·273d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 1,047 | 0 532d. | 2,027 | 0 761d. | 585 | 0·456d. | 923 | 0·442d. |
| Oil, waste, water, stores | 231 | 0·117d. | 281 | 0·105d. | 230 | 0·179d. | 229 | 0·110d. |
| Wages at station | 847 | 0·431d. | 1,072 | 0·402d. | 752 | 0 586d. | 794 | 0 380d. |
| Repairs and maintenance at station | 356 | 0·181d. | 396 | 0 149d. | 176 | 0 137d. | 261 | 0·125d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 47 | [illegible] |
| Wages, &c. | 108 | 0·055d. | 127 | 0 048d. | 26 | 0 020d. | 47 | 0 022d. |
| Repairs, renewals of mains, &c. | | | | | | | | |
| *Public lighting* | 193 | [illegible] | 192 | 0·072d. | [illegible] | [illegible] | [illegible] | [illegible] |
| Attendance | 193 | 0·098d. | 192 | 0·072d. | 306 | 0·238d. | 401 | 0 195d. |
| Renewals | | | | | — | — | 7 | 0·003d. |
| MANAGEMENT AND PROPERTY CHARGES | 1.323 | 0 673d. | 1,663 | 0 624d. | 1 006 | 0 784d. | 1,292 | 0·618d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | 719 | 0 365d. | 955 | 0·358d. | 586 | 0·456d. | 702 | 0·336d. |
| Stationery, &c. | 71 | 0·036d. | 85 | 0 032d. | 44 | 0·035d. | 59 | 0·028d. |
| Establishment charges | 120 | 0·061d. | 172 | 0·065d. | 157 | 0 122d. | 132 | 0 063d. |
| Law charges, &c. | 101[d] | 0·051d. | 131 | 0·049d. | 71[e] | 0·055d. | 121 | 0·058d. |

| | Sunderland 1899 Total. | % to mean cap. expended | Sunderland 1900 Total. | % to mean cap. expended | South Shields 1899 Total. | % to mean cap. expended | South Shields 1900 Total. | % to mean cap. expended |
|---|---|---|---|---|---|---|---|---|
| **FINANCIAL RESULTS—** | | | | | | | | |
| WORKING PROFIT FOR YEAR | £2 853 | 5 35% | £4.047 | 5 62d. | £2 150 | 4 30% | £4 020 | 5 46d. |
| Sum carried to Depreciation Fund | — | — | — | — | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 1,336 | 2 50% | 1 823 | 2 53d. | 1 596 | 3 13% | 2 175 | 2·96d. |
| Net interest on loans (incl. Debenture charges) | 1,166 | 2 19% | 1,756 | 2 44d. | 1,465 | 2 93% | 2.123 | 2·88d. |
| BALANCE FROM LAST ACCOUNT | — | — | — | — | — | — | 284 | 0 396d. |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 351[f] | 0 658% | 467[f] | 0 648d. | — | — | — | — |
| *Deficit* | — | — | — | — | [illegible] | [illegible] | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | — | — | — | — |

| | Sunderland 1899 | Sunderland 1900 | South Shields 1899 | South Shields 1900 |
|---|---|---|---|---|
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 59 0% | 58·7% | 59% | 49·6% |
| Expenditure per kilowatt capacity | £4. 6s. 10d. | £5. 4s. 10d. | £5. 0s. 2d. | £3. 11s. 10d. |
| REVENUE PER KILOWATT CAPACITY | £7. 7s. 2d. | £8. 15s. 0d. | £8. 10s. 0½d. | £7. 4s. 11d. |
| Expenditure per 8-c.p. lamp capacity | [illegible] | [illegible] | [illegible] | [illegible] |
| REVENUE PER 8-C.P. LAMP CAPACITY | 4s. 8 d. | 5s. 7½d. | 5s. 5½d. | 4s. 7 d. |
| REVENUE PER 8-C.P. LAMP CONNECTED | 5s. 4 d. | 5s. 7½d. | 6s. 1¼d. | 6s. 1 d |
| Price charged for lighting, per unit | 5d. | 5d. to 3½d. | [illegible] | [illegible] |
| Price charged for power, per unit | 2½d. | 2½d. | 2d. | [illegible] |
| Price charged for public lighting | £16 per arc per ann. | £16 per arc per ann. | [illegible] | £22. 10s. per arc, £2 12s. [illegible] |

SUNDERLAND.—[illegible]

SOUTH SHIELDS.—[illegible]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 16s. 0d. ... | 8s. 0d. | |

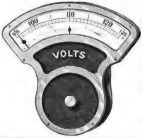
*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## PROFESSION OR TRADE?

In his presidential address to the Institution of Electrical Engineers last night, Prof. PERRY undertook to review the problem: "Is electrical engineering to remain a profession, or is it to become a trade? Is the Institution to continue to be a society for the advancement of knowledge in the application of scientific principles to electrical industries, or is it to become a mere trades union?" Prof. PERRY fears the latter will be the ultimate fate of the Institution unless its members devote greater attention to the study of mathematics and pure science. Electrical engineering of the present day, he contends, is the outcome of scientific study and the reproduction on a large scale of what has, in the first instance, been evolved in the laboratory. On the other hand, the present generation of engineers are, he asserts, descendants of the men who sneered at CAVENDISH, FRANKLIN, VOLTA, OERSTED, OHM and FARADAY; and, he asks, are men who "pile up fortunes" by utilising the discoveries of these great workers to sneer at science like their predecessors. Prof. PERRY feels so strongly on this point, and is so carried away in his eloquent appeal, that he is inclined to overstate his case. We admit that it has happened during the past session that, in the heat of debate, a mathematical investigation may have been referred to slightingly, or that one of those speakers who feel it incumbent on them to entertain the Institution meetings with humorous remarks may have chosen a collection of symbols on the blackboard as a butt against which to direct his sarcasm. Single instances of such a kind, however, do not necessarily prove that there is a general tendency to deride theory or to grudge it its proper place in the profession—or even in the trade—of electrical engineering. To make use of the two parallels from biblical history quoted in conjunction by Prof. PERRY in the last sentence of his address, although the excellent bargain made by JACOB with his mess of pottage may have been typical of the business instincts of his race, JUDAS ISCARIOT'S evil example

# NALDER BROS. & THOMPSON, Ltd.

Managing Directors: F. H. NALDER & E. THOMPSON.



**Dead Beat, Permanent Magnet, Moving Coil**

**AMMETERS & VOLTMETERS**

**EDGEWISE, SECTOR SHAPE, or CIRCULAR.**

CASES AS REQUIRED.

***34, Queen Street, LONDON, E.C.***

Telegrams:—"OCCLUDE LONDON." Telephone No. 124 Bank.

THE CHEAPEST AND MOST EFFICIENT
INCANDESCENT ELECTRIC LAMP
IN THE MARKET
IS THE
CELEBRATED

# "ROBERTSON"

HIGH VOLTAGE
AND
FANCY LAMPS
A
SPECIALITY.

**THE GENERAL ELECTRIC CO.,**
Limited,
69, 71, 88 & 92, Queen Victoria Street, LONDON, E.C.
Branches: MANCHESTER, GLASGOW, BIRMINGHAM, NEWCASTLE-ON-TYNE, DUBLIN.
Works: MANCHESTER, BIRMINGHAM, HAMMERSMITH, CLERKENWELL.

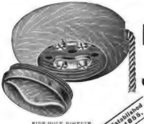
REC^D TRADE MARK

***THE MOST COMPREHENSIVE CATALOGUE EVER PUBLISHED***

ON

# ENGLISH ELECTRIC BELL MATERIALS

POST FREE ON APPLICATION.



SIDE-HOLE ROSETTE.
(Registered.)

Established 1855.

# JULIUS SAX & CO., L^td

(H. M. SALMONY, Managing Director.)

*Only Address:* EAGLE ELECTRICAL WORKS,
119, COLDHARBOUR LANE, CAMBERWELL,
LONDON, S.E.

Telegraphic Address: "SAXATILE LONDON."
Telephone No. 1215 Hop.

# Mavor & Coulson "C.C." System of Concentric Wiring

*47, King Street, Mile End, GLASGOW.* Limited.

THE TRADE SUPPLIED.

WATERPROOF and DUSTPROOF.

PARIS UNIVERSAL EXHIBITION.

1889.

GRAND PRIX,
2 GOLD MEDALS.
1 BRONZE MEDAL.

*The Highest Honours Awarded to any Exhibitor.*

1900.

APPOINTED
MEMBER OF THE JURY,
consequently
"HORS CONCOURS."

*The Highest Distinction obtainable.*

DOULTON & CO., LIMITED, LAMBETH, LONDON, S.E.

*Manufacturers of the Patent DOULTON UNDERGROUND CONDUITS.*

# CLASSIFIED TRADES' INDEX to ADVERTISERS in "THE ELECTRICIAN."

**Advertisers are entitled to entries in this List FREE OF CHARGE according to the size of their Advertisement. Additional entries are made at a low charge, particulars of which will be forwarded on application to "The Publisher." Bold Type entries or additional matter can be arranged for with the Publisher**

# Classified Index to Electrical Trades—*Continued.*

**ENGINEERS AND CONTRACTORS**—*Continued.*

| | PAGE |
|---|---|
| Clarke, Chapman & Co., Newcastle-on-Tyne, & 50, Fenchurch-st, London, E.C. | 30 |
| Connolly Brothers, Blackley, Manchester—London Agents: C. F. Quicke and Co., 301 and 303, Euston-road, N.W. | 24 |
| Crompton & Co., Mansion House-buildings, London, E.C.; and Chelmsford | 35 |
| Dick, Kerr & Co., 110, Cannon-street, London, E.C. | 5 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 7 |
| Elec. Power Storage Co., 4, Gt. Winchester-st., London, E.C.; and Millwall, E. | 42 |
| Fowler (J.) and Co., Leeds; and 6, Lombard-street, London, E.C. | 15 |
| International Electric Co. of Liege, Quai de Coronmeuse, Leige (Belgium) | 15 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, E.C.; & Charlton, Kent | 1, 12 |
| Mavor and Coulson, 47, King-street, Mile End, Glasgow | 25 |
| Thames Ironworks, Shipbuilding and Engineering Co., Blackwall, London | 21 |
| Witting Bros. (Electricite and Hydraulique, Societe Anonyme), 49, Cannon-st., London, E.C. | 9 |

**ENGINE PACKING.**

| | |
|---|---|
| United Asbestos Company, Dock House, Billiter-street, London, E.C. | 17 |

**EXPANSION SHEETING AND RINGS.**

| | |
|---|---|
| United Asbestos Company, Dock House, Billiter-street, London, E.C. | 17 |
| **FANS.**—Davidson and Co. Sirocco Engineering Works, Belfast | 5 |

**FIBRE.**

| | |
|---|---|
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| Mosses & Mitchell, 68, 69, 70, and 71, Chiswell-street, London, E.C. | 27 |

**FITTINGS FOR ELECTRIC LIGHT.**

| | |
|---|---|
| Dorman and Smith, Salford, Manchester; and London and Glasgow | 27 |
| Edison and Swan United Electric Light Company, Ediswan Buildings, 36-37 Queen-street, London, E.C., and Branches | 1, 32 |
| Electrical Company, 122-124, Charing Cross-road, London, W.C. Fittings Department: 162, Shaftesbury-avenue, London, W.C. | 31 |
| General Electric Co., 69, 71, & 68, Queen Victoria-st., London, E.C., & Salford | 25 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London; & Charlton, Kent | 1, 12 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |

**FLUORESCENT SCREENS.**

| | |
|---|---|
| Cossor, 67, Farringdon-road, London, E.C. | 12 |
| **FUSES.**—Edison & Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71, & 68, Queen Victoria-st., London, E.C., & Salford | 25 |

**GAS LIGHTERS (ELECTRIC).**

| | |
|---|---|
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71, & 68, Queen Victoria-st., London, E.C., & Salford | 25 |

**GENERATORS.**

| | |
|---|---|
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| International Electric Co. of Liege, Quai de Coronmeuse, Liege (Belgium) | 15 |
| Witting Bros. (Electricite and Hydraulique, Societe Anonyme), 49, Cannon-st., London, E.C. | 9 |

**GLASSWARE.**

| | |
|---|---|
| Atkinson, Schmahl and Co., 18, Grainger-street, Newcastle-on-Tyne | 6 |

**GLOBES AND SHADES.**

| | |
|---|---|
| Atkinson, Schmahl and Co., 18, Grainger-street, Newcastle-on-Tyne | 6 |
| Dorman and Smith, Manchester; and London and Glasgow | 27 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 7 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71 & 68, Queen Victoria-st., London, E.C., & Salford | 25 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 12 |

**HYDRAULIC PRESSES.**

| | PAGE |
|---|---|
| Stumm, W., 62, Cannon-street, London, E.C. | 3 |
| **HYDROMETERS.**—Edison and Swan United Electric Light Co., Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |

**INDIA RUBBER.**

| | |
|---|---|
| Harburg India Rubber C. Co. (F. Winter), 8, Redcross-street, London, E.C. | 33 |
| St. Helens Cable Co., Warrington & St. Helens, & 32, Victoria-st., London, S.W. | 3 |

**INSTRUMENTS.**

| | |
|---|---|
| Chamberlain and Hookham, New Bartholomew-street, Birmingham | 6 |
| Crompton and Co., Mansion House-buildings, London, E.C., and Chelmsford | 35 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| Elliott Brothers, Century Works, Lewisham, and 101, St. Martin's-lane, London | 14 |
| Ericsson (L. M.) & Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 18 |
| Evershed and Vignoles, Woodfield Works, Harrow-road, London, W. | 21 |
| General Electric Co., 69, 71 & 68, Queen Victoria-st., London, E.C.; & Salford | 25 |
| Johnson and Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 12 |
| Nalder Bros. & Thompson, 34, Queen-street, Cheapside, London, E.C. | 25 |
| Paul, R. W., 44, Hatton-garden, and Great Saffron-hill, London, E.C. | 29 |
| Pitkin, J., 56, Red Lion-street, Clerkenwell, London, E.C. | 30 |
| Richard Jules, Paris—Agents: Levi (J.) & Co., 97, Hatton-garden, London, E.C. | 30 |
| Stanley, W. F., Great Turnstile, Holborn, London, E.C. | 19 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |

**INSULATORS.**

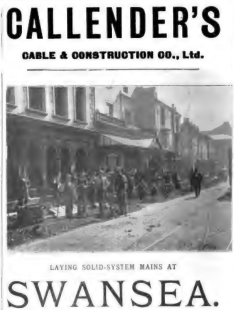
| | |
|---|---|
| Blackwell (R. W.) & Co., Ltd., 59, City-road, London, E.C. | 2 |
| Doulton and Co., Lambeth Pottery, London, S.E. | 19, 25 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71, & 68, Queen Victoria-st., London, E.C.; & Salford | 25 |
| Henley's (W.T.) Tel. Works Co., 27, Martin's-ln., Cannon-st., Lon., & N. Woolwich | 1 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent | 1, 12 |
| Mdrowsky and Co., 52, Queen Victoria-street, London, E.C. | 12 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |

**INSULATING MATERIAL.**

| | |
|---|---|
| Blackwell (R. W.) and Co., Ltd., 59, City-road, London, E.C. | 2 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, E.C., and Branches | 1, 32 |
| Jaroslaw, D., 5, George-street, Tower Hill, London, E.C. | 13 |
| Mosses and Mitchell, 68, 69, 70 and 71, Chiswell-street, London, E.C. | 27 |

**LAMPS.**

| | |
|---|---|
| Blackwell (R. W.) and Co., Ltd., 59, City-road, London, E.C. | 2 |
| Bonnella (D. H.) and Son, Ltd., 58 and 60, Mortimer-street, London, W. | 17 |
| British Thomson-Houston Co., 83, Cannon-street, London, E.C. | 13 |
| Brockie-Pell Arc Lamp, 60, Worship-street, London, E.C. | 18 |
| Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. | 33 |
| Cossor, 67, Farringdon-road, London, E.C. | 12 |
| Crompton and Co., Mansion House-buildings, London, E.C.; and Chelmsford | 35 |
| Crystal Electric Lamp, St. Stephen's Chambers, Telegraph-street, London | 23 |
| Dorman and Smith, Manchester; and London and Glasgow | 27 |
| Drake and Gorham, 66, Victoria-street, Westminster, London, S.W. | 7 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, E.C.; and Branches | 1, 32 |
| Electrical Co., 122, and 124, Charing Cross-road, London, W.C. Fittings Department: 162, Shaftesbury-avenue, London, W.C. | 31 |
| General Electric Co., 69, 71 & 68, Queen Victoria-st., London, E.C. & Salford | 25 |
| Goossens (E.) Pope and Co., 17, South Castle-street, Liverpool | 14 |



# Classified Index to Electrical Trades—*Continued.*

PAGE

**LAMPS.**—*Continued.*
Holmes (J. H.) and Co., Newcastle-on-Tyne, and 17, Soho-square, London, W. 4
Johnson & Phillips (Arc), 14, Union-ct., Old Broad-st., London; & Chalton, Kent 1, 12
Renewable Electric Lamp Co., Brunswick-place, City-road, London, N. 13
Stewart Electrical Syndicate, 57, New Compton-street, London, W.C. 2
Sunbeam Lamp Co., Gateshead-on-Tyne; & 141, Fenchurch-street, London, E.C. 15

**LAMPHOLDERS.**—Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 25

**LAMP PILLARS.**—Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 25

**LEAD COVERING MACHINERY.**
Wilson (J.) & Son, Vulcan Works, Johnstone, Scotland 14

**LIGHTNING CONDUCTORS.**
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 25
Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent 1, 12

**MANUFACTURING ELECTRICIANS.**
Dorman and Smith, Salford, Manchester; and London and Glasgow 27
Drake and Gorham, 66, Victoria-street, London, S.W. 7
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
Ericsson (L. M.) & Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg 19
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C.; & Salford 25
Henley's (W. T.) Tel. Works Co., 27, Martin's-lane, London, and N. Woolwich 1
Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent 1, 12
Telegraph Manufacturing Company, Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow and Belfast 1

**METERS (Electricity).**
British Thomson-Houston Co., 83, Cannon-street, London, E.C. 13
Chamberlain and Hookham, New Bartholomew-street, Birmingham 6
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 25
Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent 1, 12

**MICA.**—Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
Jaroslaw, D., 5, George-street, Tower Hill, London, E.C. 13
Sanders, Wake and Co., 23, Great St. Helens, London, E.C. 27
Tully and Straker, 16, Water-lane, Gt. Tower-street, London, E.C. 2

**MICROPHONES.**
Consolidated Telephone Construction and Manufacturing Company, 186-188, Shaftesbury-avenue, London, W.C.; and Coventry, England 5
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
Ericsson (L. M.) & Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg 19
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 25

**MOTORS (Electric).**
British Thomson-Houston Co., 83, Cannon-street, London, E.C. 13
Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. 31
Chamberlain and Hookham, New Bartholomew-street, Birmingham 6
Crompton & Co., Mansion House-buildings, London, E.C.; and Chelmsford 30
Crypto Works Co., 29, Clerkenwell-road, London, E.C. 32

**MOTORS (Electric).**—*Continued.* PAGE
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
Elliott (A.) & Co., 51, City-road, London, E.C. 12
Electrical Co., 122-124, Charing Cross-road, London, W.C. Fittings Department: 162, Shaftesbury-avenue, London, W.C. 31
General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C., and Salford 25
Holmes (J. H.) & Co., Newcastle-on-Tyne; and 17 Soho-square, London, W. 4
International Electric Co. of Liege, Quai de Coronmeuse, Liege, Belgium 15
Johnson and Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent 1, 12
Langdon-Davies Electric Motor Co., 101, Southwark-street, London, S.E. 19
Thames Ironworks, Shipbuilding and Engineering Co., Blackwall, London 24
Witting Bros. (Electricite and Hydraulique Societe Anonyme), 49, Cannon-street, London, E.C. 9

**MOTOR-SPEED REGULATORS, &c.**
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
Stewart Electrical Syndicate, 57, New Compton-street, London, W.C. 2

**NAME PLATES.**—Berry (W.) & Son, Christopher Works, Chalton-st, London 21

**NON-CONDUCTING COMPOSITION.**
United Asbestos Co., Dock House, Billiter-street, London, E.C. 17

**OIL CANS.**
Wells (A. C.) & Co., 99, Midland-road, St. Pancras, London; and Manchester 17

**OIL CISTERNS.**
Wells (A. C.) & Co., 99, Midland-road, Pancras, London; and Manchester 17

**OIL FILTERS.**
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C.; & Salford 25
Wells (A. C.) & Co., 99, Midland-road, St. Pancras, London; and Manchester 17

**OIL SEPARATORS.**
Baker's Patent Appliances Co., 13, Huntriss-row, Scarborough 8

**PAINTS, &c.**—Indestructible Paint Co., 31, Cannon-street, London, E.C. 37

**PATENT AGENTS.**—Chapman (J. C.) & Co., 70, Chancery-lane, London, W.C. —
Lorrain (J. G.), Norfolk House, Norfolk-street, Strand, W.C. 32

**PUMPS.**
Blackwell (R. W.) and Co., Ltd., 59, City-road, London, E.C. 2

**REFLECTORS.**
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32

**RHEOSTATS.**
Stewart Electrical Syndicate, 57, New Compton-street, Charing Cross-road, London, W.C. ("Ironclad") 2

**SAND BLAST APPARATUS.**
Tilghman's Patent Sand Blast Co., Broadheath, Manchester 17

**SCREWS, TERMINALS, &c.**
Armstrong, Stevens & Son, Whittall-street, Birmingham 28
Automatic Standard Screw Co., Halifax 1
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32

**SOCKETS.**—Edison & Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 32
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 25

**STONEWARE AND PORCELAIN.**
Doulton and Co., Lambeth, London, S.E. 10, 25

**SUPPLIES FOR CABLE SHIPS.**
Duncan, Wallet and Co., 114, Fenchurch-street, London, E.C. 37
Indestructible Paint Co., 31, Cannon-street, London, E.C. 37
Johnson and Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent 1, 12

## Classified Index to Electrical Trades—*Continued.*

| | PAGE |
|---|---|
| **SWITCHES AND SWITCHBOARDS.** | |
| Blackwell (R. W.) & Co., Ltd., 59, City-road, London, E.C. | 2 |
| Crompton and Co., Mansion House-buildings, E.C., and Chelmsford | 35 |
| Dorman and Smith, Salford, Manchester; and London and Glasgow | 27 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 7 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., and Salford | 25 |
| Holmes (J. H.) & Co., Newcastle-upon-Tyne; and 17, Soho-square, London, W. | 4 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent | 1, 12 |
| **TAPE.** | |
| Blackwell (R. W.) and Co., Ltd, 59, City-road, London. E.C. | 2 |
| Connolly Brothers, Blackley, Manchester; London Agents; C. F. Quicke and Co., 301 and 303, Euston-road, N.W. | 24 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., and Salford | 25 |
| **TELEGRAPH ENGINEERS.** | |
| Elliott Brothers, Coventry Works, Lewisham, and 101, St. Martin's-lane, London | 14 |
| Henley's (W. T.) Tel. Works Co., 27, Martin's-lane, London, and N. Woolwich | 1 |
| Johnson and Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 12 |
| Telegraph Manufacturing Co., Helsby, near Warrington, and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| **TELEPHONE APPARATUS.** | |
| C.T.C. and Manufacturing Co., 186-188, Shaftesbury-avenue, London, W.C.; and Coventry, England | 5 |
| Ericsson (L. M.) and Co., 164-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 18 |
| **TELEPHONES.** | |
| C.T.C. and Manufacturing Co., 186-188, Shaftesbury-avenue, London, W.C.; and Coventry, England | 5 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| Ericsson (L. M.) and Co., 164-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 18 |
| General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford | 25 |
| Telegraph Manufacturing Co., Helsby, near Warrington, and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| Western Electric Co., Bridge-chambers, 171, Queen Victoria-st., London, E.C. | 2 |
| **TOOLS.**—Armstrong, Stevens and Son, Whittall-street, Birmingham | 26 |
| **TRANSFORMERS.** | |
| British Thomson-Houston Co., 83, Cannon-street, London, E.C. | 13 |
| Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. | 33 |
| Crompton and Co., Mansion-House-buildings, London, E.C., and Chelmsford | 35 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., and Salford | 25 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 12 |
| **TRANSMITTERS.** | |
| C.T.C. and Manufacturing Co., 186-188, Shaftesbury-avenue, London, W.C.; and Coventry, England | 5 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| Ericsson (L. M.) and Co., 164-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 18 |
| General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., and Salford | 25 |
| **TRAVELLING CRANES.** | |
| General Electric Co., 67, 71 and 88, Queen Victoria-st., London, E.C., and Salford | 25 |
| **TROLLEY BUSHES AND WHEELS.** | |
| Blackwell (R. W.) & Co., Ltd, 59, City-road, London, E.C. | 2 |
| **TURBINE MAKERS.** | |
| Gilbert Gilkes and Co., Kendal | 6 |
| Howes, S., 64, Mark-lane, London, E.C. | 4 |
| **TURNERS (Ivory and Hard Wood).** | |
| Bonnella (D. H.) and Son (Ltd.), 58 and 60, Mortimer-street, London, W. | 17 |
| **TYPEWRITERS.** | |
| Typewriter Company, 12, 14 and 16, Queen Victoria-street, London, E.C. | 21 |
| **UNDERGROUND MAINS.**—Callender's Cable and Construction Co., 90, Cannon-street, London, E.C.; Erith Marshes, Kent | 24 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, & Charlton, Kent | 1, 12 |
| **VACUUM TUBES.** | |
| Bonnella (D. H.) and Son (Ltd.), 58 and 60, Mortimer-street, London, W. | 17 |
| Cossor, 67, Farringdon-road, London, E.C. | 13 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| **VENTILATING ENGINEERS.** | |
| Blackman Ventilating Co., 63, Fore-street, London, E.C. | 32 |
| **VOLTMETERS.** | |
| Crompton & Co., Mansion House-buildings, London, E.C.; and Chelmsford | 35 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 7 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| Elliott Brothers, Century Works, Lewisham, and 101, St. Martin's-lane, London | 14 |
| Evershed and Vignoles, Woodfield Works, Harrow-road, London, W. | 21 |
| General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C., and Salford | 25 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 12 |
| Nalder Bros and Thompson, 34, Queen-st., Cheapside, London, E.C. | 25 |
| Pitkin, J., 56, Red Lion-street, Clerkenwell, E.C. | 20 |
| Richard Jules, Paris—Agent: Levi (J.) & Co., 97, Hatton-garden, E.C. | 30 |
| **VULCANISED FIBRE.** | |
| Mosses & Mitchell, 68, 69, 70 and 71, Chiswell-street, London, E.C. | 27 |
| **VULCANITE.** | |
| Harburg India Rubber C. Co. (F. Winter), 8, Redcross-street, London, E.C. | 33 |
| **WATER HEATERS AND SOFTENERS.** | |
| Baker's Patent Appliances Co., 13, Huntriss-row, Scarborough | 8 |
| Doulton and Co., Lambeth, London, S.E. | 10, 25 |
| **WIRE COVERING MACHINES.** | |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 12 |
| **WIRE (Covered and Uncovered).** | |
| British Insulated Wire Co., Prescot, Lancs. | 10, 42 |
| Connolly Brothers, Blackley, Manchester—London Agents: C. F. Quicke and Co., 301 and 303, Euston-road, N.W. | 24 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 32 |
| Felten and Guilleaume Carlswerk Actien-Gesellschaft—Sole Agents: W. F. Dennis and Co., 33, Billiter-st., London | 1 |
| General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C., & Salford | 25 |
| Glover (W. T.) & Co., Trafford Park, Manchester; & 2, Queen Anne's-gate, S.W. | 30 |
| Henley's (W. T.) Tel. Works Co., 27, Martin's-lane, London, & N. Woolwich | 1 |
| Heddernheimer Kupferwerk, Heddernheim and Oberursel, Germany. Agents for U.K.:—De Grelle, Houdret and Co, 130, London Wall, London, E.C. | — |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, & Charlton, Kent | 1, 12 |
| London Electric Wire Co., Playhouse-yard, Golden-lane, London, E.C. | 4 |
| St. Helens Cable Co., Warrington & St. Helens, & 32, Victoria-st., London, S.W. | 3 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool Glasgow and Belfast | 1 |
| **WIRE-DRAWING MACHINES.** | |
| Geck Brothers, Altena, Westphalia, Germany | 9 |
| **WIRE MILL MACHINERY AND APPARATUS.** | |
| Geck Brothers, Altena, Westphalia, Germany | 9 |

THE

**EDISWAN** COMPLETELY ENCLOSED **MOTOR**

OWING TO ITS

**HIGH EFFICIENCY and RELIABILITY**

ENSURES A LARGE MONETARY SAVING ON THE YEAR'S RUNNING.

THOROUGHLY RELIABLE
UNDER ANY
ATMOSPHERIC
CONDITIONS.

ENTIRELY ENCLOSED
IN
CAST STEEL
CASE.

ESTIMATES FREE.

**THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD.**

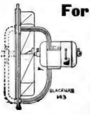
Supply Store: COLLEGE HILL, E.C. Large Stocks Kept ready for delivery of Fittings, Bells and all Accessories.

Head Office, Warehouse and Showrooms: EDISWAN BUILDINGS, QUEEN STREET, LONDON, E.C.

**BLACKMAN**

**Electric FANS**

**For VENTILATING.**



***GOLD Medal, Paris, 1900.***

*Expert Advice as to Application FREE.*

**BLACKMAN VENTILATING CO.,**
LIMITED,
63, Fore St., London, E.C.

**ELECTRICAL PATENTS.**

**Mr. J. G. LORRAIN**, M.Inst.E.E., M.Inst.M.E., Fellow of the Chartered Institute of Patent Agents.

NORFOLK HOUSE, NORFOLK STREET, STRAND, LONDON, W.C.

"PATENTEES' HANDBOOK," post free on application, gives Full Information to Inventors and upon all the chief points of the Patent Law.

*(Telegrams: "Lorrain London.")*

**"SANITAS EMBROCATION."**

For Aches, Pains, Sprains, Bruises, Stiffness, Neuralgia, Lumbago, Rheumatism, and for Veterinary Purposes.

"I have little doubt that 'Sanitas Embrocation' will come into prominent favour as a stable requisite and for various other purposes, human and veterinary."

(Prof.) WOODROFFE HILL, F.R.C.V.S.

In Bottles, 8d., 1s., and 2s. 6d. Of all Chemists, Stores, and

**THE SANITAS CO., Limited, Bethnal Green, E.**

was not imitated by the eleven colleagues from whom he had dissociated himself.

Some of Prof. PERRY's arguments as to the degeneracy of the profession of electrical engineers in this country are refutable by his own statements. All will allow that there are men whose business it is to use ordinary types of machines in well-known ways, a business which requires a comparatively small amount of originality. But these men, tradesmen though they may be, are needed. Machines must be made and must be sold to-day, but this in no wise prevents the engineer from working out an improvement in the machine or devising for it a new employment, which he will endeavour to put into practice on the morrow. Whether such traders should or should not advance to the highest rank in the Institution rests, in the first place, with the Council of that body, and the fact that there may be a difference of opinion as to this question can hardly occasion a degeneracy of the electrical engineering profession. Whether these others, obliged to rely on their profession for a livelihood, prefer to spend their leisure hours at music halls, or in the perusal of novels and in the study of poetry, can hardly affect the question. We fail to see that "those who scorn novels and poetry, and live utilitarian material lives" cannot yet devote themselves to their profession and do useful work. There are engineers, and even students of pure science and mathematics, who have no poetic instinct, or taste for novel reading, and lack the imaginative powers admired by Prof. PERRY in writers of leading articles for the daily newspapers, who yet devote what should be their leisure hours to the study of technical books and journals in order to keep themselves well abreast with progress in their profession.

Prof. PERRY also compares civil with electrical engineering. He appears to be of opinion that, since results are calculable with greater accuracy in the latter than in the former, the electrical engineer runs a greater risk of becoming a mere tradesman. A few lines later he quotes HUXLEY to the effect that "Science is organised common sense." But if he adopts this definition so absolutely he cannot think that with more detailed organisation it becomes no longer science. Again, while attributing the present backwardness of electrical engineering development in this country to the neglect of mathematics, he holds up America as an example of progress,—America, which has all along preferred the method of trial and error to that of predetermination, and whose greatest inventor has not built his greatness on a groundwork of mathematics. Finally, we regret that Prof. PERRY, who has raised his voice in indignant protest when he has been attacked by shafts sharpened with wit at the expense of accuracy, should himself try to raise a laugh by associating the name of England with those of the two countries whose decadence on the one hand and opposition to civilisation on the other are a bye-word.

Whether electrical engineering is in the main to be a trade or a profession, we are at one with Prof. PERRY when he recommends the study of mathematics and scientific methods to British engineers who aspire to be more than mere traders, and when he deplores that mathematics and science are not better taught in our public schools. We join him in exhorting the electrical industry of Great Britain to renewed efforts to regain its place in the markets of the world. Greater attention to the theoretical study of electricity will undoubtedly assist this, and is essential if our country is to retain a position in the vanguard of progress, and if the electrical profession is to retain its high standing. But Prof. PERRY's one-sided and too highly-coloured picture is, we fear, rather likely to weaken the cause he has so much at heart.

## SUBMARINE CABLE SPEEDS.

BY J. ELTON YOUNG.

The close of the century sees more than usual attention being devoted to submarine telegraphic enterprise and extension, including the inauguration of the Pacific project, and in several respects fitly marks an epoch in its progress. Mr. Heaviside has now formulated the complete theory of the propagation of waves along wires; Messrs. Crehore and Squier have just earned the gratitude of telegraph engineers by trying the transmission of signals through an ocean cable by sine currents; and the application of inductance to the line has recently been fairly well investigated. Nevertheless, there remains room for fresh elucidation of some difficult and interesting problems still only partially solved. The present article is an attempt to contribute towards this object by comparing theory with practice at its present stage.

Speaking at the Institution of Electrical Engineers on May 4th last year,* Mr. Charles Bright called attention to the desirability of an "effective" capacity value to be used in the "KR" constant for speed of signalling on long submarine cables, as well as the need of some standard of definition of signals. In the same debate Mr. F. Alex. Taylor alluded to the limitations imposed by the receiving apparatus, whilst Prof. S. P. Thompson reminded us of the influence of the inductance of the core, and Mr. Siemens suggested that of dielectric absorption as further modifying the old "KR" law. The factors thus referred to, in conjunction with the well-known action of leakage, indicate the three classes into which the various limits to speed of signalling naturally divide themselves, viz.:—

1. Those set by the constants of the cable to the propagation of waves, and their effect on the *form* of the wave impressed.
2. The limits of action of curbing or other devices applied to alter the form of the impressed impulses.
3. The disabilities of the receiving apparatus.

*Line Constants.*

On its purely theoretical side Mr. Oliver Heaviside has investigated the propagation of signals along the cable with an exhaustiveness which may well be accepted as final; and has developed the subject into one of the most monumental of mathematical studies by his extension of Lord Kelvin's original diffusion theory to include the inductance and leakage factors. The range of his treatment is so tremendous, that the telegraph engineer who attempts to explore his pages in search of practical guidance has to be at some pains to discriminate between what is applicable to his own particular problems, and what excluded by the data of the case. This remark, of course, applies very forcibly to the distinction between overland and submarine telegraphy.

It is somewhat unfortunate that the letter K has been of such universal employment to express the electrostatic capacity in connection with cable speeds, since throughout Heaviside's scheme it is used to denote the leakage conductance, whilst his symbol for the static capacity or permittance is S. Thus the old speed-constant becomes SR instead of KR; and it seems desirable to conform to this in order to avoid confusion. The term "permittance" need not be adopted yet, because, although it is shorter than the expression "electrostatic capacity," the latter is sufficiently distinguished by calling the electromagnetic capacity the inductance, and allowing the single word "capacity," as usual, to imply always the electrostatic quantity—that is, capacity for elastic displacement.

Keeping to Heaviside's notation therefore, the line constants are

R = conductor resistance,
S = capacity,
I = inductance,
K = "leakance."

* *Journal* of the Institution of Electrical Engineers, Vol. XXVIII., pp. 496–7.

As, however, telegraph engineers are more familiar with leakage resistance than with its reciprocal K, let

$$1/K = I = \text{leakage resistance.}$$

Electromagnetic theory tells us that, if these four line constants are such that

$$L/R = S/K \text{ or } IS,$$

we have the conditions of the "distortionless" circuit. Albeit this is a pure abstraction at present in ocean telegraphy, and is likely to remain so, though possibly attainable on overland lines, yet this equation is the finger post pointing the way towards the ideally perfect cable.

*Time Constants.*

Both of the quantities L/R and S/K or IS are of the dimensions of time constants, the former being the electromagnetic and the latter one of the two electrostatic time constants, of which the other, and more practical one, is RS. The electromagnetic time constant of the cable is the very small fraction

$$\frac{L \text{ henrys}}{R \text{ ohms}} = \text{seconds},$$

a magnitude of the order of thousandths of a second, unless the cable be coiled in a tank. It may be approximately defined as the quantity which would determine the rate of the electromagnetic discharge or "extra current" if there were no electrostatic capacity in the circuit.

The usual electrostatic time constant is R ohms × S farads = seconds, ranging from 1 to 10 seconds for submarine cables; and is, similarly, the time governing the rate of the static discharge in the absence of counteraction by electromagnetic capacity or inductance. It is the time in which the line would lose 63·2 per cent.* of its charge if the capacity were all collected at one spot and discharged through the resistance of the conductor.

The other electrostatic constant, expressible as I megohms × S microfarads = seconds, is always, for well-insulated cables, a magnitude of the order of minutes. For a line of dielectric resistance 1 megohm and capacity 600 microfarads it amounts to 10 minutes. It is the interval in which the cable loses 63·2 per cent. of its charge by leakage through its dielectric, were it not for the action of absorption, which somewhat retards the rate of loss of charge, and thus slightly increases this time constant. The observation of this time is useful in testing, as is well known. In signalling, whether condensers are interposed or not, the discharge chiefly occurs, in the absence of leaks, at the end of the cable; so that the resistance of the conductor is what enters into the time constant, which is accordingly RS. As the insulation is lowered more discharge is able to flow through the leakage resistance, and this time becomes shortened; but this does not appear to be expressible in any simple ratio of R to I.

The study of these time constants is instructive, and is a useful way of approaching problems of speed of signalling, more especially on overland lines. For instance, when the magnetic is one-third of the static time constant, Heaviside shows † that the impulsive inductance balances the impulsive capacity, neglecting their distribution and the leakage. It is important to notice that, whilst the first static time constant RS varies as the square of the length of the line, the second static and the magnetic ones are independent of it so long as I is the natural inductance, either of a land line or of the conductor and sheath of an uncoiled cable. Therefore the quantities *l, r, i, s* per mile will yield the same values for the ratios *l/r* and *is* as when we reckon their total amounts for the whole line.

In considering the question of how to proportion the electrical qualities of any telegraph line so as to contribute as far as possible towards the conditions of the ideal distortionless circuit, it is evident at the outset that it is hopeless when regarded from the point of view of even remotely equalising the time constants L/R and IS in a submarine cable. Nevertheless, anything which tends to reduce R, I, and S, and to increase L, is a step in the direction of raising the speed of signalling. To estimate the extent of the gain, the manner in which speed varies with the four quantities involved must be considered, which is a very complex one indeed, as students of Heaviside are aware, if rigorously treated, but is capable of much simplification by approximations. Two of these are very important in the mathematical theory—viz.: (1) the assumption of a simple harmonic variation of voltage at the sending end, which greatly simplifies the solution of the differential equations involved, and renders problems manageable which would otherwise be beyond reach; (2) the method of "operators," introduced by Heaviside. These are helpful in the elementary study of the line constants. Thus, *p* being the factor of frequency of transmission,

$$Z = R + Lp$$

is called the "resistance operator" of the line, and is seen to be composed of

Resistance + reactance,

both measurable in ohms. Similarly,

$$Y = K + Sp$$

is the "conductance operator," and consists obviously of

Leakance + admittance (*i.e.*, negative reactance),

both expressible as the reciprocal of ohms.

*Reduction of R and S.*

Designs for increasing the speed of submarine cables have of course principally been made in the direction of reducing R and S, which are by far the most effective means of doing so. Reduction of resistance stands first in this respect, whilst that of capacity comes second, as is found when studying the influence of the shape of waves on effective working speeds. In connection with lowering S, the question has been raised by Mr. Siemens whether the absorption component of capacity may not be more influential than the measured value of S indicates; that is to say, whether two apparently equal capacities per naut may differ in behaviour by reason of one of them having a smaller absorption component than the other. Measurements of capacity show, however, that such a reduction of absorption must be apparent in the value of S observed by the usual methods; and that it only slightly lowers it when measured by alternating currents of average telegraphic frequency. This again probably depends on whether the alternations are sinusoidal or intermittent makes and breaks, as in telegraphy, a point which would be worth investigating. That there exists some variation of the value of S with frequency of transmission, dependent on the absorption, seems reasonable. That is to say, irrespective of the speed factor represented by *p* in the line constants L*p* and S*p*, there is an alteration of S itself with frequency, somewhat corresponding to the hysteresis variation of L where iron is concerned, (in other words, does not residual charge affect S much as residual magnetism changes L?) The effect, whatever it amounts to—probably less than 5 per cent. in any case—would be estimated by measuring S with intermittent currents at the frequency of actual signalling. The question is, in short, equivalent to the one proposed by Mr. Bright (in the same debate in which Mr. Siemens took part), as to whether the usually observed capacity of cables represents strictly the value involved in governing speed.

There is another "effective" capacity, having a quite different meaning from that just considered, which is sometimes used in Heaviside's writings to conveniently express the result of the combination of capacity with inductance, by regarding the latter in the sense of negative capacity. This "effective" S is therefore reduced appreciably at high speeds of transmission by the inductance L of the cable, as will be considered presently.

Setting R and S aside there remain I and L to be discussed, of which the former may be taken first.

*Effects of Leakage.*

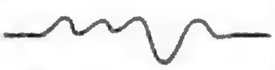
Assuming the influence of inductance to be negligible, which can be done in the case of *slow* submarine cables, the action of leakage has been traced in one of the earliest and most

* A ratio arising out of the natural logarithm, according to which loss of charge takes place, 63·2 per cent. leaving 1/*e*th of the charge in the cable.

† "Electrical Papers," Vol. II., p. 368.

admirable of Heaviside's Papers,* in which he has worked out the effects of a single leak at the centre of the line, of resistances zero, infinity, and a quarter of R respectively, with and without very small condensers at both ends. The two effects caused by leakage, to be distinguished from one another, are, firstly, reduced damping of reversals at a given speed, due to diminution of the distortion, which is a gain; and, secondly, reduced amplitude of the same, which is a loss.

The damping of ordinary reversals from a battery at about 80 letters per minute by the SR of the cable is computed, in the Paper cited, to be diminished by a leak of resistance R/32 at the centre of a cable having an SR of about 8sec. by, roughly, as much as 40 per cent. Hence, something approximating to a 40 per cent. improvement of signals might be expected, were it not that their size would be reduced by the leak to about one-ninth. Moreover, in order to bring this 40 per cent. action into full play, either the condensers must be made very much smaller than usual, thus causing the current to vanish still further, or else the speed of signalling has to be reduced considerably below the maximum permitted by the SR of the cable when worked by the siphon recorder with skilled clerks. We are, as a matter of fact, led by actual trials to the disappointing conclusion,† which instances strikingly how illusory theory can be when not specialised enough, that very little increase of *speed* is to be derived from any arrangement of isolated leaks with siphon recorder signalling. The forms of the arrival curves with and without faults in the cable show that the influence of these in improving the definition of signals is unquestionable so long as the speed is kept below that limit at which the curves of successive received dots begin to blend into a continuous wave without ripples, thus

 instead of 

because then the leakage has time to come into effective action. A glance at the arrival curves given in the Paper referred to shows that, with condensers at both ends, this action is principally brought out in their descending portion, whereas in transmission near the limiting speed of the line the curves have only time to reach their crests. As the speed of sending is lowered the leakage effects become more and more marked, the distortion tending to disappear, but the size of the signals going along with it.

If, however, a cable is going to be worked at a speed much below its maximum siphon recorder limit—as, for example, when relays are employed—then one or more leaks ought to prove of greater value. They would serve the double purpose of increasing the sharpness of the impulses, and, by discharging the line rapidly, of preventing the zero of the relay from wandering when a succession of dots or dashes is sent, which is found to be the principal difficulty in repeating recorder signals through cables. What gain in speed would be attainable can be best discovered by trials, and depends on the strength of current required to work the relay, which, of course, sets an early limit to the amount of leakage allowable.

Generally speaking, the *curbing* action of a fault can be better obtained by reducing the capacity of the condensers or by automatic curb transmission. But there is a limit to both, soon reached on long cables, beyond which signals merely become "over-curbed" without gain in definition. This limitation might be expected not to apply to leaks distributed at a sufficient number of points along the cable. As a matter of fact, however, it practically does apply; and notwithstanding that a given amount of "leakance" has more effect when it is spread along the line, yet experiment on an artificial cable proves that almost precisely the same sharpening of signals is arrived at by condenser adjustment. In short, with the condenser mode of working, practically nothing has been done in this direction of improving speed. (See "Electromagnetic Theory," Vol. I., pp. 418–428.)

* "Electrical Papers," Vol. I., p. 71, "On the Theory of Faults in Cables" (published in 1879).

† *See* "Submarine Telegraphs: Their History, Construction, and Working," by Charles Bright, F.R.S.E., pp. 682–4.

*Influence of Inductance.*

Coming now to the remaining method of reducing the distortion of signals by modification of the line constants—viz., increasing the inductance—the question first arises as to how far the natural inductance of the cable is already influential in this direction. To get a clear idea of the actual magnitude of L is by no means easy. Its minimum, as a mere dielectric constant, not allowing either for wire or sheathing, is something like 0·0002 henry per kilometre, but much larger when the form of the wire and presence of the sheathing are taken into account. Making the conductor with a copper taping round it increases it on the one hand, which has been accordingly done in recent cables, whilst the iron sheathing, on the other hand, does so to a variable extent, depending upon the strength and periodicity of the current. An attempt to further raise the inductance by adding an iron ribbon to the core was recently described by Dr. F. Breisig in a remarkable Paper reproduced in these columns,* which repays careful study.

In this research it was found that the inductance of an ordinary cable was about 0·0025 henry per kilometre for alternating currents at a frequency roughly corresponding to 150 letters per minute signalling speed (frequency $= n/2\pi =$ about 10 complete waves per second if $n = 63$).

The greatest increase of inductance that could be produced by adding iron ribbon around the core was, under these conditions, observed to be 57 per cent. Hence it was calculated that, approximately, the reduction of distortion and consequent improvement of signalling could not exceed 8 per cent. when the limiting speed was, as stated, about 150 letters per minute.

The fact that if cables were capable of faster transmission than this the influence of L would be greater, is the important point to bear in mind in dealing with this problem. For, irrespective of the variability of L itself with the frequency, arising from the presence of the iron sheathing (or iron ribbon if it were added)—which has a complicating tendency to *lower* L as the frequency is raised—we have the fact that L enters into the equations in the form of what is termed the "reactance" factor $Ln$; at least, it does so when the problem is resolved into one of the damping of simply periodic currents, as is usually done for purposes of mathematical simplification. It then forms part of the impedance, which is the well-known $\sqrt{R^2 + L^2n^2}$, when capacity is left out of account, but is, of course, in this shape totally inapplicable to submarine cables. The quantity concerned when capacity is present Heaviside has called the "equivalent impedance." Into this S enters in the same manner as L, namely, $Sn$, or negative reactance; whilst leakage is also included in the full formula. This is led up to at the close of the first volume of "Electromagnetic Theory" (p. 452), and may be quoted here. Calling V the amplitude of the potential received at the end of a cable of length $l$, and $e$ the E.M.F. impressed at the sending end, whilst K is the leakage conductance or 1/I, we have

$$V = e\epsilon^{-Pl},$$

where $$2P^2 = (R^2 + L^2n^2)^{\frac{1}{2}}(K^2 + S^2n^2)^{\frac{1}{2}} + RK - LSn^2.$$

The expression for the current amplitude is also given in the same place, namely,

$$C = e\left(\frac{K^2 + S^2n^2}{R^2 + L^2n^2}\right)^{\frac{1}{2}}\epsilon^{-Pl}.$$

Let us now neglect the leakage (as conversely inductance was ignored when considering the benefits of leakage); then the value of P becomes such that

$$2P^2 = (R^2 + L^2n^2)^{\frac{1}{2}}\,Sn - LSn^2.$$

Taking the ordinary case of working with condensers at the receiving end, we may regard the amplitude of the potential, rather than that of the current, as determining the strength of the signal. Let the cable be one having negligible leakage, as may generally be assumed of sound cables, and its other constants as follows, all reduced to the common measure

* *The Electrician*, Feb. 2, 1900.

of C.G.S. units (the inductance being purposely given a very low value at first):

$\epsilon = 10$ volts $= 10 \times 10^8 = 10^9$ C.G.S. units.
R $= 2\omega$ per km. $= 2 \times 10^9 \times 10^{-5} = 2 \times 10^4$ per cm.
S $= 0{\cdot}25\phi$ per km. $= 0{\cdot}25 \times 10^{-15} \times 10^{-5} = 0{\cdot}25 \times 10^{-20}$ per cm.
L $= 0{\cdot}001$ henry per km $= 0{\cdot}001 \times 10^9 \times 10^{-5} = 10$ per cm.
$l = 2{,}000$ kilometres $= 2{,}000 \times 10^5$ centimetres.

Let the frequency of reversals $n/2\pi$, assumed simply harmonic, be such that $n = 80$, which corresponds roughly to the rate of 200 letters per minute signalling speed. Then

$$\mathrm{P}l = 8{\cdot}76$$
and $$\mathrm{V} = \epsilon e^{-\mathrm{P}l} = \epsilon \times 1/\mathrm{K},$$
where $$\log \mathrm{K} = 8{\cdot}76 \times 0{\cdot}4343.$$
Whence $$\mathrm{V} = 157{,}820 \text{ absolute units.}$$
$$= 15{\cdot}8 \text{ millivolts.}$$

Now let L be increased to 0·0025 henry per kilometre, the other factors remaining unaltered. We then get

$$\mathrm{P}l = 8{\cdot}509,$$
and $$\mathrm{V} = 20 \text{ millivolts.}$$

If L be further raised to 0·004 henry per kilometre,

$$\mathrm{P}l = 8{\cdot}246,$$
and $$\mathrm{V} = 26 \text{ millivolts.}$$

In order to estimate the gain in speed of signalling represented by the reduction of damping in this last case, in which L has been raised from 0·0025 to 0·004, we must find how much $n$ may be increased in the above formula for amplitude so that V shall still be about 20 millivolts. Taking an increase of 10 per cent., which makes $n = 88$, we find V $= 18{\cdot}6$. Therefore the gain in speed for a 60 per cent. addition to L is somewhat less than 10 per cent., or, say, 8 per cent. This result agrees with that of Dr. Breisig's research, since I have assumed similar values of the inductances.

As is well known, the effects of such additions to the inductance became immensely enhanced at the frequencies of telephonic waves,* but for telegraphy up to 200 letters per minute, the foregoing indicates that not much is to be looked for from the naturally distributed inductance of the cable.

The investigation of what can be done by artificially—that is to say, discontinuously—distributing L, by means of induction coils, has never yet, it appears, led to a satisfactory result in dealing with the great lengths and correspondingly low speeds of ocean telegraphy. It is evident that directly the inductance is distributed in the form of shunts the number of such derived circuits that can be applied is so limited, by their attenuation of the current, that L has but small chance of asserting its influence. Putting the inductance in *series* with the line, in the shape of coils of low resistance with large iron cores, appears to be a more promising direction to pursue from a theoretical point of view. It is difficult to see how it could be safely carried out in a submarine cable, but it is worth attempting. The essential difference between the two methods is that, whilst the shunt tends to compensate the capacity at only one particular speed of transmission, inductance in series with the conductor tends to do so for all frequencies. This follows from the fact that, when L is in series with the conductor, the positive reactance L$n$ and the negative reactance S$n$ are counteracting one another, so that their resultant effect would eventually vanish for all values of $n$, by making L$n$/R $=$ S$n$/K, that is L/R $=$ S/K or IS. To approach such a result as this practically, of course, requires impossibly large quantities of inductance, but, as pointed out before, any increase of L not involving a proportionate addition to R cannot fail to be beneficial. This insertion of inductance in series indeed appears to be the only remaining direction promising much improvement in cable telegraphy so far as the line is concerned (apart from further reduction of R and S), inductive shunts being so far a failure.

* Heaviside demonstrates that, through a cable of 100km., having R4$\omega$ and S 0·25 microfarads per kilometre, telephony would be impracticable but for the inductance, even if the latter were lower than 1 millihenry per kilometre.—"Electrical Papers," Vol. II., p. 393

By far the most successful experiment yet made by means of distributed inductance coils appears to be that of Dr. Pupin, an account of which he recently communicated to the American Institution of Electrical Engineers, and which was reproduced in *The Electrician* of Aug. 10, 1900. This was a trial of telephonic transmission through an artificial line constructed to represent 250 miles of cable, not, however, of the usual submarine type but of the subterranean telephone pattern of cable, its capacity being only 0·074 microfarad per mile. The insertion of inductance coils in series enabled perfect speech to be transmitted by this laboratory line when they were placed at sufficiently frequent intervals along it. That this really represented what should occur in an actual cable, and was due to no direct induction between the coils, seems sufficiently proved by the fact that when they were distributed too widely apart speech was worse than with no coils inserted at all, by reason of reflections interfering with the wave transmission. The accordance of this, as well as of the other effects observed, with mathematical theory, renders it probable that Dr. Pupin's conclusions are quite correct so far as the action of coils without iron is concerned, such as those employed in his experiments were. It now remains to be proved how far his predictions as to the action of coils containing iron, such as would, of course, be indispensable to give enough inductance in submarine cables, can be carried out in an actual submarine line.

For telephony a definite minimum total inductance per mile is necessary, but for telegraphic purposes any addition to it far short of this telephonic amount is conducive to gaining speed, provided the condition be observed, which Dr. Pupin has now investigated in a practical way, of distributing L sufficiently to avoid the neutralisation of its benefits by reflection. The effects of reflection have not previously been brought out with clearness in practice, though there is plenty about their mathematical theory in Heaviside's work. The analogy of the stretched loaded cord is the most helpful way of realising the matter. What it amounts to appears to be that, whilst the interposition of inductance at a single point alone in the line occasions wave reflections when the wave-length is less than that of the line, its distribution at multiple points does so to a decreasing extent as the number of coils is increased, up to a certain limit beyond which there is no appreciable advantage, which he gives a rigorous method of computing.

Taking, for example, the imaginary submarine cable proposed in Dr. Pupin's patent, cited on p. 601, Vol. XLV., of *The Electrician*, and calculating for a frequency $n/2\pi$, equivalent to about 150 letters per minute (say $n = 63$), and assuming it possible to get the value of L up to 0·3 henry per mile, as he suggests, the wave-length comes out 328 miles.* It follows that his rule for sufficient distribution of the inductance coils would be easily satisfied if they were placed at every mile (or even at every 10 miles or 20 miles). Setting aside such enormous values of L, which are probably unattainable, and supposing it, for the other extreme, to be raised to only the value 0·004 per mile given in my previous example, with 200 letters per minute signalling speed, the wave-length is then about 805 miles, which would permit of still wider intervals for the coils if necessary (say, 50 miles). But since the more numerous they are the smaller the coils can be made, wide intervals would presumably be avoided in a submarine cable.

In conclusion, it must be remembered that, although calculations such as have been indicated in this Paper furnish us with a guide to gain of speed, yet they cannot be relied upon to yield more than merely approximate results. How close such approximations are to the truth depends on how far a simply harmonic system of impressed waves can be taken to represent the intermittent impulses of telegraphy, to which they are certainly not equivalent; and, when inductance coils are interposed, on the behaviour of their iron cores towards telegraphic currents. The latter will no doubt shortly receive further experimental investigation.

* Wave-length $= 2\pi$ Q, where $2\mathrm{Q}^2 = (\mathrm{R}^2 + \mathrm{L}^2 n^2)^{\frac{1}{2}} \mathrm{S}n + \mathrm{LS}n^2$, neglecting leakage.

## EXPERIMENTS ON HERTZIAN TELEGRAPHY WITH A TELEPHONIC RECEIVER.

M. Guarini has sent us an account of some experiments he has performed which constitute a verification of certain ideas of his published since June, 1899. They are described briefly below :—

1. Using a telegraphic key, a current of about 4 amperes was sent from a battery of eight accumulators through the primary of an induction coil possessing a contact breaker. The secondary of the coil gave nearly 2in. sparks between a point and a plane ; the resistance of the primary winding was 0·11 ohms, and of the secondary winding, 8,000 ohms. In

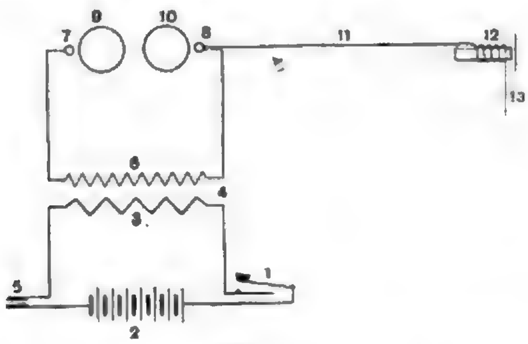


FIG. 1.

the present experiment the secondary terminals were nickeled knobs which charged a Righi oscillator with balls of about 4in. diameter about $\frac{1}{25}$in. apart. From one of the knobs, 8, Fig. 1, a single insulated copper wire about 12 metres long led to a telephone, 12, whose other wire, 13, remained hanging free. The telephone was thus in a perfectly open circuit. But when Morse signals were sent by the key, 1, they were received and interpreted easily by a listener at the telephone. M. Guarini concludes that Hertzian currents produce magnetisation of the telephone core as well as ordinary currents ; and that telegraphy on a single wire, without earth or other return, is possible by means of Hertzian waves and a telephone.

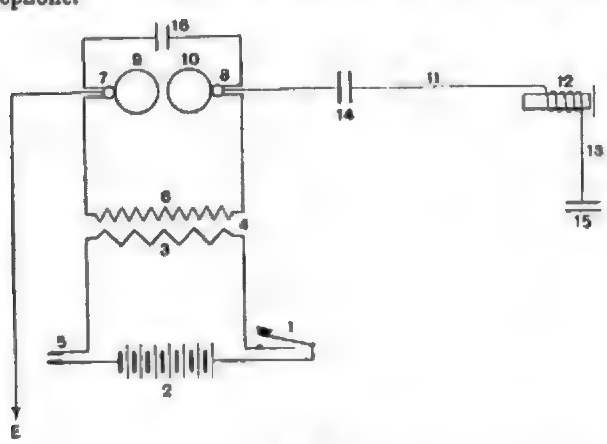


FIG. 2.

2. A condenser was interposed between the knob of the coil and the telephone. The signals were much improved. This leads M. Guarini, by analogy, to conclude that in ordinary wireless telegraphy the interposition of a condenser in the air-wire might improve the transmission of signals !

3. The condenser was attached to the free terminal of the telephone instead of being placed as in the last experiment (see Fig. 2). The noise in the telephone was again increased.

4. A combination of the second and third arrangements (*i.e.*, with two condensers) resulted in the production of still clearer and louder signals.

5. The condenser was in this case placed across the knobs, which had been placed in contact with the corresponding balls of the oscillator. The more this capacity was increased the louder became the sounds in the telephone.

6. The other knob of the induction coil was now put to earth, the second terminal of the telephone remaining free. The signals were loud, but not louder than before.

7. The knob connected to the telephone was put to earth, the other knob of the coil being free. There was practically no noise then heard in the telephone, as might have been expected. M. Guarini concludes, however, that this experiment shows that most of the energy is radiated from the knob at which occurs the greatest variation of potential !

8. The combination of the conditions in experiments 5 and 6 showed that the putting to earth of one knob of the coil is

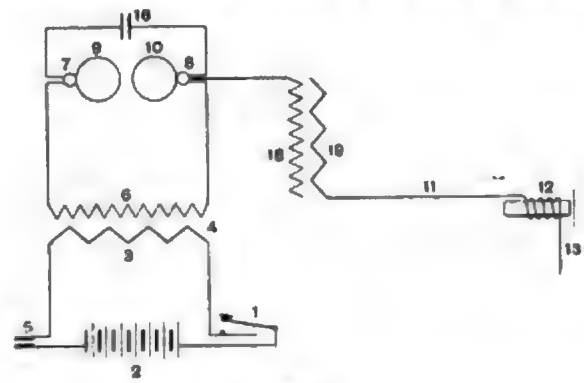


FIG. 3.

of comparatively little benefit when there is a condenser across the spark-gap of the coil.

9. By combining experiments 4, 5, and 6, and adjusting the condensers, a very powerful effect was obtained. For the first time the ear had to be protected by being insulated from the telephone. M. Guarini suggests that this demonstrates that the proper use of condensers in wireless telegraphy would

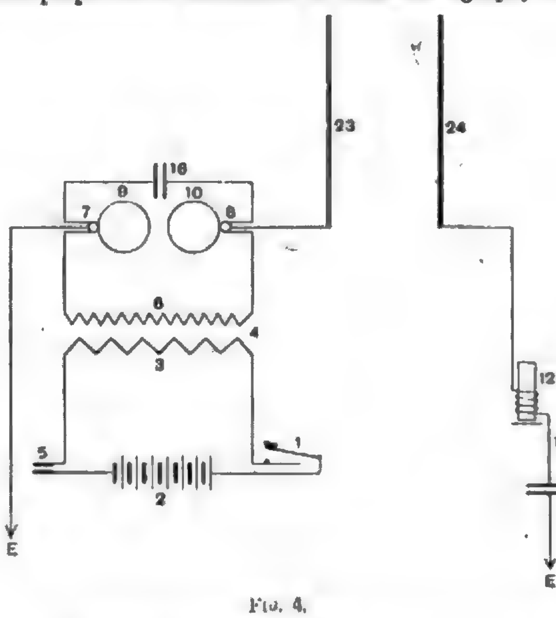


FIG. 4.

lead to a great increase in the possible distance of signalling. In experiments 10 and 11 (see Fig. 3) M. Guarini interrupts by a transformer the lead going to the telephone. He finds that the oscillations are very perfectly transformed. Next he repeated carefully the preceding experiments when all the sending apparatus was enclosed in a metal box, and found that signals were exactly as before.

Further, M. Guarini has performed a similar series of experiments when there was no conducting communication between the sender and receiver (see Fig. 4). He used horizontal "antennæ" or air-wires nearly 10ft. long and worked with a distance of several yards between them. At first the telephone terminal not connected to the receiving antennæ was free, but later was connected to one side of a condenser,

The condenser improved the signals. Afterwards, this condenser had its free terminal earthed while the free knob of the induction coil was also earthed; and from his observations M. Guarini deduces that, by this last mode of connecting, signals could easily be transmitted to distances between 10 miles and 20 miles by using antennae of 180ft. to 200ft. in length. The chief advantages of this mode of receiving are, of course, its inexpensiveness and its convenience, and these, the author thinks, may enable the method to be of some utility in special cases.

## ELECTRIC MOTOR CAR TRIALS.

Trials of electric motor cars under the auspices of the Automobile Club, are now being proceeded with in some of the prettiest and muddiest ways and byways of Kent. On Tuesday a run was made over a given course to see what distance could be traversed by the motor car on one charge of the accumulators. On Wednesday a course of 30 miles was chosen over a particularly hilly route; yesterday the course was to be an average route of better character than on Tuesday (also 30 miles in length), and to day it is proposed to repeat Tuesday's trial. The following gentlemen constituted the judges' committee :—

| | |
|---|---|
| Prof. Vernon Boys, F.R.S. | Sir W. H. Preece, K.C.B. |
| Prof. C. A. Carus-Wilson. | Sir David Salomons, Bart, J.P. |
| Mr. Hugh Harrison. | Mr. James Swinburne. |
| Major H. C. L. Holden, R.A., F.R.S. | Mr. Alex. P. Trotter. |

with Mr. C. Johnson, the secretary to the club, as secretary. Among those who had kindly volunteered as honorary official observers were—

| | |
|---|---|
| Mr. J. S. Critchley. | Mr. Robert E. Philips. |
| Mr. Ferguson. | Mr. W. R. Pidgeon, M.A. |
| Mr. M. J. O'Gorman. | Mr. Llewellyn Preece. |
| Mr. Kennaway. | Capt. Tulloch, R.A. |

The cars met at Chislehurst, and were charged from the Chislehurst Electric Lighting Co.'s station, Mr. Hanning (the resident engineer) being busily engaged superintending the charging all Monday night.

Prof. Boys gave Saturday and Sunday to the selection of routes for the electric trials, and Mr. Holden gave up the whole of Sunday (21st) to co-operation with Prof. Boys in this work, for which Mr. Henry Edmunds lent his six-horse Daimler car. Mr. Harmsworth kindly lent his six-horse Daimler car for the purpose of the examination of the roads selected for the electric trials. Mr. Llewellyn Preece also gave active assistance to the judges' committee, especially in the difficult duty of making log-sheets of the charging current supplied to the cells.

The route chosen for Tuesday was from Chislehurst to Foots Cray, Farningham, Wrotham, Ightham, Seal, Riverhead, Poll Hill, Green Street Green, Orpington and Chislehurst. This includes a sharp descent into the village of Farningham, one or two tedious hills between Farningham and Wrotham, ending in a dangerous and slippery hill into Wrotham village. Near Ightham there was also a steep hill to climb; and to attain the summit of Poll Hill, although the ascent was gradual, the road was extremely soft and made heavy running. The run was booked to start at 7:30 a.m., but in spite of the energies of Mr. Hanning and his staff it was 9:30 before the charging was completed, and the first two cars started off at 9:45. By an odd coincidence it was a vehicle bearing the name "La Toujours Contente" which took the most unexpected number of ampere-hours to satisfy it.

The following is a list of the vehicles which ran in Tuesday's competition, and the number of miles covered :—

"The Powerful," a Krieger car, entered by the British and Foreign Electrical Vehicle Co. Although seating only two, this car was very large, and provided with a heavy battery. The motors drove the two front wheels through spur gearing, and both the hind wheels were fitted with band brakes. This car had pneumatic tyres. Distance travelled, 59 miles.

The same firm's "Columbia" stanhope ran 7½ miles.

A delivery van entered by the same company chose an easier route and covered 7 miles.

"La Toujours Contente," entered by Mr. E. W. Hart, was an Austrian car, and also carried a very heavy battery and only two seats. It had a smart torpedo-like projection in front to diminish air resistance. There were four motors, whose armatures were directly mounted on the hubs of the wheels. The batteries, which we understand were new cells fitted at the last moment, were of English make with cylindrical electrodes. Possibly, in consequence of the hurry, the connections presented a very corroded appearance, and the battery conveyed both to the sense of sight and touch evidences of considerable surface leakage. This car ran 31 miles, carrying two passengers.

The "Joel" car, entered by the National Motor Carriage Syndicate, was also designed for two passengers. It carried a Rosenthal battery, and was fitted with a Joel motor. This vehicle ran 37 miles.

Two cars exhibited by the Electric Motive Power Co., one with a two-pole series motor and the other with a four-pole enclosed series motor, and each carrying two passengers although built for four, covered 17½ miles and 35 miles.

The Canadian Electric Motor Co.'s "Still" vehicle with solid rubber tyres, and fitted with an "Ideal" battery, carried four passengers 18 miles.

The Electrical Undertakings car built, for three or four passengers and carrying a Leitner battery, and equipped with a Lundell motor, conveyed two passengers 35 miles.

The weather was damp, with almost continuous rain, and necessitated considerable self-sacrifice on the part of the honorary observers who accompanied the cars. Two of the competitors had previously determined to accomplish 150 miles, but few really expected that they would succeed so far.

On Wednesday, as already stated, the route was 30 miles. It included some very hilly and more or less rough roads in the neighbourhood of Cudham and Knockholt. From Green-street Green to Cudham (2½ miles) the road rises from 300ft. to 680ft. above sea level, and Knockholt Beeches (1½ miles further on), is one of the highest points in Kent, being 735ft. above sea level. On this day the Electrical Vehicle Co.'s "Powerful" completed 28 miles out of the 30 miles, and then withdrew, owing to an accident caused by a shying horse.

The National Motor Syndicate's "Joel" car covered 38½ miles, but was delayed by a chain coming off.

The Electric Motive Power Co.'s cars, the Canadian Motive Power Co.'s car, and the Electrical Undertakings car, each completed 22 miles, the Canadian Co.'s car carrying four passengers and the other cars two passengers, including the driver. The "Columbia" stanhope, the delivery car, and "La Toujours Contente" were withdrawn from the trials.

By a lucky chance the route selected passed through Chislehurst, the starting point, at 21½ miles, so that there was not so much difficulty as there might otherwise have been in getting the disabled cars home.

Yesterday's route, also 30 miles long, was viâ Farningham, Shoreham and Otford to Poll Hill, and back by the same route as on the first day. At the moment of going to press, however, we had not received the result of these trials.

Owing to a fatal accident to his son on Saturday, Mr. Carl Oppermann, who had entered a two-passenger car fitted with a Flambeau battery, withdrew it from the competition.

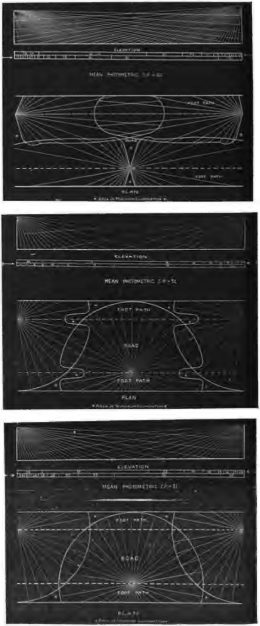
## INCANDESCENT LAMPS FOR STREET LIGHTING.

The Improved Electric Glow Lamp Co. has sent us some interesting particulars of its system of street lighting by means of reflector glow lamps. The lamps of this company, two of which are seen in Fig. 1, are of what is commonly known as the "door knob" shape. They consist of ordinary incandescent lamp filaments enclosed in a bulb shorter and of larger diameter than that employed as a standard by the majority of other lamp makers, and the upper half of this bulb is provided with a reflector. This reflector is a silver deposit protected against the action of the weather and mechanical injury by a coating of metallic copper deposited directly on the silver film.

The diagrams shown have also been sent us by the company, and form a comparison of the distribution of light on three different systems. The heights of the lamps from the ground were from 10ft.

FIG. 1.
Two-light Fitting in Ordinary Gas Lantern.

FIG. 2.
Pull Switch and Fuses in Watertight Box.



FIGS. 3, 4 and 5.

to 12ft., and in each case lanterns containing two lamps of equal candle-power and wattage were used, spaced 100ft. apart on either side of the road, *i.e.*, one lamp every 50yds. on alternate sides of the road. The road being 40ft. wide, there were 2,000 sq. ft. to be illuminated per lamp post. The diagrams, which are from tests made by the Electric Tested Lamp Co., are referred to as follows in this company's report:—In Fig. 3 I.E. street lighting system the major part of this area falls under the rays which leave the lamp at between 0deg. to 20deg. on either side of the horizontal. The candle-power over these angles varies between 60 c.p. and 80 c.p. It will be found from the diagrams that the mean illumination throughout the area is 60 c.p., diminishing to 20 c.p. below the post, attaining to 60 c.p. 20ft. from the post, increasing to 80 c.p. 50ft from the post. This is exampled by the diagram marked "Elevation" in which the number of radial lines going to each 10deg. when multiplied by 10 will give the candle-power throughout that area. Similarly, when the Figs. 4 and 5, which are the well-known "Brighton" and "Holophane or Prism" systems respectively, are compared, it will be found that the mean illumination over the whole area from Fig. 4 is 32 c.p., and from Fig. 5 is 31·2 c.p. The plans of illumination are obtained by marking points at each arc of the circle equivalent to the candle-power at that point.

Fig. 2 shows details of a "pull" switch and double pole "damper" cutout. It is enclosed in a watertight cast-iron box, tapped top and bottom for ¾in. gas barrel. The one illustrated is for current up to 4 amperes and pressures up to 250 volts.

## THE DOWSING LUMINOUS ELECTRIC RADIATOR.

Some 18 months ago we gave an account of the then fairly novel application of luminous radiation to the treatment of various muscle and joint affections, and we have from time to time referred to electric heaters in which large electric lamps are employed. Mr. Dowsing has paid considerable attention during the last two years to both these applications of electricity, and we recently inspected his latest pattern of radiator for heating rooms. The apparatus recommended as a substitute for a coal fire consists of a bright copper framework resembling an open fire-grate in appearance, in the bay of which are placed four incandescent lamps of special pattern. The intensely-reflected glow from the stove is very pleasant and cheering, and in itself gives this form of heater an advantage over other types of electric stove. Moreover, when the reflecting sheets of copper themselves become heated, the current of air which passes behind them through specially arranged channels not only prevents backward radiation to the wall of the room, but also, by flowing into the apartment, warms the atmosphere. The standard sizes consume one Board of Trade unit per hour, or if one pair of lamps be cut out by means of one of the two switches at the front of the stove, a half unit per hour. This is by no means an extravagant consumption when the convenience, instantaneousness of action, absence of all dirt and smoke, and the hygienic advantages are all taken into consideration.

Latest Pattern of Dowsing Electric Radiator.

## CORRESPONDENCE.

### AN INTERNATIONAL TECHNICAL DICTIONARY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting leading article in your issue of to-day, in which you criticise the scheme for the compilation of an International Technical Dictionary, is, I venture to think, founded on the misapprehension that the editor of the proposed dictionary would receive no remuneration. The Society of German Engineers are prepared to bear the cost of remunerating an editor and his staff of assistants. What they want is the honorary co-operation of other technical societies. This arrangement has answered admirably in the case of Dr. Murray's great dictionary, where the invaluable assistance rendered by the Philological Society and by an army of enthusiasts throughout the country has been purely honorary.

With its 15,227 members the Society of German Engineers is the largest technical society in the world, and therefore fully entitled to take the lead in this important work. The society has already voted £250 for defraying the cost of preliminary inquiries. It is thus evident that, if it is decided to carry out the work, it will be done in a generous spirit. Mr. Peters, the secretary of the Society, estimates that the work could be completed in six to eight years.—Yours, &c.,

Iron and Steel Institute, BENNETT H. BROUGH.
London, S.W., Nov. 2.

## LEGAL INTELLIGENCE.

### National Free Wiring Co. v. Jones.

Judge Lumley Smith, in the Westminster (London) County Court, last week tried an action brought by the National Free Wiring Co. to recover £61. Defendant was an hotel proprietor in the West of London. There was a counterclaim for damages for bad workmanship, and for loss owing to the plaintiffs delaying the work.

Plaintiffs' case was that, Mr. Jenkinson, their late manager, entered into a contract with defendant to wire his premises and put in 43 switches and 56 lights. There were continual complaints, all of which were attended to. The contract price was £52, and the balance of the account was for extra fittings. The work had to be done at times convenient to defendant, and that was why it was delayed in completion, and the best of workmen were not employed, though those actually employed were capable.

Mr. R. J. DRAKE, for the defendant, called evidence to show that the work was very badly done and there was great danger from fire. The contract was to do the work to the satisfaction of defendant and the insurance company. Instead of the work taking about a fortnight it occupied four months, and Messrs. Dawson were now altering it at a cost of £22, though that would not make a good job of the whole but only of the worst portion. The damage to the walls would cost quite £15 to put right. A number of guests were lost by the delay.

The JUDGE found for the plaintiffs for the amount claimed, and for the defendant for £31, remarking that he was of opinion the work was badly done.

### Tevenan v. Van den Bergh.

In the Irish Appeal Court last week, before the Lord Chancellor and Lords Justices Fitzgibbon, Walker and Holmes, the defendant appealed from a decision of the Queen's Bench Division refusing a motion for a new trial in this action which was for remuneration for services rendered in promoting a syndicate for carrying out electricity works in Ireland (fully reported in *The Electrician* for March 9). In February last the plaintiff obtained a verdict for £83. 6s. 9d. After hearing arguments which extended over two days the Court reserved judgment.

### London Electrical Cab Co. (Ltd.).

In the Winding-up Court, on Wednesday, Mr. Justice Wright made an order for the appointment of a provisional liquidator for this company on the petition of Mr. C. E. Foster.

**Electric Traction in the Lake District.**—The British Electric Traction Co. have decided to revive their electric tramway scheme for Bowness, Windermere and Ambleside, and parliamentary powers are to be applied for. The company are endeavouring to meet the views of the various local authorities as to road widening, &c., and they anticipate being able to disarm most of the recent opposition to their light railway scheme.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Cardiff Corporation require a mains superintendent for their electric lighting department. Further particulars are given in an advertisement, and applications, on forms to be obtained at the office of the borough electrical engineer (Mr. N. Appelbee), Eldon-road, Cardiff, must be sent to the town clerk (Mr. J. L. Wheatley) by 9 a.m. of 19th inst.

A chief assistant engineer to the electrical tramways engineer at Cardiff is required. Particulars from the engineer (Mr. Arthur Ellis), Old Post Office-buildings. Applications to town clerk (Mr. J. L. Wheatley) by 28th inst. See advertisement.

Barking Council invite applications for the position of resident electrical engineer. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. E. H. Lister), by Monday, 19th inst.

Portsmouth Corporation require a manager and engineer for their proposed telephone exchange. An advertisement gives further particulars, and applications must be delivered to the town clerk (Mr. Alexander Hellard) by noon of 16th inst.

Darlington Corporation require an assistant electrical engineer and a junior assistant engineer. Further particulars are given in an advertisement, and applications must be sent in to the town clerk (Mr. Hy. G. Steavenson), Boundgate, Darlington, by Nov. 15.

Wolverhampton Lighting committee invite applications for the position of chief clerk and canvasser in their electricity department. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. Horatio Brevitt) by noon of Nov. 12.

Wigan Corporation require four engineers in charge, a works foreman, three engine drivers, three stokers, and a meter inspector and installer. An advertisement contains further particulars, and applications must be sent to the borough electrical and tramway engineer (Mr. H. Collings Bishop), Bradford-place, Wigan, by 14th inst.

Bolton Electricity committee require an assistant engineer. Applications to borough electrical and tramway engineer (Mr. Arthur A. Day), Spa-road, Bolton. See advertisement.

A young telephone engineer is required to go abroad, capable of taking charge of staff and working of telephone exchange. See advertisement.

Ashton-under-Lyne Electric Lighting committee require a resident electrical engineer. Applications to borough comptroller by 10th inst.

Wrexham Town Council require a borough electrical engineer. Applications by 13th inst.

Farnworth District Council require a resident electrical engineer. Applications to the clerk by Nov. 12.

---

We are pleased to announce the appointment of Mr. Thomas Richardson to the registrarship of the Eastern and Eastern and South African Telegraph companies. Mr. Richardson, who joined the Eastern telegraph service in 1873, was for many years associated with the traffic department of the Eastern and associated telegraph companies.

Mr. S. E. Britton, electrical engineer to the Barking Council, has been appointed burgh electrical engineer at Motherwell at a commencing salary of £250. There were 48 applicants. Mr. Britton has been engineer at Barking for about 12 months, previous to which time he was chief assistant at Southampton.

Mr. J. H. Wray, assistant at Blackpool, has been appointed borough electrical engineer (out of 64 applicants) at West Bromwich at a commencing salary of £250 per annum.

Mr. G. Swift, of the Electric Construction Co., Wolverhampton, has been appointed shift engineer at the Blackburn Corporation Electricity Works, *vice* Mr. J. W. A. Binner, appointed assistant at Accrington.

---

**Aberdeen.**—Messrs. M'Elroy and Grunow have undertaken to lay down at their own expense an experimental tramway (double-line) of about 600 yards on the surface contact system. The line is to be in operation by May. Should the experiment prove successful the Corporation will have the option of purchasing the line for £1,400.

**Alleged Nuisance.**—At the Lambeth Police Court last week the Lambeth Vestry summoned the South London Electric Supply Corporation (Ltd.) for an alleged nuisance arising from the burning of refuse at their works. Mr. Bodkin, in support of the summons, said that when the corporation took over the provisional order from the Vestry, they entered into a contract to take the household refuse collected by the Vestry and destroy it in destructors which the company had erected for the purpose, the heat generated being used for the production of the steam power necessary for the electric lighting works. Subsequently an agreement was entered into by which the company were bound to pay the Vestry certain compensation in the event of their refusing to continue to receive the parish refuse. For the defence Mr. Wontner said he proposed to show that the defendants were using "the best practicable means," but the magistrate (Mr. Hopkins) said the "best practicable means" would be to use the best Welsh coal. Mr. Wontner pointed out that the company were liable to a penalty if they did not take the Vestry's refuse. What was the company to do? Mr. Hopkins: Not burn dust. Mr. Wontner: What are they to do with their contract? Mr. Hopkins: Tear it up, and pay the penalties. The summons was ultimately adjourned on the understanding that the burning of the refuse would be discontinued.

**Asylum Lighting.**—The Montrose Asylum and Infirmary Board are about to put down two new steam dynamos for the electric lighting of their establishments.

**Bath.**—During the quarter ended Sept. 30 there were 29 new consumers, representing an equivalent of 1,652 8 c.p. lamps, connected to the mains, and orders in hand represent 1,378 lamps further. When these and the additional arc lamps are running there will be 26,630 8 c.p. lamps connected, against 20,358 on Dec. 31 last.

**Bermondsey (London).**—The Vestry have resolved to invite tenders for arc lamp standards in accordance with a drawing prepared by the consulting engineers, Messrs. Kincaid, Waller and Manville.

**Beverley.**—The Council have unanimously resolved to apply for an electric lighting provisional order.

**Bognor.**—The Council is considering the question of establishing electricity works. A provisional order was obtained in 1899.

**Bradford.**—The permanent way of the Whetley-hill—Duckworth-lane and Thornbury—Stanningley electric tramway routes were officially inspected on behalf of the Board of Trade last week and the lines are now open for traffic.

The City Council have rescinded their resolution to purchase a colliery in order to be in a position to supply their own coal for the various municipal departments.

**Bridgwater.**—An inquiry was held here last week into the application of the Council to borrow £26,000 for electric lighting. Opposition was offered by the gas company and about 900 ratepayers. For the Council evidence was submitted in support of that application, and technical details were given by the consulting engineer (Mr. W. H. Trentham). The recent elections resulted in the return of a majority adverse to electric lighting, and the most was made of this fact by the opposition.

**Brighton.**—At the Council meeting, last week, the Lighting committee withdrew so much of their report as related to the recommendation that two-thirds of Mr. Arthur Wright's salary during the construction of the new works at Aldrington be charged to capital account.

**Bury.**—The plans of the proposed new tramway routes, which were prepared by the borough engineer, have been approved by the Council.

**Cardiff.**—A proposal to amalgamate the Electric Lighting and Tramways committees was introduced last week by the General Purposes committee. It was urged that, if the two committees were to act separately, the Lighting committee would have to spend £30,000 to £40,000, which might be saved by both committees working together. A conference of the members of both committees took place on Monday. The chairman of the Electric Lighting committee (Ald. Carey) presided, and explained that the reason why he thought it necessary to merge the two committees into one was that before long they would have to face the fact that to supply the demands of the town with regard to lighting, it would be necessary to go in for another station, which would mean the purchase of land at a high price. Another reason was that the machinery at the tramway power station at Roath could be used for lighting and traction, the parts being interchangeable. Out of 48 towns in the United Kingdom with electric lighting and traction 45 were working on the combined system, and his proposal was to go in for one strong committee, to be called the Traction and Lighting committee. Mr. W. Evans said another station would cost something like £30,000. He suggested that they should have a report from the tramway engineer (Mr. Ellis) before proceeding. The chairman of the Tramways committee (Mr. T. Andrews) opposed the proposal as both committees had already so much work to do. The work was enormous, and he did not see how one committee could do it. After discussion the question of amalgamation was dropped, and, on the motion of Mr. W. Evans, it was decided that, with a view of avoiding the building of another station, the engineers of the electrical and tramways departments respectively should prepare separate reports as to how the existing station and the power station at Roath could be utilised for supplying additional current for lighting and

action, the date upon which current would be available, and the price to be charged.

**Chagford (Devon).**—The Council have renewed their contract for the electric lighting of the district with the Chagford and Devon Electric Light Co. The Lighting committee reported that the electric lighting in the past had been highly satisfactory.

**Cheltenham.**—In a report to the Lighting committee on "free" wiring, the borough electrical engineer (Mr. H. Kilgour) recommends the Corporation to advance, under approved conditions, money to pay for the installations of intending customers, and to recover those moneys, together with interest, from the customers by periodic payments spread over terms of years. This scheme would avoid, as much as possible, interference between wiring contractors and their customers; the Corporation would be relieved of responsibility in respect to the installations; and, finally, the adoption of this scheme would prove advantageous both to a large number of ratepayers at present debarred from full participation in the benefits to be derived from their own property, and to the municipal electric undertaking. Mr. Kilgour's recommendations have been approved.

**Chorley.**—The plans for the proposed electricity works, drawn up by the consulting engineers (Messrs. Lacey, Clirehugh and Sillar) have been approved by the Council.

**City of London.**—Mr. A. A. Voysey, electrical engineer and inspector to the City of London Corporation, has prepared, for the Streets committee, a report (dated March, 1900) in which a review of the past and present position of electric lighting in the City of London up to the end of the year 1899 is given. Mr. Voysey summarises the events which led up to the granting of the City Electric Lighting Order, 1899, to the Charing Cross and Strand Company, of the circumstances and conditions of the permission granted to the City of London Company to alter the standard pressure of supply from 100 volts to 200 volts, and of the circumstances which led to the approval by the Board of Trade of the additional continuous current system of supply now available from the City of London Company. The subject of testing electricity meters, the public electric lighting of the main and side streets of the City, and the present position of private electric lighting are also included. The report deals chiefly with matters of historical interest. It would appear that during 1899 only 11 electricity meters were submitted for testing. Mr. Voysey reiterates his contention that every meter used in the City ought to be tested by the Corporation inspector, and states that negotiations are in satisfactory progress with the City of London and the Charing Cross and City Companies. At Dec. 31, 1899, 507 arc lamps had been installed, a slight increase over the previous year. The number of lamp failures had increased from 646 in 1898 to 918 in 1899, still, however, showing a reduction of 550 failures over 1897. The period of failure was also materially reduced. The total penalties imposed upon the City of London Company for these failures was £173 6s. 3d., an increase of £17 over 1898. Of the total of 918 failures 11 occurred with groups of lamps. During 1899 two serious interruptions in the supply of electric current to private consumers occurred, one affecting the whole of the City, and the other a portion only. Reference is made to the delay which has arisen in the settlement of the question of responsibility for lighting the side streets of the City, to the decision of Mr. Justice Kekewich on this point, and to the appeal action which the Corporation is bringing to test the question of the validity of the agreement between the City authorities and the City of London Electric Lighting Co.

**Cleckheaton.**—At the meeting of the Council on Tuesday the agreement with the British Electric Traction Co. for the construction of electric tramways was approved.

**Darlaston.**—The Council have been notified by the Midland Electric Corporation for Power Distribution that they intend to lay cables and mains for supplying electric current in the district.

**Dartford.**—An inquiry was held here last week into the application of the Council to borrow £20,000 for establishing electricity works. Technical details were supplied by the consulting engineer (Mr. W. C. C. Hawtayne). Some opposition was offered by ratepayers.

**Dewsbury.**—An inquiry has been held here last week into the application of the Council to borrow £7,500 for electric lighting extensions. The town clerk (Mr. G. T. Lee) appeared in support of the application, to which there was no opposition.

**Dudley.**—Current was switched on to the public arc lamps on Monday. The charge for current to private consumers is 6d. per unit for two hours' maximum demand, and 1½d. after. The capital expenditure amounts to £33,000, but an additional £10,000 is to be borrowed for wiring houses on the easy payment system. At the opening ceremony the chairman of the Tramways and Electric Lighting Committee (Ald. G. H. Dunn) pointed out that the generating station was not yet completed, but so far the work of installation had been satisfactory. The consumption of current in connection with the tramways to Cradley Heath and Sedgley, which had only been in operation about a fortnight, had far exceeded expectation, and he saw no reason why it should not be considerably increased. The time was not distant when they would have to enlarge the power station. Ald. G. Bagott said he was the first member of the Council to introduce the questions of electric lighting and tramways in the borough, calling the attention of the Corporation to the former in 1888, and to the latter as early as 1882. They had now one of the most perfect tramway systems in the United Kingdom, and he rejoiced that the electric light would be satisfactorily introduced before the close of the century. Mrs. Dunn switched on the current.

**Dundalk.**—The Judicial Committee of the Privy Council sanctioned last week an application by the promoters of the proposed Dundalk electric tramway for an extension of time to construct the line.

**Electric Tramways in Kent.**—The local authorities of the districts between Plumstead and Dartford have arrived at an understanding on the question of acquiring powers to construct electric tramways. It is proposed to form a connection with the existing metropolitan tramways at Plumstead and to construct a line through East Wickham, Welling, Bexley Heath, Crayford and Dartford. The Dartford and Bexley local authorities have electricity supply powers, and consider the trams will be a valuable adjunct.

**Electric Tramway Strike.**—The dispute between the Oldham, Ashton and Hyde Electric Tramways and their employés terminated on Saturday last, all the men returning to work.

**Ghent (Belgium).**—The Ghent Tramways Co. propose to adopt the overhead trolley system on the lines between Ghent and Meirelbeke and Ghent and Ledeberg.

**Hampton Wick.**—After considering the proposals of the Kingston Corporation, Edmundson's Electricity Corporation and the Richmond (Surrey) Electric Light and Power Co., for supplying electric current in the district, the Council have decided to support the Richmond Company's application for a provisional order. The company undertake to supply current to private consumers at 6d. per unit, or, at the option of the Council, 7d. for the first 1½ hours and 3d. after. The charge for power to be 3½d. and 1½d., and for public lighting £3 per incandescent lamp per annum, including attendance and maintenance, which is equivalent to 3d. per unit. The Council are to have the option of purchase at any time before the expiration of 42 years on payment of such a capital sum as will produce at 3½ per cent. a perpetual annuity of 5 per cent. upon the capital sum expended. If the Council purchase within the first 10 years it will have to pay, in addition, a sum equal to a dividend of 5 per cent. per annum, less the aggregate amount of dividends declared. But at any time after the expiration of 21 years, and before the expiration of 31 years, the Council may purchase the undertaking upon paying the then value "plus the value of the goodwill."

**Hull.**—The permanent way of the Spring Bank electric tramway route was officially inspected on behalf of the Board of Trade last week.

**Iceland.**—In connection with the proposed submarine telegraph cable to Iceland it has been decided that Seydisfjord shall be the landing station for the cable. There is to be a land line from Seydisfjord to Reykjavik. Little progress has, however, been made with the project lately.

**Ilford.**—The charge for electric current to private consumers has been fixed at 8d. per unit for the first hour's maximum demand per day and 2d. after.

**Inverness.**—By 10 votes to 8 the Council resolved to offer their late consulting electrical engineer (Mr. E. G. Craven) 2½ per cent. commission on the abandoned electric lighting scheme, plus £59 for actual expenditure. It was stated that Mr. Craven was willing to accept this offer in settlement of his claim.

**Leicester.**—The home-coming of Corporal D. F. Colson, R.E., one of the Electrical Engineers Volunteers, a son of Mr. Alfred Colson, engineer and manager of the Gas and Electric Light Department of the Corporation, justified a demonstration of welcome. Corporal Colson was unfortunately made a prisoner by the Boers last June, and suffered, with many others, the wanderings and privations which followed the punishment the burghers received from the British troops. Subsequently Mr. Colson was invalided home, and arrived at Southampton on Tuesday last, when the demonstration referred to took place, and a crowd gathered at the railway station to welcome him with open arms, and to congratulate him upon looking remarkably well in health, although still suffering from a poisoned hand.

**Leigh.**—An enquiry was held here last week into the application of the Council to borrow £5,000 for electric lighting extensions. The town clerk (Mr. P. Thomas) said the loan would be employed for extensions of the mains. The electricity works were completed in January last, and sanction had been obtained to a loan of £10,216, but £10,546 had been expended up to the present time. There were 67 consumers, representing an equivalent of 3,766 8 c.p. lamps connected, but there was no public lighting at present. The application was unopposed.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Bourne Valley and the Bishop's Waltham Light Railway Orders.

An inquiry was held last week into the application of the Llanelly and District Electric Lighting and Traction Co. for an order to construct light (electric) railways. It was explained that the existing tramway had not been very successful because it served only a very limited portion of the district. Arrangements had been made transferring the tramway to the promoters. The gauge of the existing line (3ft.) would be altered to 3ft. 6in. The system of traction would be the overhead trolley, and the cost of construction £35,000. The estimated profit (£4,000) would be ample to pay a substantial dividend on the capital of the company (£50,000). All the local authorities on the line of route approved of the scheme. After hearing evidence, the chairman (Mr. G. A. R. Fitzgerald) announced that the Commissioners were of opinion that the scheme was a very satisfactory one, and they would recommend the granting of an order.

The Light Railway Commissioners decline to depart from their form of Light Railway Orders so as to apply the provisions of the Tramways Act to the proposed light railways in Worcester. Draft clauses embodying the principal provisions of the agreement with the Council and of the Tramways Act and Order are to be submitted to the Commissioners, and the tramway company wish to obtain the order in that form or to withdraw their application and obtain parliamentary powers.

The adjourned inquiry into the application of the Swansea Corporation to construct light electric railways in the Swansea district was resumed in London on Monday, and after hearing further evidence, the scheme was sanctioned.

**Limerick.**—In view of the position in which the Council find themselves in regard to electric lighting matters, a deputation last week waited upon the Hon. T. H. Pelham, of the Board of Trade, who was in Limerick on official business, in order to obtain an extension of time for complying with the terms of the provisional order. Mr. Pelham suggested that a company should be induced to light the town, and the mayor said he was aware that a company was prepared to come in, lay down the plant and light the city for two or three years, and then hand the undertaking over to the Corporation on certain conditions. A deputation has also been appointed to approach the Local Government Board in order to get them to reconsider their decision as to a loan.

**Liverpool.**—An inquiry was held here on Tuesday into the application of the Council to borrow £14,500 for technical instruction. Councillor W. Oulton, chairman of the Technical Instruction committee, said the chief items of expenditure were lighting and electrical energy, about £2,000; mechanical and electrical engineering laboratories, £2,600; equipment of other trades, over £4,500; and special apparatus and fittings, over £5,000. He hoped a long period for repayment would be granted, say 25 years, which would involve only £1,051 per annum. Evidence was also given by Mr. A. B. Holmes, city electrical engineer; Mr. William Hewitt, director of technical instruction; and Mr. E. F. Mountfield, architect.

**London County Council.**—At Tuesday's meeting it was stated that the Fire Brigade committee is considering the subject of applying electric motors to fire engines in lieu of horses.

When the question comes before the Council as to the validity of the Council's action in running ½d. omnibuses in connection with its tramways, Mr. Beachcroft will propose that, instead of parliamentary powers being sought, negotiations should be entered into with the owners of existing lines of omnibuses to take over the Council's buses at the present fares.

**Manchester.**—The special committee appointed last week to inquire into the charges brought against Ald. Lloyd Higginbottom by Mr. S. Norbury Williams (set out in abstract in our last issue, pp. 62 and 63), presented their report to the Council on Monday. The committee reported that they met immediately after the close of the Council meeting last week, and instructed the officials of the Gas and Electricity departments to be in attendance, with all books and documents. Notice was given to Ald. Higginbottom and Mr. Norbury Williams, and both were present. The inquiry was commenced on Thursday last, and was continued until after 6 p.m. on the following day. The report proceeds:—

Several witnesses attended before us and have answered the questions put by the two above named gentlemen (Ald. Higginbottom and Mr. Williams) and ourselves, and every opportunity has been afforded for the fullest explanation. It was arranged, with the entire concurrence of Mr. Williams, that the inquiry should be confined to the items numbered 14 to 23 of Mr. Williams' charges. [These are the charges detailed in our abstract above referred to.] Since the conclusion of the inquiry we have devoted several hours to the careful consideration of the evidence and statements placed before us by Mr. Williams and Ald. Higginbottom, and also of the information obtained by ourselves by means of documents called for or questions put by us during the inquiry. Having examined into the circumstances connected with item 14 (referring to Messrs. S. Z. de Ferranti, Ltd.), we find that this item has no bearing upon the subject of our inquiry. Item 15 (British Insulated Wire Co., Ltd.): We have inquired into this matter, and are satisfied that Ald. Higginbottom is not interested in this company. Items 16, 17, 18, and 19: After considerable investigation we find that neither the action of the British Electric Works Co. (Ltd.), nor of Ald. Higginbottom as its chairman, has been such as to give rise to any substantial cause of complaint. One tender was sent in by this company without the knowledge of Ald. Higginbottom, who, on discovering it, instructed the chief engineer that it must not be considered, but it does not appear that this instruction was heard by the members of the committee present on the occasion. Item 20 (purchase of scrap metal by the West Gorton Foundry Co., Ltd.): As the company's tender was the highest, the Corporation suffered no loss by its acceptance, and we find that Ald. Higginbottom requested that it might be withdrawn, but the committee insisted on its being accepted. Ald. Higginbottom admitted the undesirability of this company sending in tenders to the Corporation. Item 21 (scale of charges for supply of electric power): This is purely a question of the policy of the Electricity committee itself. This scale was fixed by the committee on the recommendation of the chief engineer, and is very similar to that adopted in some other large towns. The imputation that Ald. Higginbottom was instrumental in reducing the price of supply for motors in order to promote his own business interests we find to be absolutely without foundation. Item 22 (cranes at Corporation gasworks): We find that, although Messrs. Frank Pearn & Co. (Ltd.) took the contracts for doing this work, they sub-let in some cases the whole and in other cases portions thereof to Messrs. Higginbottom and Mannock. Item 23 (cranes at electricity works): We find that Messrs. Higginbottom and Mannock have acted and are acting as sub-contractors in reference to the manufacture and fixing of cranes in connection with the electricity works of the Corporation.

We find that the transactions have been as follows (the amounts of the sub-contracts given below were stated by Ald. Higginbottom in his evidence before us):—

(a) That on March 14, 1892, a tender was accepted from Messrs. H. and J. Ellis, amounting to £446, for work for the Electricity department of the Corporation, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract.

(b) That on Sept. 23, 1892, a tender was accepted from Messrs. Mather and Platt (Ltd.), amounting to £230, for work for the Electricity department of the Corporation, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract to the amount of £150.

(c) That on Jan. 26, 1898, a tender was accepted from Messrs. Thomas Parker (Ltd.), amounting to £528, for work for the Electricity department, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract to the amount of £307.

(d) That on June 7, 1898, a tender was accepted from Messrs. Thomas Parker (Ltd.), amounting to £1,545, for work for the Electricity department, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract to the amount of £950.

(e) That on Feb. 14, 1900, a tender was accepted from Messrs. P. R. Jackson & Co. (Ltd.), amounting to £1,808, for work for the Electricity department, and that Messrs. Higginbottom and Mannock are sub-contractors in this contract to the amount of £1,440. (This contract is still in course of execution.)

(f) That on May 12, 1900, a tender was accepted from Messrs. the British Schuckert Electric Co. (Ltd.), amounting to £1,750, for work for the Electricity department, and that Messrs. Higginbottom and Mannock are sub-contractors in this contract to the amount of £1,382. (This contract is still in course of execution.)

In conclusion, we are of opinion that the action of Ald. Higginbottom with respect to these sub-contracts, as well as to those referred to in Item 22, has been altogether improper, and such as the committee cannot justify, having regard to his position upon the Electricity committee and the Gas committee.

The report is signed by the Lord Mayor (Mr. Thos. Briggs), who was chairman, and the six other members of the committee.

At the commencement of the proceedings at the meeting of the City Council on Monday the Lord Mayor announced that Ald. Higginbottom had sent in his resignation as alderman and Lord Mayor elect, and had paid the customary fine of £50. He had, in fact, retired altogether from Manchester civic life. Thereupon a resolution was passed declaring that the office of alderman theretofore held by Mr. Higginbottom was vacant. The Lord Mayor moved that the special committee's report set out above be approved. Mr. Maben said it would appear from the concluding paragraph of the report that it would be quite legal for any member of the Council to trade with a committee provided he was not a member of that committee. He suggested that the wording of that paragraph be amended. The words "Having regard to his position upon the Electricity committee and the Gas committee" were not inclusive enough. He moved that "as a member of the City Council" be added. Mr. Vaudrey submitted that the committee were asked to report in connection with the charges brought in connection with the Gas department and the Electricity department. They had examined into those charges alone, and their report had regard only to those charges. That was why the reference made was simply to the two committees. Mr. Boyle said all that was sought was to lay down clearly and as a precedent that it was not legal for a member of the Council to trade with any committee of the Council, whether he was a member of that committee or not. The report would establish a precedent. They wanted to declare that it was because a man was a member of the Council he was prohibited from trading directly or indirectly with the Council or with any of its committees. Ald. Mainwaring quite agreed with Mr. Maben's

amendment, the effect of which was that they condemned Mr. Higginbottom for having taken advantage of his position as a member of the Council, and not as a member of particular committees of the Council. The Gas and Electricity committees were incidents in the affair. Mr. Vaudrey raised no objection to the insertion of the words suggested. The last paragraph of the committee's report therefore reads:—

In conclusion, we are of opinion that the action of Ald. Higginbottom with respect to these sub-contracts, as well as those referred to in item No. 22, has been altogether improper, and such as the committee cannot justify, having regard to his position upon the Electricity committee, the Gas committee, and as a member of the Council.

The amendment was unanimously adopted, and the report was then approved.

**Municipal Telephony.**—The Finance committee of West Hartlepool Corporation have engaged a telephone expert to prepare a report as to obtaining a licence to establish a municipal telephone exchange.

The Hartlepool Corporation are also considering the question of establishing a municipal exchange.

A special sitting of the Hull Telephone committee was held on Friday when the town clerk (Mr. Laverack) reported that he had obtained the opinion of Mr. Asquith, Q.C., M.P., on the Council's agreement with the National Telephone Co., and Mr. Asquith was of opinion that the notice given to the National Company was a good and valid notice, and terminated the agreement on the expiration of six months from the service thereof (namely, Feb. 4); that their pipes and underground works remain where they are on sufferance only, and that the company would not, in the event of the grant of a licence to the Corporation, be entitled, under the Act of 1899, to the continued exercise of their underground powers during the term of the Corporation's licence. The chairman (Mr. Brown) moved the following resolution:

That, having regard to the report of Mr. A. R. Bennett and his estimated cost of establishing and working a municipal telephone system in the Hull telephone area, and in view of the high charges now made and the services rendered by the National Company within such area, this committee is of opinion that it is desirable the Corporation should provide and work a system of public telephone communication for Hull and adjoining district, and that application be made to the Postmaster-General for the necessary licence for the purpose.

The chairman urged that there was not the slightest doubt that if the Corporation took the matter up, and made a reasonable charge, they would be able to make a profit out of the telephone service. This resolution was carried with one dissentient.

**Neath.**—Last week the Council unanimously decided to apply for a provisional order.

**Newcastle Section of the Institution.**—The first annual dinner of the Newcastle Local Centre of the Institution of Electrical Engineers was held on Wednesday evening, at the County Hotel, under the presidency of Mr. A. W. Heaviside. Mr. Heaviside, in response to a toast by Prof. John Perry, of "The Newcastle Local Section," gave an interesting review of the development of matters electrical during the present reign.

**Newport (Mon.).**—The Corporation are recommended to appropriate a sum not exceeding £2,000 for wiring consumers' premises on the deferred payment system.

**Otley.**—The Council have instructed Mr. G. Wilkinson, borough electrical engineer of Harrogate, to prepare an electric lighting scheme for the town.

**Paignton.**—The Council have received an offer from Mr. Paris Singer to establish electricity works for the electric lighting of the central part of the town and to give the Council the option of purchasing the undertaking on certain conditions. The Lighting committee has been instructed to discuss with Mr. Singer the details of the scheme.

**Paisley.**—After much discussion, both in committee and in full Council, it was recently decided to take a poll on the question of tramway construction. The result has just been declared, and of the 5,638 voters recording their votes 3,616 were in favour of allowing a company to undertake the work, and 2,022 favoured a municipal scheme.

**Palermo (Sicily).**—The conversion of the present horse service of tramways to overhead trolley traction is nearing completion, and projects for the laying of additional electric lines are being put into execution. One of these lines runs from La Rocca to Monreale, and will prove a handy line for tourists and other visitors to the famous cathedral. The local tramway company, in order to secure the necessary municipal sanction for the extension of its lines, offered a premium of £40,000 to the Palermo corporation, but the desired concessions were not granted. At the Arenella, a suburb, an extensive range of workshops has been established by a local firm for the construction of tramcars, which, it is stated, have proved in every way satisfactory. From the power-house of the tramway company the Via Macqueda, one of the principal thoroughfares of the city, is lighted electrically, and the company has also a large number of private consumers connected to its lighting mains.

The facilities offered by the General Italian Electrical Appliances and Telephone Co. for extending the use of the telephone to ships in the harbour, previously notified in these columns, have been very little utilised. The company puts any vessel anchored in the port in telephonic communication with the shore for eight days for a fee of 10 lire.

124,255 kilos of electric wires and cables were imported into Palermo from countries outside Italy during the year 1899.

**Penzance.**—Mr. J. N. Shoolbred has been appointed consulting electrical engineer to the Council. Particulars of the applications were given in our issue of Oct. 26.

**Pickering.**—The Council decided on Monday to sanction the application of a company for a provisional order.

**Pocklington.**—The Council are considering the practicability of establishing electricity works, and a deputation has been sent on a visit of inspection to the Northallerton electricity station.

**Provisional Order Notices.**—The Cannock and Friern Barnet District Councils give official notice of intention to apply for provisional orders.

**Rathmines (Dublin).**—Owing to the increasing demand for electric current for private lighting the Council decided on Wednesday to obtain additional plant at an estimated cost of £7,500.

**Sheffield.**—The general manager of the tramways department (Mr. Fell) and the city surveyor (Mr. Wike) have been instructed to report on the facilities of the Fitzalan Market as a central tramway station. Power is to be obtained to take over the whole of the Market for the purpose.

On Wednesday the Tramways committee presented a report on the progress of the tramway conversion works. A number of routes are in process of conversion, and the Council are recommended to put a further group of routes in hand for similar conversion. As soon as certain roadwork is completed a further group will be proceeded with.

The Markets committee are considering the question of improved lighting for the markets, and the chief engineer and manager of the electric lighting department (Mr. S. E. Fedden) recently paid a visit to Leeds to inspect the lighting at the Leeds Markets, which is effected by 80 enclosed arc lamps.

**Shoreditch.**—The accounts of the joint electric lighting and refuse destructor undertaking for the year ended March 25 have just been issued. The total expenditure on revenue account was £19,284, and the income £25,490, leaving a gross profit of £6,206 for the year. The balance from last account amounts to £6,463, which made the total £12,669, and this has been applied as follows:—£3,919 for interest and sinking fund instalment, £1,000 as the nucleus of a reserve fund, £4,427 to relief of rates, £1,635 interest on overdrawn bank balance, and £69 income tax. There was thus a net profit of £1,600, of which £1,000 had been added to reserve fund, and the balance carried forward. The number of units generated during the year amounted to 2,135,191; number of public arc lamps 169, and total maximum supply demanded 1,050kw.

**Shipley.**—The Council have obtained sanction to the borrowing of £22,000 for erecting electricity works.

**Skipton.**—A canvass has been made here on the electric lighting question. Out of 281 circulars sent out 90 affirmative and 96 negative replies were received. Application is to be made for a provisional order.

**Stafford.**—An inquiry has been held into the application of the Council to borrow £10,000 for electric lighting extensions. The town clerk (Mr. M. F. Blakiston) supplied particulars of the rateable value, outstanding loans, &c. The works were established in 1895, a loan of £20,000 being obtained, of which £2,462 had been repaid. There was an increasing demand for electric current. The manager of the Gas and Electricity department (Mr. Pooley) said the output had increased enormously. During a certain period last year 33,369 units were generated, against 100,733 units in the corresponding period this year—an increase of over 200 per cent. One customer alone was now practically taking the whole of the output last year. The present application was not entirely to meet this demand, as £3,500 was required for the extension of mains. The present capacity of the works was 198kw., and, owing to the demand, there was very little reserve. It was proposed to double the capacity of the works, and the mains would be extended about 4,600 yards. The late manager (Mr. J. F. Bell) and the chairman of the Gas and Electricity committee (Mr. C. H. Wright) also gave evidence. There was no opposition.

**Todmorden.**—The Council have unanimously resolved to obtain a provisional order.

**Trowbridge.**—The consulting engineer (Mr. D. Stevenson) has presented his report on the electric lighting question. Two schemes are submitted, the smaller of which is estimated to entail a capital expenditure of £17,000, and the second £28,000. A special meeting

has been called to discuss the matter and the question of applying for a provisional order.

**Uitenhage (South Africa).**—The Town Council are considering an electric lighting scheme estimated to cost from £3,000 to £4,000.

**Underground Tramways in London.**—Mr. Benn, chairman of the Highways committee of the London County Council, is reported to have said, in a recent interview, that the idea of relieving the crowded thoroughfares of London by introducing under-street tramways has not been lost sight of, and is, in fact, under the consideration of the Highways committee, who will report to the Council on the project at an early date. The idea is to adopt these under-street tramways in all main thoroughfares where surface tramways are from any cause unworkable. Mr. Benn is reported to have summarily dismissed the notion that the expense of such a project in London might prove in any way prohibitive.

**Walton.**—A committee is considering the application of Edmundson's Electricity Corporation for consent to an application for a provisional order.

**Wellington (Salop).**—Application is to be made by the District Council for a provisional order, and Mr. T. L. Miller has been appointed consulting electrical engineer.

**Wigan.**—In a report on the progress of the electricity supply works the electrical and tramways engineer (Mr. H. Collings Bishop) states that there are applications in hand for an equivalent of over 9,000 8 c.p. lamps, and promises to take about 6,000 additional. Mr. Bishop states that these do not in any way touch the large number of small consumers who will apply for current when the date of opening the works has been fixed, and in addition the Council will have to provide current for the tramways. Considering the time that the contractors had taken to complete their contracts he thought it not too early to place orders for the next winter's anticipated requirements, and recommended that orders be immediately placed for two more steam dynamos of the same capacity as the larger sets now on order, together with the necessary cables, boosters, switchboards, steam piping, &c. Two of the boosters were required at once, as applications had come in from unexpected districts, making it necessary to start these at the earliest moment. The cost would amount to about £5,000, and this was provided for in his estimate for the £85,000 that the Council had power to expend. Mr. Bishop has been authorised to take all requisite steps to secure the prompt completion of contracts in hand, and to order further temporary plant if necessary.

**Wolverhampton.**—Messrs. Alfred Dickinson & Co. have been appointed consulting electric tramway engineers. The first route to be constructed is that from the Upper Green, Tettenhall, along Newhampton-road to Bilston-road. The Lighting committee are making extensions of plant in order to be able to supply current for tramways.

**Wrexham.**—It was reported at the Council meeting last week that one of the consulting engineers (Mr. W. H. Trentham) had been in communication with the National Electric Traction Co. in regard to the supply of current for the local tramways. The total expenditure on the electricity supply works to date is £20,240. 11s. 11d.

**Wurtemberg.**—The cement works at Lauffen, on the Neckar have recently added calcium carbide to their products. The river flows past the works, and about 5,000 H.P. of water power is utilised in the manufacture of cement and carbide and in the transmission of electric current for lighting and power to the neighbouring town of Heilbrohn.

In January, 1900, current was supplied by the Stuttgart Electric Works to 36,703 incandescents and 560 arcs. The generating machinery at present installed represents 4,340 H.P. and is steam-driven. It is now proposed to increase the plant by 400kw. and to utilise the water power at Marbach. The Stuttgart Company supplies current for the overhead tramways. These tramways consist of 20 miles of track. Wurtemberg possesses in all 49 electricity works.

Telephone development in Wurtemberg is progressing rapidly. With a population of 2,085,000 the number of subscribers in 1898 was 6,832 and in 1899 8,115. In Stuttgart alone, with a population of 160,000, the number of subscribers in 1899 was 4,500, comparing with under 4,000 in 1898. The annual subscription is £5 for communication within the town limits. Beyond these limits charges varying from ½d. to 2s. have been arranged. The charge of ½d. is for communication with the suburbs, and the scale rises to 1½d. for 10 miles beyond the town limit, 2½d. for 33 miles, 6d. above 33 miles. For trunk-line communication the following scale is provided: 16 miles 2½d., 33 miles 3d., 66 miles 6d., 333 miles 1s., 666 miles 1s. 6d., beyond 666 miles 2s.

An attempt has been made to introduce into Stuttgart, for general street passenger traffic, a number of motor cars, gas and oil-driven, but owing to the keen competition of the electric trams and the uneven character of the district very little progress is being made with motor cars.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Bibliography of X-Ray Literature and Research."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"The Manufacture of Electric Light Carbons."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, s. 6d., post free.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Shoreditch* (London) Vestry invite tenders for steam feed, blow-off and drain pipes, feed-pump and water storage tank and sundry iron work; two slow-speed Corliss engines, direct-connected current generators (output about 800kw. each set), condensing apparatus, pipes and sundry iron work. Specifications may be obtained after

29th inst. at the offices of the Vestry's electrical engineer (Mr. C. Newton Russell), Coronet-street, Hoxton, N., and specifications may also be inspected, but not obtained, at the offices of the consulting electrical engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. Tenders must be forwarded to Dr. H. Mansfield Robinson, Vestry clerk and solicitor, Town Hall, Old street, E.C., before noon, Nov. 20. An advertisement contains further particulars.

The directors of the *Midland Railway Co.* invite tenders for various stores, including telegraph instruments, stay rods, bolts, &c. (galvanised), telegraph and signal wire, castings, brass engine fittings, copper and brass tubes, fog signals, &c. Forms of tender from Mr. G. Morrall, stores superintendent, and tenders (addressed General Stores committee, Midland Railway Co., Derby) must be in by 9 a.m. Nov. 18.

*Newcastle-upon-Tyne* New Tramways committee invite tenders for arc lamps and accessories. Tenders (addressed to committee) must be left at the office of the town clerk (Mr. Hill Motum), Town Hall, by 21st inst. An advertisement contains additional particulars, and conditions of contract, &c., may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons and Talbot), 29, Princess-street, Manchester, and 26, Victoria-street, London, S.W.

*Newcastle-on-Tyne* New Tramways committee also invite tenders for arc lamp cables, telephone and pilot wires. Specifications may be obtained from the consulting engineer, Mr. Charles Hopkinson (Messrs. Hopkinsons & Talbot), 26, Victoria street, London, S.W., or 29, Princess-street, Manchester. An advertisement contains further particulars, and tenders (addressed to committee) must be left at the offices of the town clerk (Mr. Hill Motum), Town Hall, Newcastle-on-Tyne, by 21st inst.

*Kendal* Corporation invite tenders for the supply and erection of electricity generating plant, &c., particulars of which are set out in an advertisement. Specifications may be obtained from the town clerk (Mr. John Bolton), and specifications and drawings may be inspected at the offices of the consulting engineers (Messrs. Handcock and Dykes), 1, Victoria-street, London, S.W. Tenders must be delivered at the town clerk's office by Dec. 8.

*Cardiff* Corporation require tenders for a 75kw. motor generator and Tudor storage battery, lead-covered cables and a 20-ton travelling crane. Specifications may be obtained after 12th inst. from the engineer (Mr. Arthur Ellis), Old Post Office-buildings. Tenders must be delivered to the town clerk (Mr. J. L. Wheatley) before 28th inst. An advertisement gives further particulars.

*Greenwich* Guardians require tenders for an electric lighting installation at their new workhouse, Grove Park, S.E. Specifications may be had from the architect (Mr. Thomas Dinwiddy, F.R.I.B.A.), and tenders must be delivered at the Union Offices, East Greenwich, S.E., before 22nd inst. An advertisement gives further particulars.

*Bristol* Electrical committee invite tenders for an electric travelling crane and condensing plant. Further particulars are given in an advertisement, and specifications may be obtained from the city electrical engineer (Mr. H. Faraday Proctor), to whom tenders must be delivered by noon of 22nd inst.

*West Bromwich* Corporation invite tenders for wiring materials, motors and labour in wiring for power installations. An advertisement gives further particulars, and specifications may be obtained at the office of the consulting engineer (Mr. Robert C. Quin), electricity Works, Blackpool. Tenders to town clerk (Mr. Alfred Caddick), Town Hall, West Bromwich, by 17th inst.

Tenders are invited for the supply of lead covered, concentric cable, cast-iron conduit and watertight junction boxes for the District Asylum, *Mullingar* (Ireland). Tenders to the joint committee of management, before Dec. 1.

*Belfast* Gas and Electric committee invite tenders for steam pipes, pumps, &c., condensing plant, boilers, mechanical stokers and superheaters, coal and ash-conveying plant, and switchboard extensions. Tenders to town clerk by noon Nov. 23.

The joint committee of the Metropolitan and Metropolitan District Railway Companies (London) invite tenders for the electrical equipment of the Inner Circle Railway. Tenders by Dec. 1.

*London County Council* invite tenders for the supply of about 150 arc lamps for the electric lighting of Victoria Embankment and Westminster Bridge. Tenders by Nov. 13.

*Stockport* Tramways committee invite tenders for overhead equipment and rail bonds, steel rails, fish plates, &c., laying permanent way. Tenders by 24th inst.

Tenders are invited for the supply and erection of electricity generating plant at *Harwich*. Tenders to Messrs Bennett and Ward-Thomas, 11-13, Victoria-buildings, Manchester, by noon of 17th inst.

*Salford* Museum and Libraries committee require tenders for electric lighting at Irlams branch free library. Tenders by 13th inst.

*Salford* Tramways committee require tenders for erecting an electric car depôt and workshops. Tenders by 30th inst.

*Cheshire Lines Committee* invite tenders for stores for 1901, including telegraph materials, instruments, wire, &c. Tenders to secretary, Central Station, Liverpool, by 30th inst.

*Walker* Council require tenders for dust destructor, boilers, &c. Tenders to 5, St. Nicholas-buildings, Newcastle on-Tyne, by Nov. 12.

*British Electric Plant Co. (Ltd.)*, 19, Waterloo-street, Glasgow, require tenders for the erection of their new works at Alloa, N.B.

*Farnworth* District Council require tenders for wiring premises on the deferred payment system. Tenders to clerk by noon Nov. 12.

*Londonderry* Corporation require tenders for the supply of carbons for one year from Jan. 1 next. Tenders to town clerk by Dec. 1.

## TENDERS RECEIVED AND ACCEPTED.

Bermondsey (London) Vestry have considered the following tenders:—

*Contract No. 5.—Steam Piping, Feed Pumps, Water Tank, &c.*

| | | | | | |
|---|---|---|---|---|---|
| John Spencer (Ltd.), (*accepted*) | £2,672 | 10 | Babcock and Wilcox | £3,483 | 0 |
| Hopkins & Sons | 5,673 | 0 | Crompton & Co. | 3,292 | 0 |
| Alley and Maclellan | 4,500 | 0 | Aiton & Co. | 3,023 | 0 |
| | | | Thos. Howden & Sons | 2,006 | 10 |

*Contract No. 6.—Two [illegible] kw. Steam Dynamos, and one 75kw. set, Booster and Balancer.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Thames Ironworks Co. (Willans engine, accepted) | £4,334 | 0 | 0 | D. Bruce Peebles & Co. (Bellis engine) | £4,768 | 0 | 0 |
| Ditto (Reavell engine) | 3,835 | 0 | 0 | Ditto (Browett-Lindley engine) | 4,764 | 0 | 0 |
| Electric Construction Co. (Bellis engine) | 5,553 | 10 | 0 | Crompton & Co. (Willans engine) | 4,906 | 0 | 0 |
| Ditto (ditto) | 4,730 | 10 | 0 | Ditto (Bellis engine) | 4,727 | 0 | 0 |
| Ditto (Willans engine) | 5,042 | 10 | 0 | Ditto (Reavell engine) | 4,429 | 0 | 0 |
| Ditto (ditto) | 4,942 | 10 | 0 | Mather and Platt (Willans engine) | 4,840 | 0 | 0 |
| Siemens Bros. & Co. (Willans engine) | 5,447 | 0 | 0 | Ditto (Bellis engine) | 4,830 | 0 | 0 |
| Ditto (ditto) | 5,345 | 0 | 0 | Ditto (Browett Lindley engine) | 4,760 | 0 | 0 |
| Westinghouse Co. (Willans engine) | 5,409 | 0 | 0 | Ditto (Reavell engine) | 4,400 | 0 | 0 |
| Ditto (Bellis engine) | 5,109 | 0 | 0 | J. D. Macdonald (own) | 4,788 | 0 | 0 |
| Ditto (Scott and Mountain engine) | 5,000 | 9 | 0 | F. Scott & Mountain (own) | 4,495 | 0 | 0 |
| D. Bruce Peebles & Co. (Willans engine) | 5,024 | 0 | 0 | Bergtheil and Young (Alley & McLellan) | 4,138 | 0 | 0 |
| Ditto (ditto) | 4,924 | 0 | 0 | Ditto (Reavell engine) | 3,989 | 0 | 0 |

The consulting engineers (Messrs. Kincaid, Waller and Manville), in their report on these tenders, state that the Thames Ironworks Co.'s tender for their own electric generators combined with Willans engines was, under the circumstances, the best for the Vestry to elect. All the other tenders were much higher, excepting that of Messrs. Bergtheil and Young, who propose to supply Reavell engines. "This engine (continues the report) is a comparatively new one, much of the same type as that made by Messrs. Willans and Robinson, whose engines have attained a great reputation in this country. This type of engine is necessarily somewhat complicated, and as its efficiency depends largely upon proper designing and large experience of the results of the running of the engine after years of use, we cannot class the type of engine made by Messrs. Reavell with that made by Messrs. Willans and Robinson. Messrs. Bergtheil and Young also quoted for dynamos made by the Bergmann Dynamo Works, but (the report concludes) we are not acquainted with this firm of dynamo manufacturers, and believe that they must be either a Continental firm or one in the United States of America, in either of which cases you will see that it will be impossible for you to enforce the stipulation as to the trade union rate of wages, which must make some difference to English manufacturers, who must adhere to this stipulation."

The following tenders for the electric lighting of Redcross-street and Shepherd's Bush fire stations have been received by the London County Council:—

| | Redcross street. | Shepherd's Bush. |
|---|---|---|
| Barlow Bros. & Co. (*accepted*) | £270 | £260 |
| E. L. Berry, Harrison & Co. | 440 | 415 |
| Tamplin and Makovski (Ltd.) | 375 | 348 |
| F. A. Glover & Co. | 321 | [illegible] |
| G. E. Taylor & Co. | 320 | 310 |
| Electric Lighting Corporation (Ltd.) | 305 | 293 |

Messrs. Dick, Kerr & Co. have obtained the contract for re-laying the Greenock tramways from the east end of Port Glasgow, through Greenock, to the west end of Gourock (about 6 miles), for £90,000. The Greenock and Port Glasgow Tramways Co. has let the contract on the understanding that the Greenock portion of the line is completed by May 1, the Gourock portion by June 1, and the Port Glasgow portion by July 1. Tenders for the overhead electrical equipment, rolling stock, car sheds, &c., will also be placed shortly.

Plumstead (London) Vestry have accepted the tender of Messrs. Meldrum Bros. for furnaces and flues for refuse destructor and the setting of three boilers at £7,885. The tender of Messrs. Babcock and Wilcox has been accepted for three water-tube boilers and

furnace fittings at £2,138, and a contract has been let to the same firm for boilers for electric lighting at £2,045. Further tenders have been accepted from the Wheeler Condenser and Engineering Co., Aiton & Co. (steam pipes); W. Boby, Worthington Pumping Engine Co., British Westinghouse Co. (generating plant); Jas. White (instruments); Eclipse Brass and Copper Co. (storage battery); Carrick and Ritchie (crane); Callender's Company (cables and mains); British Electric Meter Co. (meters); Schattner Electricity Meter Co. (meters); and Johnson and Phillips. The total of these tenders being £40,666. The Vestry have applied to the London County Council for a loan of £20,000.

Croydon Corporation have accepted the tender of the Electric Construction Co. for the supply of additional generating plant at £6,326.

Dukinfield Town Council have accepted the tender of the Lancashire Electrical Engineering Co. for wiring the Town Hall.

Perth Police Commissioners have accepted the tender of Hands (Limited.) for the supply of cutouts (two-wire) as follows: 0 to 10 amperes carrying capacity, 8s.; 10 to 25 ditto, 11s.; 25 to 50 ditto, 12s. 6d.; 50 to 75 ditto, 15s.; and 75 to 100 ditto, 18s. The cutouts are to be supplied as required, the first order to be for not less than 100. Tenders were also submitted by the Keighley Electrical Engineering Co., the Fuse Box Co., Mr. Alexander Spark, Messrs. Williamson and Joseph, and the Reason Manufacturing Co.

The tender of Messrs. Russell and Russell has been accepted for the wiring (section 1) of the mills and warehouses of the Acme Wood Flooring Co., Victoria Park, N.E. Messrs. Taylor and Field are the consulting engineers.

Sheffield Corporation have accepted the tender of the Electric Construction Co. for two two-phase steam alternators at £13,840, and for the alteration of the phase of the existing plant from 100 to 50 at schedule prices.

The Siemens and Halske Aktien Gesellschaft of Berlin have secured a contract for the construction of a light (electric) railway between Rotterdam the Hague and Schevingen for the Zuid-Hollandsche Electrische Spoorweg Maatschappij of s'Gravenhagen. The line has to be ready for traffic by August, 1903.

Wrexham Corporation received 11 tenders, ranging from £76. 10s. to £150, for wiring the Corporation baths and depot. The lowest (that of Mr. E. M. Evans) has been accepted. The Corporation have also accepted the tender of Messrs. Babcock and Wilcox for water-softening plant for the electricity works at £255.

Strand (London) District Board of Works have accepted the tender of the Alliance Electrical Co. (the only tender) for a steam dynamo, switchboard, &c., for their destructor works at £546.

The tender of Mr. E. Nuttall has been accepted by the Bristol Electrical committee for the foundations of the new power station at Avonbank.

A 1,000kw. Parsons steam turbo-generator has recently been put down at the Elberfeld (Germany) electric lighting station.

## BUSINESS NOTICES.

Mr. Haydn T. Harrison, A.I.E.E., has given up his consulting practice in order to take up the sale of certain specialities connected with electric light and power distribution. Mr. Harrison is joined in partnership by Mr. F. S. Pilleau, and will trade as Haydn Harrison & Co., at 11, Victoria-street, Westminster, S.W.

Mr. Samuel Hartford has resigned the secretaryship of Messrs. W. T. Glover & Co. (Ltd.), and has commenced business at Collier-street, Salford, as agent for the British Insulated Wire Co., the Brockie-Pell Arc Lamp (Ltd.), Mr. Wm. Rickard, and Messrs. W. N. Brunton & Son.

The Maxim Electrical and Engineering Export Co. (Ltd.), of 65-67, Gracechurch-street, London, E.C., has taken over the business of Messrs. Edwards and Barnes, engineers, Westminster, London, and Mr. H. T. Wright has been engaged to manage this department of the Maxim Company's business. The company are making a speciality of electric light and power station steam accessories, including condensers, Berryman feed water heaters, water softeners, steam and other pipe work, and steam economising plant.

## BANKRUPTCIES, LIQUIDATIONS, &c.

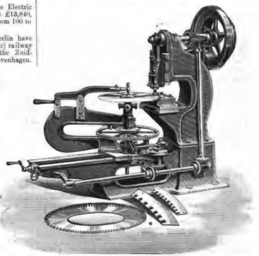
Creditors of Wm. Ramsay & Co., electrical and gas engineers, 195½, Argyle-street, and 11, Jamaica-street, Glasgow, must send particulars of their claim to Mr. T. M'Lintock, C.A., 88, St. Vincent-street, Glasgow, before Dec. 20.

**Sales by Auction.**—The preliminary announcement appears in our advertisement columns of the sale by auction of a large quantity of high-class modern electric light and power plant by Messrs. Wheatley Kirk, Price & Co. at the works of the Aluminium Co. (Ltd.), Oldbury, near Birmingham, consequent upon the concentration of the Aluminium Co.'s works at Weston Point.

Messrs. Wheatley Kirk Price & Co. will also sell by auction, in one lot, at an early date, the freehold works lately occupied by the Aluminium Co. at Oldbury, near Birmingham. Some further particulars are set out in an advertisement, and all additional information can be obtained of Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, Queen Victoria-street, London, E.C., and Albert-chambers, Albert-square, Manchester, or of Messrs. Baker, Blaker and Hawes, solicitors, 117, Cannon-street, London, E.C.

Messrs. H. S. Hawley & Co. (as will be seen by an advertisement elsewhere) will sell by auction at the Electric Launch Works and Charging Station, Eel Pie Island, Twickenham, on Thursday, Nov. 15, at one o'clock precisely, the freehold land and premises, including a well-built two-storeyed factory, with foundry, electric stores, engine house, battery room, &c. After the sale of the above land and premises the stock and fixtures will be sold in lots. All further particulars can be obtained of the auctioneers, 14, Southampton-row, High Holborn, London, W.C., and from other addresses set out in the advertisement.

**Electricians' Tools.**—Messrs. Neville Bros., 14, Water-street, Liverpool, have issued a well-illustrated list of tools for electricians, which includes armature slot clearing, magnet and induction coil winding, automatic notching and dividing, and tissue-papering machines, armature disc shears, lever and fly presses, &c. Our illustration shows a No. 2 "Stoll" armature disc, segment and ring automatic notching and dividing machine. These machines are strongly built to divide and notch accurately at a speed up to 200 notches per minute. The press is mounted on a suitable bed, with slide for support carrying the spindle, on the upper end of which the disc to be notched is held and on the lower end the dial or dividing plate. The spindle runs in long bearings, and is driven from a crank on the main shaft of the press, and has a clutch stop to the spindle after the completed revolution of the disc. It is claimed that the dial or dividing plates are inexpensive, and are easily changed. A single dial covers a wide range of disc diameters for any number of notches up to the number on the dial, or divisible into that number. For segments and rings suitable clamped plates are provided. Copies of the new list can be obtained on application.



**For Sale.**—The Middlesex Hospital authorities have 53 glass cells with base boards and porcelain insulators, also a quantity of lead and battery plates (Crompton-Howell make) for sale. Particulars from the engineer, Middlesex Convalescent Home, Clacton-on-Sea. An advertisement gives further particulars, and offers will be received by the secretary-superintendent, Middlesex Hospital, London, W.

**Plant for Sale.**—An advertisement elsewhere contains particulars of an old-established business of an electrical engineer in the south-west of London which is for disposal. Mr. H. W. Smith, 7, Featherstone-buildings, Bedford-row, London, W.C., is agent in this matter.

Leeds Lighting committee invite tenders for the purchase of rope-driven electric generating plant about to be replaced by plant of larger capacity. Particulars are given in an advertisement, and conditions, &c., may be obtained from the manager of the Electric Lighting Department (Mr. H. Dickinson), 1, Whitehall-road, Leeds. Tenders, addressed to town clerk (Mr. W. J. Jeeves), by Nov. 18.

**Westinghouse Plant**.—The British Westinghouse Company's circular No. 1,034, dealing with direct-current engine-type generators, and illustrating 200kw. and a 400kw. 250-volt engine type generators, can be obtained on application to the company.

**Coal Conveying Plant, &c.**—Messrs. Graham, Morton & Co., Leeds, owners of an improved system of elevating and conveying machinery for handling coal, have secured a contract from the Edinburgh and Leith Corporation Gas Commissioners for the erection of a complete automatic inclined retort carbonising plant which includes conveying machinery. The total of the contract is £113,803.

**Resistance Wires.**—Messrs. W. N. Brunton & Son, Musselburgh, Scotland, issue a useful list of resistance materials, &c., made by the firm. Tables relating to "Beacon," "Ferno," German silver, "Edina," and binding wires are given, together with a diagram of shapes for which wires are drawn in all qualities of steel.

**Carbide of Calcium Works.**—The United Alkali Co. have erected plant at their Sullivan Works, Widnes, for the manufacture of cabide of calcium, and announce that they are now able to supply the markets with this article. The department is under the management of Mr. Joseph Bastick, electrical engineer.

**Exports of Electrical Apparatus and Material**.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Oct. 31 to Nov. 6, with the ports of destination:—

*Africa*—Cape Town, £113; Durban, £232; East London, £340 (including £205 telegraph material); Port Elizabeth £655; Port Said, £15. *Argentina*—Buenos Ayres, £257 (including £213 telegraph material). *Australasia*—Launceston, £441; Melbourne, £1,644; Perth, £352; Sydney, £2,037 (including £360 telegraph material); Wellington, £512. *Belgium*—Ostend, £81. *Brazil*—Rio Janeiro, £7,157 (telegraph material). *Canada*—Halifax, £14; Montreal, £200. *Canary Islands*—Teneriffe, £485 (telegraph material). *Channel Islands*, £28). *China*—Shanghai, £150. *Denmark*—Copenhagen, £163 (telegraph wire). *Germany*—Emden, £57 (telegraph material); Hamburg, £300 (telegraph material). *Holland*—Amsterdam, £156. *India*—Bombay, £302 (including £121 telegraph material); Calcutta, £657; Madras, £26. *Japan*—Nagasaki, £9; Tokio, £90; Yokohama, £135; *Norway*—Christiania, £55 (telegraph wire). *Russia*—Riga, £255. *Straits Settlements*—Penang, £1,219 (including £1,172 telegraph material); Singapore, £90. *Sweden*—Gothenburg, £62 (telegraph material); Stockholm, £480 (telegraph material). *United States*—New York, £92. Total £19,274, against £16,730 in the corresponding week last year (Nov. 1 to Nov. 7).

**Imports of Electrical Goods into the United Kingdom**.—The value of the electrical goods and apparatus imported into this country during October was £174,524, against £97,107 in the preceding month. The total for the ten months ended Oct. 31 was £960,223.

## COMPANIES' MEETINGS AND REPORTS.

### Eastern Extension, Australasia and China Telegraph Co. (Ltd.).

The fifty-fourth half-yearly ordinary general meeting was held on Wednesday at Winchester House, Old Broad street, E.C., Sir John Wolfe Barry, K.C.B., in the chair.

The MANAGER (Mr. F. E. Hesse) read the notice calling the meeting and the minutes of the previous meeting, which were confirmed and signed by the Chairman. The report and accounts were taken as read.

The CHAIRMAN: Gentlemen, it now becomes my duty to offer a few remarks upon the report and accounts, and I will do so without further exordium, except to say that this being the first time I have had the pleasure of meeting the shareholders as Chairman, I wish to bespeak from them every kind of help and assistance in the arduous duty of representing this important Company as Chairman. I cannot begin my remarks without saying how very much we all feel the Company to be indebted to the late Chairman, the Marquis of Tweeddale, and what a satisfaction it is to us all that although he has found it necessary, I will not say from ill health, but from a desire to lessen his duties rather than add to them, to vacate the chair, he continues on the Board to give us the advantage of his advice and assistance in all matters connected with the business of the Company. (Cheers.) The gross revenue of the Company, as anybody who looks at the report will see, has amounted to £313,000—I will leave out the odd figures—against £324,000 in the corresponding period of 1899. On the face of it, that appears to indicate a decrease of traffic receipts of about £11,000, but it is only an apparent decrease. On the contrary, there has been an increase amounting to about £5,000, and the reason why the figures seem to show a decrease is that during the half year under review we have received less by £16,200 than we did last year, because of the termination of the Australian Government subsidies in respect of the Australian duplicate cable. On the other hand, we are relieved from the payment of £25,545 as in former half-years, which was applied to the interest and sinking fund to deal with the termination of the subsidies. We have only contributed for that purpose in the current half-year £7,683, and therefore we are really a great deal better off than we were, as far as the traffic receipts are concerned. When the debenture debt is wholly extinguished, which it will be in the current half-year, the net revenue account will be benefited to the extent of about £18,000 per annum. Therefore, although the accounts appear to indicate a diminution of traffic revenue, it is satisfactory to know that there has been an increase. (Hear, hear.) The working expenses have amounted to about £108,660, against £107,266 in the corresponding period of last year—an increase of £1,394. That increase is more than accounted for by the increased contribution to the pension fund, which has been remodelled in accordance with the arrangement made, and to certain expenses connected with negotiations which have taken place on various matters during the half year. If the expenditure and the receipts are taken into account it will be seen that we have been in a position to pay £62,500 in the way of interim dividends and we are able to transfer £100,000 to the general reserve fund and £5,000 to the reserve fund in connection with the removal of the head office, and after these transfers and dividends have been met there remains a balance of £16,832, which is carried forward to the next account, as compared with about £13,000 carried forward in the corresponding half-year. Therefore I think you will agree that everything is extremely satisfactory and fully up to the standard of what we are accustomed to at these meetings. (Cheers.) The next matter is the issue of the new capital. The unissued balance of 50,000 shares of the Company's share capital was allotted a few months ago to the shareholders at a premium of £3 a share. The object of the issue, as no doubt you will recollect, was to provide funds towards meeting the Company's financial obligations in connection with the cable to be laid between the Cape of Good Hope and Australia. The whole of the shares were taken up and an official settlement and quotation has been obtained. The shares now stand, I believe, at about £1 premium and after the end of December will rank pari passu with the old shares in regard to dividend. The next matter refers to the Tasmanian duplicate cable, which has been partially renewed during the half-year at a cost of £13,239, and the reserve fund has been debited with that amount. It is a satisfaction to know that this work was carried out by the Company's own resources, and that we were able to do it, in consequence of having those resources to draw upon, at a comparatively small expenditure. The next important matter referred to in the report is that of the new cables in China. It is a great pleasure to the Board to know that, owing to the great resources of this powerful company, they have been able, in conjunction with the Great Northern Telegraph Co., to be of material assistance to all the international interests in China by undertaking, at very short notice, to connect Shanghai with Taku, Chefoo, Wei-hai-wei, Port Arthur and Kiauchau. That has been carried out with conspicuous advantage to what we may call the interests of civilisation, and has been put into working order in such a short space of time as, I think, could not have been equalled by any other company or association of people in the whole world. (Applause.) The Pacific cable is the next matter which, perhaps, will interest the shareholders. The position is this: The latest development has been the seeking of tenders for laying the cable. They were to be sent in not later than the middle of August last, and although the result has not been officially announced on this side of the water, the Premier of New South Wales has publicly informed the Parliament of his colony that the Imperial Government has recommended the acceptance of the tender of the Telegraph Construction and Maintenance Co., amounting with cost of stations, apparatus and maintenance ship, to nearly £2,000,000. This, we ought to take note, is for a single line of cable only, and includes but one maintenance ship. The length of line between Canada and the nearest point where the cable will touch (Fanning Island) will be approaching 4,000 miles. I believe, strictly speaking, it is 3,671 knots, which is a very great length of cable in one unbroken stretch, and it must necessarily involve somewhat slow working compared with the lines belonging to the Associated Companies. The matter has now, we understand, been passed by all the colonies with the exception of Victoria. It is expected to come before the Victorian Parliament very shortly and no tender can be accepted until the Victorian Parliament has agreed to that course. Still, from information that we have there is no reason to doubt that although the estimates are very considerably more than was originally anticipated, the Victorian Parliament will agree to take their share of the very large expenditure, and, therefore, I suppose, we may take it that in two or three years' time the cable will be a *fait accompli* between Canada and Australia. I do not think from all the study I have been able to give to the question that the laying of this cable is a matter of which we need be very much afraid. Of course, there will be a certain amount of competition, but looking to the very strong position that the Associated Companies—the Eastern and Eastern Extension Companies—hold, with their vast network of cables, which will be triplicated when the authorised cable between Durban and Australia is laid, and can easily be made quadruplicate by a not very large addition to the present system of cables, and looking also to the fact of the increase of traffic which we are already able to see in the future from Australia, owing to a matter which I will refer to later—looking to these circumstances, I do not think that these companies need be very much afraid of the competition which will be engendered by the Pacific cable. (Cheers.) I was going to

say that we see a very gratifying increase of traffic, and we have no reason to doubt that that will continue. We have already agreed with three of the Australian colonies that, subject to the standard revenue being maintained, we will gradually reduce the tariff from 4s. 9d., at which it stood when the agreement was made, to 2s. 6d. per word, which is a very important reduction and must be of the greatest possible benefit to the colonies. Accordingly, in May last, we took the first step towards such reduction by reducing the tariff from 4s. 9d. to 4s. per word, and I am happy to be able to say that in spite of that reduction the standard revenue has up to now been maintained. Consequently, we have every intention of reducing the tariff next January from 4s. to 3s. 6d. per word. (Hear, hear.) If, as we hope, and I think we may hope with some amount of confidence, that the standard revenue is still maintained, we shall reduce the tariff in January, 1902, from 3s. 6d. to 3s. per word, and, again, if the standard revenue is maintained we shall reduce the rate in January, 1903, from 3s. to the limit of 2s. 6d. per word. (Cheers.) These important reductions and facilities we are able to give in consequence of our great network of cables, because it is obvious that if we were dependent on only one cable it would be extremely difficult to carry the increased traffic necessary to maintain the standard revenue with the same amount of efficiency that we are able to do by having so many other strings to our bow. (Hear, hear.) The Manager reminds me that if we are in a position to reduce to 2s. 6d. per word, our charge will be 6d. below the minimum tariff which we understand the Pacific cable proposes to accept. I do not think we have any intention of going into a war of tariffs. It is not because we want to embarrass the Pacific cable that we have agreed to such a reduction, but we made that arrangement with the colonies some little time ago, and shall endeavour to stand by it. (Hear, hear.) I am happy to be able to say that the first section of the Cape-Australian cable, namely, between Durban and Mauritius, is expected to be laid early next year, and there is reason to hope that the whole line will be completed and open for traffic by the end of 1901 or the beginning of 1902. I think that is a matter of great congratulation, and, as I say, none but a very powerful company could have undertaken this great addition to the telegraph system of the world by laying a cable all the way from the Cape to Australia without financial assistance. (Hear, hear.) I now beg to propose—

"*That the Report and Accounts of the Directors, as submitted, be received and adopted.*"

The Marquis of TWEEDDALE, K.T., seconded the motion.

Mr. JOHN NEWTON asked the distance of the cable from the Cape to Australia.

The CHAIRMAN: The total distance is a little over 8,000 knots, but the longest length is under 2,300 knots, whereas the Pacific cable will have an unbroken length of nearly 4,000 miles.

Mr. NEWTON wished to give expression to the shareholders' sentiments as regarded the retirement from the chairmanship of Lord Tweeddale, and to propose a special vote of thanks in recognition of the valuable services which his lordship had rendered to the Company, particularly during the last four or five years. It had required no end of statesmanship and business capacity to steer clear of the complications which had arisen in connection with the contemplated rival cable across the Pacific. That work had been done very satisfactorily. (Cheers.) He thought from what the Chairman had said that this Company would be able to deal with the competition when it arose. He thought that some recognition of a substantial kind should be made of Lord Tweeddale's services on an occasion like that. It was nearly 30 years, he believed, since the time when he (the speaker) was probably the most adverse critic the Board had. He was then a young man in a hurry and very sanguine. The Company then did not pay large dividends, and, as for a reserve, it was scarcely thought of, but what was now the position? He had seen the error of his ways, and it had been forced on him by the extraordinary value of the property the Company possessed. The shares had much more than doubled in worth, and they had a reserve fund which was the envy of almost every other company in existence. He was sure that there was a large amount of gratitude felt by the shareholders for the valuable services which Lord Tweeddale had rendered the Company, and he moved—

"*That a vote of thanks be given to Lord Tweeddale in recognition of his very valuable services as Chairman and Director for the last 30 years, and that it be left to the discretion of the Directors to carry out such recognition in some substantial form.*"

Mr. SHENNAN seconded the proposal.

The CHAIRMAN said that he and his colleagues welcomed the proposal with great cordiality, but he thought it was out of order until the report had been adopted.

The resolution as to the report and accounts having been passed,

Mr. NEWTON formally moved his proposal.

Mr. SHENNAN, in again seconding the same, said that the shareholders learned from the predecessor of Lord Tweeddale that his lordship was not merely an ornamental but a working Director, and there could be no denying that the shareholders had been greatly benefited by his ability and industry. (Hear, hear.)

The CHAIRMAN: It gives me great pleasure to put this proposal to the meeting. We must all recognise, as Mr. Newton has said, the extreme value of the services which Lord Tweeddale has rendered to the Company. We on this side of the table, perhaps, recognise them more fully than any shareholder can do, but it was a pleasure to hear the great benefits which the Company have derived from Lord Tweeddale's services so cordially given expression to on the other side of the table.

The proposal was then agreed to.

Lord TWEEDDALE: Mr. Chairman, with your permission, I will only say one or two words, but I wish to express to the meeting my warm thanks for the extremely handsome manner in which Mr. Newton's proposal has been received by the shareholders present, and I hope that it also represents the views of the absent shareholders. I have, as Mr. Newton has said, been for 30 years connected with this Company and the only reward I have ever looked to or have desired was that I should be able to hand over the business of the Company and the chairmanship at a time when the Company was in a prosperous position. I believe to-day it has reached the high-water mark of prosperity, and I have no doubt that under the able chairmanship of the present Chairman it will have a continued career of even greater prosperity. I beg to thank you, gentlemen. (Cheers.)

The CHAIRMAN: It is now my duty to declare the meeting special, for the consideration of the matter which is referred to in the advertisement. We only ask you to agree to amend the Articles of Association to the extent which is set out in the resolution, which I will presently read, and we do so in order that we may put this Company on all-fours with the other associated companies. As a matter of fact, we have no need at present to nominate directors on subsidiary companies, but one always feels from time to time that it may be very much to the advantage of the shareholders that we should be represented upon subsidiary companies, as it has been found to be advantageous in the case of other companies with which we have intimate relations. Therefore the Directors have considered it necessary to ask the shareholders' approval to amend the Articles of Association in that direction. We are advised by our legal officers that it is necessary that this should be done by an amendment of the Articles of Association; otherwise, there would be a legal difficulty in a Director sitting upon the board of a subsidiary company, and taking any remuneration for his services. I do not think that I need say anything more on the subject. If any other explanation is required I shall be willing to give it, but I do not think that any shareholder will object to the idea that, if we have to nominate representatives on a subsidiary company, the nominee, whoever he is, should be in all respects treated in the same way as the Directors of the subsidiary companies themselves are in regard to fees. Therefore, I think I need not go further into the question, and I will move

"*That the Articles of Association of the Company be and they are hereby altered in manner following, that is to say, there shall be added on to the end of the 104th of such Articles the following words, namely:—'Every past, present and future Director who has been or is or shall become a Director of any other Company as the nominee of this Company, may in addition to any remuneration received by him under the preceding provisions of this Article, also retain for his own benefit any remuneration to which he has become or may hereafter become entitled as a Director of such other Company, whether his qualification for such Directorship shall or shall not be held by him in trust for this Company.'*"

Lord TWEEDDALE seconded the resolution, which was at once carried.

A vote of thanks to the Chairman and Directors was passed on the motion of Mr. NEWTON, seconded by another shareholder.

The proceedings then terminated.

## West India and Panama Telegraph Co. (Ltd.).

The report of the directors of this company for the half-year to June 30 states that the amount to credit of revenue is £27,737. 17s., against £30,929. 10s. 8d. for the corresponding half-year of 1899; the expenses were £21,731. 11s. 10d., against £21,492. 4s. 8d., leaving £6,006. 5s. 2d. The directors regret this inadequate result, which is attributable to low rates and the continued unsatisfactory condition of West India trade. To the profit of £6,006. 5s. 2d. for the half-year, there is to be added interest on investments (£2,737. 12s. 7d.), making, with £279. 6s. 8d. brought forward, £9,023. 4s. 5d. to credit of revenue. The cumulative dividends for the half-year on the first and second preference shares amount to £11,769. 12s., and to meet these dividends a further £2,746. 7s. 7d. is required. It was pointed out in the last half-yearly report that there was a substantial increase over cost in the value of the investments of reserve; this is still fortunately the case, and the directors again recommend that the cumulative preference dividends be paid, and that a dividend of 6d. per share (free of tax) be paid on the ordinary shares; and that £6,000 has been transferred from reserve, leaving £953. 11s. 11d. to be carried forward. This still leaves the value of the investments greater than their cost, as shown in the accounts.

In the last report the directors stated they had addressed the Secretary of State for the Colonies as to the position of the company and asking for Imperial aid. To that application a reply from Mr. Chamberlain was received expressing regret at his inability to recommend a grant to the company from Imperial funds. As this grant would have been in the nature of aid to West India commerce by enabling the company to maintain its existing low tariffs, the directors, feeling that the company had a strong claim upon the Government, laid before Mr. Chamberlain further statements regarding its position, the originating causes of it, the great value of the system to the Imperial Government and the colonies, and solicited a reconsideration of the company's appeal. To these further communications a reply from Mr. Chamberlain was received on Oct. 25, stating his inability to reconsider his decision. The directors will have to carefully consider this decision, with a view to taking future action in the interests of the company. A copy of the correspondence with the Colonial Office is issued with the report.

The company's duplicate system, comprising 24 cables of a total length of 4,639 knots, continues in good working order.

## British Electric Traction Co. (Ltd.)

In an interim report issued by the directors of this company it is announced that an interim dividend on the ordinary shares will be paid on Dec. 22 (being six months after the last payment of dividend) at the rate of 6 per cent. per annum for the half-year to Sept. 30 on account of dividend for the financial year ending March 31, 1901, which is at the same

rate as the interim dividend paid last year. Satisfactory progress continues to be made by the company and its associated companies, and the aggregate traffic receipts on the various lines in operation show a considerable increase. The new lines opened for traffic, &c., includes :—

Swansea Improvements and Tramways Co. (5½ miles), opened for traffic by electric traction on June 30.

Potteries Electric Traction Co. (Ltd.) (working 21½ miles by electric traction, and a further 4½ miles ready for working).

Dudley, Stourbridge and District Electric Traction Co. (Ltd.) (3½ miles opened for traffic by electric traction, and a further 5 miles to be opened as soon as Board of Trade certificate is given).

Dudley and Wolverhampton Tramways 2½ miles have been reconstructed, and was opened for traffic by electric traction on Oct. 3.)

Kidderminster and District Electric Lighting and Traction Co. (Ltd.). Electric lighting supply commenced in August.

Tynemouth Electric Traction Co. (4 miles practically completed and to be opened for traffic as soon as Corporation are ready to supply current.

This list is followed by one giving the additional powers obtained by the B.E.T. associated companies.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BRITISH AND FOREIGN ELECTRICAL VEHICLE CO. (LTD.)**—This company was registered on Nov. 2, with a capital of £150,000 in £1 shares, to acquire the business of the Lecell Electric Battery Co., Ltd. (incorporated 1899), to adopt agreements with, amongst others, Emily H. Maquay (administratrix of the late S. W. Maquay), and to carry on the business of electricians, electrical and general engineers, motor car and launch builders, &c.

**COLUMBIA MOTOR CAR CO. (LTD.)**—This company was registered on Oct. 30, with a capital of £1,000 in £1 shares, to carry on business as electricians, electric motor and vehicle manufacturers, cycle makers, &c.

**ELECTRICAL TRADES SUPPLY (LTD.)**—Registered on Oct. 30, with a capital of £5,000 in £1 shares, to carry on the business of electrical and other appliance and fittings manufacturers, motor car and cycle manufacturers, dynamo, telephone, bell, electrolier, lamp, and accumulator manufacturers, &c. The subscribers include Mr. R. A. Marples, electrical engineer.

**ELECTRIC VEHICLE CO. OF GREAT BRITAIN (LTD.)**—This company was registered on Oct. 30, with a capital of £1,000 in £1 shares, to carry on the business of electricians, electric motor, carriage, and cycle manufacturers, &c.

**KETTLE RIVER POWER CO. (LTD.)**—Registered Oct. 31, with a capital of £220,000 in £1 shares, to acquire the property of the Cascade Water Power and Light Co., Ltd. (incorporated 1897), and to carry on in British North America, the United State of America or elsewhere, the business of telephone, telegraph, and cable constructors and proprietors, suppliers of electricity for light, heat, and power, electricians, electrical and general engineers, &c.

**KINGSBURGH MOTOR CONSTRUCTION CO. (LTD.)**—This company has been registered in Edinburgh with a capital of £50,000 in £5 shares, to acquire the business of the Madelvic Motor Carriage Works, and to carry on the business of electric motor car builders, &c.

**LONDON ELECTRICAL WAREHOUSE CO. (LTD.)**—This company was registered on Oct. 25, with a capital of £1,000 in £10 shares, to carry on the business of electricians, suppliers of electricity for all purposes, electrical and general engineers, &c. The subscribers are :—W. L. Madgen, electrical engineer ; F. J. Madgen, electrical engineer ; J. S. Frain, electrical engineer ; A. Foster, R. H. McClellan, R. J. Denman, and E. Wright.

**RAILWAY CONSTRUCTION AND GENERAL DEVELOPMENT CO., TASMANIA (LTD.)**—Registered on Oct. 30, with a capital of £100,000, in £1 shares, to take over the business of the Great Western of Tasmania Railway and Electric Power Co., Ltd., and to carry on the business of railway and tramway proprietors, electrical and general engineers, contractors, &c.

**RICHARDSONS, WESTGARTH & CO. (LTD.)**—This company was registered on Oct. 29, with a capital of £700,000 in £1 shares, to acquire the businesses of Thomas Richardson & Sons (Ltd.), Sir Christopher Furness, Westgarth & Co. (Ltd.), and William Allan & Co. (Ltd.), and to carry on the business of marine, electrical and general engineers, founders, &c. The subscribers are Sir T. Richardson, Sir Christopher Furness, D. B. Morison, Tom Westgarth, G. Westgarth, A. Harrison and W. B. Peat. The first directors are Sir Christopher Furness, M.P. (chairman), Sir T. Richardson (vice-chairman), W. J. Richardson, W. Allan, M.P., S. W. Furness, Tom Westgarth and D. B. Morison.

**ROWELL, STUART, KELMAN & CO. (LTD.)**—This company was registered on Oct. 26, with a capital of £100,000 in £5 shares, to acquire the businesses carried on by Messrs. Rowell, Stuart, Kelman & Co., the World Gas and Electric Syndicate (Ltd.), and the concessions and contracts of the Railway, Tramway and Waterworks Construction Co., and to carry on the business of suppliers of electricity and gas, electrical, mechanical and general engineers, &c. The subscribers are :—C. S. Kelman, J. A. Kelman, D. E. Kelman, E. N. Kelman, D. Sluter, S. Gibbs and R. W. Blackburn.

**STATTERS (BIRMINGHAM) (LIMITED)**—This company was registered on Oct. 25, with a capital of £10,000 in £1 shares (5,000 preference), to carry on the business of electrical and mechanical engineers, wire drawers, founders, &c.

**J. WAKEFIELD & SONS (LTD.)**—Registered Nov. 1, with a capital of £21,000 in £1 shares, to acquire the business of J. Wakefield & Sons, and to carry on the business of manufacturers of and dealers in electric and gas lamps, fittings and accessories, engineers, stampers, piercers, &c.

**C. WHITTAKER & CO. (1900) (LTD.)**—This company was registered on Oct. 23, with a capital of £120,000 in £10 shares, to acquire the businesses of C. Whittaker & Co. (Ltd.) and Furnevall & Co. (Ltd.), at Accrington, and to carry on the business of mechanical and electrical engineers, founders, smiths, &c.

**YORKSHIRE ELECTRIC POWER SYNDICATE (LTD.)**—This company was registered on Oct. 25, with a capital of £10,000 in £10 shares, to carry on the business of electricians, electrical and general engineers, suppliers of electric power, &c., in the West Riding of Yorkshire, south of the River Wharfe, or elsewhere. The subscribers are A. G. Lupton, C. L. Mason, R. Heedson, A. C. Briggs, L. Marcan, S. Ingham, and W. G. Jackson.

**CHLORIDE ELECTRICAL STORAGE SYNDICATE (LTD.)**—The annual return to Sept. 11 has been filed. The capital is £262,500 in 80,000 A, 30,000 B, 140,000 C and 12,500 founders' shares of £1 each, of which all the A, B and founders' and 100,000 C shares have been taken up. £1 has been called and paid up on each of 65,000 A shares. £157,500 is considered as paid on the remaining 15,000 A, 30,000 B, 100,000 C and 12,500 founders' shares.

**HALIFAX AND BERMUDAS CABLE CO. (LTD.)**—The annual return to Oct. 11 gives the capital as £30,000 in £5 shares, all of which have been taken up and paid for in full.

**JOHNSON-LUNDELL ELECTRIC TRACTION CO. (LTD.)**—The annual return to Aug. 30 gives the capital as £300,000 in 40,000 partly paid, 4,000 fully paid, and 16,000 deferred (fully-paid) shares of £5 each, of which 35,061 partly-paid, 1,131 fully-paid and 15,950 deferred (fully-paid) have been taken up. £3 has been called upon each of 35,061 shares, and £102,380. 10s. has been received, leaving £2,802. 10s. in arrears.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29$\frac{7}{16}$d. per oz. (Nov. 8). Consols (2¾ per cent.) 98$\frac{11}{16}$—98¾ for money, 98¾—99 for account, 2½ per cent. 97¾—98¼ (Nov. 8). Stocks and Shares Continuation Days, Nov. 12 and 27 ; Ticket Days, Nov. 13 and 28 ; Pay Days, Nov. 14 and 29 ; Mining Share Carry-over Days, Nov. 9 and 26.

**AKKUMULATOREN FABRIK AKTIEN GESELLSCHAFT (BERLIN).**—A dividend of 10 per cent. for the year 1899-1900 has been declared.

**ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.**—The general meeting of this company will be held on Dec. 6, when the payment of a dividend of 15 per cent. on M.47,000,000 capital and of 7½ per cent. on M.13,000,000 (against 15 per cent. on M.47,000,000 last year) will be recommended.

**BAKER STREET AND WATERLOO ELECTRIC RAILWAY CO.**—It is stated that the issue of the prospectus of the Baker-street and Waterloo Electric Railway has been delayed through a difficulty in securing the underwriting of the capital. This difficulty is said to be now overcome, and the prospectus is likely to appear in a few days.

**BERLINER ELEKTRICITATS ACTIEN-GESELLSCHAFT.**—For the past year a dividend of 10 per cent. is proposed, against 15 per cent. last year. During the year the capital was increased by nearly 3,300,000 marks, and the increased cost of fuel also partly accounts for the fall in dividend.

**CALCIUM CARBIDE TRUST.**—The *Financial Times* states that an International Trust is being promoted of the chief carbide-producing companies of Europe to establish the principle of regulating the market and preventing underselling of this commodity. A preliminary meeting of the representatives of the carbide works of Germany, Austria, Switzerland,

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways | Nov. 3 | 4,562 | + 223 | 17 | 77,972 | + 3,585 |
| Blackpool Corporation ... | „ 1 | 266 | + 94 | 31 | 26,538 | + 6,959 |
| Blackpool and Fleetwood | „ 3 | 205 | + 16 | 18 | 19,086 | + 25 |
| Bolton Corporation ..... | ... | ... | ... | ... | ... | ... |
| Bradford Corporation... | „ 6 | 630 | − 282 | 31 | 16,268 | + 3,862 |
| Brisbane Trams ......... | Sept. [illegible] | 1,789 | + 252 | 11 | 20,389 | + 4,041 |
| *Bristol Trams & Carriage | Nov. 2 | 2,897 | − 243 | [illegible] | 61,769 | + 500 |
| *Buenos Ayres & Belgrano | Oct. 7 | 2,834 | + 469 | 14 | 31,955 | + 721 |
| Central London Railway | Nov. 3 | 6,564 | ... | 14 | 71,062 | ... |
| City & South London Ry. | „ 4 | 1,936 | + 891 | [illegible] | [illegible] | +11,050 |
| Cork Elec. Trams ......... | „ 1 | 384 | + 30 | 44 | 18,261 | + 1,494 |
| Dover Corporation ...... | „ 3 | 187 | + 12 | 31 | 7,375 | + 402 |
| Dublin & Lucan Rly. | „ 3 | 73 | + 11 | [illegible] | 1,900 | + 337 |
| Dublin United ............ | „ 2 | 3,492 | + 513 | 18 | 63,351 | +9101 |
| Dublin Southern Dist.... | „ 2 | 706 | + 13 | 18 | 18,567 | |
| *Dundee Corporation ... | Oct. 31 | 481 | + 104 | 24 | 11,083 | + 1,910 |
| *Glasgow Corporation ... | Nov. 5 | 9,468 | + 728 | ... | ... | ... |
| Hull Corporation......... | „ 3 | 1,384 | + 739 | 18 | 24,862 | +13,293 |
| *Liverpool Corporation... | Oct. 27 | 8,521 | +1,493 | 43 | 339,208 | +43,456 |
| Liverpool Overhead Rly. | Nov. 4 | 1,561 | − 312 | [illegible] | 30,455 | + 778 |
| *Sheffield Tramways ...... | „ 4 | 2,643 | + 768 | 44 | 98,929 | +34,730 |

* Partly electrical.

and Norway and Sweden has been held in Berlin, under the presidency of Herr von Glenck, of the Longa Carbide Works, and a final meeting is to be held in Berlin to-day (Friday) to settle the preliminaries.

**ELECTRICAL POWER DISTRIBUTION CO. (LTD.)**—Subscriptions have been invited this week to an issue of 12,980 ordinary shares of £10 each, at a premium of £1 per share. The subscription to this issue has been guaranteed at par by the British Electric Traction Co. and the Brush Electrical Engineering Co. The share capital of the Distribution Company is £300,000.

**LONDON UNITED TRAMWAYS (LTD.)**—During the week this company made an issue of £350,000 4 per cent. first mortgage debenture stock, of which £34,125 was reserved for allotment to the holders of existing terminable debentures, and the remainder was offered for subscription at par.

**NEW BROTHERTON TUBE CO. (LTD.)**—In the report of the directors of this company just issued it is announced that a new branch has been added, comprising the manufacture of enamelled steel conduit tubes and fittings for electric wiring, and the directors anticipate that a considerable income will be derived from this new branch.

**RICHARDSONS, WESTGARTH & CO. (LTD.)**—Applications have been invited this week for the whole of the share capital of £700,000 in this company (350,000 6 per cent. cumulative preference and 350,000 ordinary shares, both of £1 each), also for £350,000 4½ per cent. perpetual debentures. Of this issue 200,000 ordinary and 150,000 preference shares and £100,000 debentures is taken by the directors and other parties and is allotted in full, leaving therefore only £300,000 for the general public. The company, as will be seen by a note elsewhere, amalgamates the well-known firms of Richardsons, of Hartlepool, Furness, Westgarth & Co., of Middlesboro', and Wm. Allan & Co., of Sunderland. The firm of Richardsons are sole representatives in this country of Messrs. Brown, Boveri & Co., and the amalgamated firm will have an important electrical department for the manufacture of engines for electric power. The list closed yesterday (Thursday).

**STOCK EXCHANGE NOTICES.**—The committee has been asked to allow the 4 per cent. debenture stock of the *Kensington and Knightsbridge* and *Notting Hill Electric Lighting Companies* to be quoted in the official list. 13th inst., has been appointed a special settling day in 20,000 vendors' ordinary fully-paid £1 shares (Nos. 27,001 to 47,000) of *Davis and Timmins (Ltd.)*, the further issue of 4,300 fully-paid £1 shares (Nos. 140,001 to 144,300) of the *Pearson Fire Alarm System (Ltd.)*, and the further issue of 10,000 ordinary £5 shares (£2 paid, of which £1 is premium, and numbered 90,001 to 100,000) and 10,000 6 per cent. cumulative preference £5 shares (£2 paid, of which £1 is premium, and numbered 70,001 to 80,000) of *Willans and Robinson (Ltd.)*. The 10,000 6 per cent. cumulative preference £5 shares (Nos. 60,001 to 70,000) of the latter company have also been ordered to be quoted in the official list.

**TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)**—The directors have declared an interim dividend at the rate of 8 per cent. per annum.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct. 31. | | Price Wednesday, Nov. 7. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 7. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckb'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ½ | ½ | ½ | ½ | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 13½ | 13½ | 3 11 1 | ... | ... | ... |
| [illegible] | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 10/8 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | ... | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 6½ | 6½ | 6½ | ... | ... | [illegible] | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | 10 | 9½ |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| 31,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary ... new | 6 | 6½ | 6 | 6½ | 4 12 4 | March | 6½ | 6½ |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December | 111½ | 111½ |
| $1,400,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,570 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 8½ | 9½ | 4 4 3 | February and August | 9½ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 13 | 13½ | 4 9 0 | January and July | 13½ | 13½ |
| £100,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | 9½ | 9 |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 5 0 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. (all pd.) (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | ... | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 3 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2½ | ... | ... | ... | ... |
| 42,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 55,000 | 10 | 8/0 | Metropolitan Elec. Supply Ord. | 13½ | 14½ | 13½ | 14½ | 3 18 10 | April and October | 13½ | 13½ |
| £720,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 7 | June and December | ... | ... |
| £450,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 7 | ... | 9½ | 9½ |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15 | 16 | 4 7 7 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6½ | 6½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ½ | ½ | ½ | ½ | 12 16 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 6 18 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 185 | 185 | 190 | 200 | 4 0 0 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 60,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15½ | 15½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | " " | ... | ... |
| [illegible] | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 99 | 101 | ... | ... | 10½ | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 2 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 29,437 | 5 | ... | Do. Do. | 11 | 12 | 11½ | 12½ | ... | ... | 12½ | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 15,000 | 10 | 6/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | 15 | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 103 | 105 | 103 | 105 | 4 17 1 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 23 | 24 | 23 | 24 | 3 8 11 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 15,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 45,000 | 10 | 11/0 | British Elec. Trac. Ord. | 13 | 14 | 13 | 14 | 7 8 2 | ... | 14½ | 14½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 12 3 | February and August | 12½ | 12½ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 121 | 124 | 121 | 123 | 4 1 4 | ... | 122 | ... |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | 5 | 5½ |
| 27,500 | 5 | ... | Do. "B" | 3½ | 4½ | 3½ | 4½ | ... | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 14 4 | ... | ... | ... |
| £120,000 | Stock | 13/9 | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 98 | 99 | 98 | 99 | 6 1 0 | ... | ... | ... |
| 206,257 | 10 | 3/9 | Central London Ordinary | 10 | 10½ | 10 | 10½ | 3 17 1 | June and December | 10½ | 10½ |
| £355,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 54 | 61 | 54 | 55 | 2 7 5 | February and August | 55 | 54 |
| 37,500 | 10 | 1/5½ | Do. Ordinary (Nos. 22,501 to 60,000) | 5 | 6 | 5 | 6 | 2 9 4 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £230,000 | Stock | 5% | Do. (1898) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £241,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 118 | 123 | 118 | 123 | 3 5 1 | May and November | 121½ | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896), Ltd., Ordinary | 17½ | 18 | 17½ | 18 | ... | ... | ... | ... |
| 53,187 | 10 | ... | Do. 6 per Cent. Preference | 16½ | 16½ | 16½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21 | 23 | 21 | 23 | 3 12 6 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 16 | 14½ | 16 | 3 14 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | ... | 9½ | 10½ | 4 17 7 | May and November | ... | ... |
| 37,000 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8½ | 9½ | 8½ | 9½ | 4 8 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 13 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 104 | 106 | 104 | 106 | 3 16 0 | January and July | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| £140,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 4 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 3½ | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | 16½ | 17½ | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | ... | ... | 10½ | 10½ | 4 13 0 | " " | ... | ... |
| 11,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11 | 12 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 6 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10½ | 4 15 3 | February and August | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock | 104 | 107 | 104 | 107 | ... | ... | ... | ... |
| £40,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 92 | 95 | 3 3 1 | June and December | 93 | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Oct 31. | | Price Wednesday, Nov. 7. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 7 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 103 | 3 17 6 | January and July | ... | ... |
| 38,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 85 | 90 | 5 11 1 | ... | ... | ... |
| £912,720 | Stock | 15/0 | Anglo-American | 52 | 54 | 52 | 54 | 5 11 1 | Feb., May, Aug., Nov. | 52½ | ... |
| £3,036,640 | Stock | 30/0 | Do. Preferred | 96 | 98 | 97 | 99 | 6 1 10 | " " | 99½ | 98½ |
| £3,036,640 | Stock | 27/0 | Do. Deferred | 10½ | 11½ | 10½ | 10½ | 12 11 2 | " " | 10¾ | 11½ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 11 5 | Jan., Apr., July, Oct. | ... | ... |
| £1,349,406 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 17 10 | " " | 103 | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary xd | 6½ | 7½ | 6½ | 7½ | 7 17 0 | February and August | 7½ | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. xd | 14½ | 15½ | 14½ | 15½ | 6 9 0 | " " | ... | ... |
| 12,981 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £90,600 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10½ | 10½ | 10½ | 6 10 0 | Jan., Apr., July, Oct. | 10½ | ... |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 102 | 99 | 102 | 4 8 6 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary | 149 | 154 | 148 | 153 | 4 11 4 | Jan., Apr., July, Oct. | 150½ | 149 |
| £1,826,886 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 99 | 102 | 98 | 101 | 3 9 5 | " " | ... | ... |
| £1,482,266 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) xd | 113 | 116 | 113 | 116 | 3 7 10 | May and November | 113½ | 113 |
| 260,000 | 10 | 3/6 | Eastern Extension | 14½ | 15½ | 14½ | 15½ | 4 11 10 | Jan., Apr., July, Oct. | 15⅛ | 15⅛ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) is'd at £3 pm, all pd | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 114 | 116 | 114 | 116 | 3 7 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 | 102 | 100 | 103 | 3 17 9 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs (red. xd | 101% | 104% | 99% | 104% | 3 18 5 | May and November | ... | ... |
| 100,227 | 10 | 1/9 | Globe Telegraph and Trust xd | 10½ | 11 | 10½ | 11 | 4 13 4 | Jan., Apr., July, Oct. | 10½ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference xd | 15 | 16½ | 16 | 16½ | 3 17 6 | " " | 16½ | 16½ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 33 | 31 | 33 | 3 15 7 | January and July | ... | ... |
| £94,200 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 | 101 | 99 | 101 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European xd | 49 | 53 | 49 | 53 | 4 14 6 | May and November | 51½ | 51½ |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 104 | 107 | 5 13 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 103 | 100 | 103 | 3 17 9 | June and December | ... | ... |
| 11,830 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 4 | " " | 126½ | ... |
| 15,609 | 10 | ... | West African Telegraph | 3½ | 3½ | 3½ | 3½ | 4 9 2 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 101 | 99 | 101 | 4 19 0 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ½ | ½ | ½ | ½ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 14 4 | January and July | ... | ... |
| 88,321 | 10 | 1/0 | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | 1½ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ | 7½ | 6½ | 7½ | 8 0 0 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 12 6 | January and July | ... | ... |
| 297,980 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 14½ | 15 | 14½ | 15 | 4 10 4 | Mar., June, Oct., Dec. | 14½ | 14½ |
| £76,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series 1906) | 106 | 109 | 106 | 109 | 4 11 4 | June and December | ... | ... |
| £313,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 103 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 324,460 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | ... | | ... | | ... | July | ... | ... |
| 172,680 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 5 0 0 | November | ... | ... |
| 96,402 | 1 | 1/0 | Do. 6 per Cent. Preference | ¾ | 1 | ¾ | 1 | 6 0 0 | " | ... | ... |
| 600,000 | 5 | 2/6 | National | 4½ | 4½ | 4½ | 4½ | 6 17 2 | February and August | 4⅛ | 4⅛ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 15 | 13 | 15 | 4 0 0 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 13 | 15 | 13 | 15 | 4 0 0 | " " | ... | ... |
| 280,000 | 5 | 2/6 | Do. 6 per Cent. Non Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | " " | 5⅛ | ... |
| 2,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 93 | 97 | 93 | 99 | 3 11 5 | June and December | 9½ | 96½ |
| £1,000,000 | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | ... | ... | 103½ | 103 |
| 171,504 | 1 | 6/6 | Oriental xd | ½ | 1½ | ½ | 1½ | 5 3 9 | April and October | ½ | ... |
| 88,000 | 5 | 4/6 | United River Plate | 4½ | 5½ | 4½ | 5½ | 6 14 4 | July | ... | ... |
| 16,629 | 5 | 3/6 | Do. 6% Cumulative Preference (fully paid) | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | ... |
| 13,361 | 5 | ... | Do. do. (£3. 10s. paid) | ... | | 3½ | 3½ | ... | ... | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 2d. | Alliance Electrical Co. 6% Cum. Pref. | 1 | 1½ | 1 | 1½ | 4 8 11 | ... | ... | ... |
| 120,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ¾ | ⅞ | ¾ | ⅞ | 7 7 8 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ½ | ⅝ | ½ | ⅝ | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ½ | ⅝ | ½ | ⅝ | ... | ... | ... | ... |
| £90,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 99 | 97 | 99 | 4 4 2 | ... | ... | ... |
| 40,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10 | 11 | 9½ | 10½ | 4 15 3 | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6½ | 6½ | 6½ | 6½ | 4 16 0 | ... | ... | ... |
| 100,000 | 5 | 1/6½ | British Westinghouse 6% Preference | 4½ | 5½ | 4½ | 5½ | ... | ... | ... | ... |
| 90,060 | 3 | 1/3½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 8 4 | September | ... | ... |
| 18,731 | 3 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 3 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | " | ... | ... |
| 15,731 | 3 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 108 | 111 | 108 | 111 | 4 0 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 105 | 103 | 105 | 4 7 0 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. xd | 12½ | 13½ | 12½ | 13½ | 6 11 1 | " " | 13½ | 13½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 | 5½ | 5 | 5½ | 4 10 11 | " " | 5½ | 5 |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 18 11 | November and May | ... | ... |
| 300,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | 1½ | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) xd & rights | 97 | 100 | 97 | 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1½ | ¾ | 1½ | 5 6 8 | ... | ... | ... |
| 51,000 | 3 | 2/0 | Crompton and Co. (Nos. 1 to 32,000) | 3½ | 4½ | 3½ | 4 | 5 12 4 | January and July | 3⅛ | 3⅛ |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 18 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1½ | ¾ | 1½ | 5 6 8 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 93 | 90 | 93 | 4 7 8 | June and December | 93½ | ... |
| £100,000 | Stock | 27/4½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 96 | 100 | 96 | 100 | ... | ... | ... | ... |
| 36,600 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half-yearly | 4⅛ | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 104 | 101 | 104 | 4 7 6 | ... | ... | ... |
| 112,100 | 3 | 1/2½ | Electric Construction Co. (Limited) | 2 | 2½ | 2 | 2½ | 5 8 8 | January and July | 2⅛ | ... |
| 25,000 | 3 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3½ | 2½ | 3½ | 4 6 2 | July | 3 | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 104 | 105 | 103 | 105 | 3 16 3 | January and July | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ | 13½ | 13½ | 13½ | 6 11 1 | February and August | 13½ | 13½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 | 5½ | 5½ | 5½ | 3 18 3 | " " | 5½ | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 | 112 | 109 | 112 | 4 0 8 | " " | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 20 | 21 | 20 | 21 | 3 11 5 | " " | 20½ | 20½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | March and September | 101½ | 101 |
| 37,350 | 12 | 11/0 | Telegraph Construction and Maintenance | 38 | 40 | 38 | 40 | 4 9 11 | March and July | 37 | 37½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 20,000 | 5 | 9/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 10½ | 11½ | 6 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5½ | 5½ | 5½ | 4 6 11 | ... | 5½ | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | 11⅛ | 10½ |
| 30,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 4 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,174. [No. 4. Vol. XLVI.] FRIDAY, NOVEMBER 16, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

The construction of the Baker-street and Waterloo Railway —a deep-level underground electric railway—has been in progress so long that many of our readers will learn with surprise that the Baker-street and Waterloo Railway Company has only recently issued its prospectus and applied to the public for a share capital of £2,385,000. The subscription list closed, in fact, on Wednesday. The prospectus discloses some interesting particulars in regard to the method of promoting and financing this important metropolitan railway undertaking. Up to the present time the construction and other work has been carried on by the London and Globe Finance Corporation (Ltd.). By contracts already entered into, the Company will pay this Corporation £3,096,000—namely, £2,322,500 in cash or shares, and £773,500 in 4 per cent. debenture stock—for the following considerations. (Note, by the way, that the sum to be paid is equivalent to the entire share capital and all but £83,000 of the total borrowing powers.)

The considerations are that the Corporation shall construct and equip the line for a three-minutes' service of trains; run it for one year after it is opened for public traffic; and hand over possession of the entire undertaking, together with a working capital of £50,000, to the railway company. Somewhat unusual as is this method of promoting an engineering undertaking of the character of the Baker-street and Waterloo Railway, it has this recommendation to shareholders, that it throws all the many risks during the construction and the early period of working the line upon the London and Globe Finance Corporation. On the other hand, it is questionable whether the railway company has not shifted off these risks at somewhat too high a price. Naturally, the financial corporation must protect itself against contingent and unforeseen risks; and this it can do only by charging a proportionately high price for its contracts and considerations. In disburdening its shoulders of the load during the earlier stages in the progress of the line, the railway company may find that it has burdened itself in perpetuity with the dead load of excessive capital—an evil which it would feel the effects of when it comes to take over the undertaking.

Prof. Perry, in his presidential address last week, alluded to the differences between the Kew Observatory authorities and the London United Tramways Co., and made reference to the conference which had taken place between the parties interested and representatives of the Board of Trade. In another column of this issue we give an account of the proceedings at this conference, which are of more than local interest, as the settlement of the present controversy will apply also to future traction schemes in the neighbourhood of magnetic observatories. It is significant of the acute state of feeling on both sides, that, in spite of the earnest persuasive efforts of Sir Courtenay Boyle, the Permanent Secretary of the Board of Trade, no compromise could be arrived at. Although it is eminently a case for compromise, and one in which compromise should not only have been possible but easy, we cannot but welcome the final result of the conference, viz., that the Board of Trade is to draft regulations as to the extra precautions (if any) which are to be adopted by the tramways company. These regulations, prepared by a department which will act without bias towards either side, will, no doubt, be applicable to all cases of a like nature and will, once for all, settle the course that is to be adopted in the solution of a difficult problem.

The Paris Exhibition was closed on Monday, and opinions are varied as to whether it is to be designated a success or a failure. We are not concerned with its financial results, or whether the bondholders, the unlucky concessionaires, or the exhibitors relegated to the *oubliettes* beneath the galleries, are most to be pitied. The effect on the electrical

engineering industry has been considerable, and, on the whole, propitious. British firms did not take much advantage of the facilities offered them to exhibit their wares; but, on the other hand, the British engineer has had a unique opportunity to see exactly what competition he has to cope with in the markets of the world. Our special correspondent (whose series of notes on the exhibition is, by the way, not closed with the exhibition itself) describes this week machines made in Belgium, Austria, Hungary, and even in Holland, which our engineers cannot afford to pass by with contempt; and, altogether, an excellent collection of the products of electrical engineering firms of different nations was assembled and afforded the possibility of instructive comparisons, even if no startling novelties or epoch-making inventions were brought forward. Undoubtedly, from the electrical engineer's point of view, the exhibition has been a success.

No less than three deaths from electric shock occurred on Monday and Tuesday this week, and once again attention is attracted to the dangers of high-pressure electric current. One of the accidents occurred on the now notorious switchboard at the Manchester-square station of the Metropolitan Electric Supply Co., which has already been the cause of several fires and one other fatal accident. This switchboard has been remodelled lately, but it is evidently still a source of danger. In our opinion, no switchboard should be allowed in a generating station in which, as even in the rebuilt one at Manchester-square, it is possible merely by putting out one's two hands, to touch simultaneously two metal surfaces at a difference of potential of 1,000 volts. Of course, all the engineers and switchboard attendants know that the panels are dangerous, but it is just this familiarity that breeds the proverbial contempt in the case of risks of this kind. Since the inquests on the victims at Newport and Cheltenham have not yet been concluded it is premature to comment on these two cases. In general, however, both in generating stations and sub-stations there is too much laxity with regard to the efficient protection of high pressure metals, and if at Cheltenham or Newport the accident has been through an absolutely unpreventable cause, an examination of the records of deaths from electric shock will show that this would be an exception.

In a Paper read before the Glasgow local section of the Institution of Electrical Engineers on Wednesday, Mr. Chamen ventilated a grievance. When the Board of Trade regulations were remodelled in 1896, and the limit of pressure permissible on a consumer's premises was increased to 250 volts, there was general jubilation, and "declared" pressures of 200, 210, 220, and 230 volts came into vogue. Mr. Chamen, when he took in hand his fine extension of the Glasgow electric supply system, adopted 250 volts as his "declared" pressure, but in this he stands alone. The Board of Trade interpretation of its own regulations is that 250 volts is the outside limit, and that, if the supplier of electrical energy desires to take advantage of a permissible 4 per cent. variation in pressure, he must declare 240 volts as his voltage at consumers' terminals. This interpretation of the regulations has been no secret, at all events during the past year, for just a year ago (*The Electrician*, Vol. XLIV., p. 81) we called attention to it. If Mr. Chamen has been successful in evading it he is to be congratulated and not to be condoled with. The Glasgow electric lighting system will be handed down to posterity as the only one in Great Britain at the opening of the new century in which a pressure so high as 250 volts was constantly available to its consumers.

**Royal Society.**—Among the Papers down for reading yesterday was: "Argon and its Companions," by Prof. Ramsay, F.R.S., and Dr. Travers.

**The Tramways and Light Railways Association.**—The Council of the Tramways and Light Railways Association has appointed Mr. Norman Thompson, B.A. (Cantab), A.I.E.E., Secretary of the Association. His offices are at Clun House, Surrey-street, Strand.

**Institution of Electrical Engineers.**—We are informed by the secretary that an extra meeting of the Institution will be held, by kind permission, in the rooms of the Institution of Mechanical Engineers, at 8 p.m., on Thursday, November 29th, when a Paper will be read by Mr. W. E. Langdon, vice-president, on "The Supersession of the Steam by the Electric Locomotive."

**Personal.**—We learn that Mr. C. H. Wordingham, the city electrical engineer at Manchester, has intimated to the Electricity committee of the Manchester City Council that he will not renew his engagement with the Corporation when it expires on March 31, 1901. Mr. Wordingham originally supervised, for the consulting engineer the late Dr. John Hopkinson, the erection of the Manchester electricity undertaking, and in 1892 was appointed resident engineer-in-charge.

**The Académie des Sciences.**—The Académie des Sciences at its last meeting selected by ballot two names to be submitted to the Minister of Public Instruction as those of candidates for the chair of Physics and Mathematics rendered vacant at the Collège de France by the death of M. Bertrand. In the ballot for the first candidate M. Brillouin obtained 26 votes, and M. Marcel Deprez 17. In the ballot for the second candidate M. Marcel Deprez obtained 27 votes out of 32.

**Cable Interruptions and Repairs:**—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Tangier—Tarifa | Jan. 3, 1900 | — |
| Ceara—Maranham | Feb. 20, 1900 | Nov. 13, 1900 |
| Pará—Maranham | Mar. 2, 1900 | — |
| Môle St. Nicolas—Cap Haitien | Mar. 7, 1900 | — |
| Zanzibar—Mombasa | Sept. 20, 1900 | — |
| Paramaribo—Cayenne | Oct. 6, 1900 | — |
| Havre—Waterville | Nov. 8, 1900 | — |
| Aden—Zanzibar | Nov. 9, 1900 | — |

**Wireless Telegraphy in Hawaii.**—We notice, in a recent number of the *Western Electrician*, of Chicago, that it is reported from the Hawaiian Island that the Marconi system of wireless telegraphy introduced there for inter-island communication has not been entirely successful. The signalling between Honolulu and Molokai is not satisfactory. It is assumed that the heights of the upright conductors at the two points have not been sufficient, and that when this fault is remedied all will work satisfactorily.

**Obituary.**—We regret to announce the death of Herr Johannes Hausmann, chief engineer at MM. Felten and Guilleaume's cable works. Herr Hausmann, who had been in the service of the firm for nearly 25 years, was a valued servant and had earned the esteem and respect of all his colleagues.——We also learn with regret that M. Jules Sarcia, one of the pioneers of electrical industry in France, has passed away. He was the collaborator of Marcel Deprez in his historical experiments on the electrical transmission of power, and during several years was manager of the Société pour le travail électrique des métaux.

**New Canadian Cable.**—It is announced that Mr. R. R. Dobell, a member of the Canadian Ministry, has declared, in a speech at Quebec, that the Canadian Government intend to lay a short cable from Belleisle (Newfoundland) to Scotland,

via the North of Ireland, at an estimated cost to Canada of £200,000. Mr. Dobell is reported to have stated that Denmark would join in the project, and that the rate for messages would be 6d. per word. We have not been able to obtain any confirmation as to the revival of this old project, but presumably the existing landing rights of the Anglo-American Telegraph Co., so far as Newfoundland-Labrador is concerned, will in any case be respected.

**Society of Model Engineers.**—The annual general meeting of this Society was held in the Memorial Hall, Farringdon-street, E.C., on Thursday, November 8th, at 7 p.m., about 60 members being present. The business included the alterations of rules and the election of officers for the ensuing session, which resulted as follows: Chairman, Mr. Percival Marshall, A.I.Mech.E.; vice-chairman, Mr. Jas. C. Crebbin; hon. secretary and treasurer, Mr. Herbert Sanderson, The Mount, Ealing, W. Committee: Messrs. W. J. Tennant, A.M.I.Mech.E., A. M. H. Solomon, W. Bashford, and A. Loebl. The conversazione of the Society will be held on Saturday, December 1st, and all particulars of this and conditions of membership of the Society may be obtained from the honorary secretary.

**Wireless Telegraphy on the Ostend Boats.**—On Friday last the official trials of the Marconi installations took place, and proved completely satisfactory. The Belgian Government officials, after viewing the instruments on board the "Princess Clementine," went to La Panne, the land station, while the vessel started for Dover. Messages were continually exchanged during the journey, and, just before reaching Dover one was received from M. Gerard, the chief of the Belgian Cabinet, conveying his congratulations to the Marconi Company. This message was transmitted to Dovercourt, near Harwich, thence to Chelmsford, and by telephone forwarded to the London office of the company. The Belgian authorities intend, it is said, to have other of their vessels fitted, and there appears once again to be some prospect of installations being placed on the Dover-Calais boats also.

**Electrical Engineers (R.E.) Volunteers.**—An exploder, in the shape of a small portable dynamo enclosed in an iron case, captured from the Boers in South Africa by the Electrical Engineer Volunteers, has been brought home by Major Crompton and presented to the Institution of Electrical Engineers. It is believed to be the apparatus used by Theron for blowing up bridges and doing extensive damage. At the meeting of the Institution on November 8th, Major Crompton, in presenting it, mentioned that the train in which he travelled back to Cape Town had been attacked, and it was only by a rare piece of good luck that he had been able to retain possession of the capture. Some amusement was occasioned by Mr. Swinburne pointing to the name plate upon the case, with the remark, "It has Siemens' name on it." Mr. Alexander Siemens, who was present at the Council table, immediately explained, "Not ours," the legend on the plate being, as a matter of fact, "Siemens and Halske."

**Fatal Accidents at Electricity Works.**—On Monday last an unfortunate accident occurred to Mr. Thomas Griffiths, assistant electrical engineer at the Newport (Mon.) electricity works. It appears that he was engaged in some work on the 2,000-volt switchboard and came in contact with some live metal upon it. Death was almost instantaneous. The inquest was formally opened on Wednesday and adjourned to to-day, when probably further particulars will be forthcoming. ——Another fatal accident occurred at Cheltenham on Tuesday to a jointer, Richard Edwards, who was working in one of the sub-stations, together with two other men. It appears probable that Edwards fell against a live transformer, in his fall partially removing the indiarubber mat with which it was enveloped. The sub-station is roomy (15ft. by 14ft. by 11ft. high) and well lighted, and the transformers at which the men were working were not live at the time. The inquest was opened on Wednesday, and after formal evidence of identification had been given by the widow, the inquiry was adjourned for a week to allow of the attendance of the inspector of factories for the district. The coroner, in his remarks, referred to the post mortem examination, held the previous evening, which revealed no weakness of the heart or other organs sufficient to account for death, apart from some shock to the system, such as that of receiving an electric current. That being so, the circumstances demanded the fullest inquiry before the jury were able to arrive at the cause of death. So far as he could see, the occurrence was one of those to which persons were subject to who were engaged in work similar to that of the deceased man.——Another case of death by shock occurred on Tuesday at the Manchester-square Station of the Metropolitan Electric Supply Co. An account of this will be found in the detailed report of the inquest in another column.

**The Automobile Anniversary.**—Out of the 149 vehicles entered for the "Anniversary" motor-car run from London to Southsea last Saturday, 103 bearing official numbers started from the Horse Guards, Whitehall. Seven others, without numbers, also started from Whitehall, and many more joined en route. Of the 103 numbered vehicles only 17 failed to reach Southsea. A feature of the run was that, for the first time on record, an electrical vehicle completed the trip. This car was the "Powerful," which took part in the trials at Chislehurst last week. It has been introduced into this country by the British and Foreign Electrical Vehicle Co. (a concern which has taken over the London Electrical Cab Co.'s premises at Lambeth), and is equipped with two electric motors of 3 N.H.P. each geared on the "Kriéger" system to the front wheels. The car, which accommodates only two persons, has a battery of 60 "Leecoll" cylindrical electrode cells on board, with a capacity of 250 ampere-hours, and weighing about 3,360lb. The complete weight of the car is about 2½ tons. At Guildford, whilst the driver and his passenger lunched, the cells were connected to the Supply Company's mains for about an hour and the car reached Southsea without any further charging. The quiet running of this vehicle was much admired and commented on at all the towns through which it passed. Going up the Hindhead it ran at an average speed of 8½ miles an hour, which, although it appears a very fair rate considering the character of the incline, is much below what some of the oil-driven cars made. For instance, Mr. Mark Mayhew's 16 H.P. Napier car attained the summit at 24·9 miles an hour, and four or five others approached very closely to this figure.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY,) November 16th.**

North-East Coast Institution of Engineers and Shipbuilders.

*7.30 p.m.* General Meeting in the Sunderland Literary Society's Lecture Hall, Fawcett-street, Sunderland. The business of the evening includes a discussion on the Paper, by C. H. Innes, on "The Stress Produced in a Connecting Rod by its Motion," and a Paper on "Liquid Fuel," by E. L. Orde.

Institution of Mechanical Engineers.

*8 p.m.* Ordinary General Meeting. Paper to be read and discussed: "Capacity of Railway Waggons as affecting Cost of Transport," by J. D. Twinberrow.

Electro-Harmonic Society.

*8 p.m.* Concert (Ladies' Night) at the St. James' Hall Restaurant (Banqueting Hall), Regent-street, W.

**WEDNESDAY, November 21st.**

Royal Microscopical Society.

*7.30 p.m.* Meeting at 20, Hanover-square, W.

Royal Meteorological Society.

*7.30 p.m.* Ordinary Meeting at the Institution of Civil Engineers, Great George street, Westminster, S.W.

Society of Arts.

*8 p.m.* First Ordinary Meeting of the Session. Opening Address by Sir John Evans, F.R.S.

**THURSDAY, November 22nd.**

Royal Society.

*4.30 p.m.* Ordinary Meeting at Burlington House, W.

Institution of Electrical Engineers.

*8 p.m.* Ordinary General Meeting. Paper to be read: "Telegraphs and Telephones at the Paris Exhibition, 1900," by John Gavey.

Institution of Electrical Engineers.

Opening Meeting of the Dublin Local Section at the Royal Dublin Society.

**FRIDAY, November 23rd.**

Physical Society.

*5 p.m.* Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "The Anomalous Dispersion of Carbon," by Prof. R. W. Wood. (2) "The Liquefaction of Hydrogen," by M. W. Travers. (3) "On the Refraction of Sound by Wind," by Dr. E. H. Barton.

# THE PARIS EXHIBITION.—XII.*

(BY OUR SPECIAL CORRESPONDENT.)

The third of the Belgian dynamos ought by rights to have been mentioned first of all, and, in fact, to have been described before the machines of the other countries, as it was the first to be in operation. It was a Kolben machine driven by a Carels engine. The engine was a tandem compound one with Corliss valves and designed for 100 revs. per min., although at the Exhibition its speed was only 94 revs. per min. Fig. 75 is a general view of the engine and dynamo. The main dimensions are: Diameter of H.P. cylinder, 660mm.; L.P. cylinder, 1,050mm.; stroke, 1,150mm.; and it is designed for a pressure of 10 kilogrammes per square centimetre, at which, running condensing at its normal speed and with an expansion of 18 times the original volume of steam, it develops 1,000 H.P., its maximum output being 1,300 H.P. The valves follow more or less the Sulzer lines. A section of the high-pressure valve is shown in Fig. 77. It is seen that both admission and exhaust valves are controlled by the same eccentric, and the details of the gear are clearly seen in the figure, and require no further explanation.

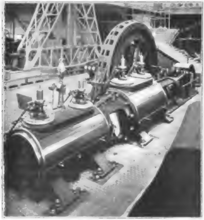


FIG. 75.—GENERAL VIEW OF CARELS-KOLBEN GENERATING SET.


FIG. 76.—WINDING THE ARMATURE OF THE KOLBEN ALTERNATOR.

The dynamo is a three-phase alternator, to generate current at 3,000 volts and 50 ∽ per second. The flywheel magnet has 64 poles, and is made in two castings. The double design of the arms is clearly seen in Fig. 78, which furthermore shows the configuration of the armature casting and the method of fastening on the pole pieces to the flywheel rim. The core magnets are of oval section, and have cylindrical projections which fit exactly into corresponding holes in the flywheel rim. The poles are laminated

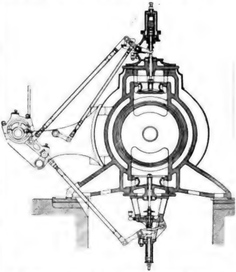


FIG. 77.—SECTION OF VALVE OF H.P. CYLINDER OF CARELS ENGINE.

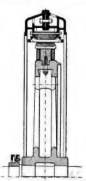


FIG. 78.—SECTION OF KOLBEN ALTERNATOR. SCALE, 1 : 50.

---

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, September 14 and 28, October 5, 12, 26, and November 2.

and cast into the steel cores. Copper ribbon 25mm. by 5mm., wound on edge, is employed for the coil, and the windings are insulated from one another by means of parchment paper. The armature or stator has a laminated iron core with deep slots which are insulated by micanite troughs. The high-pressure winding within these slots consists of 96 coils. Fig. 76 shows one-half of the armature carcase being wound in Messrs. Kolben's shops. The whole frame can be shifted axially, so that single armature coils as well as single magnet coils can be replaced without difficulty. It is also adjustable in a vertical direction by means of heavy bolts resting on cast-iron sole plates. The total weight of the dynamo without exciter is 63 tons.

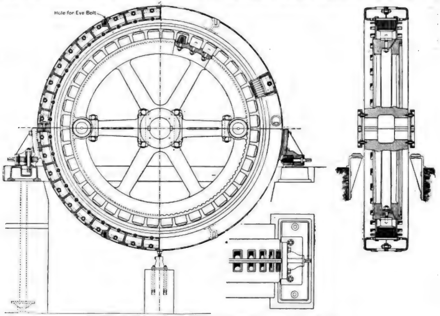


Fig. 79.—1,200 Kilovolt-Amperes Ganz 3-phase Alternator. Scale 1:50.

Fig. 80.—100 kw., 330 volt Ganz 3-phase Alternator.

The exciter is a six-pole continuous-current machine whose armature is keyed directly on to the main engine shaft and is overhung beyond the outboard bearing of the engine. In spite of its slow speed it generates an exciting current of 80 amperes to 100 amperes at 100 volts. The current from the alternator was chiefly employed for lighting "Old Paris," there being a sub-station containing seven three-phase trans-

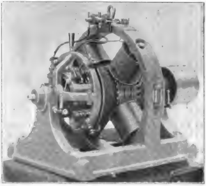


Fig. 81.—Small Ganz Continuous-Current Dynamo.

formers which reduced the pressure to 110 volts, at which voltage the current was employed for lighting by arc and incandescent lamps. The Kolben Co. is hardly to be blamed that a humming arc lamp was installed in the Colonne concert room.

Messrs. Ganz & Co.'s exhibits were more scattered, and did not occupy such prominent positions as those of some of the other large firms. Two fine Ganz three-phase alternators were shown in the Austrian and Hungarian sections, and one of these machines (the one in the Austrian section) is illustrated in Fig. 79, which gives some interesting details of its design. The machine generates 1,200 apparent kilowatts at a pressure of 2,200 volts. As seen in the illustration, it is of the flywheel type with a fixed laminated armature. There are 40 poles, each one with a single layer of copper ribbon, the turns being insulated from one another by rice paper. This insulation is said to suffice as the exciting current is at a very low pressure. The armature cores are made up of ½mm. sheet with numerous passages for ventilation, and the armature winding consists of insulated cables laid in micanite tubes. In the dynamo illustrated, there are three slots per pole; but in a similar machine with 48 poles instead of 40, and a frequency of 50 instead of 42∿ per second in the Hungarian exhibit there were only 2½ slots per pole for the winding of each phase. The rating of 1,200 kilovolt amperes is for a power factor of 0·7 and this machine is designed for 42∿ per second. The internal diameter of the armature is 4,100mm., and the total weight of the machine is roughly 45 tons, about half of which is the weight of the flywheel magnet.

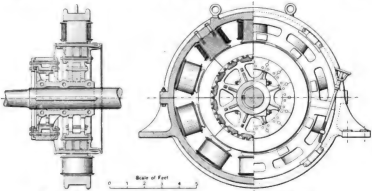


FIG. 83.—500-VOLT, 600-AMPERE DYNAMO BY THE "ELEKTROTECHNISCHE INDUSTRIE," HOLLAND.

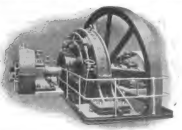


FIG. 84.—GENERAL VIEW OF DUTCH ENGINE AND DYNAMO.

Fig. 80 is interesting from the manner in which the exciter is fixed on the alternator frame. The machine is built for an output of 100kw., with power factors from 1 to 0·7, at a pressure of 330 volts and a speed of 420 revs. per min. The field magnets have 40 cylindrical poles, and the frequency is 42 ∿. The exciter develops a maximum of 100 amperes at 20 volts, and its current is led to the field magnets by a wire through the hollow shaft of the machine, the casting itself being used as a return. In the details of its design the machine resembles the large one described above and shown in Fig. 79. Its complete weight is 4 tons.

In Messrs. Ganz's exhibit were also some four-pole continuous-current machines of an airy and rather unusual design shown in Fig. 81. They are of small output, up to about 20kw., at pressures of 120 volts, and presumably they are intended for use as boosters and balancers, and the simple design has been adopted to combine cheapness with good ventilation.

Among the Austrian exhibits may be mentioned a fine 1,000kw. continuous-current machine built at the Vienna works of Messrs. Siemens and Halske. It was driven by a vertical triple-expansion Ringhoffer engine, being placed between the two lines of cylinders and run at 95 revs. per min. The armature of the dynamo was screwed to the flywheel of the engine. Considering its output the dynamo is very small, the diameter of the drum-wound armature being only 2·5m., and the width of the armature core 54cm. The machine is wound with "Arnold" series-parallel winding. Although the dynamo is 14 polar the winding of the armature has only 10 parallel circuits. The distance of the polar surfaces from the armature core increases in the direction of rotation of the armature as sketched in Fig. 82. The following are the main dimensions of the machine :—

FIG. 82.

External diameter of the armature, 2,500mm.
Width of the armature core, including ventilation slots, 540mm.
Aggregate width of ventilation slots (5mm. to 10mm. each), 50mm.
Number of slots for winding, 286.
Dimensions of ditto, 13mm. × 50mm.

Radial depth of armature iron, 180mm.
Winding 1,144 bars 4mm. × 18mm. in 10 parallel circuits.
Current density in armature at normal load, 2·52 amp. per sq. mm.
Maximum induction in teeth, 24,900 C.G.S. units.
External diameter of commutator, 2,080mm.
Length of commutator, 270mm.
Number of commutator bars, 572.
Width of insulation between commutator bars, 0·8mm.
Aggregate surface of carbon brushes (both poles), 2 × 370 sq. cm.
Current-density at 2,000 amperes load, 54 amp. per sq. cm.
Number of poles, 14.
Air-gap at leading horn, 8mm.
Air-gap at trailing horn, 12mm.
Cross section of yoke, 1,600 sq. cm.
Mean field in air-gap, 9,000, C.G.S. units.
Internal diameter of yoke, 3,360mm.
Outer diameter of yoke, 3,880mm.
Number of turns on each field coil, 770.
Diameter of wire on field coils, 5·0mm.
Ampere turns per pole at full load, (about) 18,500.
Total loss at full load, 15kw. = 1·3 per cent.
Total weight of machine, exclusive of shaft, 45·6 tons.
Calculated efficiency, exclusive of friction losses, 95 per cent.
Temperature rise after 24 hours' running at full load, 30°C.

Among the dynamos generating current for exhibition purposes was a continuous-current machine, built by the "Electrotechnische Industrie," of Slikkerveer, Holland. A general view of this dynamo, which is driven by a "Stork" engine, is shown in Fig. 84, and the details of the dynamo in Fig. 83. The machine is designed for 600 amperes at 550 volts. It is mounted between the two cranks of the cross-compound engine, the main dimensions of the latter being: H.P. cylinder, 580mm.; L.P. cylinder, 875mm.; stroke, 1,000mm. The speed of the set is 115 revs. per min. The engine is constructed to work with superheated steam of 150lbs. pressure at a temperature of 350°C. No steam jacket is employed for either cylinder. The high-pressure piston rod has its stuffing box lined with cast-iron and asbestos packing rings, and these are found quite suitable for use with the superheated steam, having given no trouble. The bedplate of the engine is made in two parts, one for each cylinder, extending from the cylinder to the main bearing, and with cylindrical guides for the cross heads, the whole resting for its full length on masonry. The connecting rods, cranks and crank shafts are made of Siemens-Martin steel. Steam is admitted into both cylinders by means of double-seated valves, the exhaust valves being worked independently by means of eccentrics. Maker's tests of the steam consumption of the engine are said to have given 4 to 4½ kilogrammes per horse-power per hour with steam at 375°C.

The dynamo is a 10-pole machine and shunt-wound. The magnet field is of cast-steel, with poles of circular section. The diameter of the armature is 2mm., and its width 400mm. This is formed of discs (each disc consisting of eight segments) insulated from one another by paper and carried on a cast-iron spider with dove-tailed projections on the segments, so that there are no bolts through the armature iron. The armature has 224 slots insulated with micanite troughs, and each containing four conductors of laminated copper strip measuring 3mm. by 20mm. Drum winding is employed, and the winding at the back end of the armature is bent round so that the only soldered joint is at the commutator end. The connections of the armature windings to the commutator are of "Rheotan," a high resistance material. The commutator has 448 hard-drawn copper segments mica insulated. Its diameter is 1·5 metres, and its useful width 300mm. There are four carbon brushes per pole. The carbon brushes are held in their place by wooden wedges so that no binding wires are necessary. Six amperes are required for exciting the field magnets—or 1 per cent. of the full output. The armature weighs 6½ tons and the whole generator about 26 tons. The machine is designed so that by connecting the armature windings in two parallel sides with the commutator bars the machine can be used to generate 1,200 amperes at 250 volts. The commutator has been designed to take this double current without overheating.

**Erratum.**—On p. 40 of the article in *The Electrician* for November 2, column one, fourth line from bottom, for Fig. 72 read Fig. 71; and column two, line nine, for Fig. 73 and Fig. 74 read Fig. 72 and Fig. 74.

## RITCHIE'S TELAUTOGRAPH.

We referred a few weeks ago to a new writing telegraph, the invention of Mr. Foster Ritchie. We had had an opportunity of testing its capabilities on that occasion, but were requested not to publish a technical description of the instrument at once, owing to the foreign patents not having been fully secured. Now, however, we are in the position to give a detailed account of this most ingenious instrument, the Telautograph Co. having invited us to view it a second time, when Mr. Ritchie patiently explained to us the details of its construction.

Fig. 3 shows the principle on which the instrument is based and Fig. 2 is a diagram of the connections. The pen is fixed at the extremities of two links, A and B, which are fixed to the arms of two otherwise independent rheostats, C and D. Each of these is connected through the battery to one of the two lines and has a total resistance of 7,000 ohms, divided into 496 steps. One of these rheostats is shown by the side of the instrument in Fig. 5. Thus currents, varying in magnitude with the position of the pencil, are sent along the two lines which connect the sending and receiving instrument.

Fig. 1.—General View of Instrument.

The receiving part of the instrument consists of two large d'Arsonval galvanometer movements, with strong controlling springs to ensure constancy. The spindles on which the moving coils are fixed are connected to a link motion corresponding to that of the transmitter part of the instrument, and move a pen along a similar piece of paper.

Having indicated the general principle on which the instrument is based, we now come to its constructive details. As is seen in Fig. 2, a battery is placed at each end of the line, these two batteries being normally in opposition. Before starting to write, the operator takes up the pencil, seen in the general views of the instrument, Figs. 1, 5 and 6, and, with the point of it, pushes back a lever at the left of the lower or transmitter part. This works a mechanical grip, which clutches the paper and moves it forward about ¾in., and at the same time operates a switch reversing the home battery, cuts off the receiving part of the home instrument, and connects up the transmitting portion. A further movement of this lever momentarily opens up the circuit of the home battery, the reason for which will be explained presently. The paper is 5in. wide, and a length of about 2in. is exposed at one time. During the motions of the pencil on the paper,

currents varying in strength are sent along the lines F and G, returning in each case by the earth.

The lower part of Fig. 2 represents the transmitting part of the home station, and the upper part the receiving part of the distant station, but the complete instrument in each case is made up of a transmitter and a receiver. H and K are the coils of the d'Arsonval galvanometer movements, these movements being also seen distinctly in Figs. 5 and 6. The coils have about 600 turns of silk-covered wire impregnated with shellac varnish, and only the coil revolves, the cylindrical piece of iron at its centre being fixed. The magnets are electromagnets excited by the local battery. An interesting feature of the instrument is that, instead of extreme delicacy being attempted in the construction of these movements, the reverse is the case. Twenty-four-volt secondary batteries are employed at each end of the line, and the rheostat naturally forms the greater part of the resistance in the circuit, so that fairly strong currents, telegraphically speaking, flow through the coils. Added to this that the magnets of the d'Arsonval system are highly magnetised, it is seen that considerable mechanical forces come into play, so that the controlling spring attached to the moving coil is strong, and, as a matter of fact, so strong that the spindle of the moving coil is merely held between centres, jewels being unnecessary. Thus the motion of the coil is decisive and dead-beat, and, moreover, adjustment is easy and the whole mechanism is substantial.

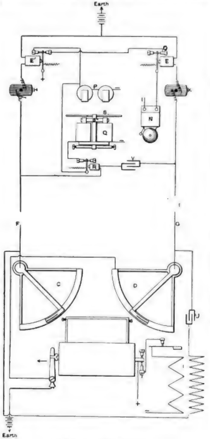


FIG. 2.—DIAGRAM OF CONNECTIONS.

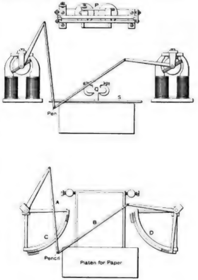


FIG. 3.

After traversing the moving coil on its way to the distant battery, the current passes on either side through a relay E' and E. These relays are so adjusted that the weakest current (sent when the pencil is at the top left-hand corner of the paper) just suffices to cause their armatures to be attracted. When the current is momentarily interrupted by moving the paper-shifting and starting lever, the relay E' drops back. This causes the current normally flowing through the paper-shifting magnets P to be momentarily

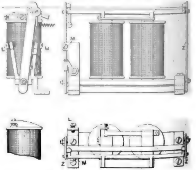


FIG. 4.—DETAILS OF PAPER SHIFTER.

interrupted, and the release and re-attraction of the armature of P actuates the grip which moves on the paper. The details of this paper-shifter are shown in Fig. 4, which is more or less self-explanatory. The whole frame Z rocks backward and forward when the current through the coils is interrupted and re-made. L and M are merely stops. The relay E is for the purpose of signalling. A press-key on one side of the transmitter (not shown in the diagram Fig. 2) on being depressed breaks line F and puts line G to earth. This causes the relay E′ to release its armature and the relay E to make a contact at O, so that the local circuit of the bell N is closed and the bell rings. It should be mentioned that to avoid a multiplicity of lines in Fig. 2 all the wires leading to the battery are not shown but some are broken off and + or – marked against them.

We now come to the ingenious device by means of which no characters are written on the paper at the distant station unless the pencil is actually pressing on the paper at the transmitting end. Motions of the pencil are transmitted to the pen, but the latter does not touch the paper until the pencil does. Normally the "pen-lifting" magnet Q is excited by the local circuit, the armature of the relay R being against the left-hand stop. This magnet Q raises the pen from the paper by slightly moving the cross-bar S in a horizontal direction away from the vertical paper. When, however, the pencil presses upon the platen on which the paper is stretched, it puts the battery in contact with the screw T, which closes the primary circuit of a small induction coil I whose hammer vibrates. Thus a vibratory secondary current is transmitted to line G through the condenser U, and passes to the receiving end, through the condenser V, and energises the relay R. This breaks the local circuit of the magnet Q and allows the pen to fall back on the paper. The vibratory current returns by the line F, and not by earth, so that it does not affect neighbouring telephone circuits. The circuit KEE′H has fairly high self-induction, and the relays E′ and E are not influenced. It is also noticed that the local current reaches Q through the secondary contacts of the relay E′ as well as of the relay R, so that when the apparatus is not in use and no current is flowing through E, no current is being wasted in the pen-lifting magnet. The same applies to the magnet P.

Fig. 5.—General View of Telautograph (cover removed).

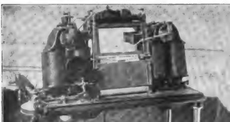


Fig. 6.—General View of Telautograph (cover and paper removed).

On finishing his message, and before laying down his pencil, the operator must press down, with the point of the pencil, a small plunger key on the left of the instrument to reverse the home battery so that it opposes the distant one, and to connect up the receiver to line instead of the transmitter. This switch is not shown in the diagram. The action of depressing this plunger also opens a local bell circuit, which is, moreover, opened at another contact so long as the operator's arm is resting on the desk. If, therefore, he retires from the instrument without switching off by depressing the plunger key, the bell circuit is closed and the bell rings until the omission has been remedied.

A telephone is employed in connection with the instrument. When the telephone is on its hook, the writing telegraph is connected to the lines in the manner already detailed, and on removing the telephone the writing telegraph is disconnected and the ordinary telephone connections substituted. The telephone is seen to the left in Figs. 1, 5 and 6.

As already mentioned, a 24-volt secondary battery is employed at each end, and with this the instrument is found to work well on a line up to 300 ohms resistance. The resistance of each of the moving coils is about 185 ohms, and of the relays only about 20 ohms each.

An interesting detail is the pen employed. This resembles a tiny pipe-bowl, from which a thin glass tube conveys the ink to the paper. Each time the

**paper is moved on by pushing over the paper-shifting lever, and the circuit is thereby broken, the pen returns automatically to the inkpot on the "isobath" principle, as seen in Fig. 4. As mentioned in our previous note on Mr. Ritchie's invention, writing and sketches are reproduced distinctly and legibly by the apparatus, and, although the handwriting is somewhat distorted, its character does not disappear.**

## THE SCHUCKERT SURFACE-CONTACT TRACTION SYSTEM.

Messrs. Schuckert & Co., of Nuremburg, have had exceptional facilities for experimenting with their surface-contact system of electric traction. In 1896 they commenced laying down a line in Munich, and since then they have had opportunities of observing its defects and how they might be eliminated, so that in the summer of last year they were able to put in an improved system, which, we are informed, has since given no trouble. In the present article, we propose to describe the system with the firm's most recent innovations.

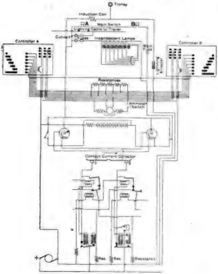


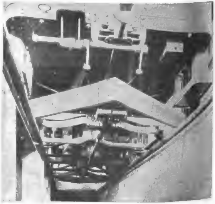
Diagram of Munich Car Connections.

On p. 121 is a diagram showing the connections of the surface studs, relays, &c. 1, 2, 3, &c., to 6 on the figure represent the contact knobs, and each of these is connected to a relay or switching apparatus placed in a switchbox along the line of route. The switching apparatus contains a contact lever (7 to 12 in the figure) and two coils, one of which (13 to 18) serves to lift the lever, and the other, which is doubly wound (19 to 24 and 25 to 30), serves to break contact. The coils are so connected that when the contact-making coil of one relay is energised, the contact-breaking coils of the relay behind is also in circuit, so that only one knob can be alive at one time. Thus the contact-making coil 16 of knob 4 is permanently connected to the upper draw-off coil 23 of contact stud 5, and to the lower draw-off coil 27 of contact stud 3, the circuit being completed through one of these latter two coils to earth, according to the direction in which the car is travelling. The coils of the contact-breaking magnets terminate in groups connected to the contact pieces 32, 33, and 34, 35 arranged symmetrically with regard to the levers 36 and 37, which are controlled by the coils 36 to 41. This arrangement enables the direction of the car to be reversed.

To trace out the action of the switches let us assume that the current collector 42 of the car is situated on contact stud 5, as shown by the full line in the drawing, and that the car is travelling in the direction of the arrow-head above. At starting, the current from a small battery carried on the car, passes through the skate 42, the stud 5, the magnet coil 17, to the magnet coil 24, and thence to the group of contacts 35, through the switch-lever 37, to the rails or return conductor. Coil 17 attracts the lever 11, causing it to connect the distributing cable with the contact stud 5, and enabling the car to proceed in the direction of the arrow-head. The skate reaches the stud 4 just before it leaves 5, and energises the

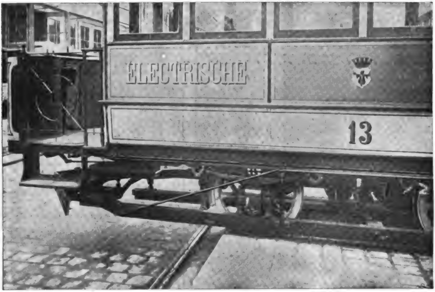
Brush Collector.

coil 16—this time without the help of the battery—while at the same time the draw-off coil of the knob just passed by the collector, but still beneath the car, is energised by the same current and switches off. The multiple switch levers 36 and 37, in the direction of travel referred to, are placed over to the right touching a series of contacts 33 and 35 respectively. These levers are reversed automatically as

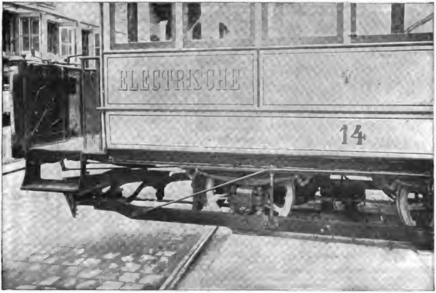


Chain Collector.

soon as the skate has touched the last of the contact studs belonging to the group and connected with the end relay of each group. Should it be necessary, for instance in case of accident, to change the direction in which the car is moving, this can be done by means of hand switches 43 and 44 arranged at convenient distances along the route.



Car with Brush Current-Collector.



Car with Chain Current-Collector.

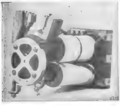
In the above description the complete details of the circuits and *modus operandi* have not been gone through, but they are fairly evident from the diagram. The diagram on p. 118 shows the circuits on the car, as arranged at Munich, where the trolley system is employed outside the town.

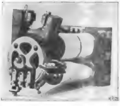

Distribution Box with Cable Coupling Box.


Distribution Box Closed.

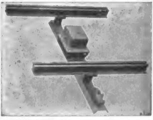

Distribution Box Opened.

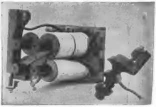

General View of Car at Munich.

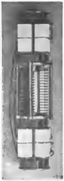

Contact Apparatus without Safety Device.


Contact Apparatus Complete with all safety Devices.

A section showing the contact plug and its junction box and accessory apparatus is shown opposite. Beneath the rails is an iron sleeper connected to the rails by short pieces of I iron, and in the centre of the sleeper is a sheet-iron case. The contact stud is of hardened cast-steel let into the granite block, which in size and appearance resembles an ordinary paving stone. This block is set into the cast-iron case with cement. The granite block is on the same level as the rest of the street paving, and the stud projects about two or three centimetres. The figure above is a general view of the arrangement. These contact knobs are placed on straight track, about 4 metres apart, and slightly less on curves. At points and crossings "dummy" surface knobs are arranged which are not in connection with the main, and only serve to support the skate of the car and prevent it coming into contact with the rail.


Contact Block in Connection with Rails and Sleeper.

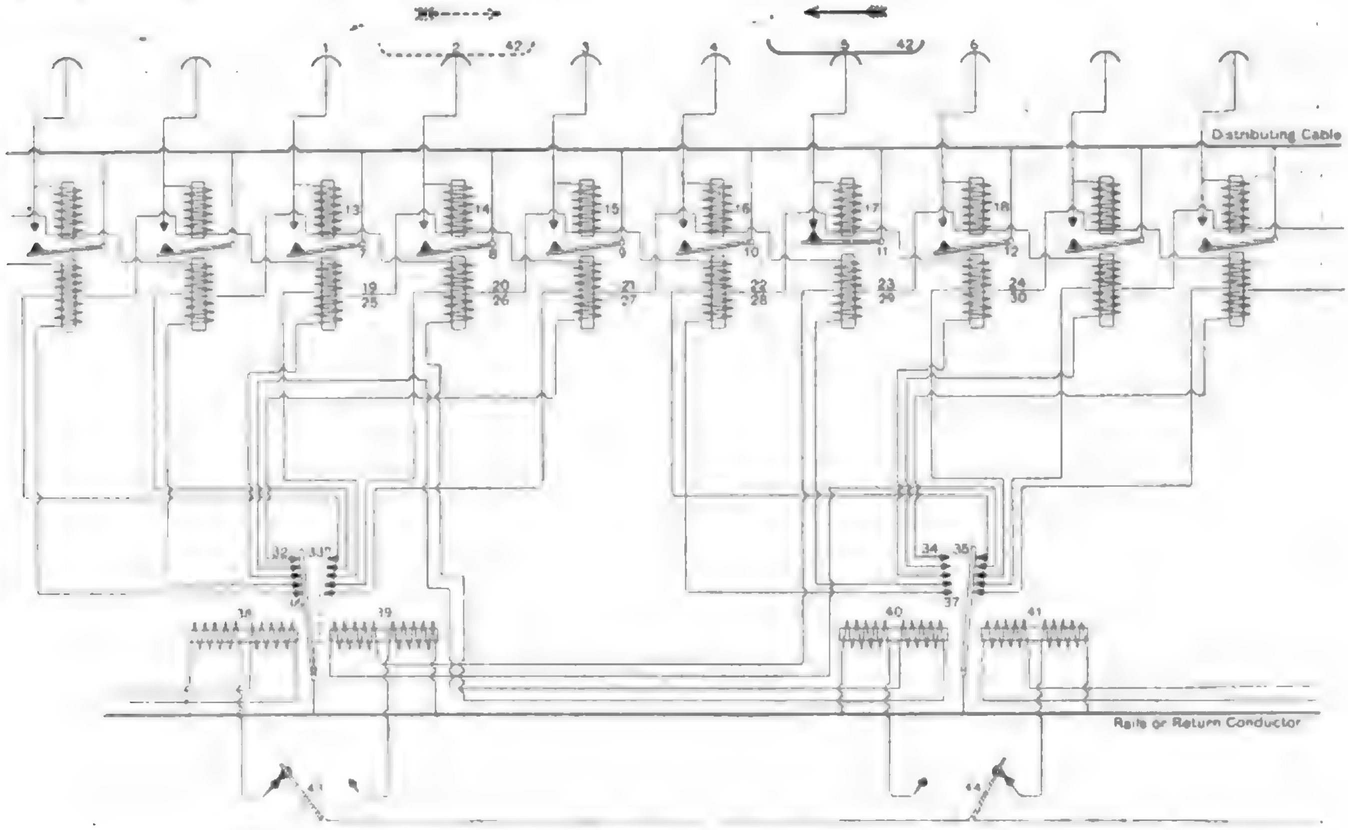

Contact Apparatus Unmounted.


Group Switch.

An important feature of the system is that there is no mechanism beneath the contact knobs. The switch relays are placed together in groups of about

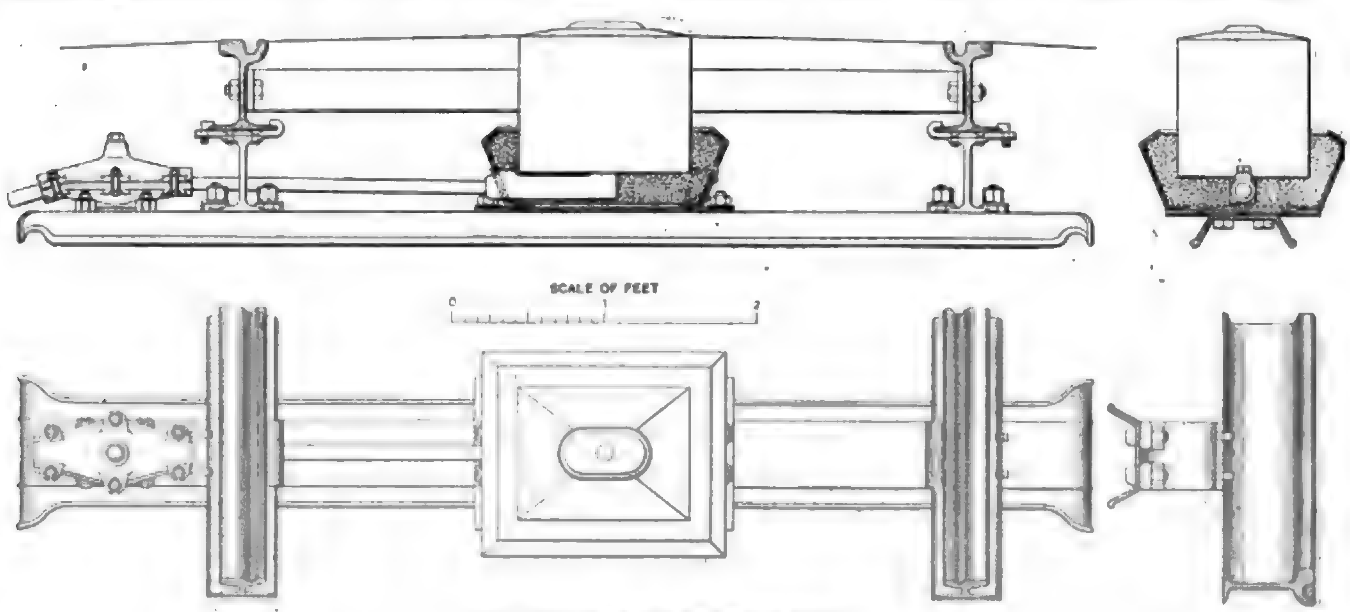
30, and each is connected to its corresponding contact knob by cable. The first figure on the opposite page shows the cast iron distribution box containing the switch relays. It is let into the roadway in upright position, the upper edge ranging even with the street level. The cover resembles an ordinary manhole cover. The next figure shows the box after removing cover, when an inner cover will be noticed. This latter is shaped like a diver's bell; the inner channel contains oil. The third view shows the box open. By these means, and without the use of any packing material, it is claimed that a perfectly reliable hermetical closure is obtained, which renders impossible the penetration of mud or moisture of any kind.

The fitting of the distribution boxes is effected at the works, so that they have merely to be placed in their position, when the track is laid. The windings of the coil and the other connections end in contact plates for which there are corresponding springs in the box, so that the mechanisms are merely slipped in and can be removed easily.



General Scheme of Connections.

Three figures opposite illustrate one of the relay switches. It consists of two pairs of magnets arranged diametrically. One pair serves to close the circuit and the other to open it. The coils are provided with fairly fine winding, taking ½ ampere at 500 volts. The main contact, clearly seen at the top in the figures in the first column is carbon-tipped, and the lever turns on a centre between the four coils. As the lever attains its switching-off position, the switching-off magnets attract another armature also, which closes two contacts and short-circuits the switching-in magnets. No arc requires to be extinguished within the apparatus, as the break of current to the car takes place, if at all, in the street between the contact stud and the current collector. The



Plan, Elevations and Section of Track.

The relays are attached to a wooden lining arranged at some centimetres distance from the iron sides of the box. The distribution boxes are arranged apart at distances corresponding to the number of relays each contains (*e.g.*, 30 × 4 = 120 metres), and they can be placed either in the centre of the track or on the side-walk. It is also possible to arrange the relays in a flat wall case or in pillars, &c.

cutting out of the relays takes place at the moment when the current collector touches the next stud, operating the next switch in such a way that from this switch a current is sent through the pull-off magnet coil of the previous relay.

One illustration on p. 120 shows the relay fitted, as at Munich, with a safety device, which provides against three of the apparatus remaining simultaneously in the "on" position without the automatic cutout coming into operation. Moreover, when no current is passing through any of the magnets, the switching lever falls by gravity into the "off" position. The contacts in front, which rotate with the switch lever, are so arranged that, so long as a third switch-relay is "on," so that three knobs are live, a catch falls, preventing the driver from replacing the automatic cut-out. These automatic cut-outs are placed at certain distances apart, dividing the line into sections.

The sectional switch is also illustrated on p. 120. This is arranged, together with the relay, in the distribution box, and it is designed as an electro-magnetic switch. When a motor-car travelling an ordinary course passes from one section to another, the current is automatically switched over, as shown in the general diagram. In changing the direction of travelling when the car is in the centre of a section, the circuit operating the sectional switch requires to be closed by a hand-switch, as already explained. These hand-switches are arranged along the track at distances of 60 metres.

In two illustrations on pages 118 and 119, representing photographs of a Munich car, the current collector in the form of a steel wire brush is clearly shown. Another form of current collector used is also shown, consisting of a Gall chain with numerous link discs.

In front and behind the current collector a wide brush, the so-called short-circuiting brush, is so arranged that it connects the rails with the contact stud. The contact studs not covered by the current collector must, as already mentioned, be dead. Should an instance occur in which, through some mechanical defect, the relay switch remains in circuit, then the short-circuiting brush would short circuit the stud to the rail. This would operate an automatic section cut-out, and the traffic on the section in question would be stopped until the defect was remedied.

## CARS ENGAGED IN THE AUTOMOBILE TRIALS.

Some of the makers of the motor cars which took part in the trials last week have, at our request, sent us descriptions of the vehicles they entered :—

**The Electric Motive Power Co.'s Four-seated Dogcart.**—Fig. 1 gives a good idea of the carriage which is designed and built on the "Northey" system. The battery weighs, complete, 12cwt., and has a capacity of 19½ H.P. hours when discharged in 4½ hours. The series-wound enclosed motor has four poles, is separately slung, and drives through a double universal arm and single reduction spur gearing on to the differential gear of the live axle.


Fig. 1.—Electric Motive Power Co.'s 4-seat Dogcart.

The company's special controller (Fig. 2) enables ordinary speeds of 3, 6, 9, and 12 miles per hour respectively to be obtained by different groups of parallels of the cells, with also the same number of reverse speeds. An important point in connection with this controller lies in the fact that the motor circuit is never broken when moving from one speed to another, the cells being arranged in gradual groupings, thus obviating any wear and tear due to sparking.

Three brakes are arranged, one an automatic electric brake operating to recuperate the cells; (2) a rim brake engaging on aluminium plates on the driving wheels; (3) a band brake on the live axle working in both directions.

The battery, which is of the company's own type, is composed of 60 cells, each giving an average potential difference of 2·35 volts during discharge. Great care has been taken in the design that all splashing of electrolyte shall be prevented, while corrosion is entirely absent by reason of their being no other than white metal used in the construction of the connectors and bolts of the battery.

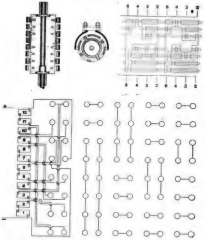


Fig. 2.—Controller of Electric Motive Power Co.'s Car.

An interesting feature is the design of the steering hubs, the pivoting point of the wheels being in the centre of the plane of the wheel tyres. The advantage of the construction is obvious from the point of view of withstanding strain alone. The weight of this car is 27½ cwt., and an average run of between 55 miles and 60 miles should obtained on one charge.

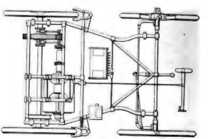


Fig. 3.—Plan of Frame and Motor Suspension.

[The second carriage, a four-seated electrical phaeton, entered by this company for these trials, was withdrawn on account of the motor having a higher gear ratio than was desirable to cope with the very hilly routes, especially when the roads are in so heavy a condition, this latter carriage being specially designed for London work.]

**The Electrical Undertakings' (Ltd.) Four-wheeled Dogcart.**—This vehicle is illustrated in Fig. 4. Total weight, including battery, 2,800lb.; weight of battery, about 1,000lb.; having a watt-hour capacity of 15,000 at 20 amperes discharge. Two motors, 2½ H.P., each working up to 5 H.P. Six speeds forward and two back; zero or stop puts on electric brake. Minimum speed, 2 miles per hour;

maximum, about 25 miles on level. Speeds not materially increased downhill because the battery recuperates; the motors becoming generators check the car. Seats four, including driver. Controlled entirely by one handle. Can travel over 60 miles on good roads on one charge. Good hill climber; internal spur gearing.

**The Joel Car.***—The car in question is of the voiturette type, providing comfortable accommodation for two passengers; its general appearance is seen in Fig. 5. Before going into full details of the various parts we may first of all mention that its chief features of interest are the following:—(1) The underframe for carrying two motors, which separately drive each of the rear wheels; (2) the motors themselves, in which the armature revolves outside the field magnets: (3) the controller and its connections, which are so arranged that the motor runs at its normal and most efficient speed when the vehicle is travelling up hill; and (4) the Rosenthal accumulators which are used.

Fig. 4.—Electric Undertakings Co.'s 4-wheeled Dog-Cart.

The vehicle consists primarily of the usual front and rear axles, with their steering and driving wheels respectively, upon which are carried by separate springs both the special underframe, seen in Figs. 6, 7 and 8, and the carriage body. The accumulators are carried in the body, and the two motors are mounted upon the underframe.

Fig. 5.—The Joel Electric Car.

Referring to Figs. 6, 7 and 8, the underframe is built of steel tubes, T T, which form an open-ended and cross-stayed rectangle; the ends of the side members of this frame are connected front and back by springs, S S, and these springs are attached to the centres of the front and rear axles respectively. The front spring S lies horizontally, and that at the back is placed vertically. This rear spring in the carriage which we examined has been replaced by a straight spring, which does not come into contact with the axle, but whose ends are suspended from the axle by a pair of spiral springs; these last-mentioned springs are in compression as they are placed beneath the flat cross spring S and are held at their lower ends by pins which pass through them from the axle.

The underframe thus forms a flexible perch bar between the two axles. It is also connected with the rear axle in such a way that driving chains, C C, can be tightened when necessary by the adjustment nuts P P.

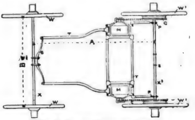


Fig. 6.—The Joel Underframe (Plan).

Two motors M M are fixed to the frame, and each of these is connected with one of the rear wheels by the roller chains C C. In order to reduce the size of the large chain wheels the motor itself is fitted with a toothed-wheel reducing gear, having a speed ratio of 2 to 1 (this is not shown in the drawings, but is fitted to the actual car). The gear ratio of the chain wheels is 5 to 1, and hence the total speed reduction is 10 to 1. In practice, the front spring S is connected to the axle by a single pin, and the axle is therefore free to move in a vertical plane about this centre. The framework and the motors can readily be removed by taking off three nuts and the chains C C. The front wheels are 2ft. 6in. diameter, and the rear wheels 2ft. 9in., the front track is 3ft., and the rear track 4ft. 6in. The wheel base is 4ft. 6in. Pneumatic tyres are fitted.

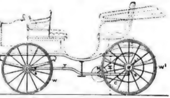


Fig. 7.—The Joel Car (Side Elevation).

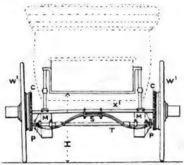


Fig. 8.—The Joel Car (Back View).

The form of motor used is seen in Fig. 9, and its detailed construction is shown in Figs. 10, 11 and 12. Fig. 10 is a longitudinal section, Fig. 11 is a side elevation, and Fig. 12 is a plan of the field magnets. The shaft A is held stationary in the outside casting, which secures the motor to the underframe. This shaft carries the fixed field magnets L. The field magnets are made in two pieces, which are bolted together as shown, and which carry between them

---

* The description of this car is from the *Automotor Journal*, to whom we are indebted for the loan of the blocks for Figs. 5 to 12.

and inside their pole pieces, N S, the magnetising coil V. Twelve poles are provided. The six north poles interlacing alternately with the six south poles, and all the pole-pieces lying in the same radial plane. Mounted about the shaft A, and free to revolve upon it, is a sleeve which carries the armature Y, the commutator Z, and the driving wheel P. The armature Y is a laminated iron ring which is bolted to the spider arms y, and which is slotted transversely around its inner face. Each of the slots T carry two insulated square copper wires, w, and these wires are connected about the sides of the ring to form overlapping complete windings about the whole armature. One extra slot, T, is provided for connecting the final ends of the windings in series. The general system of this zigzag winding crosses the armature 12 times in one complete coil. In the motors of larger size more than two wires are laid in each of the slots T.

By this construction the inventor claims that he reduces the weight of the motor, and that he decreases the amount of ineffective copper. The two motors fitted to the voiturette are said to weigh 112lb. each, and to bear an overload of 100 per cent. They develop normally 2 H.P. at about 700 revs. per min. Their efficiency at 40 volts is given as 70 per cent. at half load, 85 per cent. at normal load, and 89 per cent. with a 50 per cent. overload. They are shunt wound, and are completely enclosed in an aluminium case, which also contains the spur gearing.

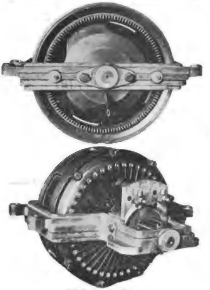


Fig. 9.—The Joel Motor.

The method of fixing the two motors to the framework prevents them from receiving sudden shocks or jars either from uneven road surfaces or from their own effort when starting the vehicle; in these latter circumstances the whole frame, together with the motors, is at first lifted somewhat against the action of the spiral springs, and as the car moves forward it returns to an intermediate position, dependent upon the tractive effort required.

The controller consists of a single drum carrying contact blocks which complete the necessary circuits successively between the insulated spring blocks. In order to give the drum a rapid action between its various positions a spring roller is fixed in engagement with a cam wheel, and a pair of flat springs tend to hold it in either of its normal positions by pressing against flats on the shaft.

The 12 diagrams here given provide for the following combinations and results: (1) Charging position; the two batteries in series across the charging terminals. (2) Low speed reverse (three miles an hour); the batteries in parallel, the fields fully excited in the abnormal direction, and the motors in series. (3) Electric brakes; the armatures short circuited, and the fields fully excited. (4) Low speed ahead (three miles); the same as No. 2, but the fields excited in the normal sense. (5) Intermediate speed (six miles) and maximum torque; the armatures in parallel and otherwise the same as No. 4. (6) Increased speed (eight miles); the same as No. 5, but a resistance placed in the field circuit. (7) Ten-mile speed; added resistance in this circuit. (8) Twelve-mile speed. (9) Top-speed; the strength of the fields reduced to a minimum. The weight of the car is about 4cwt. apart from the accumulators.

The accumulators used upon the "Joel" car are those known as the "Rosenthal." Something over 12 watt-hours per pound is claimed for them, and we are told that the batteries used for some twelve months are still up to this very high capacity. The accumulator of the pasted type, the positives and negatives being similar except in thickness. The cast-lead grids consist of vertical rods, having a diamond section, and of inter-connecting horizontal bars, having a circular section. These grids are pasted in the usual way, and the whole of the grid is completely covered. The positives are protected by perforated ebonite plates which press against their surfaces. Ebonite separators are used between the plates, and the sections are held together by rubber bands, which also serve the double purpose of springy cushions and of bridge pieces. The sections are fitted into ebonite boxes, with vent valves on the lids and with rubber round the lugs. The vents are provided with cup-shaped recesses, and consist of plates of ebonite, which are attached to small rods fitting freely in the holes in the lids.

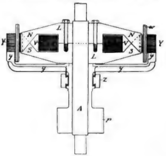


Fig. 10.

The connections are made with copper wires, which are let into, and soldered to, the lead lugs. Four of these boxes of eight cells slide into the body, underneath the seat, from the back of the car. Each cell has a couple of rubber bands passed round it, and these tend to absorb shocks or vibration. The thirty-two cells provided for the voiturette weigh 7cwt.

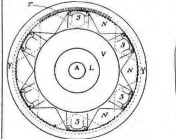


Fig. 11.

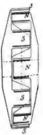


Fig. 12.

The figures given regarding weight and capacity of the Rosenthal accumulators are as follows:—(1) Discharge, 20 amperes; capacity, 143 amperes-hours; weight of plates, 18·1lb. (2) Discharge, 20; capacity, 170 ampere-hours; weight of cell, complete, 25lb. (3) Approximate capacity of cell (No. 2), after 12 months' use, 140 ampere-hours.

We are told, also, that these plates show no signs of disintegration excepting, after long use, at the corners of the positives. They are said to be capable of discharging at 40 amperes without harm; in practice, upon the car, they have to exceed this considerably at times.

Some particulars as to the results of the trials will be found on a later page of this issue.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Photo-electric Rays.*—E. Merritt and O. M. Stewart have traced the connection between cathode rays and the particles discharged from negatively-charged bodies under the influence of ultra-violet light along lines resembling the famous investigations of Lenard (see *The Electrician*, Vol. XLV., p. 858). For simplicity the authors call the streams of particles discharged through the influence of ultra-violet light "photo-electric rays," and they then proceed to show that they are of essentially the same nature as cathode rays. This is the conclusion already arrived at by J. J. Thomson, who has even determined the ratio $e/m$ for these rays, and found it to lie between $5{\cdot}8\times10^6$ and $8{\cdot}5\times10^6$. The authors employed an arc lamp in place of a spark-gap as a source of ultra-violet light, and their vacuum tubes were essentially the same as Lenard's, with a slanting side-tube to direct the ultra-violet rays on to the cathode. Their magnetic-deflection experiments led them to the conclusion that two kinds of particles are concerned in the photo-electric discharge: (1) The small rapidly-moving corpuscles of the photo-electric rays, forming a fairly compact stream normal to the cathode; (2) the relatively heavy and slowly-moving negative ions, which form a stream having the same general direction as the photo-electric rays, but much more diffuse and not appreciably affected by a magnetic field.

[Merritt and Stewart, *Phys. Review*, October, 1900.]

*Efficiency of Acetylene Flame.*—A lengthy investigation both of the radiant efficiency and the total efficiency of the acetylene flame has up to the present yielded results which have led E. L. Nichols to make a preliminary announcement concerning them. The radiant efficiency, *i.e.*, the ratio of luminous to total radiation, was computed both by the method of Melloni and by the spectroscopic method, the latter consisting in the exploration of the spectrum and the comparison of the areas enclosed by the curve within and without the limits of visibility. The total efficiency, *i.e.*, the ratio of luminous energy to total energy supplied, was computed by means of the heat of combustion, the amount of gas supplied, and a modification of Thomsen's method. As regards the radiant efficiency, that was found to be 0·105, or practically the same as that of the arc light, which is equally "cold," and twice as "cold" as either the incandescent or the Welsbach lamp. The contrast with the radiant efficiency 0·32 of the vacuum tube remains therefore as great as ever. In the matter of total efficiency, on the other hand, the acetylene lamp stands very high. The figure given is about 0·02, or at least double the corresponding figure for the arc light. The magnesium flame alone, with its astonishing efficiency of 0·1, is superior to the acetylene flame.

[E. L. Nichols, *Phys. Review*, October, 1900.]

*Resistance of a Galvanometer.*—W. S. Davy describes what he believes to be a new method of measuring the resistance of a galvanometer. It is based upon the principle that if the terminals of a galvanometer are brought to a certain potential difference, and the resulting current through the galvanometer gives a certain constant deflection, then, if we double this potential difference, it will be necessary to double the resistance of the galvanometer circuit if we wish to maintain the needle at the same reading. Use may be made of the uniform fall of potential along a potentiometer wire. In this method, the galvanometer terminals would be placed in contact with points on the wire a suitable distance apart, and the deflection noted. This distance would then be doubled, and at the same time a resistance would be inserted in series with the galvanometer and varied until the deflection became the same as at first. Then, supposing the resistance of the part of the wire between the terminals is negligible in comparison, the resistance inserted will be the same as that of the galvanometer. If it is not negligible the effect of the potentiometer wire may be determined by taking points three times as far apart as the original points, and observing what resistance is then necessary to keep the galvanometer current the same.

[W. S. Davy, *Phys. Review*, October, 1900.]

*Coherer Materials.*—A large variety of metallic powders have been examined by T. Mizuno with regard to their behaviour in coherers. The point chiefly studied by the Japanese physicist is the change produced by several successive sparks, and for this purpose he noted the value of the resistance after every spark up to 25. He finds that in platinum, lead, nickel, aluminium, cadmium, copper, steel, and potassium coherers, the action of electric waves is to reduce their resistances at first to a large extent, and then this reduction continues, though with some intermediate rise and fall, until the resistances assume certain final values. In the case of tin, bismuth, zinc, antimony, and especially iron, the resistances are diminished at first, but soon afterwards the changes become very irregular, the diminution and increase occurring at random. But it often happens that zinc, lead and potassium coherers, as well as those made of electric fuse, suddenly assume an infinite resistance. In the case of coherers with mixed metals, such as iron with silver, cadmium, Rose's or Wood's metals, and also silver with Wood's metal, the mode in which the resistance changes seems to be chiefly governed is shown by the percentage ratio of the constituents. In fact, the history of each coherer presents the character which would belong to the predominant constituent.

[T. Mizuno, *Phil. Mag.*, November, 1900.]

*Electric Traces on Sensitive Plates.*—V. Schaffers has made an elaborate study, suggested by Leduc's reproduction of globe lightning on a small scale, concerning the manner in which photographic plates, or plates of a similar constitution, are influenced by the discharge from an influence machine, conveyed through electrodes in the shape of needle points in contact with the film. A great variety of actions may be observed, according to the arrangement of the electrodes, the current strength, and the material of the film. Tracings of the lines of force are obtained with mercuric chloride suspended in gum or silver bromide in gelatine. Zones of various degrees of intensity, arranged along equipotential lines, are obtained with silver chloride suspended in gum, or silver bromide emulsion in starch. Gold iodide gives beautiful diagrams of continuous lines of force. But the most interesting phenomenon is that of the ball of light which emerges from the negative electrode, passes for a small distance along the glass underneath the film, and proceeds more or less slowly towards the positive electrode, fusing the medium and reducing the salt as it goes along. It does not necessarily move along the lines of force, but chooses the line of least resistance, and may cut across previous traces at an acute angle. The ball may be, of course, a simple cathode phenomenon, produced at the head of the track of reduced salt, which forms a prolongation of the cathode.

[V. Schaffers, Pamphlet, printed by Hermann, Paris, 1900.]

*Cathode-ray Colouration.*—Some colourations resembling those due to the oxidation of steel have been obtained with cathode rays by W. B. von Czudnochowski. He uses a spherical bulb and a spherical cathode, and exposes crystals of fluorspar or rock salt to the radiation from the cathode just below the point at which the rays converge. The violet colouration of colourless fluorspar has long been known, but with the arrangement described the uniform bronze colour seen by reflected light is replaced by coloured rings. The extreme edge appears bronze-coloured; then comes a full yellow, then red, and, lastly, a bluish-violet in the centre. On further exposure, the rings widen out and a new system is developed in the centre. After 15 minutes' exposure colourless Tirolese fluorspar shows the following rings, counting from the edge: silver-grey, yellow, orange, brown, blue. Northumberland fluorspar and rock salt show similar colours, which are, however, masked, in the case of the latter, by the uniform brown colouration of the whole surface. The regular series of colours appears to be: grey, yellow, orange, brownish-yellow, violet, yellow, red, violet. The series observed in steel is: straw-yellow, orange, red, dark blue, light blue, pink, green, water-blue, pale yellow. Newton's rings follow the reverse series.

[W. B. von Czudnochowski, *Physik. Zeitschr.*, November 3, 1900.]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1872).

Published every Friday, Price Sixpence ; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 16s. 0d. ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## STEAM ENGINE REVELATIONS.

The nineteenth century has been popularly named the Age of Steam. Its closing months give no indication that the early years of the new century will witness any radical change in the mode of utilising the energy of fuel for large motive power. Steam is still, and promises for some time to remain, the only practicable agent for developing power on any large scale. Other and more efficient forms of heat engine are rapidly taking its place for purposes requiring only small or moderately large amounts of power; but, unfortunately, where power amounting to hundreds of thousands of horse-power is needed the steam engine stands unrivalled among heat engines. We use advisedly the word "unfortunately"; for it is not on account of superior efficiency, but rather in spite of superior inefficiency and lavish wastefulness, that it stands thus pre-eminent. It is well known that heat engines, as a class, are necessarily more or less inefficient; inviolable laws of thermodynamics have fixed a proportion of original and ineradicable iniquity upon them, from which there is no redemption. But of all classes of heat engine, the steam engine is that which displays in the highest degree this inherent wickedness; it has been improved and reformed almost up to the utmost possible limit, and still it cannot be made to refrain from wasting nearly all the energy bestowed on it for the performance of useful work. Quite recently Mr. ARTHUR BALFOUR cast the reflection upon modern engineering science, that it had discovered no means of utilising the vast sources of energy in coal and other fuel than that which involves the utter waste of more than three-quarters of the energy expended. It is scarcely fair to blame engineering; unless, indeed, scientific engineers are to be expected to abandon the principle of the heat engine, and proceed forthwith to seek a mode of obtaining energy from fuel without the aid of thermal combustion. The way to this goal is rough and thorny; many have attempted to enter it, but few have remained in it very long. Direct production of electricity from coal is the chief aim of these scantily-encouraged workers; but their efforts are still in the most hypothetical corner of the laboratory stage, and some time

must elapse, we fear, before they will succeed in turning an engine flywheel. *Nolens volens*, we must utilise coal in the old-fashioned, unscientific way, by burning it in a boiler furnace and making steam, that most perverse of all fluids, drive an engine.

Having made up our mind perforce that the steam engine cannot be improved beyond a certain low limit—somewhere in the region of between 20 and 30 per cent. efficiency—the practical problem is, how to contrive to bring the actual efficiency as nearly as possible up to that limit. With so much energy leaking away, as it were, with a guaranteed safe conduct, it becomes all the more imperative to see that no unauthorised and illegal desertion of heat units takes place. This can only be done with satisfactory results by carefully studying all the possible outlets by which energy might escape; and scientific engineers have made this a practical study ever since the thermodynamic principles of the steam engine began to be understood. Nothing, by the way, better illustrates the improving influence of theory on practice than does the history of the steam engine, viewed in relation to the results of scientific research and study. A complete review of this aspect of the subject would necessitate a survey of the entire chain of engineering apparatus, from the boiler furnace to the pulley or driving shaft of the engine; for at each and every one of the stages along this chain energy is wasted of necessity, and is liable to be wasted unnecessarily also. We are, however, directed by the subject more immediately in view, to consider only those sources of energy-waste which occur within the cylinder of the steam engine itself; although, as a matter of thermodynamics, the steam generator—the boiler and its furnace—is more sinful than the actual engine, in regard to that inevitable and iniquitous degradation and loss of energy to which we have made reference already.

The behaviour of steam within the cylinder of an engine has hitherto proved a somewhat difficult matter for direct study, inasmuch as, the cylinder being closed on all sides, visual or other direct observation of the steam is attended by numerous obstacles, and often has been considered impossible. For some time past, Mr. BRYAN DONKIN has striven to overcome these difficulties, and to perfect an instrument by means of which the behaviour of steam within a cylinder during the running of the engine might be visually observed. Such an instrument was named by HIRN a "revealer," a name which has been universally adopted. The indications of a perfect revealer would, indeed, be revelations. The researches which Mr. BRYAN DONKIN has conducted with two forms of revealer are recounted in a valuable Paper he read recently before the Institution of Mechanical Engineers. A reprint of this Paper, with some illustrations showing the construction of the instrument itself, is completed in the present issue. First as to the instrument: There are two forms described, though a still earlier form than either of these consisted merely in a cylindrical glass vessel communicating by a connecting pipe with one end of the cylinder, much in the same manner as an indicator is connected. In fact, in all its forms the revealer is modelled closely—and too slavishly, we think—upon the steam engine indicator. It consists essentially of a closed glass chamber, forming a *cul de sac* communicating with the interior of the cylinder, in such a manner that the pressure of the steam within the chamber rises and falls correspondingly with the change of pressure within the cylinder itself. The state of moisture of the steam and of the cylinder walls is inferred from observation of the corresponding condition of the steam and glass surfaces in the revealer. In the earlier of the two forms described by Mr. DONKIN there is a mass of cast-iron suspended within the glass chamber, the cylinder steam circulating around this mass and inside its hollow interior. But, in the latest form of the instrument, a closer imitation of the actual conditions within the engine cylinder is provided by excluding the cylinder steam from the interior of the cast-iron mass, this interior being capable of becoming steadily heated or cooled by jacket steam or by water circulation. In this way the conditions of either a jacketed or a non-jacketed engine cylinder are more nearly copied, and the effects which are observed to take place within the instrument are therefore rendered less unlike those which take place inside the engine. For details as to the mode of using the instrument, and in regard to the experiments which Mr. DONKIN has conducted by means of it, we must refer our readers to the Paper; we would also draw their attention to a highly valuable and suggestive *critique* by M. NADAL, forming an appendix to the Paper.

As is pertinently remarked by M. NADAL, "the improved revealer has an action of its own, which represents or does not represent the phenomena produced in the steam cylinder according to whether the little cylinder is or is not placed in the same conditions as the walls of the steam cylinder." We dismiss at once all consideration of other forms of revealer than that designated the improved form, because it will be obvious to all who are familiar with the steam engine that these earlier forms did not even qualitatively imitate the actual conditions within the engine; and, therefore, although each of these ingenious revealers had "an action of its own," that action was widely diverse from the action of steam in the engine cylinder. But we may go even further and question whether the most improved pattern of revealer described by Mr. DONKIN really comes nearly enough to imitating the actual conditions within the engine. We have said that, in our opinion, the revealer is designed too slavishly on the lines of the ordinary indicator. Like this last-named instrument, it consists of a side chamber attached to the cylinder by means of a connecting pipe, which can be opened or closed at will—a *cul de sac* annexed to the cylinder space. For the purposes of gauging the variations of pressure during the stroke of the engine, which is all that is required in the indicator, such a method can be made to answer perfectly; but as a means of observing actual steam and wetted surfaces in the conditions occurring in the cylinder, this method is not only imperfect, but in our opinion radically and hopelessly wrong, and is utterly misleading in regard to the indications which are observed by means of it. Steam cooped up in a *cul de sac* can never be in the same condition as steam in the main cylinder, subjected, as the latter is, to the action of the piston and the sweeping in-rush and out-rush from the ports. The pressure may be the same in the two cases, but the conditions of temperature and wetness will be far from being the same. And the difference is not trifling, but is such as to render comparison quite impracticable; we entirely disagree with Mr. DONKIN's statement that "the effects of condensation, as shown by the revealer, may be within 85 per cent. to 95 per cent. of the truth." This statement implies that the revealer can be used quantitatively, whereas careful reflection justifies doubt whether its indications are even qualitatively useful. For, not only is the steam in the revealer confined in a side chamber in such a manner as to be exempt from the sweeping-out action of exhaust, which would rid it of much of its suspended moisture, but it will further be seen that the relative proportion between the mass of the steam and the area of the metallic surfaces of the cylinder is far different in the revealer from what it is in the engine. This last must exert an effect so marked as to be absolutely the determining factor in the formation and evaporation of water. How then can observations in the

revealer be held to indicate even in a qualitative degree what takes place in the engine?

There are many obstacles to the construction of an instrument that would enable the actual interior of an engine cylinder to be placed under visual or photographic observation during the running of the engine; but we do not believe that these obstacles are insurmountable. It would be necessary in the first place to illuminate the interior of the cylinder; but this should present little or no difficulty. A small lens, capable of withstanding the steam pressure—and warmed if need be, to prevent condensation on its inner surface, by means of an electrically-heated coil surrounding it—could readily be inserted in the cylinder end. Through this lens the rays from an arc lamp could be introduced and scattered over the cylinder walls. By means of a similar lens, connected to a telescope or camera, observation of the interior could be made; and all this could be effected without in any way disturbing the ordinary proportions and working of the engine. With such an instrument as this the varying condition of the steam and of the cylinder walls would stand revealed in a far more satisfactory manner than they ever can be by the comparatively indirect method involved in the use of Mr. BRYAN DONKIN's revealer.

There are several causes which combine to produce the wetness which it is the main purpose of the revealer to indicate: but, whatever may be the causes in each individual case, it is probable that a knowledge of the distribution of that wetness in the mass of the steam and over the surrounding surfaces during the cycle of operations in the cylinder would go far towards a settlement of the vexed questions that enshroud the problem of the steam-engine jacket. Much has been written and said on the merits and demerits of the jacket; and the line of demarkation between useful and useless, or even wasteful, jacketing is still not clearly drawn for many common types of steam-engine. When our knowledge of cylinder liquefaction becomes something more than a study of indicator cards and thermometers; when, in fact, it includes direct knowledge of when and where and in what amounts moment by moment steam is liquefied and re-evaporated, a great advance will have been made towards raising the efficiency of the steam-engine more nearly to that major limit, the inflexible smallness of which every engineer so much deplores.

## OBSERVATIONS ON AN IMPROVED GLASS REVEALER, FOR STUDYING CONDENSATION IN STEAM-ENGINE CYLINDERS, AND RENDERING THE EFFECTS VISIBLE.*

BY MR. BRYAN DONKIN.

(*Concluded from page 85.*)

*Latest Experiments* (May, 1900).—The author has been able to make a few more experiments, with the revealer in all cases open to the low-pressure cylinder of the same steam engine, and now adds three tables giving details. All these latest tests have been carried out with a new square cast-iron cylinder, similar to that shown in Fig. 3, but with four sides, and so arranged that it can be either heated by steam, cooled by water, or kept at a constant temperature, and the thermal effects thus studied. The temperature of the wall was taken in each case. The tables hardly require explanation, but the following is a summary of the chief points. When circulating water was used in the jacket the quantity was weighed, and the rise in temperature noted. Indicator diagrams were also taken in each test from the low-pressure cylinder.

*Table I. First Set. Hot Walls Cooled Down.*—Six experiments with different pressures of steam in the jacket of the revealer cylinder, and therefore at different cylinder temperatures. At the start, and for some time after, the steam heated the cylinder to a given temperature. It was then shut off, and the effects noted every minute, until a constant and minimum temperature was reached, due to the steam from the low-pressure cylinder. The object was to determine the different rates of cooling of the previously-heated revealer cylinder. The only condition varied was the temperature of the little cylinder. Comparing column 5 with column 11 it will be seen that in these experiments the walls assume, *not* the mean temperature of the two strokes (column 13), but nearly that of the *steam stroke only* (column 11). The tests also prove that notwithstanding the water on both sides of the cast-iron surfaces, their heat absorbing properties are greater than their heat emission to the exhaust.

*Table II. Second Set. Cooled Walls Heated Up.*—Two experiments were made. At starting the revealer cylinder was cooled by circulating water to a certain constant temperature; the water was then shut off, and the rise in temperature of the cylinder noted every minute. The object was to determine the different rates of heating the previously cooled cylinder, and also whether the exchanges of heat were affected by more or less water on the cylinder surfaces due to condensation. The temperature of the cylinder only was varied by altering the quantity of circulating water. Comparing tests 1 and 2, about twice as much heat passed in No. 2 per unit of surface, although it had to pass through a greater thickness of water on the walls exposed. This seems to prove that this water does not interfere with the passage of heat through the cast-iron walls, and that the heat absorption goes on notwithstanding it.

*Table III. Third Set. Constant Temperature Cylinder Walls.*—Two experiments were made without shutting off the circulating water. The cylinder was cooled down to the desired temperature, which was then kept constant. One object was to determine whether the heat exchanges would be influenced by more or less condensing water on the external surfaces of the cylinder. Comparing these two tests, about twice as much heat passed in No. 2 from the low-pressure cylinder to the circulating water per unit of surface exposed. It had also to pass first through a greater thickness of water or drops on the surfaces. This seems to prove that this surface-water does not interfere with the passage of heat through the cast-iron cylinder walls, and that the heat absorption proceeds all the same. Several of these experiments agree with M. Nadal's theoretical investigations, as published in the "Revue de Mécanique," and with the conclusions he draws—namely, that the heat-absorbing properties of cast-iron are much greater than their heat-emitting properties, and the former are little influenced by the drops or condensation on the steam-engine cylinder walls. The author has not yet made experiments with surfaces slightly oiled; all the above were carried out with fairly clean surfaces. A little oil from the steam cylinder might, perhaps, have been on them in places, but they appeared quite dry, and even a little rusty to the touch. Mr. Martin Smith, to whom he acknowledges his thanks, helped the author in these latter tests. In these experiments the junction pipe from the engine cylinder to the revealer was very carefully covered.

*Radiation Experiments, including the Heat Lost along the Connecting Pipe to the Low-pressure Cylinder-cover.*—The temperature of the engine-room was 84°F. to 85°F. The revealer was not open to the low-pressure cylinder. The trial started at 9.8 a.m., with the wall at a temperature of 298deg.; the steam was then shut off from the revealer jacket. At 3 p.m. the temperature had fallen to 105°F., equal to 193deg. fall in temperature in 368min. or 0·525°F. per minute, which is equal to 1·133lb. × 0·125 (specific heat) × 0·525°F. = 0·074 thermal unit per minute. The loss of heat by radiation of cast-iron cylinder at this rather high temperature of 298°F. includes the heat transmitted along pipe to cylinder-cover.

*Gain of Heat by Revealer Cylinder at a Lower Temperature, some Radiation also taking place.*—The revealer was on the top, but not open to the low-pressure cylinder, all cocks being shut off. In 7½ hours the revealer cylinder rose in temperature from 94°F. to 100°F. = 6deg. rise. The temperature of the engine room also rose from 70°F. to 78°F. = 8deg. rise. At these low temperatures the conduction of heat along the connecting pipe is greater than the radiation. The temperature of the cylinder therefore rose with the temperature of the engine room.

*Communication by M. Nadal, Ingénieur des Mines, France.*

The experiments recently made by Mr. Bryan Donkin with his improved revealer throw fresh and important light on various questions touching the phenomena of condensation in steam-engine cylinders. One of the first points to be considered is, whether that which takes place in the revealer accurately represents similar occurrences in the cylinder. Mr. Donkin is of opinion that "the effects of condensation, as shown by the revealer, may be within 85 per cent. to 95 per cent. of the truth." From this point of view we must distinguish between the three types of revealers: 1st, the original glass revealer without an internal cast-iron cylinder; 2nd,

* Paper read before the Institution of Mechanical Engineers, Oct. 19.

**Table I.**—*Six Experiments on Steam-jacketed Revealer (Cylinder with Square Sides), May 1900, by* Mr. BRYAN DONKIN, *on Factory Compound Engine. Revealer on Top of Low-pressure Cylinder.*

With different pressures of steam in jacket to give different wall temperatures (cast-iron) 230deg. to 300deg., and exposing walls to low-pressure cylinder (steam-jacketed) for cooling effects. Small cylinder first heated in all cases to temperature given in Column 3; steam then shut off and cooling effects noted until a constant minimum temperature was reached. Revealer always open to low-pressure cylinder before and after shutting off steam in jacket.

Cast-iron cylinder with square sides:—Height, 2½in. = 63mm.; sides, 1·6in. = 40mm.; centre hole or jacket 1in. = 25mm.; weight 1·133lb.; surface exposed 0·11 sq. ft.

[*1st Series—Hot Walls Cooled Down.*]

| No. of Experiment. | Pressure of steam in revealer jacket and equivalent temperature (by tables). Lbs. p. sq. in. F.° | Temperature of cast-iron revealer walls before shutting off steam in jacket. F.° | Difference of temperature of Cols. 3 & 2 due to throttling of steam. F.° | After shutting off steam in jacket. Time to reach minimum and constant temperature. Min. | F.° | Temperature of revealer walls, beginning and end of experiment and drop. F.° | Drop of temperature of revealer walls per min. F.° | Heat lost by revealer walls (weight = 1·133lb.) Thermal units per min. | Heat lost by revealer walls (sq. ft. surface = 0·11 sq. ft.) Thermal units per sq. ft. per min. | Temperatures from indicator diagrams of pressure taken from L.P. cylinder at the time. Maximum initial. F.° | Steam stroke (mean). F.° | Experiment stroke (mean). F.° | Both strokes (mean). F.° | Difference of temperature between Cols. 11, 13 & 5, or cooling head of heat. Beginning and end of experiments. F.° |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 8 = 183° | 230° | 230°<br>183°<br>—47 | 26 | 184° | 230°<br>184°<br>—46° | 1·77° | 1·77 × 1·133 × 0·125 = 0·25 | 0·25 ÷ 0·11 = 2·26 | 209° | 187° | 135° | 161° | 230° 161° —69°<br>184° 161° —23° |
| 1 | 18 = 222° | 250° | 250°<br>222°<br>—28° | 35 | 185° | 250°<br>185°<br>—65° | 1·85° | 0·26 | 2·36 | 206 | 185° | 134° | 160° | 250° 160° —90°<br>185° 160° —25° |
| 2 | 33½ = 256° | 263° | 263°<br>256°<br>—7° | 33 | 184° | 263°<br>184°<br>—79° | 2·40° | 0·33 | 3·01 | 209° | 187° | 138° | 162° | 263° 162° —101°<br>184° 162° —22° |
| 4 | 31½ = 252° | 268° | 268°<br>252°<br>—16° | 50 | 176° | 268°<br>176°<br>—92° | 1·84° | 0·26 | 2·36 | 211° | 189° | 140° | 164° | 268° 164° —104°<br>176° 164° —12° |
| 5 | 50½ = 281° | 285° | 285°<br>281°<br>—4° | 39 | 180° | 285°<br>180°<br>—105° | 2·70° | 0·38 | 3·45 | 208° | 185° | 137° | 161° | 285° 161° —124°<br>180° 161° —19° |
| 6 | 59¾ = 292° | 300° | 300°<br>292°<br>—8° | [illegible] | [illegible] | 300°<br>180°<br>—120° | 3·07° | 0·43 | 3·91 | 211° | 186° | 134° | 160° | 300° 160° —140°<br>180° 160° —20° |
| Remarks. | Increasing pressure and increasing temperature. | Increasing temperature of walls. | Decreasing difference with less throttling (60lb. in boiler). | Minimum constant temperature about same in six experiments—Mean 181½°. | | Increasing drop of temperature. | Increasing. | Increasing quantities of heat for increasing wall temperatures. | Increasing. | About same. Mean 6 experim'ts = 209°. | About same. Mean 6 experim'ts = 186½°. | About same. Mean 6 experim'ts = 136°. | About same. Mean 6 experim'ts = 161°. | Much greater difference of temperature at commencement of each experiment than at end. |
| 1 | 2 | 3 | 4 | 5 | | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |

Approximate temperature of top of low-pressure cylinder cover 162 F. by experiment with oil and thermometer: compare this with Column 13 = 161°, or about same.

*Conclusions, &c.*—Comparing Column 5 with Column 11 it will be seen that in these experiments the walls assume—not the mean temperature of the two strokes (Column 13)—but nearly that of the steam stroke (Column 11). This tends to prove that, notwithstanding the water on the cast-iron walls, the heat-absorbing properties are greater than their heat emission to the exhaust. Fog and moisture on walls:—Little or none with the hotter walls, but as the temperature of walls decreased, both fog and drops increase much. Specific heat of cast-iron taken as 0·125 thermal units per lb.

**Table III.** (*3rd Series*).—*Revealer Experiments.—Cylinder kept at Constant and Low Temperatures.*

Two experiments with water-cooled cylinder (square sides), May, 1900, by Mr. BRYAN DONKIN, on factory compound engine. Revealer on low-pressure cylinder, and kept always open to it. Cylinder cooled with circulating water to reduce its temperature and keep it constant at temperatures given in Column No. 2.

| No. of experiment. | Temperature of cylinder reduced to (by water) Fahr. | Quantity of heat gained by the water equals that passing through cylinder. Thermal units per min. | Quantity of heat passing per sq. ft. surface. Thermal units per sq. ft. per min. | Temp. from indicator diagram of pressures taken from L.P. cylinder at the same time. Maximum initial. Fahr. | Steam stroke (mean). Fahr. | Experiment stroke (mean). Fahr. | Both strokes (mean). Fahr. | Remarks and conclusions. |
|---|---|---|---|---|---|---|---|---|
| 1 | 140½° | 0·38lb. × 26·1° rise = 9·9 T.U. to keep cylinder at 140½°. | 89 | 212° | 188½° | 132½° | 163° | * |
| 2 | 132½° | 1·38 × 16° rise = 21·76 to keep cylinder at 132½°. | 196 | 213° | 191° | 141° | 166½° | † |
| 10 to 20 minute expts. Comparis'ns. | Fairly constant temperature maintained by circulating water. | About twice as much heat passing in No. 2 than in No. 1 from L.P. cylinder steam to the water. | About twice as much heat passing per sq. ft. surface from steam to water. | Temperatures rather higher in No. 2 experiment than in No. 1. Diagram about same as Fig. 4. | | | | ‡ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

NOTE.—In this series the tests were made without any turning off of the water. Column 3 gives lbs. of circulating water as weighed and its rise of temperature. Specific heat cast-iron taken as 0·125. Cast iron cylinder 2½in. long with 1·6in. sides, 1in. hole in centre, weight 1·133lb. External surfaces 0·11 sq. ft.

* With much water on the glass walls and fog one could not see well the metal walls. All previous experiments show that there must have been much water on these surfaces at such a low temperature as 140½deg.

† With much water on the glass walls and fog one could not see well the metal walls. All previous experiments show that there must have been much water on these surfaces at such a low temperature as 132½deg.

‡ Comparing these two tests (1 and 2) about twice as much heat passed in No. 2 from the low-pressure cylinder to the circulating water per unit of surface exposed. It had also to pass through a greater thickness of water and drops on the surfaces. This seems to prove that this surface water does not interfere with the passage of heat through the cast-iron cylinder walls, and that the heat absorption proceeds all the same.

**Table II.** (*2nd Series*).—*Revealer Experiments.—Cooled Walls Heated Up.*

Two experiments with water-cooled revealer cylinder (square sides), May, 1900, by Mr. BRYAN DONKIN, on factory compound steam-engine. Revealer on low-pressure cylinder, and kept always open to it. Water in first place allowed to cool cylinder to a constant temperature, and then water shut off, and heating effects noted.

| No. of experiment. | Temperature of cylinder cooled to—then water shut off.<br>Fahr. | Heat gained by circulating water to keep cylinder at temperatures given when open to L.P. cylinder.<br>Thermal units per min. | After water turned off, time and constant temperature reached.<br>Min. | <br>Fahr. | Rise of temperature of cylinder per min.<br>Fahr. | Heat gained by the cylinder.<br>Thermal units per min. | Heat gained by cylinder per per sq. ft. of surface.<br>Thermal units per sq. ft. per min. | Temp. from indicator diagrams of pressures taken from L.P. cylinder at same time.<br>Max. initial.<br>Fahr. | <br>Steam stroke (mean).<br>Fahr. | <br>Exp'm't stroke (mean).<br>Fahr. | <br>Both strokes (mean).<br>Fahr. | Remarks and conclusions. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 139° | 0·4lb. × 30° rise = 12 T.U. per min. to keep cylinder at 139 F. | 24 | 139<br>172°<br>——<br>33° rise | 1·38 | 1·38<br>1·133lb. ×<br>0·125 =<br>0·193 | 1·74 | 212° | 191° | 138° | 164° | * |
| 2 | 107 | 4·12lb. × 4° rise 16·5 T.U. to keep cylinder at 107 F. | 22 | 107<br>172<br>——<br>65° rise | 2·95° | 0·415 | 3·78 | 212° | 188° | 138° | 163° | † |
| Comparisons. | Cylinder at start cooled to temperature given. | About 10 times more water used in No. 2 than in No. 1, and much more heat withdrawn to obtain lower temperature 107 F. | About 23min. to get a constant hotter temperature due to L.P. cylinder steam. | | About twice rise in temperature in latter experiment. | About twice as much in latter case. | Per unit of surface about twice as much. | About same in the two tests. Diagrams like Fig. 4. | | | | ‡ |
| 1 | 2 | 3 | 4 | | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |

NOTE.—Column 3, quantity of circulating water weighed and rise of temperature taken to get thermal units in water. Specific heat cast-iron taken as 0·125. Cast-iron cylinder used 2½in. long, with 1·6in. width sides, 1in. hole in centre, weight 1·133lb. External surface walls exposed 0·11 sq. ft.

* A large amount of condensation on glass and cylinder walls and with fog at start with colder walls (139deg.), much less at end of test with hotter walls (172deg.).

† Very large amount of condensation on glass and cylinder walls, also fog at beginning of test with colder walls (107deg.), then gradually less at end with hotter walls (172deg.).

‡ Comparing tests 1 and 2, about twice as much heat passed in No. 2 per unit of surface, although it had to pass through a great thickness of water on walls exposed. This seems to prove that this water does not interfere with the passage of heat through the cast iron walls, and that the heat absorption goes on notwithstanding this water.

the same instrument with an internal cast-iron hollow cylinder, in contact on all sides with the low-pressure cylinder steam; and 3rd, the latest revealer with a cast-iron cylinder, having only its external surface in contact with the steam from the engine cylinder, while the interior may be heated and cooled at will. The drops of water, such as are deposited on the walls of the cylinder, are produced by the cooling of the steam against the surfaces with which it comes in contact. In the cooling thus taking place, what part is played by the glass, and what by the cast-iron surfaces? This may be approximately determined beforehand. Heat is much less easily propagated through glass than through cast-iron, because the coefficient of internal conductibility of glass is about 82 times less than that of cast-iron. On the other hand, the calorific capacity of glass is greater than that of iron, in fact, almost double. Taking these circumstances into consideration (see "Principes de la Théorie Mathématique de la Machine à Vapeur," "Revue de Mécanique," December, 1898) we find that a cast iron wall ought to absorb at least six times more heat than a glass wall. Consequently the effects of condensation seen in the revealer of the original type, which was wholly of glass, would be at least six times less marked than in the cylinder of the engine, if these effects were due only to the action of the walls of the revealer themselves. But this is not the case. If it were, the revealer would always show the same results for the same cycle of steam, whether the steam engine cylinder were jacketed or unjacketed. As this is not so, it follows that the greater part of the drops seen in the revealer—of the original or first type—are not due to the cooling of the glass, but have been simply carried in with the steam, and precipitated on to the glass. We may even assume that the drops, as well as the fog, are almost entirely owing to the cooling caused by the junction pipe uniting the revealer to the cylinder when this pipe is not covered, as its internal surface is relatively large. Mr. Donkin has, in fact, brought out in his experiments the great influence this connecting pipe has on the condensation, and has verified the following phenomena: By artificially cooling the short iron connecting pipe between the revealer and the cylinder with cold water and a sponge, the fog or cloud on admission of the steam at the commencement of the steam stroke is much increased, as is also the diameter of the globules on the internal glass walls. The steam seems to be chilled. Two other revealers, with single glasses, and longer and uncovered connecting pipes fixed on to the same end of the same low-pressure cylinder, gave during the same stroke greater condensation effects and larger globules, with more fog. In this latter case the action of the glass itself in producing the moisture is very small. The drops seen on the glass have been carried in and flung against it by the current of steam previously formed elsewhere, principally—perhaps entirely—in the uncovered junction pipe.

This view is confirmed by Mr. Donkin's experiments made in December, 1899, on the latest (third) type of his revealer. When the latter is fixed to the low pressure cylinder of a compound engine, and steam from the boiler is admitted into the little cast-iron cylinder, so that it is jacketed in exactly the same way as an engine cylinder, neither fog nor condensation are seen. Now the glass cylinder is not jacketed, but simply protected from external cooling, and its action is always the same in all experiments; the absence of condensation and fog in the above case effectively proves that of itself it has no marked action on the effects of condensation. On the other hand, the motor (steam-engine) piston in these experiments acts like an unjacketed wall, and must therefore cause a certain amount of steam to condense on it. As this separate condensation is not shown in the revealer, it confirms the opinion that when moisture and drops of water are seen in the latter, they come only from the cooling of the steam in the connecting pipe. When live steam from the boiler is admitted into the little revealer cylinder, the junction pipe of the low-pressure cylinder is heated by condensation at either end, and as it is at a higher temperature than that of the steam inside, it does not give rise to any condensation. The foregoing considerations show that the phenomena taking place and seen in the revealer depend mainly on the arrangements and covering of the connecting pipe.

In the second type of revealer the little hollow cast-iron cylinder acts like a non-jacketed wall; in other words, like a motor piston or like the little inner cylinder of the third type of revealer when steam is not admitted to it. The trial made in December, 1899, on the latest type (Fig. 3) shows very clearly that what takes place in the revealer does not always correspond to the phenomena in the engine cylinder. In this experiment live steam from the boiler is first admitted into the little cylinder of the revealer, then shut off. Its mean temperature in the small cylinder is 299°F. or 148°C. at admission; it then falls, and at the end of 35min. it becomes stationary and equal to 187°F. or 92°C. In the first case (with the steam at the higher temperature) the little cylinder affects condensation like the jacketed cover of a steam-engine cylinder, and since neither condensation nor fog are seen in the revealer, this proves that the jacketed walls of the steam cylinder, being much hotter than the working steam, cause no condensation. In the second case (when the temperature of the steam has fallen) the surface of the little cylinder acts like the motor-piston surfaces, which are not heated, and as the latter cause condensation of the steam, we get the corresponding effect of much fog and slight condensation in the revealer. In the one case, as in the other, the phenomena of condensation in the steam cylinder, taken as a whole, have not varied. In the first the revealer does not show what is occurring in the cylinder; in the second it shows it with almost perfect accuracy.

*Summary.*—To summarise the matter, the improved revealer has an action of its own, which represents or does not represent the phenomena produced in the steam cylinder according to whether the little cylinder is or is not placed in the same conditions as the wall of the steam cylinder. The influence of the connecting pipe may sometimes cause the indications of the revealer to vary considerably from the phenomena actually taking place in the motor cylinder. But in any case these indications are of great interest, and we may now study the precautions necessary to make them wholly conform to reality.

*Temperature of Walls in Type* 3.—In the experiment of December, 1899, after the admission of live steam to the little cast-iron cylinder of the revealer had been shut off, the mean temperature of this cylinder, after a certain time, becomes stationary, and ought to represent the temperature at which the walls of the steam cylinder would be, if the admission of live steam to the jacket were arrested. The mean temperature of the little unjacketed cylinder is hotter than the temperature shown by the diagram, 197°F. - 168·4°F. = 28·5°F. This conclusion perfectly agrees with the results formerly obtained by Mr. Donkin ("Experiments on a Vertical Single-cylinder Steam-engine," *Proceedings* of the Institution of Mechanical Engineers, January, 1895), results which led the writer, by applying to them the equations of the propagation of heat, to draw up a formula giving the mean temperature of unjacketed walls. For a condensing engine this formula is as follows ("Revue de Mécanique," May, 1899, and February, 1900: "Théorie Mathématique de la Machine à Vapeur"):—

$$t_o - v = 0{\cdot}42\,(t_o - t_d) + 0{\cdot}08\,(t_o - t_e)$$

in which $t_o$ is the maximum temperature of the indicator diagram,
$t_d$ is the temperature at the end of expansion,
$t_e$ is the minimum temperature of the diagram,
$v$ is the mean temperature of the metal wall.

These temperatures may be expressed in either Fahrenheit or Centigrade degrees, without altering the coefficients of the formula. In the trial in December, 1899, $t_o$ was = 220 F., $t_d$ = 175 F., $t_e$ = 135 F. Applying the formula we get $v$ = 194·3 F.; while the thermometer marking the mean stationary temperature of the little unjacketed cylinder gave 197 F. These two figures sufficiently agree, although the first is a little lower than the second, and confirm Mr. Donkin's former experiments in a satisfactory manner. It might be supposed that if the stationary temperature of the little cylinder is higher than the mean temperature from the diagram, the difference is due to the heating of the revealer by radiation and conduction along the connecting pipe, the revealer being placed at the top and close to the cover of the steam cylinder. Such heating does actually take place, but we have reason to believe it is not of much importance. It may, however, serve to explain why the value for $v$ found by experiment (197 F.) is slightly higher than that deduced from theory (194·3 F.). To determine accurately the influence of this heating we have only to cut off the admission of live steam to the jacket of the little revealer cylinder, and to that of the steam cylinder. The resulting fall in the temperature ($v$) would show the effect of radiation and conduction. The knowledge thus gained would be confirmed if it were possible, at the same time, to take the mean temperature of the unjacketed cover of the steam cylinder. [This has since been done.]

*To obtain the Temperature of the Cylinder Walls.*—Lastly, the improved revealer (3rd type) can easily be used to determine the mean temperature of the unjacketed walls, without the necessity of boring holes in the walls of the motor cylinder itself. The experiments of December, 1899, also yield very interesting conclusions with respect to the greater or less ease with which the heat penetrates or is given out by the cast-iron metal surfaces. As soon as the little cylinder was no longer heated internally, its mean temperature fell 103°F. in 35 minutes, or about 2·0°F. or 1·6°C. per minute. From this Mr. Donkin deduces the corresponding flow of heat. The weight of the little revealer cylinder being 1·06lb. the loss of heat (taking 0·113 as the specific heat of cast-iron) is 0·08895 calorie per minute, and, the external surface of this cylinder being 0·095 sq. ft., the flow of heat is 3·72 T.U. per square foot per minute (or 0·17 calorie per square metre per second). If the steam be again admitted to the jacket of the little cylinder, the mean temperature of the latter rises from 197°F. to 285°F. in about a minute (92°C. to 140°C.) The amount of heat which penetrates from the interior surface of the cylinder is therefore 2·668 calories per minute, this surface being 0·00487 square metre in extent. Thus the flow of heat increases to 547 calories per square metre per minute, or 9·11 calories per second, and is 54 times greater than the flow of heat given out by the external surface of the cylinder, as above calculated. This shows the extraordinary rapidity with which the heat passes from the jacket steam into the cylinder metal, while, on the other hand, it is given out slowly and with difficulty from a dry metallic surface in contact with steam colder than itself.

We may especially notice from Fig. 4 that, in the interval from half to three-quarters of a minute after the live steam had been re-admitted to the little cylinder, the temperature of the latter rose from 240°F. to 270°F., that is, 30°F. or 16·65°C. Hence we may conclude that during this interval the flow of heat rose to 12·3 calories per square metre per second. From the theoretical equations of the propagation of heat we can calculate what would be the flow of heat per square metre per second per degree Centigrade difference in temperature between the steam and the metal surface in contact with it; in other words, the coefficient called the "absorbing power." If this be calculated in terms of the equations given above it should be 36 calories [in English units, 7·38 T.U. per square foot per second per degree Fahrenheit]. The mean difference between the temperature of the steam and that of the metallic surface during the interval we are now considering is 0·34°C.

Thus while the absorbing power of the wet metallic surface is 36 calories, the emitting power of the dry metallic surface, calculated in the same way, is only about 0·1 calorie. This result tends again to justify the opinion put forth by the writer in his "Théorie Mathématique de la Machine à Vapeur," and to close the discussion lately started between Prof. Anspach and himself respecting the possible maximum value of the "absorbing power."

## MAGNETIC OBSERVATORIES AND ELECTRICAL TRACTION.

The following is a report of the proceedings which took place at the conference between representatives of the Board of Trade, the Government observatories and laboratories, and of the electric railway and tramway interests on Oct. 31:—

Sir Courtenay Boyle, K.C.B., Permanent Secretary of the Board of Trade presided, and was accompanied by Mr. F. J. S. Hopwood, Sir Thomas Blomefield, Mr. A. P. Trotter, and other officials of the Board of Trade. Among the representatives of the Government observatories and laboratories who attended were Mr. W. H. M. Christie, the Astronomer Royal; Profs. Rucker, Ayrton, and Perry; Mr. R. T. Glazebrook, Director of the National Physical Laboratory; Rear Admiral Sir W. J. L. Wharton, K.C.B., Hydrographer to the Admiralty; and Lieut. Colonel E. Raban, R.E. Among those who attended to represent the railway and tramway interests concerned were Sir Benjamin Baker, Sir William Preece; Mr. George White (Chairman), Mr. J. Clifton Robinson (Engineer), and Mr. S. White (Secretary) of the London United Tramways Co.; Mr. H. Montagu Smith, Charing Cross, Euston, and Hampstead Line; Mr. J. Leadley, Great Northern; Prof. Kennedy, Mr. H. F. Parshall, Mr. R. P. Brousson, Major Cardew; and Mr. Oakley, Great Northern and City Railway; Mr. Manville, Mr. W. C. C. Hawtayne, and Mr. T. E. Britton, Barking and Ilford line.

Sir COURTENAY BOYLE briefly recalled the circumstances under which they had met. At a meeting on November 15, 1899, he had pointed out that certain of the Government departments had represented to the Board of Trade, under the terms of the section with reference to the use of electrical power, that the employment of such power in traction was likely to affect certain instruments of a delicate nature in use at the observatories. The point of the application had been that certain regulations should be made to prevent such injurious and disturbing effects. On that day certain statements had been made by Prof. Rucker and those acting with him with regard to the effect upon the instruments in the observatories. These statements and the figures which were supplied were, to some extent, challenged by the representatives of the tramways companies. It had been thought then that the proper course would be to appoint a small expert committee to investigate carefully the amount of magnetic disturbance produced in the neighbourhood of electrical tramways and railways constructed and working under Board of Trade regulations, and to report as early as practicable. He therefore called upon Mr. Trotter, the chairman of that committee, to explain the present position of the matter.

Mr. TROTTER referred to an interim report of the Observatories Clause committee, which concluded with the statement that suitable alterations of the feeder cables could be defined for the future by regulation. Although in the opinion of some of the members of the committee, the drafting of a regulation or regulations was not within the reference, they had consented to meet to discuss the matter. On July 20, a plan showing special cables and details of electrical distribution had been submitted by the London United Tramways Co., and Mr. Glazebrook undertook to calculate the disturbances likely to be produced at Kew Observatory by this scheme. On July 30 Mr. Glazebrook had sent him a memorandum, in which he held out hopes that the scheme might suffice to permit of the working of the recording instruments. Mr. Glazebrook would not assert that it must fail; but could not say positively that it must succeed. The whole scheme was experimental, the theory was confessedly incomplete, and in practice might be impossible to carry out. The most important features of the scheme were that the line should consist of isolated lengths of one mile, and so fed and boosted that no point on any section of the rail within 2 miles of Kew Observatory should differ in potential by more than 0·2 of a volt from the potential of the earth in its neighbourhood. At a greater distance than 2 miles a difference of 1 volt was suggested, but this was still under consideration. These requirements were accepted by Mr. Parshall. On August 8 further calculations were sent by Mr. Glazebrook, and Mr. Parshall prepared another plan. He gave an estimate showing that the special cables, &c., would involve the expenditure of a very large sum. On September 7 Mr. Glazebrook wrote that the additional scheme would in all probability be sufficient to protect Kew Observatory, but that it was impossible to say with complete certainty that the protection would be

complete. Since this date Mr. Glazebrook had called his (Mr. Trotter's) attention to the fact that several new tramway lines were proposed in the neighbourhood of Kew, and that these would cause disturbances unless dealt with in the way suggested for the present lines. The general result was a deadlock. The observatories members candidly said that they could not predict with certainty the efficacy of the proposed remedy, and the engineer members protested that the expenditure would be unreasonable, seeing that it might prove useless.

Prof. RUCKER, in reply to Sir Courtenay Boyle, said that the Government department still invited the Board of Trade to make regulations for the protection of instruments at the observatories. The practical proposal mentioned by Mr. Trotter was originally that drawn up by the representative of the companies. The departmental proposal was that the lines should be insulated; the companies put forward further proposals, which, after full consideration, the department was disposed to accept, although it could not take the responsibility of saying that they would be in all respects satisfactory.

Mr. PARSHALL said that a part of the arrangements proposed were accepted by Mr. Glazebrook in his letter of Sept. 7, but certain reservations were made which would entail further expense upon the company of several thousand pounds. Since that time the lines had been completed so far that it was possible to test the practicability of those arrangements. Experiments showed that the currents circulating in the rails from outside sources, even before the lines were put into operation, caused a difference of potential in the lines during many hours of the day of 0·8 volt, or four times greater than discussed at the time as necessary for protection of the Kew Laboratory. In other words, these regulations as formed would debar the use of rails in the earth at all, quite apart from electrical working. He had placed near the Kew Observatory a magnetometer supposed to be identical with that of Kew, and had passed a current of 80 amperes in and out of the line at Brentford with a view to observing any possible effect. The effect of passing 80 amperes into the line and back through the rails, was about 100 times greater than would be the effect in the arrangement referred to in the proposed plan. The effect on the magnetometer was negligible. The instrument used showed a width of line corresponding to external magnetic disturbance equal to about 600 amperes put in the line at Brentford and taken back over the rails to the power-house. This, together with a known current passed into the line, would indicate that the liability of Kew being interfered with by the tramways had been greatly over estimated. Apart from this, there was the fact which must not be lost sight of that the present currents circulating from sources unknown and having no connection with the tramways, exceeds the requirements of the proposed regulations, and this, before the tramways make any use of their own rails as a return circuit. For these reasons he had had to advise the company as to the impracticability of constructing their lines so as to conform to the suggested conditions.

Mr. GEORGE WHITE (chairman of the London United Tramways Co.) explained that the capital outlay involved to meet Mr. Glazebrook's conditions, although considerable, was not the only difficulty. It would be necessary to curtail the number of cars which could be run upon the line by something like 50 per cent., as it would prevent extra cars being run on holidays. The excess capital outlay on the small piece affected within the 2-mile radius of Kew meant £24,000, and taking into account also the conditions suggested by Mr. Glazebrook the excess minimum expenditure would be upwards of £40,000, and he was told further that, in order to comply with all the technicalities, the excess outlay might be four-fold, or something like £100,000. He suggested that the instruments affected might be removed from Kew, and quoted the following remarks upon this point made in a letter of Mr. Glazebrook's last July. "Whilst, therefore, not opposing the scheme, we think it right to point out that it may fail to give the necessary protection; in which case it may be necessary to consider the alternative of removing the recording instruments to some completely isolated position, and we desire before the sanction of the Board of Trade is given to the scheme that this question should be brought to the notice of the Government departments concerned. It should be understood that it is the recording instruments alone that would need to be removed. The rest of the magnetic and other work now carried on in the observatory would continue there, as the protection would be ample for that."

Sir COURTENAY BOYLE said that it was extremely difficult for him or for the Board of Trade to suggest that the Government departments who held the ground should be obliged to move these instruments at the cost of the State because of certain commercial undertakings coming into their neighbourhood.

After some remarks by Prof. AYRTON,

Prof. PERRY said that they did not quite believe in the estimates of £24,000 or £40,000, or possibly £100,000, which had been mentioned, nor did they quite appreciate the difference which Mr. Parshall suggested with reference to the 0·8 of a volt. The department had said from the beginning that what it wanted was an insulated return which would give perfect protection, and when the plan was prepared, to which reference had been made, there was no mention of excessive expense or outrageous outlay.

Mr. J. CLIFTON ROBINSON said that it would be impracticable to carry out the four trolley-wire system. He had demonstrated that a year ago, when he showed that not less than 13 wires would have to go over one particular point in the overhead construction, forming a complete network over their lines; and considering the matter not altogether as an æsthetic question, they had appealed to the Board of Trade on the ground of safety and for other considerations to eliminate that proposition. Mr. Trotter himself would not be a party to 1,000 volts being carried overhead, especially under low railway bridges.

Mr. TROTTER: That is another alternative.

Mr. CLIFTON ROBINSON, continuing, said that there would be 1,000 volts with the four-wire system such as Prof. Perry approved of. His company considered that there was no sufficient ground to depart from what was recognised as the universal practice of working tramways—the standard regulations of the Board of Trade. If future developments arose when these theories could be put to the test of practice, then would be the time for the introduction of such safeguards as might be proved necessary, and as might be ordered by the Board of Trade.

Sir COURTENAY BOYLE pointed out that apparently Parliament was not satisfied that the old regulations were sufficient for the protection of the observatories, otherwise it would not have passed the new observatories' clause.

Prof. RUCKER said that this was not merely a matter affecting scientific experiments and observations carried on at Kew, for it had also a direct bearing upon certain industries carried on in London. For instance, Kew was a centre where the Kew magnetometers were tested, and the makers got orders upon the condition or requirements that the instruments must be tested at Kew. The fact that there is such an institution at hand where such tests could be carried on near where the makers were at work did help that trade. In the course of the last four years they had had to test instruments ordered from Russia, Italy, India, New Zealand, Portugal, Holland and the United States, and in every case they were ordered with the condition that they should be tested at Kew, so that the instrument-making industry is affected by this matter. Again, in the case of the magnetograph, they had supplied £4,000 worth of them. The number and value might not be large as compared with what was spent by the tramway companies, but surely even a small industry was not to be crushed out because of tramway requirements. The instrument-making trade was going largely from England to Germany, and if it were crushed out a serious injury would be done not merely from a scientific point of view but also to a Government institution which was useful for some of the purposes of trade.

Major CARDEW asked Prof. Rucker if they were to understand that the testing work at Kew would be absolutely prevented by a certain limited amount of earth disturbance produced by electric traction. He understood that the variations in magnetic instruments might be somewhat disturbed, but would it be necessary to remove the magnetometers from Kew?

Mr. GLAZEBROOK: The magnetometers would not require quite so much protection as the recording instruments.

Sir COURTENAY BOYLE asked if there were elsewhere in the possession or working of Governments departments, instruments of similar extreme delicacy to those used on the magnetic side of Kew, which it might also be very difficult to protect.

The ASTRONOMER ROYAL (Mr. Christie) said that so far they had been considering the effect of these magnetic disturbances on Kew, or those which might be anticipated from a tramline] already constructed, but in the case of Greenwich Observatory they had to consider carefully what provision should be made, or what protection should be provided, with reference to tramways about to be constructed. It was very important, in view of the fact that the tramline with regard to which the London County Council had recently obtained the power to use electric traction, passes within 700yds. of the magnetic observatory at Greenwich. It was very important that every precaution should be taken to prevent magnetic disturbances there. The Greenwich registers were as delicate as those at Kew, and the record had been carried on for 60 years with a large expenditure of money on the part of the Government. It might be reckoned that something like £100,000 had been spent in getting these registers. The magnetic registers so obtained had given very interesting results, and afforded material for interesting observations as to the connections between terrestrial magnetism and sun spots. The connection between the sun spots and the state of the weather was of some importance from a commercial as well as from a scientific point of view. These registers had to some extent been disturbed since the construction of the City and South London Railway. When he had called attention to that fact at the last meeting he had been met with the objection that that railway was not then working under Board of Trade regulations. These disturbances had been reduced to such a point that, although they were quite appreciable and did sensibly affect the registers, still they did not vitiate the results. But if they were to have tramlines brought within 700yds. of the observatory he was afraid their register would be ruined completely, and that the 60 years' work of Greenwich in that respect would be brought to an end just when it was becoming of increased interest and value.

Sir COURTENAY BOYLE asked whether it was not conceivable that arrangements might be made by which the whole of the magnetic observations of the State might be made at one place and communicated thence to the various departments?

The ASTRONOMER ROYAL explained that the work at Greenwich and at Kew is carried out upon somewhat different lines. At Kew its importance consisted largely in the verification of instruments, and there was, of course, a comparison of the magnetic disturbances between the two stations. The position was this: The registers at Greenwich had been carried on for 60 years upon one system, and that long series was valuable for purposes of comparison with reference to cosmical phenomena, such as that he had referred to concerning the sun spots. At Kew the series had not been carried on so long, but still it was of importance to have the means of comparison between the two observatories. Interesting results came out from a comparison of the two. The point he wished to enforce was that in the case of Greenwich it cannot be a question of moving the instruments, for that would mean that the work must cease. It must be carried out in connection with the astronomical observatories which, of course, could not be moved; and the same magnetic work could not be carried out at a distance upon the same lines or under the same supervision. The series would be broken and the comparisons would not serve in the case of observations recorded at another place under different conditions.

Prof. KENNEDY asked whether supposing the Greenwich Observatory

were protected, the delicate observations now made at Kew might not be as well carried out at Greenwich?

The ASTRONOMER ROYAL said that the comparison of the work of the two observatories was of secondary importance. Still, it led to results of considerable interest. An essential point was that at Kew there was verification of instruments, the working out of new forms of instruments, and the carrying out of some experimental work which was foreign to the scope of their duties at Greenwich.

Admiral WHARTON remarked that any decision come to on the subject of the line threatening Kew would, to a great extent, govern all future questions of that sort.

Sir COURTENAY BOYLE agreed that it must be so. There would certainly be applications for electrical railways near Greenwich.

Admiral WHARTON said that the question was how far the delicate scientific work carried on in these Government observatories should be disturbed and injured for the sake of commercial undertakings that, so far as he understood, could, by means of the expenditure of additional money, be carried on without involving such disturbance. There was a difference of opinion, apparently, as to the total extra amount that would have to be spent in order to give the needful protection. The principle of allowing a line to be opened under conditions which you are nearly certain would affect the scientific work, with a sort of vague understanding that, if it is found to be so, something will be done hereafter, would be a very dangerous principle. He did not think it would be likely, as a matter of practical politics, that after the line had once been started it would be easy to introduce modification. The Admiralty looked with some apprehension upon the effect of projects which threatened to disturb the value of the Royal Observatory at Greenwich.

Sir COURTENAY BOYLE wished to hear from the Hydrographer to what extent he agreed with the Astronomer Royal as to the possibility or otherwise of the division of the astronomical and magnetic work at Greenwich. Might not the magnetic work be done with almost equal advantage elsewhere?

Admiral WHARTON explained that it broke the continuity of the record. Work of that kind was infinitely more valuable if carried on at the same spot for a large number of years with the same instruments and under the same conditions. He understood that there were means by which these electrical tramway undertakings could be worked without disturbing scientific observations.

Major CARDEW said that they did not admit that at all. The idea of the perfectly insulated system was purely theoretical. In New York, where they had a so-called insulated system, there were continual faults. When you get a fault on two sides there must be disturbance, and that might occur just when there is some important terrestrial observation to make. His opinion is based upon the number of faults that did occur. In electric lighting lately at Westminster they had had a fault so large that it reduced the lamps to about half the proper pressure.

Mr. HAWTAYNE said that the Ilford and Barking tramways would be situated some 5 miles or 6 miles away from Greenwich, and he thought the only line which Mr. Christie referred to was that of the London County Council?

The ASTRONOMER ROYAL said that the line of the London County Council, for which the use of electricity was sanctioned, was the one which would at present more seriously affect Greenwich Observatory, but there were other lines which might, to some extent, affect and disturb it. The tendency of his observations was to show that in the case of lines worked under the Board of Trade regulations at a distance of over 4 miles, the effect was not serious, although it was perceptible. They could still carry on their registers. With regard to Major Cardew's remarks, it was quite a different matter to have an occasional accidental interruption of a photographic register which was constantly at work, rather than to have constant interruptions or disturbances in the absence of proper precautions. An occasional interruption could either be ignored or allowed for.

Mr. PARSHALL asked whether there was any effect at all noticed at Kew now from existing electrical undertakings.

Mr. GLAZEBROOK said that he had not accurately compared the curves lately, but so far as he knew there was nothing in the curves that they had obtained at Kew or Greenwich within the last few months to interfere with the comparisons that had been previously made from time to time.

In reply to Mr. Hawtayne Colonel RABAN said that the Admiralty did not so regard the Ilford lines to be outside of this question.

Sir COURTENAY BOYLE then pointed out what was the formal position they would have to adopt if they could not, by friendly discussion, get nearer a settlement of the difficult issues before them. The formal course would be for the Board of Trade to ask the departments which had represented that regulations were necessary to draft such regulations as they suggested. It would probably be difficult for them to do so, because a greater or less degree of protection might be demanded in different cases. But the formal course would be for the Board of Trade to ask the departments concerned to draft their proposed regulations, and then to have copies of these sent to the different companies and parties affected. That was a long process not likely to lead to an immediate settlement. But the Board of Trade would be obliged to take that course if they could not now, by negotiation and conference, get nearer to a settlement of the points at issue.

Mr. GLAZEBROOK said that since the scheme proposed by Mr. Parshall was now withdrawn the only thing his department could ask for was a complete insulated return. They had no other plan by which thorough protection could be secured.

Prof. RÜCKER agreed with Mr. Glazebrook that if the matter was to be fought out on the lines of what would protect Kew they must fall back on the insulated return. He did not forget, of course, that the very important suggestion had been thrown out, which he ought not to discuss, because he was there as a representative of Government departments, and had no idea what they would think of the question of compensation for moving instruments away from the observatory, but he fully recognised the importance of the proposal; it was a new factor.

Sir COURTENAY BOYLE said that Mr. White, in a most cautious, temperate, and politic spirit had suggested that a possible way out of the difficulty was a contribution from his company towards the removal of certain instruments from Kew. As there were present representatives of the railway interest, they would no doubt let him know whether they associated themselves with that suggestion.

Sir WILLIAM PREECE said that while sympathising with his scientific friends he was also very much mixed up with the commercial side of the question, and he represented that day rather the commercial side than the scientific. There would be no difficulty in transferring the magnetic observations, which were at the root of all the trouble, to another spot. There were islands about this coast within easy reach of London where such electric and magnetic disturbances could never be experienced.

Mr. TROTTER said that he should have liked Mr. Parshall to have given them more information with regard to the experiments conducted within the past few days. He understood him to say, that since the West London line commenced, the rails of his company, by their better conductivity, picked up strong currents presumably generated by their neighbours. If that was so, it entirely altered the question of a possible double return and double trolleys. It might complicate any possible regulations such as those suggested by Mr. Glazebrook.

Mr. PARSHALL answered that the experiments had been conducted within the last fortnight, and there was no doubt that they had a maximum fluctuation of $\frac{1}{10}$ths of a volt.

Sir BENJAMIN BAKER said that it appeared to him that there were three interests concerned in this matter, and so far they had only been discussing two of them. They had been discussing the interests of the Tramway Company from a commercial point of view, and also the case of the observatories at Kew and Greenwich, but they must not forget the interests of the seven millions of people who were just now tasting the sweets of electric traction, and he fancied that if the points which Prof. Rucker brought forward about these particular instruments at Kew were put before the quarter of a million of people who travelled on Monday over the West London Railway they would have considered those instruments an insignificant matter as compared with electric undertakings providing the general public with an essential service. It was easy to imagine what the population of the metropolis would say if they were told that it was a question of tramways or no tramways, and that they might have to occupy 1½ hours to travel in an omnibus a distance which could be covered within 20min. by electric traction.

The ASTRONOMER ROYAL remarked that it was not the London electric railways, but the suburban lines which came into the immediate neighbourhood of the observatories that they wanted, in some respect, to control. Many years ago the Greenwich Observatory fought a similar question against the railways. Strong public pressure had been brought to bear upon the Government to allow a railway to be carried under Greenwich Park by a tunnel. This was successfully resisted, and the result was that the line was carried through Blackheath on the other side, so as not to interfere with the observatory, and ultimately the Greenwich Extension line was carried out at such a distance that it did not seriously affect their observations. Similar consideration had had to be shown on other occasions at the instance of the Government, so as to avoid the danger of interference with the work of the observatory.

Sir COURTENAY BOYLE: Can Mr. White tell us approximately, even in the roundest figures, and without being at all bound to his estimate, what would be roughly the cost of having a perfectly insulated return?

Mr. WHITE: It is impossible to say definitely, but I am told approximately the sort of figure would probably be about £150,000, upon the items which appear for £80,000 under the Board of Trade regulations.

Sir COURTENAY BOYLE desired to bring back the meeting to the main question. The Board of Trade was asked by the scientific departments to impose certain regulations with reference to electric traction. He had endeavoured to the utmost of his ability to get some sort of agreement, but at present there were not any agreed proposals acceptable to both sides. Would the re-appointment of the committee tend to facilitate or to make possible any agreement as to what the regulations should be? If not, then the Board of Trade must take their own line and decide on some regulations. He was particularly anxious to avoid that, because it was most desirable that they should arrive at something acceptable to both sides. It would be his distinct duty, after what had been said, to bring before the State departments concerned the suggestion which Mr. White had made earlier in the afternoon, that a possible way out of the difficulty might be the removal of the magnetic work of the Government to some more suitable site. Meantime, pending the decision of that question, was there anything they could do to facilitate a possible agreement? Would it be possible by inviting the co-operation of some gentleman of high scientific attainments, such as Lord Kelvin, to give them the advantage of his assistance.

Lieut.-Col. RABAN said that at the Admiralty they felt that the actual question to be settled in this particular case was only a small part of what might ultimately be involved, because what was settled here must influence other schemes. It would be rather important if they could get to know what an insulated system would cost; if there was such a thing as an insulated return, that would affect the question materially. He believed such a thing as an insulated system had been used in various towns. Government requirements and the interests of the State had to be taken into account in other cases, as in the case of magazines; railway companies had had to be put under considerable restrictions with regard to approaching within a certain distance of magazines, and yet railways were still being made. It should not be forgotten that, so far as the observatories and their sites were concerned, the Government authorities were the people in possession, who had a right to put forward their reasonable requirements. The three points to be considered were: Is there such a thing as perfect insulation? What would be the difference in the cost of providing it? and has it been employed elsewhere with success under similar conditions?

Mr. CLIFTON ROBINSON: I believe there is no such thing as a perfectly insulated return in any tramway in this country.

Prof. AYRTON: There is no use splitting hairs, but you know what we mean by an insulated return. How could the interests of those concerned be sacrificed if we had, for instance, such a system as Major Cardew and Sir William Preece have actually supplied on the Metropolitan Railway between Earl's Court and High-street, Kensington.

Mr. TROTTER said that they all knew the system which Sir William Preece and Major Cardew had carried out on the Metropolitan Railway. In the Central London there was practical insulation, and the County Council proposed in their line to have conduit lines on the streets for the return. That was most suitable in the proper place, but it must be recognised that when they came to dealing with an extensive suburban area the putting of conduit lines over so many miles would involve a large expense. There was another system which he might call the Cincinnati system, where they had two overhead wires, but he was told the number of accidents which happened to it was rather serious. It had to be shown by the engineers that the Cincinnati system was impracticable. When he was in Switzerland last year he saw the system at work with two trolley wires; but there might be a difficulty in the case of junctions and turn-outs.

Prof. AYRTON: No doubt if Mr. Trotter is a reader of *The Electrician* he will have seen reference to a system patented by Major Cardew for overcoming the difficulties in connection with the magnetic observatories.*

Sir COURTENAY BOYLE.—Please help me as far as you can, gentlemen, with the best method of settling the practical difficulty now before us.

The ASTRONOMER ROYAL said that if the County Council proposed to adopt the conduit system, and to treat Greenwich as an urban district, they would remove all difficulty so far as Greenwich was concerned.

Mr. MONTAGUE SMITH suggested that the Board of Trade might allow the tramway to be opened for six months, and that the Committee could report upon its magnetic effect during that time, if there were an undertaking from the company to comply with any requirements that might, as a result, be found necessary.

Sir COURTENAY BOYLE, after again expressing his determination to bring before the scientific departments of the State the question of the possibility of the removal of the magnetic work from Kew and Greenwich, once more asked those present which alternative they preferred: The re-appointment of the committee to consider the regulations framed on each side, or that the Board of Trade should draft regulations.

Prof. KENNEDY believed they would get through the matter most quickly if the Board of Trade framed the regulations.

Mr. WHITE: We have been two years trying to hitch horses, and we are here still. I think the Board of Trade had better take the matter up.

Prof. RUCKER: I am inclined to agree with that.

Sir COURTENAY BOYLE: Then the Board of Trade will frame regulations and send them to each side. Please remember that I am just as anxious as you are to get on with a settlement of the question, not only as it affects the London United Tramway Co., but also the other companies to which the clause applies.

Prof. KENNEDY, as representing the London County Council scheme, said that the County Council quite held to their proposal that they should make an insulated conduit system within the range of Greenwich Observatory.

Sir COURTENAY BOYLE said that the Board of Trade would frame the regulations as speedily as may be, and would send them to the parties concerned in due course.

The proceedings then concluded.

## ELECTRICITY SUPPLY.†

BY W. A. CHAMEN.

This subject has been dealt with so often and by such able hands that the author feels some diffidence in venturing to write a Paper upon it. The brief remarks which are now offered, however, will bear only upon two points in connection with the subject, and will naturally take some colour from the particular aspect of the question as applied to the city of Glasgow.

### SYSTEM AND PRESSURE OF SUPPLY.

The fact that several undertakings which have commenced with an alternating single-phase high-tension supply have recently been actively engaged in changing their central or nearer areas to low-tension continuous current, supplied direct from dynamos fixed in the generating station without transformation of any kind, must surely be taken as a clear indication that low-tension continuous current is found to be more suitable and more economical for all purposes, where the distance is not so great as to make it too costly in copper. This change has, of course, been brought about by the alteration in the Board of Trade regulations allowing the use of a pressure in consumers' premises not exceeding 250 volts, and consequently of a three-wire system with a pressure not exceeding 500 volts across the outers. Mr. Addenbroke, in a very able Paper read before this Institution in London a few years ago, foretold this result, and showed that with a favourably selected position of generating station an area measuring 5 miles in diameter could be economically dealt with by means of low-tension continuous current under these altered conditions. Experience has proved this to be so, and in Glasgow the supply is at present carried on over a radius of 2½ miles each way from the new station at Port Dundas. It does not follow, of course, that it will always be economical to work in this way, as the load may grow to such an extent as to warrant putting down other generating stations at the more distant points rather than transmitting many thousands of horse-power through cables from a generating station already fully taxed by a demand of some 20,000 H.P. to 30,000 H.P. within a radius of much less than 2½ miles around it.

On the other hand, there may be cases where small amounts of current require to be transmitted to exceptional distances, and in such cases small auxiliary high-tension plants, either continuous or alternating, would seem quite justifiable. The fact, however, that these may be necessary is no reason whatever why the whole generating plant should be made high-tension and current transformed down even in central areas close around the generating station. The obvious common-sense principle on which to proceed is surely to use simple low-tension direct supply at as high a pressure as possible, and when this fails to meet the case to supplement with high-tension transmission for the remainder.

A well-known consulting engineer, in a discussion on this subject some three or four years ago, went so far as to admit that this was the right line to go upon, but said that he found the public wanted an alternating-current supply and not a continuous one, and in consequence recommended that low-tension alternators be used for direct supply to the home areas and that step-up transformers be used in connection with this same supply for reaching the outlying districts, thus avoiding the necessity for any kind of separate generating plant for this purpose. The idea was ingenious, but the author is not aware that any use has been made of it, possibly because it has been found that the public do not, after all, want alternating current. For supplying motors or arc lighting who would prefer single-phase alternating current to continuous? And for incandescent lighting, what is to be gained by using alternating current? It may seem to be wasting your time to ask these questions or to put these arguments before you, but no less a genius than Mr. Ferranti only recently publicly stated his opinion that single-phase alternating current would yet come to be the universally accepted system of supply.

There are, of course, those who say that two-phase or three-phase alternating current of low periodicity will shortly supersede everything else, but in their case the public are not found to want alternating current but continuous, and this is managed by means of rotary converters. The object of this system is said to be to allow the generating station (which for some reason, never yet satisfactorily explained, is bound to contain the whole generating plant of any one undertaking or more if possible) to be situated at a considerable distance from the area of supply, where land is cheap and coal readily obtainable. In a place like London, where the cost of land within the lighting area is practically prohibitive, where railway accommodation is impossible and the conditions and restrictions arising through the interests of surrounding proprietors most onerous, there is no doubt some reason for adopting such a system; but it is somewhat remarkable that in the case of the Glasgow tramway power supply, in which this system is being introduced, there was much anxiety to get a site, not as near the coal pits as possible, but as near the centre of the city as might be. The site ultimately purchased is about the same distance radially from the centre of the city as the Port Dundas electricity supply works, and figures were given to show both the extra capital which would be involved in going further afield and the annual extra cost through loss in distribution.

Again, it is argued that the weak spot in a continuous-current system is the commutator of the dynamo, but experience has proved that this is an absolutely erroneous idea. Nothing could be more satisfactory than the running of the brushes and commutators of most of the dynamos as now constructed, and, in fact, two and three-phase alternating systems rely entirely upon commutators in the rotary converters.

The conclusions to which these considerations seem to point are: (1) That there is no more economical or satisfactory method of supply than low-tension continuous current, generated upon a site or sites within the area of supply if possible, and supplemented by a small amount of high-tension plant if necessary in order to supply remote corners of the area which may be beyond the reach of low-tension supply. (2) That if it be impossible to find sites within the area at any reasonable price and with railway accommodation and freedom from onerous restrictions due to surrounding proprietors, then a high-tension generating station or stations without the area will be the next best arrangement, though the cost of supply will be increased to some extent. And it therefore follows that in order to ensure supply at the maximum economy in years to come, sites should be retained in suitable positions within, or as close as possible to the area of supply, and with proper railway accommodation and

* See *The Electrician*, Vol. XLV., pp. 802 and 868.—Ed. *E.*

† Paper read at the meeting of the Glasgow Local Section of the Institution of Electrical Engineers, November 14, Lord Kelvin in the chair.

freedom from hampering restrictions, even at some sacrifice in the interval until they are required.

As regards the exact pressure of supply to consumers, it is obvious that the higher the pressure the more economical will be the distribution, and it must also be clear that where lighting and tramways are supplied from the same generating station it is an advantage to have the pressure for both purposes alike. The pressure allowed by the Board of Trade for tramway supply is 500 volts, and the dynamos are usually constructed to run from 500 volts to 550 volts for that purpose. These same dynamos will therefore be most suitable, if they are to be used alternatively on lighting mains, for supply on a 500-volt three-wire system, using 250 volt lamps in consumers' premises, with balancers or equalisers to compensate for out-of-balance middle-wire currents. They will allow up to 50 volts drop in feeders at times of heavy load. The Board of Trade regulations for lighting place the limit for low-tension supply at 250 volts, but although the city of Glasgow has some 1,500 consumers with a maximum load of about 3,000kw. already supplied at this pressure, and the municipalities of Govan and Greenock have also considerable numbers of consumers supplied at the same pressure with complete satisfaction, the Board of Trade are declining to sanction more than 240 volts declared pressure in the London district and elsewhere. The argument appears to be that the 250-volt limit is one beyond which the pressure must on no account go, and that consequently it cannot be a declared pressure with the margin of variation allowed in another part of their regulations.

Whatever may be the actual construction to be put upon the words from a legal point of view, surely it is unreasonable and inconsistent to take this line. The Board of Trade is appointed to look after the interests of the public, but in what way do the public suffer through being supplied at 250 volts? The thing is done and is an admitted success. It has been in operation in Glasgow for about 18 months, and no trouble of any kind has arisen in connection with it. There can, therefore, be no scientific or practical reason why it should not be allowed. The proposal to establish 240 volts means yet another voltage to worry manufacturers and contractors, and through them the public. If the Board of Trade had taken the line of establishing a standard voltage for the benefit of everybody concerned there would have been some clear object in it, but the result of this decision will be to make at least five different standard voltages—viz., 200, 220, 230, 240, and 250 volts—in use in various places in the kingdom.

On the other hand, to agree upon 250 volts as the maximum declared pressure in consumers' premises would have tended to settle all new work down to this standard, and would have avoided the addition of another voltage to the already too numerous standards in use. At a time like the present, when standardisation is so much talked about, electrical engineers will do well to give this matter special attention, and if necessary approach the Board of Trade in a body with a view to getting 250 volts sanctioned. It is hard, however, to see what necessity there can really be for taking so much trouble about so small a matter, as all that is required is for the Board of Trade to agree to that reading of Clause 1 in the "Regulations for Securing the Safety of the Public" which shall allow 250 volts to be a declared pressure, subject to the variation of 4 per cent. from that pressure, as laid down in Clause 7 of the "Regulations for Ensuring a Proper and Sufficient Supply of Electrical Energy."

Probably the real reason why electrical engineers have not taken any decisive action about this matter is that all the older undertakings are already committed to some other voltage, and will naturally not feel called upon to press for 250 volts when they themselves use 220 or 230, and would not find it worth while to exchange to 250. This, however, is short-sighted policy, and it seems to have resulted in the meantime in the standardisation not of any of the existing voltages, but of another one, viz., 240, for all new work. In the case of Glasgow, the author of this Paper was faced with the problem of converting an existing 200-volt three-wire system into one of a higher pressure, and the question immediately arose as to whether it would be right to be contented with a 400-volt system, using 200-volt lamps in consumers' premises, or to adopt any higher voltage. While making an alteration, it was clear that if any departure were made from the simple multiple of the existing state of things, additional complications would arise in consumers' premises. The next consideration was whether the advantage to be gained was worth the complication and the cost thereof, and it then became necessary, in order to ascertain what the advantage would be, to settle upon some definite pressure as a basis for calculation. Granting that 250 volts could be used, it meant the difference between a 400-volt and 500-volt supply, i.e., an increase of 25 per cent. on the voltage. The value of this increase need not be enlarged upon in a Paper addressed to electrical engineers. The advantages to be gained in the way of the saving of copper in the mains and ease of regulation of voltage over considerable distances seemed so great as to make it well worth while to take the step.

Glasgow always wishes to be in the front line, and it certainly would not have been so had it settled down contentedly to a 400-volt three-wire system at the point when it was starting to lay a distribution system, designed rapidly to extend over an area of some 28 square miles. There is no doubt whatever in the author's mind that this alteration to 250 volts was the right step to take, and if the Board of Trade do not think so now, there cannot be the slighest doubt but that they will come to that opinion shortly. It is, however, much to be regretted that in the meantime other new underterkings should be started in various places at 240 volts instead of 250 volts.

There can be no cause for alarm or for the statement that it is a stretching of the regulations which will never end, for it must be quite clear to any one that 250 volts is the absolute limit of declared pressure at customers' terminals (apart altogether from motive power supplies which are granted at 500 volts by the special permission of the Board of Trade), and no one could possibly go beyond this figure without deliberately defying the regulations. The author holds, of course, that the regulations as they now stand are perfectly capable of being read so as to allow this 250 volts as a declared pressure, and he doubts very much whether any judge, after hearing arguments, would not decide that the real meaning of the rules is that 250 volts may be used. The words of the two clauses upon which the whole arguments depends are as follows:—

*A.—Pressure of Supply to Consumers.*

1. "The pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals except with the express approval of the Board of Trade."

*B.—Variation of Pressure at Consumers' Terminals.*

"The variation of pressure at any consumer's terminals shall not under any conditions of the supply, which the consumer is entitled to receive, exceed 4 per cent. from the declared constant pressure."

For a time a great deal was made of the argument that 250-volt incandescent lamps could not be made satisfactorily. Before deciding upon the matter, therefore, the leading lamp manufacturers were consulted, and they all stated that there would be no difficulty, and that they would be very pleased to take orders for such lamps. For the most part they have been as good as their word, and although some makers have not been quite successful as yet, they will no doubt shortly be able to fall into line with their competitors. Lamps of even 5 c.p. or 6 c.p. have been in use in Glasgow for over 15 months past at 250 volts without failure. The efficiencies of the good lamps now in use are:—

| | | |
|---|---|---|
| 5 c.p. and 6 c.p. | 5 | watts per candle. |
| 8 c.p. | 4 | ditto |
| 16 c.p. | 4 | ditto |
| 32 c.p. | 3½ | ditto |
| 50 c.p. | 3½ | ditto |

There seems to be but little in the old idea that thin filaments could not be made to last. The leading manufacturers seem to have so far conquered their original difficulties in this respect that even 250 volts does not seem to be the limit to which they can go. Indeed it seems doubtful whether in attempting higher pressures the proximity of the terminals in the present design of lamp would not cause greater trouble than the thinness of the filaments. Up to 250 volts, however, no trouble has occurred in this respect.

There is another possibility to be borne in mind in connection with this matter, and that is the introduction in the near future of the Nernst incandescent lamp. The construction of the filament in this lamp lends itself most readily to the use of 250 volts or even 500 volts. The possibilities which lie before us with the Nernst incandescent lamp, giving the necessary light with about half the amount of energy consumed in the present form of lamp, combined with the advantages of the 250-volt supply, are great.

A word may not be out of place on the vexed question of interfering with existing arrangements in some consumers' premises, such as two ordinary open-type arc lamps in series on 100 volts, special small motors for dentists' use, low-voltage heaters and cauteries and such-like complications. One frequently meets the argument that the increase in pressure is all for the benefit of the Corporation, and not for the benefit of the consumer. This argument is, of course, used by those who think that they will suffer by the change, but they are a very small minority, and do not realise that the object of the change is the cheapening of the supply all round.

It is absurd to talk about "the benefit of the Corporation." Who are the Corporation but the representatives of the people, and whose is the undertaking but the people's? The object of the Corporation is to give that form of supply which is most economical, and consequently most convenient, for the majority. Electric light has been in the past too much the exclusive light of the rich man, who can well afford to pay a high price and to indulge in every kind of low-voltage complication which suits his own special fancy or convenience; but to maintain low voltage to suit these consumers means to keep up the price and to prevent the great British public from using electric light at all. The benefit of the majority, while at the same time dealing justly with existing consumers in making the change, is what the Corporation aims at. There are no dividends to make, and all profits are used, after providing for the lasting financial soundness of the undertaking, in reducing the price.

The Corporation might have been content to leave things as they were and let the price remain high, but this would have prevented

the growth and spread of the undertaking, leaving the supply to those who could afford to pay for it, and whose special and exceptional circumstances it happened to suit. Most people want light, and they want it in 8, 16, or 32 c.p. lamps. These, therefore, demand the first and most careful consideration. The question is how to supply these at the lowest cost. Having settled that, the other consumers must be made to accommodate themselves to the altered condition of things, and it is surprising, after all, how very little difficulty is experienced in modifying existing appliances to suit the new conditions.

Voltmeters are met with in several houses supplied at 100 volts. They are not readily altered to suit 250 volts, but why should they be allowed to interfere with progress? They are at best most unnecessary and objectionable things for consumers to have. It is a significant fact that it is only in 100-volt supplies as a rule that these voltmeters are found.

In concluding, attention should be drawn to the anomalous position in which the Board of Trade have put the owners of undertakings by allowing them to increase the pressure of supply to all consumers, but only with the consent of such consumers in the case of those supplied previously to the date of the revised regulations. In Glasgow common sense has always so far prevailed, but in London it does not seem to have done so, and a mere handful of consumers have in some cases held out against the change for no apparent reason whatever, except the unpleasant peculiarities of certain kinds of human nature.

A deputation, representing some of the London supply companies, waited upon the President of the Board of Trade about the matter. While admitting that it seemed unfair for a few consumers to have the power of practically upsetting the whole undertaking, the president is reported to have said that the companies should have done more to conciliate the consumers. One cannot help feeling that the companies in London are hardly dealt with. Every improvement they try to make seems to be obstructed by County Council, Board of Trade, or some other body. They are supposed to be doing everything purely for their own selfish gain, and never with the object of improving the conditions for the consumer. Would not the case be very different if the local authorities of London all held the electrical undertakings in their own hands? Would the President of the Board of Trade have made the same remarks if the local authorities had been making the representation before him? Yet the necessity for the change is the same with the companies as with the undertakings in the hands of local authorities. It is to be hoped that the Board of Trade will give compulsory powers in this matter of change of voltage, subject to arrangement or compensation to be settled by an independent arbitrator.

The local authorities of London may quite possibly be the right parties to own the electricity undertakings, and it is their own fault that they are not so. Glasgow has realised the importance of the matter, and purchased the original undertaking from Messrs. Muir, Mavor, and Coulson, and more recently the Kelvinside Company's undertaking. The whole of this latter company's consumers have now, with one exception, been changed to the 250-volt supply, and great progress has been made with the change of the old central area. Govan, which is not at present part of Glasgow, has started its own supply at 250 volts, so that if ever it is annexed it will join up with Glasgow without further change. In this way the whole of Glasgow and the adjoining communities are in a fair way to get a universal supply at 250 volts, with the exception of Partick, which is said, under the decision of the Board of Trade, to be laying dawn a supply at 240 volts. This is not good, but Glasgow may nevertheless congratulate itself that it is not like London.

## THE AUTOMOBILE CLUB TRIALS.

**The following are rough figures concerning the perform ances of some of the vehicles during the trials last week. They are subject to revision by the judges' committee. It should be borne in mind that the condition of the roads throughout was as bad as it could be, and, except on the last day, the routes included very considerable gradients. Descriptions of the routes were included in our article last week, and also brief descriptions of the vehicles. Fuller descriptions of some of the cars will be found in another page of this issue:—**

### No. 1. **The British and Foreign Electrical Vehicle Co.'s "The Powerful."**

*Tuesday.*—Started from Chislehurst at 9:48; first stop 10:5 for 4 minutes owing to brake wire breaking; second stop 11:17 for 1 minute owing to flock of sheep; third stop 11:20 for 20 minutes to assist No. 5 car, which was stranded; fourth stop 12:38 for 3 minutes, having taken wrong turning; fifth stop 12:50 for 2 minutes to find route (driver here took opportunity to oil motor, but caused no delay; observer suggests this should not be entered against car); sixth stop 1:3 for 1 minute, road blocked by traffic; arrived Chislehurst 1.11.

Route B (continuing the run over a short route in order to test how long the car would run on one charge): started again 1:33; seventh stop at 1:43 for 1 minute due to traffic; 2:15 passed through Chislehurst without stopping; eighth stop at 2:58, again arrived at Chislehurst and stopped for 7 minutes; ninth stop at 3:40, stopped half-way up hill, about 2¼ miles from Chislehurst. Run may be assumed to have finished here. Total distance 34⅝ + 8⅝ + 8⅞ + 6⅞ = 59 miles. The total time taken was 5 hours 52 minutes. From this, stops Nos. 2, 4, 5, 6, 7 may certainly be deducted, making 8 minutes off, and total time 5 hours 44 minutes; and if stop No. 3 is allowed, total time 5 hours 24 minutes; average speed 10·92 miles per hour. Beyond brake wire breaking, no mishap occurred to car.

*Wednesday.*—Started at 11:6; first stop 11:58 for 1 minute, doubtful as to route; second stop 12:30, 1 minute, owing to traffic; arrived Chislehurst 12:46; 10 minutes rest. Started on route D 12:56. Third stop 1:6, 2 minutes, owing to bad skid; started at 1:8, but unable to proceed. Run officially ended here, though car was able to proceed round whole route, when the fault—caused by pump breaking one of the cell containers, and allowing all the acid to spill—was discovered and rectified by cutting the cell out. The official run was 21¾ + 2½ = 24¼ miles; time taken was 11:6 to 1:6 = 2 hours; number of stops were three, lasting 12 minutes, all of which were allowable, so that total time of running was 1 hour 48 minutes, and distance covered 24¼ miles; rate 13·47 miles per hour. The mishap to car was entirely due to the side slip.

*Thursday.*—Started 10:53; first stop 12:23, for 9 minutes to examine motor—slight smell arising, but was found not hot; it was oiled; arrived Chislehurst 1:15. Total distance 29¼ miles; total time 2 hours 22 minutes; stop must be included; average speed, 12·29 miles per hour.

*Friday.*—Started 8:56; first stop 9:5, for 3½ minutes, to be weighed; second stop 9:28, 1 minute, to find route; third stop 9.47, 1 minute, to find route; fourth stop 9:57, 1 minute, for traffic; fifth stop 45 minutes, 12:25 to 1:10, for lunch; sixth stop 3:24; run officially ends; battery exhausted; this is half-way up hill past football field, 1½ miles from Chislehurst. Total run—Chislehurst to Sidcup, 5 miles; seven circles of 7½ miles, 53½ miles; extra first round, ⅞ mile; homewards, ⅝ mile; total, 60 miles. Total time, 8:56 to 3:24, 6 hours 28 minutes, less 6½ minutes = 6 hours 21 minutes, and 15 minutes allowed for lunch = 6 hours 6 minutes; average speed, 9·8 miles per hour. Actual time of running, 5 hours 36 minutes; average speed, 10·7 miles per hour. Weight of car, 48½cwt.

### No. 8. **National Motor Carriage Syndicate's** Joel Car with Rosenthal battery.

*Tuesday.*—Started 10:31 a.m.; first stop 11:46, 2 minutes; second stop 12:36, 10 seconds, to ask way; third stop 1:5, 10 minutes (noticed that cap of lubricator to countershaft was gone; driver filled all lubricators); fourth stop 2:16, 3 minutes, to oil lubricator without cap; fifth stop 2.56, 1 minute, to enquire way; sixth stop 3:11, 5 seconds, to put rug round driver's legs (the car went about 2 miles out of its route about this time); seventh stop, a few seconds, to regain right road; arrived 3:47. Distance travelled 34¾ miles (excluding detour). Time 5 hours 16 minutes. Stops allowable—say, 2 minutes. Total 5 hours 14 minutes; average speed 6·6 miles per hour.

*Wednesday.*—Started 11.42, first stop 1:20, one chain came off; on attempting to start at 1:30 chain mounted pinion and bent it, the car was pushed a few hundred yards to blacksmith; fresh start made at 2:38; total stop 1 hour 18 minutes; second stop 2:38½, to again examine chains; started 2:45; third stop 3:20, half a minute, to pull up spray; arrived 3:37 Chislehurst. Started for route D 3:58; fourth stop 4:3, half a minute, to examine motor; fifth stop 4:33 to examine car; official run ended; 4½ miles of D run. Examination showed axle bent. Chain was taken off, and the car returned home driven by one motor. Total distance covered 30⅜ miles.

*Thursday.*—Car started at 3:40 p.m.; first stop 4:22, 5 miles from Chislehurst, one motor not working properly; chain was taken off, disconnecting this motor, and car returned to Chislehurst with second motor.

*Friday.*—Started 10:30; first stop 11:4, puncture; restarted and returned to Chislehurst 2:22, after repairing four punctures; weight of car 19cwt.

### No. 11. **Electric Motive Power Co.'s Car.**

*Tuesday.*—Start 10:24; first stop 12:42, 2 minutes, to feel round; second stop 12:55, half a minute, to find route; third stop 2:26, 5 minutes, to cool; motor car had climbed hill from Orpington, the observer getting out and two people pushing; fourth stop 1 minute after, second passenger out and people pushing up second hill; fifth stop 2:50½ for 15 minutes, started 3:5½, two people pushing; arrived 3:14; official run ends at 2:24 on first hill. Total time, four hours; total distance, 33 miles; average speed, 8·25 miles per hour.

*Wednesday.*—Started 11:37; arrived 1:54; no stop; time, 2 hours 17 minutes; distance 21¾ miles; average speed, 8·8 miles.

*Thursday.*—Started 11:15; first stop, 1:10 for 10 minutes for dinner; car was oiled at same time by an assistant; second stop, 3 minutes, to find route; 2:37 up Orpington Hill, observer dismounted and the car was pushed for 2 minutes; arrived 2:59. Time, 3 hours 44 minutes, less 13 minutes = 3 hours 31 minutes; distance 29¼ miles; average speed, 8·3 miles per hour.

*Friday.*—Start, 11:7; first stop, 11:20, 5 minutes, for weighing—30½ cwt.; arrived 1:15; time, 2 hours 3 minutes, excluding stop; distance 14¾ miles; average speed 7·2 miles per hour.

### No. 12. **The Canadian Electric Motor Co.'s** Still Motor Co.'s Car with "Ideal" Battery.

*Tuesday.*—Started at 10:6; first stop 10:36, 1 minute, to adjust brake; second stop 11.45; after this no further readings taken; cells nearly

exhausted; passengers had to alight on all hills; distance travelled 23 miles. Time, 1 hour 39 minutes; average speed 13·94 miles per hour.

*Wednesday.*—Started 11:40; arrived 1:35 (no stops); distance 21¾ miles; time 1 hour 50 minutes; average speed 11:25 miles per hour.

*Thursday.*—Started 11:15; first stop, 35 seconds, to ask way; two passengers got out on Orpington Hill, also on next hill; arrived 2·37; distance 29½ miles. Time 3 hours 22 minutes; average speed 8·68 miles per hour.

*Friday.*—Started at 9:10; first stop, 4 minutes, at weighing machine; second stop, 10 seconds, to find way, 9:35; third stop, 10 seconds, to find way, 9:57; fourth stop, 2 seconds, for traffic; fifth stop, 10:43, 10 minutes, for examination of motor; sixth stop, 10:54, off-side driving wheel skidding, 1 minute; seventh stop, 11:2, 2½ minutes, examination and oiling, discovered that cup of the ball bearing on motor shaft had come off; eighth stop, 11:13, to oil damaged bearing; 9th stop, 11:19, to fix up shaft; tenth stop, 11:32, to fix up shaft; 11:36, two passengers got off; distance run 20 miles. Time, 2 hours 26 minutes, less 4 minutes, equal to 2 hours 22 minutes; average speed 8·4 miles per hour.

No. 13. **The Electrical Undertakings' Car** with Leitner Battery and Lundell Motor.

*Tuesday.*—Start 10:24; first stop 12:51, 5 minutes; driver had walked some 100 yards just previously; 1:0—1:2, driver walked; 2:50, car fully discharged on Orpington second hill; distance, 33¼ miles. Time, 4 hours 26 minutes; average speed, 7·5 miles per hour.

*Wednesday.*—Started 11:39; arrived 2:12; distance, 21¾ miles. Time, 2 hours 33 minutes; average speed, 8·5 miles per hour.

*Thursday.*—Started 11:15; arrived 3:5; distance, 29¼ miles. Time, 3 hours 50 minutes; average speed, 7·63 miles per hour.

*Friday.*—Started 10:50; first stop, 3 minutes, 11:6, to weigh (weight, 26¼ cwt.); second stop 2:30, ¼ minute, to take voltage; third stop 3:43; total time, less stop for weighing, 4 hours 50 minutes; distance, 35¾ miles; average speed, 7·4 miles per hour; walked 1½ miles home.

## CORRESPONDENCE.

### PROF. PERRY'S PRESIDENTIAL ADDRESS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Prof. Perry's brilliant address to the Institution of Electrical Engineers was an intellectual treat that was evidently appreciated by the audience, but it appeared to me, at any rate, that the effect was somewhat marred by the introduction at the end of the discourse of such a controversial matter as the question at issue between the Kew Observatory and the London United Tramways Co. regarding the extent and scope of the requirements to be imposed upon the company for the prevention of interference with certain delicate magnetic observations.

Prof. Perry is an Irishman, I am credibly informed, and no doubt the temptation to trail his coat is a strong one, but the inclusion of such a challenge in an *ex cathedrâ* address must be deprecated.

He appeared to think that his action in taking a strong line on the Observatory side required explanation and defence. No such suggestion has, so far as I am aware, been made. On the contrary, I think that everyone feels how important it is that the case for the Observatory should be put as strongly and clearly as possible. But when Prof. Perry claims that, in insisting upon impracticable conditions for electric tramways within an indefinite distance of Kew, he is acting as much in the interest of electrical engineering as of the Kew Observatory, I feel it necessary to state that those who have taken the other side in the controversy maintain that it is too late to hope for absolute freedom from electric and magnetic disturbance in the immediate neighbourhood of London; and that, on the contrary, the true interest of both parties will be best served by adopting our suggestion, that the magnetic observatory should be removed to a position where the necessary freedom from disturbance can be secured for all time. We repudiate the suggestion that we are antagonistic to scientific research. What we do oppose is a fetish set up in its name.—Yours, &c., P. Cardew.

London, Nov. 13.

### TROLLEY-WIRE ACCIDENTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I would ask your indulgence to be allowed to correct what might be a misconception in your reference to automatic devices for "switching off the overhead traction wire when it breaks" contained in your notes of the last issue. It seems to me that most of your readers will assume that the accidents in Carlisle and Plymouth happened *in spite of the use* of automatic devices you refer to; but, so far as I am aware, there is only one town in England in which the automatic device for "switching off the overhead traction wire when it breaks" is used, and that town is Blackpool. I need hardly reiterate the remarks of the newspapers in their accounts of the successful action of this device on more than one occasion. They are probably well known to most of your readers.—Yours, &c., Robt. C. Quin.

Blackpool, Nov. 10, 1900.

[Accidents such as those referred to in our note are more often occasioned by the breakage of guard wires or telephone and telegraph wires than by a broken trolley wire. The sentence, quoted in part only by Mr. Quin, is: "In spite of guard wires and devices which are constantly being patented for automatically switching off an overhead traction wire when it breaks or another wire comes in contact with it, accidents are being continually reported owing to such causes."—Ed. *E.*]

### M. GUARINI'S EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With regard to M. Guarini's research, may I say that I performed very similar experiments myself in April, 1899. I found that the sound of the telephone was enormously increased if the free terminal was connected to an elevated piece of galvanised iron netting. This was just before Mr. Marconi first used it in one of his installations. All my attempts to interrupt the lead and so make it wireless failed, partly, perhaps, because I was carried away into a still more interesting research. But as I soon showed that earthing any part of the copper conductor obliterated the results, I concluded that the sound was merely caused by a momentary rush of current trying to equalise the difference of potential between the secondary terminal and the wire netting (or free wire), which in that case would merely act as a capacity. If this is so, then earthing the free terminal of the telephone should increase the sound, which I think will be found to be the case.—Yours, &c., R. H. Martin.

London, Nov. 14.

## LEGAL INTELLIGENCE.

### Attorney-General v. the National Telephone Co.

This case was in the list for hearing before Mr. Justice Wills and a special jury in the Queen's Bench division on Monday.

Mr. DALDY said the action was brought by the Attorney-General, on the relation of the London County Council, to restrain defendants from breaking up streets in the County of London for the purpose of laying their telephone wires underground without the consent of the Council. Plaintiffs' case was based on two grounds. First, it was claimed that under the Telegraph Acts defendants had no right to do what they had done, and, secondly, that the defendants were creating an obstruction by breaking up the streets. The defence was that defendants were not acting under the Telegraph Acts at all, and what they had done created no obstruction. Plaintiffs joined issue, and some issues might arise which it might be necessary for the jury to try.

Sir EDWARD CLARKE, Q.C., for defendants, said that he should like to point out that correspondence had taken place between the solicitors to which, in the interests of public time, he thought he ought to call his lordship's attention. This was one of two sets of proceedings brought against the Telephone Company, one by the Postmaster-General, and the other by the Attorney-General, on the relation of the London County Council, involving substantially the same questions, viz., whether there had been an interference with public rights, and whether an injunction should be granted. Both questions involved very serious questions of law as well as very complicated questions of fact. The case of the Postmaster-General came on first, and in that proceeding, which came before one of the Courts some time ago, the Telephone Company submitted to terms under which the company, as between the Government and itself, was restrained from doing any work for the purpose of extending the existing system of the Telephone Company under the streets of London, and the whole object that could be achieved by success in the litigation which was now before his lordship, had, he (counsel) thought been completely fulfilled by the terms arrived at in the other action. In those circumstances his clients had written to the London County Council suggesting that the action should stand over *sine die*. The Council, however, declined. He could not, on behalf of his clients, consent to judgment or to give any undertaking in this action. He thought his lordship would understand that there were considerations with regard to the legal relations of the Council and the company which would prevent him, under any circumstances, submitting to a judg-

ment in this action which must, he thought, involve a very long investigation of facts—facts which would involve several findings by the jury, and on which his lordship would be asked to deal with a question of law as to the granting of an injunction. It was a litigation which could not in any case stop there. He was very much impressed by the idea that it would be a very grave misfortune if they spent several days of public time to fight the case out in that Court when they had already got sufficient material for going to another Court, and what was asked by this litigation was already secured by the terms secured in the other action.

Mr. DICKENS, Q.C., for plaintiffs, said it seemed to him there was some difficulty in the way. The two sets of proceedings were not identical. The injunction in the case of the Postmaster-General did not protect the interests of the County Council in the event of the Postmaster-General and the Telephone Company coming to an arrangement. He did not, however, wish to enter into a litigation of a long character. The difficulty he was now in was that he had not had an opportunity of seeing the members of the Highways committee, and he (Mr. Dickens) should not like to take upon himself the responsibility, as counsel, of doing anything without consulting them.

Mr. Justice WILLS: I do not quite appreciate the difficulty of the defendants in giving the same undertaking to the plaintiffs that they have given the Postmaster General. I suppose it is not very likely that the Postmaster-General will allow them to break up the streets without obtaining the consent of the County Council. On the other hand, the Council has not got the security of anything between itself and the defendants.

Sir EDWARD CLARKE said that if his lordship would look at the affidavits he would find that there were serious questions which made it impossible for the Telephone Company to come under terms and any injunction or order in this case, because there were important legal questions which the company wanted to raise. But he had pointed out to his learned friend that precisely the same result might be obtained if this case were ordered to stand over, with leave to apply to restore it. If, on its standing over, the Telephone Company did anything in contravention of the undertaking and the injunction submitted to in the other action this case might come into the paper next day.

Mr. Justice WILLS: That does not seem to be unreasonable.

Sir EDWARD CLARKE said he did not wish to give any undertaking in this action, but he was quite ready to say that no action should be taken, if the case stood over finally, in contravention of the Postmaster-General's order without the Telephone Company giving notice to the County Council.

His LORDSHIP in the result adjourned the case generally with liberty to the County Council to apply to have it restored.

## Corporation of Wolverhampton v. the British Electric Traction Co.

This action, which had reference to running powers over the Wolverhampton tramways, came before Mr. Justice Joyce in the Chancery Division yesterday (Thursday).

The action was brought for the specific performance of a statutory contract by which defendants or their predecessors in title were under liability to sell a tramway to the Corporation of Wolverhampton. By the Dudley, Sedgley, and Wolverhampton Tramways Order, 1880, powers were given to certain persons to construct and maintain tramways in the parishes of Sedgley and Wolverhampton. In 1893 those rights and powers, which in the meantime had been amended and extended by the Sedgley and Wolverhampton Tramways Act, became vested in a company called the Dudley and Wolverhampton Tramway Co. (Ltd.). That company, in turn, in 1899 entered into a contract to dispose of its undertaking to the British Electric Traction Co., the defendants, and the latter took the position of the original promoters under the Act of 1880. By an Act of 1899 the Corporation obtained power within a certain time to give notice to the promoters of the Tramway Company to sell the undertaking to them, the consideration to be a sum to be agreed upon. On Sept. 20 of that year the Corporation gave notice to purchase, but the value could not be agreed upon, and Sir F. Bramwell was appointed arbitrator. A purchase price of £4,250 was agreed upon before the arbitrator sat, and that sum was accordingly made his award. Subsequently, although the Corporation's cheque was sent it was returned, and defendants for the first time, it was said, raised the question of running powers over the plaintiffs' tramways. They refused to complete the contract unless the Corporation gave them running powers over the Corporation lines. In defence it was pleaded that sec. 17 of the Act of 1880 provided that if at any time tramways were made or purchased within the borough of Wolverhampton by the Corporation the promoters of the company should make and maintain the necessary junctions, and that the parties should grant to each other running powers over the respective lines under Board of Trade conditions. By the sale of the line in question to the Corporation defendants became entitled to the rights and privileges of the original promoters under the order of 1880, but these rights the Corporation refused to give, and defendants thereupon declined to complete the sale, being apprehensive that the Corporation would sever the portion sold from the remainder of the undertaking. The defendants accordingly counterclaimed for a declaration that on conveyance of the tramway in question to the Corporation the defendants became entitled to running powers over the whole of the Corporation's system.

Mr. WARMINGTON, Q.C., for plaintiffs, said the case resolved itself into the construction of Acts of Parliament. Defendants said they were entitled by statute to running powers over that portion of the tramway which was the subject-matter of the contract. The Corporation denied that. He summarised his argument for plaintiffs into two contentions. First, that the defendants were seeking to apply sec. 17 of the Order of 1880 to a subject matter wholly foreign to the section. It was a section introduced into the provisional order for the protection of the local authority against the promoters. It was not a section which gave additional powers to the promoters, but subjected the promoters to certain liabilities at the request of the Corporation. His second point was that in the Tramway Act of 1899 the same idea was carried forward, because sub-section 4 of sec. 5 of that act provided "Nothing in this order, save as by this section, provided shall authorise the promoters to exercise any powers within the borough of Wolverhampton." What the defendant company were seeking was to have running powers over a tramway within the borough, not by this Act of 1899 but by the Act of 1880, although the provision of the latter act was that they should only have such powers as are "by this act conferred." That was followed and confirmed by the Corporation's Borough Act of 1899, which provided by sec. 54 that as soon as the acquisition authorised by sec. 5 of the Tramways Act of 1899 had been carried out the provisional order of 1880 shall cease to apply thereto. Therefore he submitted that the contract was by statute and that the Corporation were entitled to specific performance. Alternatively there was a claim for damages.

Mr. FREEMAN, Q.C., for defendants, said the only point he was concerned to argue was whether his clients had a right to the running powers they claimed. He submitted that sec. 17 was inserted in the provisional order of 1880 not wholly or principally in the interests of the Corporation, but in order to secure for everyone concerned and the public that continuous means of transit should be preserved from outlying places like Dudley and Sedgley into the heart of the borough of Wolverhampton. In this case the line within and without the borough boundary was in actual physical continuance, and it did not, he submitted, lay within the power of the Corporation to say that because they did not require the promoters to do that which was impossible—viz., make junctions and communications, because these, in fact, were already made, therefore the second part of the section which related to running powers did not arise. The language was plain, that if the Corporation was so empowered, as in fact it was so empowered, and was required by the promoters, as it had been required, to grant running powers, then the Corporation "shall" grant such powers. Apart from the legal obligations, the arrangement was fair, because the company running trams over the Corporation's lines would receive only the cost of so running, and the profits would go to the Corporation. It would be a gross public inconvenience if either party was entitled to cut arbitrarily the already existing line, or to stop the through running of the trams.

Mr. WARMINGTON replied that this was a special clause for the benefit of Wolverhampton only, and not for the benefit of the public as apart from the interests of the borough.

Mr. JUSTICE JOYCE intimated that he would consider his judgment.

## Madras Electric Tramways Co. (Ltd.). Electric Construction Co. (Ltd.) v. Cooper and Others.

This case came before Mr. Justice Cozens-Hardy yesterday (Thursday), the short point involved being whether the first mortgagees—debenture holders who were in possession by their trustees, were entitled to the whole amount which had been advanced and expended by them on the Madras Electric Tramways Co.'s undertaking in priority to the second mortgagees. The facts sufficiently appear from the judgment.

Mr. Justice COZENS-HARDY, in his judgment, said the real question at issue was, Who were entitled to a sum, roughly, of £80,000, which represented the purchase-money of the Madras Tramways undertaking? and in what priority that sum was to be paid out? There were several claims. There were the trustees, who claimed their costs, charges, and expenses, which were not disputed, and therefore must be paid, and there were several persons who claimed a 6 per cent. charge in priority to everyone, and they claimed for the full amount of the advances which they had made. These claimants were the Electric Construction Co., plaintiffs in the action. They were also first debenture holders, the Construction Company holding nearly all the first debentures. They were 5 per cent. debentures, besides which there were second debentures, half of which were held by plaintiffs and the other half by the British Electric Traction Co. The Madras Tramways Co. was now in the course of winding-up. It had borrowed money in 5 per cent. debentures. The trustees for those debentures had power to take possession of the concern on the happening of certain events, which events did happen in 1895, and the trustees entered into possession. They had power to carry on the business; they did so, and in doing so, spent large sums of money. The money for carrying on the business was furnished by the plaintiff company. This went on for some time until in 1897 there had been a very large sum of money advanced. A transaction took place in 1897 by which the Madras Tramways Co., the Electric Construction Co., the debenture holders and the trustees all came together and arrived at a certain bargain. The deed in which this bargain was set out gave the Construction Company an absolute first security upon all the property of the Tramway Company, and gave them interest at the rate of 6 per cent. on that charge. The validity of that charge was not and could not be disputed. Although the plaintiff company were under no obligation to lend the Tramways Company further moneys they did lend very large sums in addition. Upon what terms did they lend those further moneys? These sums were, he held, advanced upon the condition that they should be part of and subject to the security given by the deed, carrying 6 per cent. interest. The security for these advances was absolutely beyond question, until the moment arrived in November, 1898, when the plaintiff company had notice that the Madras Tramway Company had done, what they were perfectly at liberty to do, namely, issued a second debenture to the defendants, the British Electric Traction Co. He (the learned Judge) thought that he must find that the terms of the bargain were set out in the deed referred to, and that he could not and ought not to consider what might have been the rights of the parties if the money had been advanced by the plaintiffs independent of such a deed. He found, therefore, that any advances made by the plaintiff company subsequent to Nov. 25, 1898, when notice was given of the second mortgage, were postponed to the second mortgagee's claims.

**Donberger v. Gaudson and Spencer.**

At Clerkenwell (London) County Court on Monday, before Judge Edge, Q.C., Mr. Sigmund Donberger, manufacturers' agent, sued Messrs. Gaudson and Spencer, electrical engineers, for £28. 15s. for goods sold and delivered, and damages sustained by breach of contract. The case for the plaintiff was that in June last, when there was a boom in small lamps for electrical illumination owing to the holding of a large number of carnivals on behalf of the war funds, his traveller obtained an order for £13. 15s. worth of goods from defendants. Portions of the goods were delivered, but the remainder they refused to accept. The defence was that when the second instalment of the lamps was supplied they were valueless to defendants, as the Islington Carnival for which they were required had been held. Judgment for plaintiff for £20. 5s., and costs.

**Recording Telegraphs (Ltd.).**

A creditors' petition for the compulsory winding-up of this company again came before Mr. Justice Wright on Wednesday.

His LORDSHIP adjourned the hearing of the petition for a week.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Scarborough Electric Supply Co. require a mains superintendent. An advertisement gives further particulars, and applications must be sent to the resident engineer (Mr. F. G. Holden) by 22nd inst.

Bolton Electricity committee require an assistant engineer. Applications to borough electrical and tramway engineer (Mr. Arthur A. Day), Spa-road, Bolton. See advertisement.

Cardiff Corporation require a mains superintendent. Applications to town clerk by 19th inst. A chief assistant engineer to the electrical tramways engineer at Cardiff is also required. Applications by 28th inst.

A junior assistant is wanted in the testing department of the Brighton Corporation electricity works. Applications to resident engineer and manager (Mr. J. Christie). See advertisement.

Belfast Gas and Electric committee require a junior assistant in the mains department; also an improver. Applications to city electrical engineer (Mr. Victor A. H. McCowen) by 19th inst. See advertisement.

Barking Council require a resident electrical engineer. Applications to clerk by 19th inst.

Mr. E. Trenam, chief superintendent of Postal Telegraphs in the Manchester district, has been appointed telegraph manager at the secretary's office, St. Martin's-le-Grand, London, E.C. Mr. Trenam entered the service of the Electric Telegraph Co. in 1857, and when the telegraphs were transferred to the Government in 1870, was appointed assistant superintending engineer of the Midland district, and in 1872 was transferred to Leeds in the same capacity. There he remained for 20 years. In 1892 Mr. Trenam was selected for the post of chief superintendent at Manchester, and since that time he has been principally engaged in the organisation and extension of the trunk telephone system, of which 18 principal centres were under his control.

The Postmaster-General has also appointed Mr. Thomas Mason, chief superintendent of the special telegraph arrangements branch, to be traffic manager for telegraph business in the United Kingdom. This is a new departmental post.

Out of a large number of applicants, Mr. E. A. N. Pochin, B.A., M.I.E.E., has been selected for the position of electrical engineer to the Marconi Wireless Telegraph Co. (Ltd.).

Mr. N. Thompson, B.A., A.I.E.E., has been appointed secretary of the Tramways and Light Railways Association, whose offices will be at Clun House, Surrey-street, W.C.

Dr. S. R. Milner has been appointed demonstrator and assistant lecturer in physics at University College, Sheffield.

Mr. J. W. Beauchamp has been appointed works manager at the factory of the Sheffield electric light department at £200 per annum.

**Ballymena (Ireland).**—A report on electric lighting is to be considered at the next meeting of the District Council.

**Blackpool.**—There has been some re-adjustment of the committees of the Council. Two committees have been appointed to deal with electric lighting and tramway matters. Hitherto, both departments have been under the charge of an Electric Lighting and Tramways committee. Ald. Brodie has been re-elected chairman of the Tramways committee, and Ald. Grime has been elected chairman of the Electric Lighting committee.

It has been decided to apply for power to construct a tramway in Middle-lane, and a double line in Lytham-road. £50,000 is to be borrowed for the construction of the permanent way and electrical equipment of tramways already authorised, and the Board of Trade have sanctioned the borrowing of £9,300 for the purchase of additional tramcars.

**Blaydon.**—Owing to the unsatisfactory system of lighting, the Council have applied to the owners of a neighbouring colliery (the Priestman Company) to give a supply of current. The same company is supplying current for the lighting of a neighbouring village (Victoria Garefield).

**Bournemouth.**—Mr. A. P. Trotter held a Board of Trade inquiry at Bournemouth on Tuesday into the application of the Corporation to borrow £174,750 for the construction and equipment of electric tramways under the Council's provisional order of 1900. The town clerk (Mr. J. Druitt, jun.) and the borough surveyor (Mr. F. W. Lacey) appeared in support of the application. Mr. Lacey said the whole of the lines would be within the borough, the longest run from the depôt would be 2 miles, and the steepest gradient 1 in 14. Mr. Druitt explained that the Poole and District Electric Traction Co. were now constructing a light (electric) railway from Bournemouth to Poole, while the Christchurch and Bournemouth Company had also powers to construct a tramway between the two towns. The clerk explained unless the Corporation constructed the tramway within two years the other companies could step in and carry out the work. On behalf of some property-owners Mr. Franklin opposed the proposal to erect the generating station in Southcote-road, as it would depreciate the value of property in the neighbourhood.

**Breach of Electric Wiring Regulations.**—At the Barnsley Police Court, last week, Mr. Alfred Sharp, a local electric wiring contractor, was charged, under the Electric Lighting Acts, 1882 and 1888, with supplying another person with electricity. Mr. H. Horsfield, town clerk, prosecuted, and explained that the act provided that for any breach defendant was liable to a penalty of £5 and a further penalty of 40s. per day. The offence was that defendant supplied his next door neighbour with electric current without having received consent of the undertakers, the Town Council. The assistant engineer to the Council saw defendant last week, and noticed the connection had been made. It was admitted there had been no fraud, but the borough electrical engineer (Mr. Bastow) said it was a dangerous practice. It was also admitted that Mr. Atkinson had asked for a supply of current to his own premises. Defendant pleaded that there had been no attempt to defraud. He had placed the fittings in his neighbour's premises, and as the gas supply went wrong, the defendant suggested making a connection from his service. A fine of 20s. and costs was imposed.

**Canterbury.**—The Council are recommended to apply for sanction to borrow a further £13,000 for extensions of the electricity works.

**Cheltenham.**—The promoter of the Cheltenham-Cleeve light electric tramway (Mr. T. Nevins) has now let contracts for the plant and equipment, and the work of constructing the permanent way will shortly be commenced. On the suggestion of the borough electrical engineer (Mr. Kilgour) the Demerbe rail is to be employed.

**Clydebank.**—The Burgh Commissioners have decided to apply for an electric tramway provisional order.

**Dover.**—Amongst the improvements to be made in this town will be the construction of a new viaduct road at a cost of £100,000, which will provide a fine approach from the pier stations, and a direct double line for the electric tramways.

**Dungannon (Ireland).**—The District Council, who are applying for electric lighting powers, are advised that it would be more economical to use steam power in generating electric current than to adopt the proposed Benburb water power scheme. The estimated cost of steam-driven plant is £7,000.

**East Ham.**—Extensions of the arc lighting, estimated to cost £1,280, have been authorised.

**Edmonton.**—The District Council have rescinded their resolution to apply for a provisional electric lighting order, as it was thought that a separate application by the Council for electric lighting powers would militate against the success of the bill which is being promoted by a number of the North Metropolitan Councils for power to establish electricity supply.

**Electric Tramway Strike.**—The Oldham, Ashton and Hyde Electric Tramway (Ltd.) has withdrawn from the proposed arbitration on the recent strike of their employés. The dispute is, however, closed, the men having been reinstated.

**Elland.**—The Council are negotiating for the purchase of a site for their proposed joint electricity and refuse destructor undertaking and a deputation has been appointed to visit Bradford where similar works are in operation.

**Guisborough.**—The Northern Counties Electric Supply Co. are applying for a provisional order, but before consenting the District Council wish to see a draft of the proposed order.

**Hereford.**—The Council have decided to put down an additional 250kw. steam dynamo and to carry out certain extensions of the mains at an estimated cost of £5,000. Sanction for borrowing this sum has been applied for. At present the equivalent of nearly 8,000 8 c.p. lights is connected to the mains.

**Holyhead.**—In the report of experts appointed to consider the practicability of utilising the power of the water running through "Pont Lasinwan" in the generation of electric current it is stated that there is sufficient power to generate 25,000 H.P.

**Inquest**—Yesterday (Thursday) Dr. Danford Thomas held an inquiry, at the Marylebone Coroner's Court, into the circumstances attending the death of Rowland Herbert Pickworth, 22, electrical engineer's assistant, who died from an electric shock whilst at work at the Metropolitan Electric Supply Co.'s station, Manchester-square, on Tuesday last.

Mr. REUBEN PICKWORTH stated that deceased (his son) had been in the employ of the Metropolitan Company as assistant electrical engineer at Manchester-square for 18 months, and he enjoyed excellent health. On Tuesday morning he learned of his death, and he afterwards heard that he was engaged at the works when, by some means while putting on a switch at the switchboard, his hands came in contact with a live wire, and his death occurred instantly.

GEORGE BRANDON, a switchboard attendant, stated that men engaged at the works were instructed as to their duties and as to the precautions necessary to be taken. Gloves were provided for use in the works. On Tuesday morning at 7 o'clock witness found deceased at work. At 8:30 he saw deceased engaged in connecting up some large cable, and this had to be connected with the switch. He would not wear gloves, but would prefer insulated handles, and if such were used then the work could be done with perfect safety. He turned round and looked at deceased and saw him falling, and he then noticed that deceased had evidently received a shock, having, instead of taking hold of the insulated handle, taken hold of the metal work with both hands. He went and pulled deceased away by taking hold of his coat, and endeavoured to restore him, but without avail. A doctor was called and it was found that death had ensued.

A JUROR asked if there was any likelihood of the witness receiving a shock in pulling deceased away.

WITNESS said there was if he had attempted to pull him away by the hands, therefore he took hold of him by the coat. There was no doubt that deceased took hold of the metal thinking it was not charged. Deceased could see by a lamp overhead whether the current was on or off.

ARTHUR WYATT, superintendent of the Manchester-square station, stated that deceased was well acquainted with the duties and regulations with regard to what precautions were necessary to be taken for safety. There was at the works a large switchboard, and there were certain connections with it and the mains—in fact, a dozen. The connections could have been made with perfect safety if deceased had taken hold of the insulated handle. The switchboard itself was insulated. Deceased went on night duty, and had been at work all through the night receiving current from their station at Willesden. Witness went to the works about half-past nine on Tuesday morning and then found that deceased was dead. Had deceased looked above his head he would have seen whether the current was on or not by the pilot lamp. At the time of the accident the voltage was 1,000. He examined the machinery and found nothing amiss. The work that deceased was doing was similar to that which he would do every day. There was nothing to prevent deceased touching the metal if deceased's hand slipped. There was certainly exposed metal on the switchboard.

Dr. J. P. SIMPSON stated that he was called in and found life extinct. The hands were both destroyed, clearly showing that electricity had passed through the body from one side to the other, and death was instantaneous from shock.

Mr. REGINALD TODD, chief engineer to the Metropolitan Company, said that the ordinary precautions were taken for the safety of those engaged at the works, and to enable anyone to see whether the current was on a switch, there was, above the board, a pilot lamp. In this instance no doubt deceased took hold of the switch by the metal portion with both hands, thinking the current was off. He would consider whether it was not possible for some method to be adopted by which any similar accident could be avoided in future. The switch was constructed so that it could be used by one hand only, and to prevent the hand slipping from the insulated handle there was a flange at the end of it.

Mr. GEORGE BLENKINSOPP, Government Inspector, said he had visited the works and found that it was worked on the high-pressure system. There was metal work on the switchboard that was exposed, and if this was taken hold of without the insulated handle it would be dangerous. The Royal Commission on Dangerous Trades made a recommendation with regard to switchboards, that all metal parts should be insulated, or means taken to make it impossible for workers to touch them. The recommendations of the Committee had not, up to the present, been put in force by the Home Office.

The CORONER said there was no doubt from the evidence that deceased must have forgotten the switch was charged when he took hold of it. He should not advise the jury to recommend in their verdict any particular kind of protection because it might be that they as laymen might recommend something that would be unsuitable. They had better leave it to the company to find out what were the best methods to adopt.

The JURY returned a verdict that deceased died from the effects of an electric shock at a time when deceased's hands came in contact with the electric current of a switch when he was changing-over the current, and that death arose from accidental causes. The jury recommended to the immediate consideration of the company the necessity of protecting the metal parts in such a manner that a similar occurrence cannot occur.

**Keighley.**—The memorial stone of the new electricity station building was laid by the Mayor (Mr. Longsdon) on Friday last. The electric lighting scheme is being carried out under the supervision of the borough electrical engineer (Mr. J. M. Smyth). The Council have obtained sanction to a loan of £34,600, and it is anticipated that current will be available by Easter next. At first it is proposed to put down plant of a total capacity of 800 H.P., but provision has been made for extensions. Distribution is to be on the continuous-current three-wire system, at a pressure of 230 volts.

**Kimberley (South Africa).**—Notwithstanding the stress of martial events, the chief citizens of this go-ahead city, with the mayor, Mr. H. A. Oliver, at their head, on Oct. 13 formally opened an electric lighting station in connection with the electric power station in Stockdale-street. The decision to establish electricity supply at Kimberley was taken by the Town Council in 1898, but some difficulty was found in obtaining the necessary £25,000 capital for a start. The De Beers Company came to the rescue, and a bill was passed enabling the project to be carried through. The successful tenderers for the generating works and their equipment were Messrs. Reunert and Lenz. The contract was signed in 1899, and the work was to have been completed in February, 1900, but owing to the siege this had proved impossible, and incurred a delay of seven or eight months. At the start it was decided to charge 1s. 6d. per unit for current, but this has been reduced to 1s., although fears are entertained that this price will not prove remunerative. When the additional boiler, which is now on order, is installed, the station will have a capacity of 5,000 8 c.p. lamps. Already over 4,000 lamps have been applied for. At present the supply is cut off at 1 a.m., but a large battery of accumulators, costing £5,000, is on the road, and will enable this early hour to be considerably extended. Messrs. Reunert and Lenz were heartily congratulated upon the success of the inauguration and on the general completeness of the works. These congratulations were extended to Mr. Wilms, the supervising engineer, and his staff. Mr. Reunert, who returned thanks to a toast in honour of his firm, said there was no question of the absolute certainty that the installation at Kimberley would be a paying one, and the price charged for current was reasonable compared with that paid in other parts of South Africa. He anticipated that in the early future they would be able to reduce even this comparatively low price. He claimed for his staff that they had been successful in helping to keep the Boers out of Kimberley, for the Boers had mistaken the trenches that were being dug for the electric lighting cables for military trenches, where dynamite was to be placed to blow up the besiegers if they approached too near.

**King's Norton.**—The question of complying with the terms of the provisional order obtained in 1898 is engaging the attention of the Council and the Board of Trade are asked to extend the time in which this is to done.

**Kingswinford.**—The Kingswinford electric tramway was officially inspected on behalf of the Board of Trade on Friday.

**Leamington.**—The Council are seeking sanction to a loan of £7,000 for refuse destructor works.

**Legal and Ethical Aspects of Municipal Contracting.**—At a meeting of the Leeds Corporation attention was called to the fact that the tender of Messrs. John Fowler & Co. for the extension of a switchboard gallery had been accepted, and that an alderman was a member of that company. The town clerk ruled that, while for a member to supply a corporation with goods was contrary to law members of a limited liability company could do so, although members of the Council.

**Leyton.**—The steam plant at the electricity works was started on 3rd inst.

**Light Railways.**—The Spen Valley Light Railway (Extensions) Order has been submitted to the Board of Trade for confirmation. Objections by Dec. 6.

Crewe Town Council are about to apply for an order to construct a system of light (electric) railways in the borough. The scheme includes eight lengths of line which will be constructed to a gauge of 3ft. 6in.

**Limerick.**—The Corporation have been notified by the Board of Trade that, under the special circumstances, they will defer consideration of the question of revoking the provisional order for 12 months. If by the expiration of that period the undertakers have not taken definite steps to carry out the obligations under the order, the Board may not feel justified in allowing the order to remain in force. On Wednesday a deputation waited upon the Local Government Board to induce them to reconsider their decision as to a loan.

**London Bridge.**—In the improvement scheme which has been prepared by the Bridge House Estates committee of the City Corporation, provision is made for the electric lighting of the bridge by arc lamps erected in the centre.

**London County Council.**—At Tuesday's meeting it was agreed to loan Hampstead Guardians £1,142 for the installation of the electric light at their workhouse.

The Fire Brigade Committee reported that it had been the practice to allow public institutions, theatres, business premises, &c., to have direct electric communication with the nearest fire stations, a charge of £5 being made for the privilege. Success had attended the experiment of utilising (by means of an apparatus designed by Commander Wells) fire alarm posts for the transmission of telephonic messages,

and it had been determined that all fire alarm posts fixed in the public thoroughfares of London should be adapted for this purpose. It was now proposed that the same thing should be done with respect to these private communications, and that on the putting in of the new apparatus the annual charge should be reduced to £2. 2s. Agreed.

**Lynn.**—There are at present 226 customers, representing the equivalent of 7,244 8 c.p. lamps, connected to the electric supply mains. The Electric Lighting committee have resolved that "For the present a number of 8 c.p. lamps of 190 volts instead of 200 volts be used, with the object of easing the load."

**Manchester.**—Mr. D. Boyle has been re-elected chairman of the Tramways committee. A sub-committee has been appointed to confer with the Electricity committee as to the supply of electric energy for the tramways.

Dr. Bishop has been appointed chairman of the Electricity committee in succession to Mr. Lloyd Higginbottom and Mr. J. Phythian has been appointed deputy-chairman. Mr. Phythian is an engineer, and was at one time deputy chairman of the committee. Dr. Bishop was instrumental in bringing about the recent inquiry into the working of the Electricity department by a special sub-committee. An abstract of the report of this sub-committee, which was presented to the Council on 31st ult., was given in our issue of 2nd inst.

**Mansfield.**—In the bill which the Council are promoting powers are sought to acquire land for electricity and gas works, also to enter into agreement with tramway, light railway, and other companies, for the supply to them of electric energy, and to raise money for electricity supply.

**Midsomer Norton.**—A committee has been appointed to confer with the Radstock District Council on the proposal to establish joint electricity works for Midsomer Norton and Radstock.

**Minas (Brazil).**—Dr. Olympio de Assis of this city announces that several electric tramway lines are about to be constructed, and he desires that manufacturers of electrical plant and apparatus and of street railway material in general shall forward him price lists, catalogues, and any other information they may be disposed to send.

**Municipal Telephony.**—The Hove Council have withdrawn their opposition to the Municipal telephone scheme of the Brighton Corporation.

Mr. A. R. Bennett has offered to prepare a report on the telephone question for 20 guineas and travelling expenses, for the Cheltenham Corporation. The matter has, however, been deferred until the result of the Eastbourne application for a municipal telephone licence is ascertained.

**Newport (Mon.).**—The Corporation have adopted the recommendation to appropriate £2,000 for wiring consumers' premises on the deferred payment system. It is intended to limit the expenditure in any one case to £20, except in special cases.

The Corporation have decided, on the recommendation of the Tramways committee, to work the tramways on the expiry of the present lease (in July next).

**Normanton Electrical Scheme.**—A conference of local authorities was held at Normanton on Wednesday to consider the electric lighting and tramway scheme of the United Kingdom Electrical Association. Councillor W. Shaw presided, and the Featherstone, Pontefract, Castleford, Whitwood, Warmfield, and Snydale Councils were represented. Normanton, Castleford, Whitwood, and Featherstone approved the scheme, the others deciding to refer the question again to their respective Councils for further consideration. A sub-committee, consisting of two from each Council, is to be appointed to further investigate the matter.

**Orange River Colony.**—Notice is given that the patent laws of the late Orange Free State have been in no way altered or disturbed by the transfer of this territory to her Britannic Majesty. Persons interested in obtaining letters patent or renewing patent rights or letters granted should therefore proceed as hitherto. Applications, specifications, &c., may now be drawn up in the English language.

**Paisley.**—In future customers of the electricity department are to have the option of taking current at a uniform rate of 5d. per unit or of adhering to the present maximum-demand system, *i.e.*, 7d. for the first hour and 3d. after. In reply to a request from Callender's Company for payment of the balance of their account against the Corporation for cables and mains, the clerk has been instructed to say that the funds of the electric lighting department are exhausted, but that application has been made for additional borrowing powers, and that the municipality anticipate being in a position to meet payments in three or four months.

**Patent Prolongation.**—The British Aluminium Co. (Ltd.) have decided to apply to the Privy Council for a prolongation of the term of letters patent for "An improved process for the preparation of aluminium, aluminium bronzes, and alloys of aluminium by electrolysis." Notice of opposition must be given by Dec. 20.

**Pemberton.**—Sanction to a loan of £20,000 for electric lighting has been obtained by the Council.

**Penang.**—A preliminary report and estimates for the proposed electricity supply undertaking for Penang has been presented by Mr. O. V. Thomas to the Municipality. The report states that the condition of public lighting of Penang is incomplete and unsatisfactory, and the termination of the present public lighting contract is favourable for considering the introduction of the electric light, more especially as the support likely to be given to such a project by private consumers is considerable. The streets are now lighted by some 800 oil lamps of an average candle-power of 9 c.p. per lamp. The cost of this light is $1·99 per lamp per mensem, exclusive of repairs and renewals of lamps. Mr. Thomas recommends the use of 16 c.p. incandescents at moderate distances for street lighting, as likely to be more effective than lamps of greater power at greater distances. Arc lamps are recommended in places where their higher illuminating power can be used to best advantage. He recommends the retention of the existing lamp posts for the incandescent lamps, substituting for the lanterns now used a curved wrought-iron tubular bracket with weatherproof conical reflectors, the lamps being fixed 14ft. above the street levels. The arcs are to be rested on wrought-iron tubular poles with ornamental cast-iron bases at a height of 20ft. 2,000 c.p. enclosed arcs are recommended as economical in maintenance. It is estimated that 950 incandescents would be required for the street lighting and 40 arcs. The estimates include provision for a probable demand for 7,500 8 c.p. lamps for private lighting, mains being required in about 12 miles of streets. The high-tension alternating-current system is recommended at 2,000 volt pressure with 200 volt supply for street lighting and 100 volt or 200 volt supply for private consumers. On the subject of water power the report states that a certain amount of this power is available near Penang, but its distance from the centre of the area of supply would render a steam-driven plant more economical. The site for the supply station is placed on the Pinang river which is conveniently near the area to be lighted and has the advantage of water transport for fuel, &c., and a plentiful supply of water for condensing purposes. As refuse destructor plant is to be erected on the adjacent land economies are estimated from the utilisation of the steam power from these works. Mr. Thomas recommends that the station equipment should consist of two 150kw. generating sets, with Lancashire-Galloway tube boilers and steam alternators of the turbine type. Two sets of estimates have been prepared: (A) For public lighting only, amounting to £15,834 (or £105. 11s. per kilowatt capacity); and (C) For public lighting and private supply, £27,450 (or £91. 10s. per kilowatt capacity). In an appendix, Mr. Thomas recommends that a system of "free" wiring should be introduced at Penang, and further recommends to the Municipality the system adopted by Mr. H. Bowden, of the Brompton and Kensington Co., under which installations of six lamps are put in free of cost to the consumer. It is hoped, since the Municipality has passed a unanimous resolution in its favour, and as public sympathy is in support, that a start will be made with the works during 1901. The final decision of the Municipality is likely to be given early in the new year.

**Penistone.**—The joint committee of the Penistone and Thurlstone Councils and the Penistone Guardians have engaged Mr. J. Hamer, Halifax, to report on the question of erecting electricity works.

**Presentation.**—Last week the employés of the Auto Machinery Co. presented their late manager, Mr. William Cannell (who is leaving to take up the position of general works manager of the British Electric Works Co., at Aston) with a dressing case and travelling bag.

**Provisional Order Notices.**—Messrs. A. G. Robson, A. W. Dixon and J. A. Jeckell give notice of intention to apply for a provisional electric lighting order for Whitley and Monkseaton (Northumberland). Similar notices have been given by the Alfreton and Hindley District Councils and by the Roundhay and District Electric Lighting Co. (Ltd.) for Roundhay (Leeds).

**Ryde.**—The Corporation discussed, last week, a report from their Electric Light committee recommending that the consulting engineers (Messrs. Kincaid, Waller and Manville) be instructed to obtain tenders for electricity generating plant. An amendment to refer the matter back was carried chiefly on the ground that the proposed expenditure of £30,000 to £35,000 was excessive.

**Saltburn.**—The Council have offered £8,000 for the electricity works of the Cleveland and South Durham Assets Co.

**Scarborough.**—The New General Traction Co. are about to apply for powers to construct electric tramways in this town, and plans and particulars have been submitted to the Corporation. It is proposed to construct 12 miles of track at an estimated cost of £120,000. The company wish to obtain a concession for 50 years, but the Corporation are to have power to purchase at 20 years.

**Sheffield.**—The report has been issued of the chief engineer and manager of the Electric Lighting Department (Mr. S. E. Fedden) on his recent visit to the Continent to gather information as to the most recent practice in single and polyphase machinery. Mr. Fedden was unable to obtain permission to inspect the large new station

on the Seine, about 6 miles below Paris, which has already 12,000 H.P. of polyphase machinery installed, working at 3,500 volts. He, however, saw a large number of very fine engines and alternators at the Paris Exhibition, more especially in the German section. The report states that the Germans had made a great advance in all electrical machinery during the past few years, and, as a rule, the design of the five large representative manufacturing firms exhibiting was very similar. It was also similar to American practice, but the finish of the work of the German machinery was far superior to that of the American. He saw polyphase motors at work for all purposes, from ¼ H.P. up to 135 H.P. Alternating motors were working spinning and printing machinery, cranes, elevators, and the moving staircases; and, in fact, almost everything imaginable where clean and easily-accessible power might be required. One 125 B.H.P. polyphase motor, belted to the centrifugal pump for supplying the water to all the fountains round the Trocadero building, was working under most exceptionally trying conditions, on account of the wet place in which it was erected, but he was informed that it ran steadily almost day and night, and no trouble had been experienced on account of the high voltage (3,500) or otherwise. A new liquid air machine was being worked by an electric motor. There were a few single phase motors working, but the proportion was small compared with the polyphase. After referring to some of the steam alternators exhibited by German and French firms, Mr. Fedden states that the ruling periodicity is 50 per second. The alternators were insulated for any voltage that might be required and were coupled direct to the engines. The speeds were all low, varying from 80 to 125 revs. per min. The largest polyphase alternator on exhibit was one of 3,000 kw. by the Allgemeine Elektricitats Gesellschaft. Reference is next made to the exhibit of the Nernst Lamp Co., to the general illumination at the Exhibition, and to the "Bremer" arc lamp. Mr. Fedden says: "The reason why this lamp gives so much more light than our present arc lamps is that the arc itself furnishes considerable light, and so makes a more even distribution of illumination, whereas in the present ordinary lamps most of the illumination comes from the glowing carbons. I have considerable hopes of this lamp, and trust that it will be placed upon the market in a practical form in time to be considered when the question of the arc lighting of the streets of Sheffield is gone into." Mr. Fedden visited the Paris Municipal Buildings, which are most lavishly decorated, and there observed that the incandescent gas lighting, which had been installed on a very elaborate scale, was being replaced by the electric light.

At Strassburg, the first thing he noticed was a polyphase motor working in the pouring rain, without a cover of any sort over it. It was down by the river side, screening builders' sand and gravel. He ascertained that it was not unusual to use those motors wherever they might be required, either on new buildings for working mortar mills or for lifting the material to practically any height. The man in charge simply knew how to switch it on and off at meal times and otherwise took no notice of it. The polyphase plant at the generating station at Strassburg consisted of 4 900kw., 1 265kw., and 2 280kw. steam alternators, giving current at 3,000 volts; 2 600kw. and 2 300kw. continuous current steam dynamos, generating current for the tramways at 500 volts; 2 200 and 1 400 ampere polyphase motor driven exciters, and 1 200 ampere steam engine exciter. A large battery of accumulators was also installed as a stand by for the tramways, and also for exciting the alternators in case of the breakdown of the mechanical exciters. Compressed air was laid on throughout the station for cleaning the running machinery, and the Westinghouse air compressor was run by a motor. Many hundreds of motors from ½ H.P. to 100 H.P. were also being run off the mains, one factory alone taking 300 H.P. from 6 a.m. to 6 p.m. The capital expenditure at Strassburg worked out at about £92 per kilowatt installed against about £150 in Sheffield. Coal was very expensive, and the cost per unit, notwithstanding the advantage of the heavy day-load factor, came out at 1·43d.

At Nuremburg Mr. Fedden spent several hours in the Schuckert Company's factory, where 8,000 men are employed. An excellent opportunity was here afforded of comparing the continuous and alternating systems side by side, and Mr. Fedden considers there was very little to choose between the adaptability and working of the two methods, except that the alternating current motors could stand very much more rough usage, and did not require so much looking after as those run by continuous current. Portable tools, worked by motors, were carried about the shops to all heavy work, instead of moving heavy work to the tools. He saw much two-phase machinery in the course of construction, and took special interest in a large generator, to work direct with 20,000 volts, for a power transmission scheme.

At Mannheim Mr. Fedden visited the recently erected works of Brown, Boveri & Co. There was no steam power at these works. The result was that everything was spotlessly clean. All power was obtained from the town's electricity mains. Overhead travelling cranes were driven by polyphase motors, also all shaftings on which tools were grouped, and, in addition, all isolated machines on which it was advisable to couple a motor direct. The 20 H.P. and 30 H.P. motors were just bolted to the side columns or roofs of the shops, and from here they were belted to the shafting. They therefore took up no floor space and, on account of their requiring so little attention, it was possible to put them quite out of reach. These motors started up on full load without any sparking on the collector rings or on the starting resistance. One speciality of the firm's manufacture was that, after starting the motors, the collector rings were short circuited and the brush was lifted. For some years past Mr. Feddon had been asked by manufacturers who use steam hammers when it would be practicable to actuate hammers of this class by electric power, and prior to his visit to these works he was unable to answer the question. He now had actually seen such hammers working by electricity. The hammer itself was worked by compressed air, and on to the compressor was geared a polyphase motor, which was not started up until the man was ready to start using the hammer. When the latter was required the man simply walked over and put on the switch, and by the time he got back to the fire and got out the metal, everything was ready to start hammering. He was told much finer adjustments were obtained with the hammer than were obtainable when working by steam. Polyphase motors were being turned out wholesale, of all sizes. Mr. Fedden saw a large order for small motors being executed for spinning machines.

At Frankfort Mr. Fedden visited the town electricity works. The system is single phase alternating current. The capacity of the station is 9,000 H.P. Besides lighting there is power distribution of about 4,000 H.P. by means of single phase motors from ½ H.P. to 100 H.P. The voltage in the primary mains is 3,000, and there are 3 130 H.P. induction motors taking their current at 3,000 volts at the city pumping station. The works also provide power for the Frankfort tramways. It was converted from alternating to continuous current by motor generators at a converter station of 4,700 H.P. capacity and there were at present installed 3 750 H.P. motor generators, all of which were made up of high-tension single-phase alternating current motors, direct coupled to the continuous-current dynamos which supply current for the large tramway system in Frankfort. The efficiency of these motor generators was 90 per cent.

At Cologne (next visited) the works of the Helios Company were taken. Here Mr. Fedden saw a number of polyphase generators and motors being constructed for all voltages. All the machinery at the works, including the travelling cranes, was worked by motors of this type. The majority of new works put in hand was polyphase. For the Cologne electricity supply there is a project on foot for building a large polyphase station outside the city, to convey the current to sub-stations, to be there transformed to continuous current by rotary convertors for the tramways, and by static transformers for helping the present supply stations which will shortly be loaded up. The two existing Cologne stations are unable to run in parallel on account of the different wave forms of the alternators, one station being held as reserve in case of breakdown at the other.

In conclusion, Mr. Fedden reports that throughout Germany he found that a very large number of small villages, from about 300 inhabitants upwards, were supplied with electric light. All the goods yards at the railway stations were brilliantly lighted by arc lamps. The cattle markets and nearly all the principal markets were similarly lighted, and in many towns where gas was used in the streets he found, on inquiry, that they were only waiting for the concessions to expire in order to carry out the street lighting by arc lamps. The employment of high pressure alternating currents, preferably of the polyphase type, had given a tremendous impetus to the growth of electrical undertakings for the transmission of power over large areas. Alternating current was successfully generated and transmitted at high voltages without the use of step up transformers, as had been usual in American practice. Alternating current was now employed for work which a short time ago was considered to be totally impossible. Polyphase machinery was long-lived on account of the simple and solid construction of the type of generators and motors. Owing to the great development of high-tension alternating current the switching and controlling gear had been completely remodelled and greatly improved within the last few years, in order to meet the severe demands made upon it, without risk of breakdown or danger to attendants. Polyphase motors will, he thinks, in particular, be used in preference to continuous current in mines and foundries, and other places of similar description, on account of the rough treatment and heavy duty which they can withstand, and also because no skilled attendance is required. Polyphase motors were now being used on the Continent for driving jib cranes, travelling cranes, traverses, rolling mills, turntables, plunger pumps, rotary pumps, centrifugal machines, lifts and elevators. They were also adapted to all kinds of ventilators, ring spinning frames, weaving looms, and, in fact, almost every type of machinery. Polyphase traction was now being used on the Continent for a number of mountain railroads, and Mr. Fedden quite expects that within a few years it will become general for light railway work. He made numerous inquiries at the different factories he visited with regard to the use of two and three-phase current, and was informed that they were practically the same as regards efficiency, duty and starting torque. The only apparent benefit of three phase over two-phase was in the saving of copper in the mains for long distance transmission. This was not material in Sheffield, as they already had many miles of mains laid which could not be suitably converted to the uses of three-phase, but which could be converted to two-phase. Electricity works of the later construction are designed and built sufficiently capacious for the reception of machinery that may be required for some years to come, although this placed a rather heavy burden on the starting of a new undertaking. Mr. Fedden was also much struck with the comprehensive way in which those undertakings were generally organised and carried out, and, although he was loth to say so he confessed that in the matter of central station practice generally they had many lessons to learn from the Continent. The result of his visit convinced him that his late report as to the future system of supply for Sheffield was based on the right lines, and he had every confidence in proceeding with the work of changing over the present monophase system to polyphase. Further he had every reason to be satisfied that he was conforming to the latest up to date practice in laying down a new polyphase power station and converting the old one.

It will be seen that Mr. Fedden's report contains much that is both novel and interesting, and he appears to have made good use of the time and opportunities at his disposal.

**Southport.**—The Council have decided to increase the salary of the borough electrical engineer (Mr. C. D. Taite) from £300 to £400 per annum, with annual increments of £50 for two years.

**Southwold.**—The Coast Development Co. have, it is stated, informed the Council that they are unable to carry out their proposal to establish electricity works. Plant has been put down for lighting the Company's new hotel and pier, but current is not generally available. The Lighting committee has been requested to report.

**Telegraphic Communication with the French Congo.**—The telegraph has been completed from Brazzaville to Libreville on the French Congo, bringing the district of Stanleypool into direct communication with Europe.

**Telephone Trunk Line Delays.**—The National Telephone Co. has notified its subscribers of an intimation from the Post Office that a minimum of 20 minutes must always elapse before any reply can be expected by a subscriber as to whether he can get through to the town on the trunk service with which he wishes to communicate. The delay is attributed to an insufficiency of trunk lines and a paucity of operators.

**Theatre Exits.**—Prince A. T. Dshavachoff, a Russian engineer, is stated to have invented an electrical device by which the opening of the extra exit doors at theatres and other places of entertainment can be manipulated from the stage. This device is said to have been applied for the first time at the newly-constructed National Theatre in the Alexander Park, St. Petersburg.

**Tramway Extensions in the Potteries.**—The Potteries Electric Traction Co. have decided to apply for powers to extend their system in the North Staffordshire district by the construction of a line from Stoke-on-Trent through Hartshill to Newcastle-under-Lyme. Another line will be constructed from Trent Vale to Newcastle, and other lines will serve the districts between the centre of the town and Far Green, Hanley, and also the centre of Hanley and Bucknall. Further extensions are under consideration.

**Trowbridge.**—The Council considered Mr. Stevenson's report on the electric lighting question on Monday, and decided to apply for a provisional order.

**Walsall.**—The Council have received sanction to a further loan of £5,678, balance of £15,000 recently applied for to meet the expenditure on the Pleck electricity extension, &c.

**West Bromwich.**—An arrangement has been come to by which the Corporation will lease the tramways, when acquired, to the South Staffordshire Tramways (Lessee) Co. for 21 years, to be extended to 30 years if Parliamentary sanction be obtained. The Corporation are to reconstruct the tramways and equip them electrically, the company taking current from the Corporation.

**West Yorks Electric Power Scheme.**—A company entitled the Yorkshire Electric Power Syndicate (Ltd.) has been formed to obtain Parliamentary powers to supply electricity in bulk in West Yorkshire. The portion of the West Riding included in the scheme is that lying south of the rivers Wharfe and Ouse, and the turnpike-road from Bolton Bridge through Elsack and Skipton to Foulridge on the Lancashire boundary. The area is about 1,800 square miles, with a population of about 2½ millions. It contains 17 municipal and county boroughs, 119 urban districts and 22 rural districts, including Leeds, Bradford, Keighley, Halifax, Todmorden, Brighouse, Huddersfield, Dewsbury, Batley, Morley, Pudsey, Wakefield, Ossett, Barnsley, Sheffield, Rotherham, Doncaster, Pontefract, Goole, &c. Mr. A. G. Lupton, Leeds, is chairman of the directors, and has as colleagues on the board Mr. R. Armitage, Sheffield; Mr. A. C. Briggs, Normanton; Mr. Crowther, Huddersfield; Mr. R. Hudson and Mr. C. L. Mason, Leeds; and Mr. F. Priestman, Bradford. Of the 158 local authorities included in the area, only 11 have electricity works, three have works in progress, and in 18 cases, though provisional orders have been secured, no further steps have been taken towards carrying out the powers. There are to be four main generating stations, each serving an area of some 16 miles in diameter. Though the sites of the stations are not yet definitely decided upon, they will probably be located in the vicinity of Rotherham, Methley, and Mirfield in the colliery area, and at Bingley in the manufacturing area. The proposed minimum capital of the new company is £3,000,000, with power to issue debentures for £1,000,000. The engineers to the syndicate are Messrs. Gibbings and Baker, and Messrs. W. T. Pressland and John Sturgeon, who promoted the successful Lancashire scheme of last session.

**Workhouse Lighting.**—Christchurch (Hants.) Guardians have received a communication from the Local Government Board, enclosing a copy of an extract from a report made by their architect (Mr. G. Smith) with reference to the proposed electric lighting installation at the workhouse and cottage homes. Mr. Smith considers the undertaking a large one for a workhouse such as that at Christchurch, and regrets that the Guardians do not propose to obtain electric current from some public supply. The consulting engineer (Mr. G. R. Peers) has been asked to report.

The Stowe Guardians have decided to adopt electric lighting at their children's home.

In a report to the Kensington (London) Guardians Prof. H. Robinson states that both for economy and convenience the Guardians would be well advised to generate their own electricity for the lighting of the workhouse, infirmary, and offices in Marloes-road.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Bermondsey* (London) Vestry invite tenders for the supply and erection of 71 cast-iron arc lamp columns, arc and incandescent lamps, automatic switches and fittings. Further particulars are set out in an advertisement, and specifications may be obtained at the Town Hall, Spa-road, Bermondsey. Specifications can also be inspected, but not obtained, at the offices of the consulting engineers (Messrs. Kincaid Waller, and Manville), 29, Great George-street, Westminster. Tenders must be sent to Mr. F. Ryall, solicitor and vestry clerk, Town Hall, Bermondsey, before noon of Dec. 3.

*Cardiff* Corporation require tenders for a 75kw. motor generator and Tudor storage battery, lead-covered cables and a 20-ton travelling crane. Specifications may be obtained after 12th inst. from the engineer (Mr. Arthur Ellis), Old Post Office-buildings. Tenders must be delivered to the town clerk (Mr. J. L. Wheatley) before 28th inst. An advertisement gives further particulars.

*Hendon* Urban District Council invite tenders for the supply and erection of generating plant and apparatus as set out in Sections A to I in an advertisement elsewhere. Specifications, &c., can be obtained by manufacturers at the offices of Mr. Robt. Hammond, consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W., on and after Monday next, and tenders must be addressed to Mr. Henry Humphris, clerk to the Council, Public Offices, The Burroughs, Hendon, by 4 p.m. of Dec. 31.

*Oldham* Electricity Committee invite tenders for an extension of the tramway switchboard. Specification may be obtained from Mr. A. Andrew, Gas and Water offices, Oldham, and further particulars are given in an advertisement. Specifications and drawings can also be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W., and tenders must be addressed to Mr. Andrew, before Tuesday, 27th inst.

Offers are invited by the *Dorking* Urban District Council for the purchase and transfer of their provisional order. Brief particulars are given in an advertisement, and offers have to be sent in to Mr. George Scales, 35, High-street, Dorking, by Nov. 21.

*Shoreditch* (London) Vestry invite tenders for steam feed, blow-off and drain pipes, feed-pump and water storage tank and sundry iron work; two slow-speed Corliss engines, direct-connected current generators (output about 800kw. each set), condensing apparatus, pipes and sundry iron work. Tenders to Dr. H. Mansfield Robinson, Town Hall, Old street, E.C., before noon, Nov. 20.

*Newcastle-upon-Tyne* New Tramways committee invite tenders for arc lamps and accessories. Tenders (addressed to committee) must be left at office of town clerk by 21st inst.

*Newcastle-on Tyne* New Tramways committee also invite tenders for arc lamp cables, telephone and pilot wires. Tenders (addressed to committee) must be left at office of town clerk by 21st inst.

*Belfast* Gas and Electric committee invite tenders for steam pipes, pumps, &c., condensing plant, boilers, mechanical stokers and superheaters, coal and ash-conveying plant, and switchboard extensions. Tenders to town clerk by noon Nov. 23.

*Standard Life Assurance Co.* require tenders for wiring their new premises at Leeds. Applications to Mr. A. Neill, 18, Cookridge-street, Leeds, or Mr. A. A. C. Swinton, 66, Victoria-street, London, S.W.

*Brighton* Corporation invite tenders for points and crossings, sole plates, manhole covers, tie bars, fish bolts, &c. Tenders by Dec. 6.

*Brighton* Corporation also require tenders for the construction of the permanent way of their electric tramways. Tenders by Dec 13.

*Cheshire Lines Committee* invite tenders for stores for 1901, including telegraph materials, instruments, wire, &c. Tenders to secretary, Central Station, Liverpool, by 30th inst.

*Greenwich* Guardians require tenders for an electric lighting installation at their new workhouse, Grove Park, S.E. Tenders to the Union Offices, East Greenwich, S.E., before 22nd inst.

*Salford* Tramways committee require tenders for erecting an electric car depôt and workshops. Tenders by 30th inst.

*Bristol* Electrical committee invite tenders for an electric travelling crane and condensing plant. Tenders to engineer (Mr. H. Faraday Proctor), by noon, 22nd inst.

Tenders are invited for lead covered, concentric cable, cast-iron conduit and watertight junction boxes for District Asylum, *Mullingar* (Ireland). Tenders to joint committee of management, before Dec. 1.

The joint committee of the Metropolitan and Metropolitan District Railway Companies (London) invite tenders for the electrical equipment of the Inner Circle Railway. Tenders by Dec. 1.

*Stockport* Tramways committee invite tenders for overhead equipment and rail bonds, steel rails, fish plates, &c , laying permanent way. Tenders by 24th inst.

*Glasgow* Corporation require tenders for the construction of sumps for the condensing-water system for the Pinxton power station. Tenders by 17th inst.

Tenders are required for hiring plant for the electric lighting of the State Apartments, *Dublin* Castle, during the next season. Tenders to Secretary, Board of Public Works, Dublin, by 27th inst.

*Kendal* Corporation invite tenders for electricity generating plant, &c. Tenders to town clerk's office by Dec. 8.

*Londonderry* Corporation require tenders for the supply of carbons for one year from Jan. 1 next. Tenders to town clerk by Dec. 1.

*Leeds* Lighting committee require tenders for extensions of the electricity station buildings, Whitehall-road. Tenders by 27th inst.

*Halifax* Corporation require 36 tramcars, trucks, motors and electrical equipments. Tenders by 27th inst.

*Cuevas* (Almeria, Spain) Municipal Council invite tenders for the electric lighting concession for 20 years. Tenders to el secretario del Ayuntamiento by 30th inst.

The municipal authorities of *Nimegen* (Holland) are inviting tenders for the construction of a system of electric tramways in the town.

Tenders are invited for a concession for the electric lighting at *Chinchilla* (Spain) for 20 years, 130 10-c.p. lamps will be required for public lighting in the first year, to be afterwards increased to 250.

Proposals are invited for a concession for the construction of electric tramways at *Santander* (Spain). Applications by Dec. 10, to Provincial Government, Santander, or the Minister of Agriculture, Madrid.

## TENDERS RECEIVED AND ACCEPTED.

Bradford Corporation have accepted the tender of Messrs. Newton, Bean and Mitchell for the supply and erection of engine and dynamo complete, with all the necessary steam and exhaust piping, drain pipes, valves, &c., for the Southfield-lane destructor works. The tender of Messrs. Collinson Bros. has been accepted for the supply and erection of a switchboard, arc lamp posts, arc lamps, incandescent lamps, instruments, and the supply and running of the necessary cables.

Aberdeen Corporation have accepted the tender of the British Westinghouse Company for 12 electric tramcars, and equipment for six horse cars, spares are being placed meantime by the Corporation.

Ayr Corporation have accepted the tender of the Lorain Steel Co. for the supply of steel rails, fish-plates, bolts and nuts, tie-bars, &c., for their electric tramways at £6,104.

Worthing Town Council have accepted the tender of Messrs. Oliver & Co. for arc lamps and switches, at £850. 17s.

## BUSINESS NOTICES.

Mr. C. A. Baker, M.I.E.E., has entered into partnership with Mr. A. H. Gibbings, and in future the firm will practise under the title of Gibbings and Baker. Mr. Gibbings, in notifying this partnership, states that he has found it necessary on account of the rapid development of his business. Mr. Baker has recently returned from Russia, where he has been responsible for the carrying out of a large contract at St. Petersburg, consisting of a complete system of distribution for electric light and power equivalent to 10,000 H.P. Mr. Baker prepared the plans and specifications for the installation, and advised generally on all points connected with the electrical equipment of the undertaking. This contract and several others were supervised by Mr. Baker on behalf of the Telegraph Manufacturing Co. Mr. Baker, whose connection with the electrical industry extends over 15 years, is also well known in London and the provinces.

Messrs. R. F. Read and A. A. Jenkins (trading as Read and Jenkins), electrical and mechanical engineers, All Saint's Chambers, High-street, Bristol, and Gloucester and Hereford, have dissolved partnership. Debts by Mr. Jenkins.

Messrs. J. C. Lyell & Co. notify they are now connected to the National Company's metropolitan telephone system. No. 2469 Gerrard.

Messrs. A. Vandam & Co. have removed to 15, Gerrard-street, Soho, London, W.

On and after Christmas Day the addresses of Telautograph Co. and of Mr. Hubert Feilden Jackson, will be 19, New Union-street, Moorgate-street, London, E.C.

The British Schuckert Co. have opened a branch office at Cleveland-buildings, 94, Market-street, Manchester, to be under the management of Mr. Frank Sinclair, who will in future represent the company in Lancashire, Cheshire, Westmorland and Cumberland.

## BANKRUPTCIES, LIQUIDATIONS, &c.

At the Burnley Bankruptcy Court last week the examination was resumed of Robert Foster (Nelson) and Walter Baker (Burnley), electrical engineers' and plumbers' merchants, trading under the style of Robert Foster & Co., and also at Nelson, under the style of the Nelson Electrical Engineering Co.

In reply to the Official Receiver, Foster admitted that on the first examination he said that no statement was made out showing how the business stood when he took Baker into partnership. There was, however, a rough statement made by himself, assisted by a Mr. Buckley, but there was no later statement. He knew the business was insolvent when he took Baker into partnership. There was a loss of £43 per week between August and January. Can you suggest where it has gone?—No answer. What was your turn over?—Between £3,000 and £4,000 per year. He said Baker was with him five years in Nelson and Burnley, and had had access to the books at both places. Walter Baker said he had been in partnership with Foster. He did not know how the business stood in July last. No balance sheet was shown to him, and he was told that the firm was worth £1,000. He got a receipt to that effect. Foster had had the principal management of the works—the buying and selling, and he had been the manual worker. Seven or eight months after he became a partner he heard derogatory remarks about the business. Since August, 1899, he had been trying to withdraw. His father was guarantor for £400 or £500.

An order was made for the production of trading accounts from Jan. 1, 1899, and of a bought and sold account, and a further deficiency account, and the examination was then adjourned for their production.

At Wandsworth (London) County Court last week the public examination took place of Cornelius Bennett Harness, of electric belt fame. The total liabilities were stated to be about £7,500 and assets nil. Debtor attributed his insolvency to liability in respect of a guarantee given in connection with the reconstruction of the Medical Battery Co. (Ltd.) and to law costs. He told the Official Receiver that the business of the company which he originated 20 years ago was carried on most successfully till November, 1892, and from 1899 to 1892 a profit of over £15,000 was made. Litigation had entirely ruined the business. The examination was adjourned to 22nd inst.

The liquidator of the Chitty Dynamo and Motor Co. (Ltd.), (Mr. G. S. Barnes) has been released.

---

**Sales by Auction.**—Messrs. Wheatley Kirk, Price & Co. announce in our advertisement columns the sale by auction on Wednesday, Dec. 5, at 10 for 11 o'clock, of the important freehold land and works lately occupied by the Aluminium Co. (Ltd.) at Oldbury, near Birmingham. Details of the extent of the land and the modern character of the works are given in the advertisement, and further particulars, plans and conditions of sale will shortly be obtainable of the auctioneers, 46, Watling-street, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester, or of Messrs. Baker, Blaker and Hawes, solicitors, 117, Cannon-street, London.

Messrs. Wheatley Kirk, Price & Co. will also sell by auction on the same day and at the same time the valuable electric light and power plant installed at the above works. Some particulars of this plant are given on another page, and the attention of municipal corporations, electrical contractors and others is especially called to the importance of this collection of high-class machinery and apparatus. Catalogues will shortly be ready, and these and all further particulars can be obtained of the auctioneers and solicitors as above.

**Plant for Sale.**—An advertisement contains particulars of electric lighting plant—consisting of a 3 H.P. Priestman oil engine, dynamo and spare parts, accumulators, &c.—which is for sale. Applications to Mr. G. Jármay, Hartford, Cheshire.

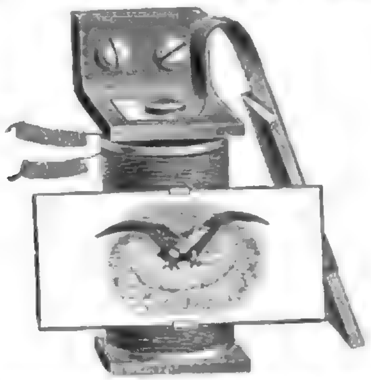
Messrs. C. D. Perkins & Co., 9, Bennett's-hill, Birmingham, in an advertisement, offer some first-class plant, machinery, tools, &c., of an old-established engineering business for disposal at valuation only.

**Business, &c., for Disposal.**—An advertisement contains particulars of an old-established business of an electrical engineer in the south-west of London which, together with the stock-in-trade, machinery and plant (nearly new), shop fixtures, fittings, &c., are for disposal. Mr. H. W. Smith, 7, Featherstone-buildings, Bedford-row, London, W.C., is agent in this matter.

**B.T.H. Plant.**—Magnetic blow-out automatic circuit breakers are illustrated and described in pamphlet No. 77 issued by the British Thomson-Houston Co. In pamphlet No. 78 Thomson horizontal edgewise instruments are described.

**Westinghouse Plant.**—The Westinghouse 12A tramway motor is described and illustrated in circular No. 1,035 issued by the British Westinghouse Co. Sectional drawings of the machine are shown.

**New Pendulum Indicator.**—Messrs. Julius Sax & Co., Eagle Works, Coldharbour-lane, Camberwell, London, have recently placed on the market a new patent pendulum indicator, for which it is claimed that the method of making the connections inside the case is novel. Hitherto the bell has been put in series, this movement requiring large battery power. In the new indicator the current goes through the indicator bobbins, only exerting its full force on the armature, which, when contracted, closes a local circuit for the bell by means of a rubbing contact spring. The movement has two bells, and the spring is so arranged that there is an entirely closed magnetic circuit. Only small battery power is required, or with ordinary power a more decided saving and a louder ringing off is



Movement of New Patent Pendulum Indicator.

effected. The pendulum swings for two minutes, and every part of it is rigid. A large stock of these indicators, made at the company's London works, is ready for immediate delivery.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 7 to Nov. 13, with the ports of destination:—

*Africa*—Cape Town, £326; Durban, £191. *Australasia*—Auckland, £279; Melbourne, £1,028; Otago, £57; Sydney, £172. *Belgium*—Ostend, £209. *Brazil*—Rio Janeiro, £1,352 (including £1,147 telegraph material). *Canada*—Halifax, £13,877 (telegraph cable). *Chili*—Valparaiso, £66. *Colombia*—Santos, £35 (telegraph material). *Germany*—Hamburg, £400 (telegraph material). *Gibraltar*—£29. *India*—Bombay, £383; Calcutta, £1,562. *Italy*—Genoa, £40. *Japan*—Hiogo, £770 (telegraph cable); Yokohama, £10,436 (including £7,586 telegraph cable). *Spain*—Barcelona, £25. *Straits Settlements*—Singapore, £208. *Uruguay*—Monte Video, £165,723 (telegraph material). *West Indies*—Trinidad, £7. Total £197,175, against £71,320 in the corresponding week last year (Nov. 8 to Nov. 14).

## COMPANIES' MEETINGS AND REPORTS.

### West India and Panama Telegraph Co. (Ltd.).

The forty-seventh ordinary general meeting of the members of this Company was held on Wednesday, under the presidency of Mr. William Andrews.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, I do not propose to-day to go into any details or to detain you with the accounts. The expenses show an increase of £240. There are decreases on general account—salaries of staff, London expenses, &c.—of £1,043; but these decreases are converted into an increase in consequence of the repairs to cables and land lines having cost £1,282 more, being the difference of the £240 on the wrong side of the account. The receipts were £27,737 against £30,929, or a decrease of £3,191. Of this amount the traffic receipts account for £1,233, the subsidies for £984, and exchange for £453. I do not propose to go into anything further with respect to the accounts. The most important matter really is to consider the policy of the Company, and what has taken place in recent times. The shareholders have had the correspondence that has been exchanged by the Company with the Colonial Office. The Directors have thought that the Company was entitled to more consideration from the Government than the Government appears to have been inclined to show. We proved that the present unsatisfactory position of the Company was brought about by the introduction of a competing line for traffic to and from Jamaica and the West Indies generally, but landing at Jamaica. This cable was worked at artificially low rates, which were only made possible by a Government subsidy. The tariff for messages by this new line was actually fixed by the Parliament of this country, and since the Spanish-American war, when traffic has assumed normal dimensions, the traffic of these competing lines only produces just half the amount of the revenue, the other half consisting of the Government subsidies. Without the assistance of the latter these companies could not pay out of message revenues their statutory debenture redemption obligations, nor sinking funds, nor dividends. This proves, therefore, that the original stimulated demand for lower tariffs for West Indian telegraphic communications, however desirable, was not practicable, because of the paucity of the business. It also proves—I am rather anxious to show this—that the introduction of the low rate for telegrams between Jamaica and Europe was not the natural result of fair competition by any company, but was originated by Parliament, and rendered possible only because based on the subsidies given by the Government. It was, consequently, a Government reduction, and not a company reduction; but as a consequence, the outcry throughout the West Indies for further reductions between Jamaica and this Company's stations along the Company's own line became so great, and this Company was so strongly urged to assist West India commerce, and promises of other support to West India interests were so encouraging, that, with the hope of helping this latter, and assisting to establish a new order of things of a more encouraging nature, the Company did make large reductions. Well, you all of you know that the support that was supposed to be forthcoming at that date did not come into operation, and that the business appeared to go from bad to worse. It did not increase at all, and the result therefore of these reductions, contrary to what might have been anticipated, was simply disappointing. The shareholders are acquainted, of course, as I said before, with the correspondence between the Company and the Colonial Office. The Directors did think that the Company would have been met in a fair, if not a liberal spirit. The object of the aid solicited from the Imperial Government was really, and in practical effect, aid to the West Indies, because it was to enable the low rates introduced over the Company's own line to be maintained and continued for the benefit of the commerce of the West Indies, although, of course, it would also have benefited the Company. Gentlemen, much has been made of a proposal to establish an all-British cable between Jamaica and the other British West India Islands. An all-British cable, we know, is a popular sort of cry, however much or however little meaning there may be in it; but this Company has already drawn the attention of the Government to the fact that, with its duplicated cables, the Company is in a position to give the Government an all-British cable, embracing Demerara as well as all the other British West India Islands and Jamaica, while preserving communication by a separate cable or cables with all the other West India Islands now connected up by the telegraph. This can be accomplished with the utmost attainable economy by this Company only, with assured stability of communications, with cables already laid, and on the spot, provided with a repairing ship, and forming duplicate lines—in fact, a complete duplicated established telegraph system, which has been proved by many years of work. We are pleased to see—no doubt, in large part resulting from the policy of the Colonial Office—that prospects are held out of a revival in West India trade and commerce. New lines of steamers are being established, new applications of machinery, new agricultural industries are being fostered, and sugar, which is one of the big touchstones of the West Indies, is on the upward grade. We think that our telegraphic communication is not without its importance to the prosperity of the West Indies. The Directors feel that this is not quite the moment to raise the rates. Just as trade appears to be budding, and likely to blossom and bear fruit, it does not seem quite the time to nip these buds by the frosty influence of increased charges for telegrams. What we feel inclined to do is to urge the shareholders to hold their ground for the present in the situation in which we are placed, and to allow the Board to be guided by circumstances. The Directors will do their best in all directions with prudence and circumspection for the shareholders' benefit. We must try all round and see if some means cannot be devised of obtaining aid and reconciling conflicting interests, so as to produce an arrangement beneficial to all the properties engaged in the service. As you are aware from the report, the Directors again recommend on this occasion that the cumulative dividends be paid, and that a dividend of 6d. a share, free of income-tax, be paid on the ordinary shares, and that the sum of £6,000 be transferred from the reserve account and be devoted to this purpose, leaving £953 to be carried forward. This will still leave the value of the investments to which we have drawn your attention better than their cost as shown in the accounts, owing to the judicious character of the stocks chosen for the purpose. I now move the adoption of the report and accounts, and the payment of the dividends set out therein.

Mr. HENRY HOLMES seconded the motion.

The CHAIRMAN: We have received about five letters with respect to the proposals of the Directors and the general policy. Four of the writers approve of the general policy, and think that we are going in the right direction. One of them, from a debenture holder, objects to our paying a dividend out of the reserve, and another, from a preference shareholder, objects to our paying 6d. to the ordinary shareholders. With respect, however, to the preference shareholders and the ordinary shareholders, they are, of course, both on the same platform—they are both equally the owners of the reserve account—and we have thought that it would be rather an improper thing to take the preference dividend out of the reserve and not to give the ordinary shareholders the benefit of the same operation. Both the ordinary and the preference shareholders are equally entitled to it, and the reserve is equally their property.

Mr. VARLEY said that the shareholders were much indebted to the Directors for circulating the correspondence with the Colonial Office. When they last met it was at a critical time, and now they were in a crisis in their affairs. The answer they had received meant that unless there was a change in the position, the dividend hereafter would disappear not only on the ordinary shares, but on the preference shares also. This was the most unfortunate outcome of the subsidy which had been given to a rival company. The evil of giving subsidies to competing concerns was a growing one, as they saw at the present time

in the case of the National Telephone Co., to compete with which £2,000,000 of public money was now being employed. He suggested that Mr. Chamberlain should be again approached with a memorial from the shareholders, showing him clearly that it was owing to the subsidies which had been granted to their rivals that this Company had been brought to their knees.

Mr. VEARES said he felt certain if the shareholders held on, as the Chairman had advised them to do, they would be all right in the end. He firmly believed in the strict integrity of the Board.

Mr. BIRKS said he thought their troubles were attributable not so much to the loss of subsidy or to the competition of the new companies as from their dreadful agreement with the Cuba Submarine Telegraph Co. The Chairman would tell them that while this question was before the Court of Appeal it could not be discussed, but he did respectfully suggest that it was looking in the wrong direction for the source of their troubles when they referred to competition, which had only existed for a couple of years. The appalling agreement with the Cuba Company held them by the throat. Judging from the correspondence with the Colonial Office it seemed to him that they would get nothing from the Government.

The CHAIRMAN said he thought it should be their policy to endeavour to obtain something from the Treasury if they could.

Mr. VARLEY : We are going to expect something—justice.

The CHAIRMAN : I think so, too.

A discussion ensued on the question of paying off the 5 per cent. debentures of the Company, and depleting the reserve for this purpose, but the feeling of the meeting was against this course.

The CHAIRMAN : Several remarks have been made by shareholders as to approaching the Government, the question of the subsidies, and the question of the rates. Well, we have gone through all these points, I think. In our memorial to the Colonial Office we showed that if they did grant the subsidy we asked for, it would be the means of maintaining the low rates; in fact, that is the big groundwork of the application. There was another point—we were ready to let the Government and the Colonial Governments send messages free over our lines. There was give and take in both directions. Mr. Birks suggested calling a meeting of the shareholders later on, but I do not think that would be a wise proceeding. I think you must leave the matter to us, and if we do not do the thing to your satisfaction you must turn us out. He then put the resolution for the adoption of the report and the payment of the dividends mentioned, and declared it carried unanimously.

A cordial vote of thanks to the Chairman and Directors terminated the proceedings.

## Cape Electric Tramways (Ltd.).

A meeting of shareholders of this company was held on Wednesday, Sir CHARLES EUAN-SMITH, K.C.B., C.S.I., in the chair.

The SECRETARY (Mr. S. W. Jameson) read the notice convening the meeting, and

The CHAIRMAN said: Gentlemen, the board can again honestly congratulate the shareholders upon the result of the company's operations for the past year. The anticipations of increasing success which were expressed to you last year have been fully justified. We have, after fully providing for all debenture interest, paid 9 per cent. interest on the shareholders' capital against 6½ per cent. in the preceding year. We have carried £20,000 to reserve against £8,000, and we now recommend the payment, as bonus, of a further 3 per cent. on the share capital—absorbing £12,000—and carry £12,000 to next account. When the troublous times in South Africa are taken into consideration this result is extremely satisfactory, and we feel further that in the future we may confidently look forward, with the restoration of peace, to the development of fresh sources of income. Our receipts for the four months since the annual accounts were closed (June 30, 1900) show a steady increase of £14,400 over July, August, September, and October, 1899. On our Cape Town system we have carried over 3,000,000 more passengers than we did in the preceding year, and on the Port Elizabeth system over 400,000 extra. With regard to the action brought against the company by the Eastern Telegraph Co. an appeal against the decision of the judges at Cape Town is now before the House of Lords, and nothing further can be said in regard to this important question. I now move that the report and accounts for the year ended June 30 be received and adopted.

Mr. C. S. REED asked what sum had been set aside for wear and tear of rolling stock.

The CHAIRMAN : We have £28,000 in reserves.

A resolution increasing the capital of the company by the creation of 100,000 additional ordinary shares of £1 each, ranking for dividend and in all other respects with existing ordinary shares of the company, to be issued as the directors may deem fit, was then proposed by the chairman. He explained that the shares would be offered in the first place to existing shareholders pro rata at such a premium as the financial position of the company might, in the opinion of the board, be considered equitable. It was not proposed to issue more than 40,000 shares at present, so that 1 share in 10 would be offered to every existing shareholder on the basis of his present holding. In view of the extensions and improvements which would become inevitable if they were to take full advantage of their opportunities, the directors asked for powers providing for the full increase of the capital. The abnormally heavy strain to which their machinery, rolling stock and permanent way had been subjected during the past year necessitated a good deal of work in keeping it up to the mark. All this, however, would be provided from the reserve fund. There were, however, many more or less considerable extensions of their system that had to be provided for, and their chief engineer (Mr. Fearnside Irvine), had made an exhaustive investigation into their present and future requirements, and it was after due consideration of his report that the directors had decided to ask for additional powers. The fresh capital would be profitably employed. He wished it to be particularly understood that they were now going to offer only 40,000 of the new shares. They did not know whether it would be necessary to issue the remainder, but nothing would be done without the shareholders being consulted.

Mr. REED said that by extending their tramway systems the value of the property in the neighbourhood of their lines would be increased. Would it not therefore be as well to issue the whole 100,000 shares, and invest in some of the adjacent land before other people got to know of the proposed extensions.

The CHAIRMAN said they might trust the directors to keep their eyes open to any advantage of this kind that might offer itself.

The resolution was then seconded, and carried unanimously.

The board of directors were re-elected, and a vote of £1,500, free of income tax, to the directors, in recognition of their services, was approved. The auditors (Messrs. Deloitte, Dever, Griffiths & Co.) were re-appointed, and the proceedings terminated with a vote of thanks to the chairman and directors.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29⅜d. per oz. (Nov. 15). Consols (2¾ per cent.) 98⅞—98⅝ for money, 98⅞—98¾ for account; 2½ per cent. 97½—98 (Nov. 15). Stocks and Shares Continuation Days, Nov. 27 and Dec. 11; Ticket Days, Nov. 28 and Dec. 12; Pay Days, Nov. 29 and Dec. 13; Mining Share Carry-over Days, Nov. 26 and Dec. 10.

**BAKER STREET AND WATERLOO RAILWAY CO.**—Subscriptions have been invited this week for 65,000 4 per cent. preference and 172,500 ordinary shares of £10 each in this company at par. The share capital is £2,885,000 with borrowing powers to the extent of £734,000. Interest is to be paid during construction half yearly, at the rate of 3 per cent. per annum. The line starts from the Elephant and Castle, runs past Waterloo, under the Thames to Charing Cross, Piccadilly-circus, Oxford circus to Baker-street, Marylebone, Edgware-road on to Paddington, the depot and generating station being situate about a quarter of a mile south of Waterloo station. The Baker-street and Waterloo system will be connected with the Chatham and South Eastern, City and South London, South Western, Waterloo and City, District, Central London, Metropolitan, Great Central and Great Western Railway systems. Construction contracts have been entered into to complete the line to the satisfaction of the Board of Trade and the company's engineer for a total sum of £3,096,000 payable as to £2,322,500 in cash or shares, and £773,500 in 4 per cent. debenture stock, the contracting corporation undertaking all risks and contingencies in connection with construction, providing all trial, legal, engineering, administration and other expenses during construction, maintaining the line for one year after opening for public traffic, and paying to the Baker street and Waterloo Railway Co. £50,000 for working capital, thus leaving, out of the authorised capital of the company, a further £83,000 for general purposes. The list closed on Wednesday.

**CORRECTION.**—In a City Note in our last issue a dividend at the rate of 8 per cent. per annum was attributed to the "Telegraph Construction and Maintenance Co. (Ltd.)." This should have read the "Telegraph Manufacturing Co. (Ltd.)."

**COVENTRY GAS FITTINGS, ELECTRICAL AND ENGINEERING CO. (LTD.)**—At a meeting of shareholders on Monday, resolutions were passed in favour of reconstructing the company. It was decided to wind up voluntarily, to appoint Mr. T. M. Daffern liquidator, and to form a new company to be called the New Coventry Gas fittings and Electrical Engineering Co.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation | Nov. 3 | 620 | 120 | 23 | 16,342 | + 2,199 |
| *Birmingham Tramways. | „ 10 | 4,491 | + 77 | 18 | 82,463 | + 3,663 |
| Blackpool Corporation... | „ 8 | 253 | + 90 | 32 | 26,782 | + 7,050 |
| Blackpool and Fleetwood | „ 10 | 170 | - 12 | 19 | 19,256 | + 13 |
| Bolton Corporation ...... | ... | ... | ... | ... | ... | ... |
| Bradford Corporation... | „ 11 | 673 | - 316 | 32 | 16,948 | + 4,129 |
| Brisbane Trams ......... | Sept. 26 | 1,823 | + 356 | 12 | 22,212 | + 4,400 |
| *Bristol Trams & Carriage | Nov. 9 | 2,941 | - 57 | 19 | 64,710 | + 443 |
| *Buenos Ayres & Belgrano | Oct. 14 | 2,242 | + 248 | 15 | 34,237 | + 963 |
| Central London Railway | Nov. 10 | 5,699 | ... | 15 | 76,761 | ... |
| City & South London Ry. | „ 11 | 1,848 | + 766 | 19 | 30,242 | + 11,815 |
| Cork Elec. Trams ......... | „ 8 | 383 | + 8 | 45 | 18,644 | + 1,502 |
| Dover Corporation ...... | „ 10 | 185 | + 13 | 32 | 7,560 | + 415 |
| Dublin & Lucan Rly. | „ 10 | 71 | + 14 | 19 | 1,971 | + 351 |
| Dublin United ............ | „ 9 | 3,539 | + 544 | 19 | 71,690 | + 9700 |
| Dublin Southern Dist.... | „ 9 | 752 | - 41 | 19 | 19,319 | |
| *Dundee Corporation ... | „ 1 | | ... | ... | ... | ... |
| *Glasgow Corporation ... | „ 10 | 9,163 | 303 | ... | ... | ... |
| Hull Corporation ......... | „ 10 | 1,357 | + 690 | 19 | 26,310 | + 13,983 |
| *Liverpool Corporation... | „ 3 | 8,555 | + 1,408 | 44 | 347,757 | + 44,864 |
| Liverpool Overhead Rly. | „ 11 | 1,541 | 143 | 19 | 31,996 | + 635 |
| *Sheffield Tramways ...... | „ 11 | 3,608 | + 751 | 45 | 101,537 | + 35,481 |

* Partly electrical.

**EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH CO. (LTD.)**—An extraordinary general meeting of this company will be held at Winchester House, London, E.C., on Thursday, 22nd inst., at 2:45 p.m., to confirm the special resolution passed at the extraordinary meeting held on the 7th inst.

**HALIFAX AND BERMUDAS CABLE CO. (LTD.)**—By a clerical error the capital of this company was stated in our last issue, page 106, as £30,000 in £5 shares. The amount should have been £50,000.

**R. HORNSBY & SONS (LTD.)**.—The directors recommend the payment, on Dec. 15, of dividends of 6 per cent. per annum on the preference stock, and 8s. per share (5 per cent. on the amount called up) on the ordinary shares, tax free, for the year ended Sept 30. £10,000 is placed to reserve and £5,899. 13s. 11d. carried forward.

**STOCK EXCHANGE NOTICES.**—Nov. 28 has been appointed a special settling day in the further issue of 10,000 6 per cent. cumulative preference £10 fully paid shares (Nos. 110,001 to 120,000) and 15,000 ordinary £10 fully-paid shares (Nos. 75,001 to 90,000) of the *British Electric Traction Co. (Ltd.)*. The shares have also been ordered to be quoted in the official list. Application has been made to the committee to appoint a special settling day in and to grant a quotation to provisional certificates for £100,000 4½ per cent. first debenture stock of the *Blackheath and Greenwich District Electric Light Co. (Ltd.)* The committee has also been asked to appoint a special settling day in the further issue of 2,200 ordinary £10 fully-paid shares (Nos. 10,001 to 12,200) of the *Notting Hill Electric Lighting Co. (Ltd.)*, and to allow £250,000 4½ per cent. first debenture stock of the *Calcutta Tramways Co. (Ltd.)* to be quoted in the official list.

**TELEGRAPH MANUFACTURING CO. (LTD.)**—An interim dividend at the rate of 8 per cent. per annum for the half year ended Sept. 30 last will be paid on the ordinary shares of this company (both original and recent issue) on 1st prox. The transfer books of the ordinary shares will be closed from 16th to 30th inst. inclusive.

**WALKER AND WALLSEND UNION GAS CO.**—An extraordinary meeting was held on Friday to pass a resolution sanctioning the creation and issue of new stock for raising additional capital authorised by the company's Electric Lighting Act, 1899, and the Electricity Capital Act, 1900. The chairman (Col. Crawford) moved that the company create and issue the whole of the ordinary shares remaining unissued in the electricity capital of the company, and raise £25,000, part of the additional authorised capital, by the creation and issue of new ordinary or preference shares of the nominal amount of £10 each, or of new ordinary preference stock as the directors may determine. He said the amount of capital held by the Gas Company was £51,700, and their first bill of 1899 gave them authority to raise £100,000. That left a balance of £48,300, and under their act of this year they proposed to ask the shareholders for permission to raise £25,000 further, making the total capital £125,000. The electricity works at Walker are rapidly approaching completion.

The resolution was adopted unanimously.

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 7. | | Price Wednesday, Nov 14. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 14. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | | |
| £140,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd. | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | 6½ | ... |
| £70,000 | Stock | 19/8 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | 104 | 102½ |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 6 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) ... xd | 6½ | 6¾ | 6½ | 6¾ | ... | | 6¼ | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | ... | ... |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | 5¾ | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6 | 6½ | 6 | 6½ | 4 12 4 | March | 6⅛ | 6½ |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December | ... | ... |
| $1,500,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,679 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 8½ | 9½ | 4 4 3 | February and August | 9¼ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 13½ | 13 | 13½ | 4 9 0 | January and July | 13⅛ | 13¼ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | 127 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | 9⅛ | 8½ |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 5 0 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. allotted (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | 110½ | 109½ |
| [illegible] | 5 | ... | Folkestone Electricity Supply Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2½ | ... | ... | 2 | ... |
| 49,440 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | 4½ | ... |
| £150,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 45,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 13½ | 14½ | 13 | 14 | 4 15 10 | April and October | 13½ | 13¼ |
| £720,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 7 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 7 | ... | 98 | 97 |
| 6,451 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 14½ | 15½ | 4 10 4 | March | 14½ | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅜ | [illegible] | ⅜ | [illegible] | 12 10 0 | ... | ... | ... |
| £315,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 5 15 0 | January and July | ... | ... |
| 15,000 | $100 | $8 | Royal Electric Company of Montreal Shares | 190 | 200 | 190 | 200 | 4 0 0 | April and October | ... | ... |
| £115,600 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15½ | 15⅛ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 9 | " " | ... | ... |
| [illegible] | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 99 | 101 | 99 | 101 | ... | ... | [illegible] | [illegible] |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | ... | ... | ... |
| 60,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 29,457 | 5 | ... | Do. D[illegible] | 11½ | 12½ | 11½ | 12½ | ... | ... | [illegible] | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 103 | 105 | 103 | 105 | 4 17 1 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 23 | 24 | 23 | 24 | 3 5 11 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 13,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10½ | ... |
| 45,000 | 10 | 11/0 | British Elec. Trac. Ord. | 14 | 15 | 13½ | 14½ | 3 17 11 | ... | 14⅛ | 14¼ |
| 50,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 [illegible] 9 | February and August | 12⅛ | 12 |
| £300,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 122 | 121½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 16 3 | ... | 4¾ | ... |
| 27,500 | 5 | ... | Do. "B" | 3½ | 4½ | 4 | 4½ | ... | ... | ... | ... |
| £300,000 | Stock | 5% | Do. 5 per Cent. Debentures | 103 | 108 | 103 | 108 | 4 11 4 | ... | ... | ... |
| £150,000 | Stock | 13/[illegible] | Do. 5% 2nd Deb. Stock Prov. Certs (all pd.) | 89 | 91 | 89 | 91 | 5 1 0 | ... | ... | ... |
| [illegible],267 | 10 | 5/0 | Central London Ordinary | 10 | 10½ | 10 | 10½ | 3 11 10 | June and December | 10⅛ | 10⅛ |
| £455,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 54 | 55 | 54 | 55 | 2 7 5 | February and August | ... | ... |
| [illegible] | 10 | [illegible] | Do. Ordinary (Nos. 12,501 to [illegible]) | 5 | 6 | 5½ | 5½ | 2 11 [illegible] | " " | 5½ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £250,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | " " | ... | ... |
| £211,[illegible] | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 118 | 121 | 118 | 121 | 3 5 1 | May and November | ... | ... |
| [illegible] | 10 | ... | Dublin United Trams (1896) Ltd., Ordinary | 17½ | 18 | 17½ | 18 | | ... | ... | ... |
| [illegible] | [illegible] | ... | Do. [illegible] Preference | 10½ | 11½ | 10½ | 11½ | | ... | ... | ... |
| [illegible] | [illegible] | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | | ... | ... |
| [illegible] | 10 | 7½% | Imperial Tramways Ordinary | 21 | 22 | 21 | 22 | 3 12 6 | March and September | ... | ... |
| [illegible] | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 1[illegible] 9 | " " | ... | ... |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. Debentures | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 8,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | 9½ | 10½ | [illegible] | 10½ | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8⅛ | [illegible] | [illegible] | [illegible] | 4 4 9 | February and August | ... | ... |
| [illegible] | 10 | 5% | Do. 5 per Cent. Preference | 13 | 14½ | 13 | 13½ | 3 1[illegible] [illegible] | " " | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture | 104 | 106 | 104 | 106 | 3 14 0 | January and July | ... | ... |
| [illegible] | 100 | 5 | Montreal Street Railway [illegible] Mort. Debs. (19[illegible]) | [illegible] | [illegible] | [illegible] | [illegible] | 4 15 0 | ... | [illegible] | ... |
| £1[illegible] | 100 | 4½ | Do. [illegible] 4½ Debentures (192[illegible]) | 103 | 105 | 103 | 105 | 4 6 4 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 16½ | 17½ | 16½ | 17½ | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | 10½ | 10½ | [illegible] | [illegible] | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11 | 12 | 11 | 12 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 9½ | 10½ | 4 15 3 | February and August | ... | ... |
| £135,000 | Stock | [illegible] | Do. 4½ per Cent. Debenture Stock ... xd | 103 | 107 | 103 | 105 | 4 5 9 | " | [illegible] | [illegible] |
| £40,000 | Stock | 5% | Waterloo and City Ordinary | 92 | 95 | 92 | 95 | 3 3 1 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 7. | | Price Wednesday, Nov. 14. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 14 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | Highest | Lowest |
| £36,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 103 | 3 17 8 | January and July | 19 | — |
| 36,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | — | — |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 86 | 90 | 5 11 1 | ... | — | — |
| £833,720 | Stock | 15/0 | Anglo-American | 53 | 54 | 53 | 55 | 6 11 2 | Feb., May, Aug., Nov. | 52½ | — |
| £3,099,640 | Stock | 30/0 | Do. Preferred | 97 | 99 | 98 | 100 | 6 0 2 | " " | 99½ | 98 |
| £3,098,640 | Stock | 27/0 | Do. Deferred | 10½ | 10¾ | 10½ | 11 | 12 5 6 | " " | 11 | 10⅞ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 11 5 | Jan., Apr., July, Oct. | — | — |
| £1,539,496 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 102 | 104 | 3 17 4 | " | 103½ | 103½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ | 7½ | 6½ | 7½ | 7 17 0 | February and August | — | — |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14½ | 15½ | 6 9 0 | " | 15½ | — |
| 13,931 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | — | — |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " | — | — |
| £30,800 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | — | — |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10¾ | 10½ | 10¾ | 6 10 6 | Jan., Apr., July, Oct. | 10¾ | 10¾ |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 103 | 99 | 102 | 4 8 0 | June and December | — | — |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary | 148 | 153 | 148 | 153 | 4 11 4 | Jan., Apr., July, Oct. | 150½ | 149 |
| £1,836,666 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 98 | 101 | 98 | 101 | 3 9 5 | " " | 99½ | 99 |
| £1,483,300 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 116 | 113 | 116 | 3 7 10 | May and November | 113 | [illegible] |
| 250,000 | 10 | 2/6 | Eastern Extension | 14½ | 15½ | 14½ | 15½ | 4 11 10 | Jan., Apr., July, Oct. | 15⅛ | 14¾ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) 13pd. is'd at 23pm. all pd | 6½ | 7½ | 6½ | 7½ | ... | ... | 15⅛ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 116 | 119 | 116 | 119 | 3 7 10 | February and August | ... | — |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 100 | 103 | 100 | 103 | 3 17 9 | February and August | ... | — |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 103% | 99% | 103% | 3 18 5 | May and November | ... | — |
| 1[illegible],227 | 10 | 1/9 | Globe Telegraph and Trust | 10½ | 11 | 10½ | 11 | 4 13 4 | Jan., Apr., July, Oct. | 10⅞ | 10⅞ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | " " | 15½ | 15⅛ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 33 | 31 | 33 | 3 15 7 | January and July | 32½ | — |
| £34,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 98 | 101 | 99 | 101 | 4 9 1 | June and December | ... | — |
| 17,000 | 25 | 12/6 | Indo-European | 49 | 58 | 49 | 51 | 4 14 4 | May and November | ... | — |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | ... | — |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 | 108 | 100 | 103 | 3 17 9 | June and December | — | — |
| 11,830 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | 7½ | 7½ |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 125 | 130 | 4 12 4 | " " | 130½ | 125 |
| 15,000 | 10 | ... | West African Telegraph | 2½ | 3½ | 2½ | 3½ | 4 9 3 | December and July | ... | — |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 | 101 | 98 | 101 | 4 19 0 | March and September | ... | — |
| 30,000 | 3½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | ... | — |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 14 4 | January and July | ... | — |
| 88,321 | 10 | 1/0 | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | ½ | 11 |
| 34,462 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ | 7½ | 6½ | 7½ | 5 0 0 | " " | ... | — |
| 4,000 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 6 | 7 | 5 | 7 | 6 11 6 | " " | ... | — |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 13 6 | January and July | — | — |
| 207,900 | 10 | 5/0 | Western Telegraph (late Br zil'n S'bm'rine) £486 b'n's | 14½ | 15 | 14½ | 15½ | 4 15 11 | Mar., June, Oct., Dec. | 14½ | 14⅛ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 | 106 | 103 | 106 | 4 14 4 | June and December | ... | — |
| £313,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | — |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | 25 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 16 1 | August | — | — |
| 234,830 | 20/0 | 1½d. | Consolidated Telephone Con. and Manfg. | ... | | 4/3 | 4/6 | ... | July | — | — |
| 72,600 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | 1 | ½ | 1 | 5 0 0 | November | — | — |
| 86,403 | 1 | 1/0 | Do. 5 per Cent. Preference | ½ | 1 | ½ | 1 | 5 0 0 | " | — | — |
| 590,000 | 5 | 2/6 | National | 4½ | 4½ | 4½ | 4½ | 5 13 1 | February and August | 4½ | 4⅛ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 15 | 13 | 15 | 4 0 0 | " " | 13½ | .. |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 13 | 15 | 13 | 15 | 4 0 0 | " " | .. | .. |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | " " | 5⅛ | ... |
| 2,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 93 | 96 | 93 | 97 | 3 11 5 | June and December | 96½ | 96 |
| £500,000 | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | ... | ... | 103 | 102 |
| 171,504 | 1 | 0/6 | Oriental | ½ | 1½ | ½ | 1½ | 5 3 9 | April and October | ½ | — |
| 58,000 | 5 | 4/6 | United River Plate | 4½ | 5½ | 4½ | 5½ | 6 18 4 | July | 5 | — |
| 16,620 | 5 | 2/6 | Do. 5% Cumulative Preference (fully paid) | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | — |
| 23,361 | 5 | ... | Do. do. (£3. 10s. paid) | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | — |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | June and December | ... | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 8d. | Alliance Electrical Co. 5% Cum. Pref. | 1 | 1½ | 1 | 1½ | 4 8 11 | ... | ... | ... |
| 138,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ½ | ¾ | ½ | ¾ | 7 7 8 | March and September | ... | — |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ½ | ½ | ½ | ½ | ... | ... | ... | — |
| 80,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ½ | ½ | ½ | ½ | ... | ... | ... | — |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 93 | 9. | 93 | 4 4 1 | ... | ... | — |
| 73,000 | 5 | 5/0 | British Insulated Wire Ordinary | 9½ | 10½ | 10½ | 11½ | 4 6 11 | July and February | 9⅞ | — |
| 70,000 | 5 | 5/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 4 16 0 | January and July | ... | — |
| 100,000 | 5 | 1/6½ | British Westinghouse 6% Preference | 4½ | 5½ | 4½ | 5½ | ... | ... | 4½ | — |
| 90,050 | 2 | 1/3½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 5 4 | September | .. | 1½ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | — |
| 90,000 | 2 | 1/3½ | Do. 3 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 5 8 | " | ... | — |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | — |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 108 | 111 | 108 | 111 | 4 0 11 | March and September | ... | — |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 105 | 103 | 105 | 4 7 0 | January and July | ... | — |
| 20,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 12½ | 14½ | 12½ | 13½ | 5 11 1 | " " | 12½ | — |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 | 5½ | 5 | 5½ | 4 10 11 | " " | 5⅛ | — |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 18 11 | November and May | — | — |
| 300,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | — | — |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | — | — |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ½ | 1 | ½ | 1 | 6 10 0 | March | — | — |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ½ | 1½ | ½ | 1½ | 5 6 8 | ... | — | — |
| 54,000 | 3 | 2/6½ | Crompton and Co. (Nos. 1 to 32,098) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | — | — |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 18 0 | " " | — | — |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ½ | 1½ | ½ | 1½ | 5 6 8 | ... | — | — |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 3 0 0 | February and August | ... | — |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 18 4 | " " | ... | — |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 5 | June and December | 93½ | 93 |
| £100,000 | Stock | 2/4½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 96 | 100 | 96 | 101 | ... | ... | ... | — |
| 36,400 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half-yearly | ... | — |
| £275,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 104 | 101 | 104 | 4 7 6 | ... | 103½ | — |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 2 | 2½ | 2 | 2½ | 5 6 8 | January and July | 2⅛ | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3½ | 2½ | 3½ | 4 4 2 | July | 3⅛ | ... |
| £182,300 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 18 3 | January and July | ... | — |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 12½ | 13½ | 13½ | 13½ | 5 11 1 | February and August | 12½ | ... |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 3 15 3 | " " | 5⅛ | 5⅛ |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 | 112 | 108 | 112 | 4 0 4 | " " | ... | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 20 | 21 | 20½ | 21½ | 2 9 9 | " " | 20½ | — |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | March and September | ... | — |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | 36 | 40 | 36 | 41 | 4 0 11 | March and July | 37½ | 37½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | — | — |
| 15,000 | 5 | 9/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 10½ | 11½ | 6 4 4 | ... | 10½ | 10⅛ |
| 30,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5½ | 5½ | 5½ | 4 6 11 | ... | ... | — |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | ... | — |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | " " | 6½ | 6⅛ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 4 | May and November | ... | — |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,175. [No. 5. Vol. XLVI.] FRIDAY, NOVEMBER 23, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

The Héroult process for the production of aluminium has been a conspicuous manufacturing success, but that success has taken some time to attain. It is not surprising that, as the patent (No. 7,426 of 1887) is about to expire, application should be made for an extension. The claim in the specification is for "the production of aluminium from alumina by the hereinbefore-described electrolytic process using cryolite as a flux in fusing the alumina to be electrolysed." The chief points mentioned in the specification are the use of a carbon crucible as cathode and a carbon rod as anode, the employment of cryolite as a flux, and of alumina as the substance to be decomposed electrolytically. Heating the crucible externally by a furnace is contemplated, a proceeding for which internal heating by the current is now substituted. It is well known that the Héroult and the Hall processes, which divide between them the greater part of the world's production of aluminium, bear a very striking resemblance to each other, and it may be deduced that a process of this kind is at present the only practicable means of manufacturing the metal. Thus it comes about that the continued protection of the Héroult process means an extension of the British Aluminium Co.'s monopoly in this country. That corporation has displayed much energy and enterprise and is entitled to a fair reward. It will be for the Judicial Committee to decide whether an adequate reward has yet been reaped.

At the Physical Society's meeting on Friday the 9th inst., Mr. A. Campbell read three small Papers which will, we think, interest many of our readers. The method he proposes for phase-turning is ingenious, and will doubtless prove useful in special cases; while his method of power-measurement in alternating-current circuits may be capable of fairly extensive application. The author, at the beginning of his first Paper, mentioned briefly a point which, though not of very great practical moment, possesses some interest. It was mentioned because of the difficulty which always besets the experimenter who wishes to define what he means by the "phase-difference" between two independent alternating-current circuits of identical frequency. Of course, if we had to deal with pure sine curves only this difficulty would not exist, but on ordinary supply systems the current and voltage curves depart so considerably from the simple sine form that, as Mr. Campbell indicates, it is found necessary to distinguish between what is called the "time-lag" and that angle whose cosine is the power-factor.

A Paper on "Electromotive Force and Osmotic Pressure" was read at tedious length by Dr. Lehfeldt. As will be seen from our reprint of the Society's official report the author connects by means of a thermodynamic cycle the E.M.F. and the osmotic pressure in a concentration cell. In part the Paper is an endeavour to correct the well-known result of Nernst, and, therefore, is of some importance. But we were, nevertheless, sorry to find that the author's enthusiasm for his subject should have caused him to cling so long to the rostrum as to do injustice to the authors of the Papers to follow.

Electrically caused fires are happily scarce. Were it not so, the space devoted in our daily contemporaries to correspondence would have to be enlarged, for whenever electricity is or is thought to be the cause of a fire, at least one and often half-a-dozen long letters are written about it to the editors of the daily newspapers. It is probably the rareness of such accidents that occasions this, for although we sometimes see an outcry against low-flash oils, phosphorous matches, bad gas fitting, and careless smokers, no one seriously proposes that when insuring his house against fire a householder is to undertake to test the petroleum he employs for his lamps, to employ no other than strike-only-on-the-box matches, to forswear water-seal pull-down gasoliers, or to have a minimum number of receptacles for cigar ends in each room. Yet

D

regulations on a par with these are enforced with regard to electric lighting, and tamely submitted to; and notwithstanding this, every fire which an enterprising newspaper man labels "caused by a defect in the electric wires" is an occasion for one or more members of the general public to clamour for more stringent regulations.

In the particular case which happened last week and has evoked this demand from Messrs. Holt, Gray, and Moore in a letter to *The Times*, a fire at a photographic studio in Regent-street appears to have been caused by the electric current. At this studio a large current was employed, and possibly too lavish use was made of temporary connections by the consumers themselves. If on the other hand the fire was occasioned by part of the permanent installation, there is little doubt that the wiring did not conform with the fire office rules, which certainly do not err on the side of laxity. If they have a fault it is that they are so stringent and so multitudinous that there is a risk of the wiring contractor ignoring them altogether, either through lack of means to carry out their provisions, or through lack of time to read them through.

The discovery of the Röntgen rays placed in the hands of surgeons and physicians a new and valuable aid to the diagnosis of disease and the examination of injured internal organs. But the employment of this novel and, indeed, unique instrument had not long been in vogue before it became evident that operation with the rays was liable to be attended by considerable inconvenience, not to say serious injury, to the patient. Cutaneous inflammation and rapid loss of hair were among the most common *sequelæ* of exposure of bare portions of the human frame for a period sufficiently lengthy to allow of a photograph being taken. The erratic manner in which these unpleasant *sequelæ* manifested themselves, and the notable absence of any such effects from a large majority of such operations, rendered it difficult to discover the precise cause of the trouble. Great diversity of opinion as to this cause arose in the minds of experts, some attributing the mischief to the rays themselves, others inclining to the view that it had its origin in the electrification commonly attending the use of Röntgen ray apparatus.

From whatever cause arising, however, it became more and more clear that no patient could be exposed for a lengthy period to these rays with absolute security against decidedly unpleasant consequences. Nevertheless, the percentage of cases where really troublesome results ensued was so small, and the advantages of the rays for purposes of examination and diagnosis were so marked, that the medical profession were fully justified in adhering to the practice of using these rays in their consulting and operating rooms. Probably, however, few practitioners were prepared to see the verdict of a coroner's jury attributing death partly to the effect of exposure to Röntgen rays; yet such a verdict was found only last Friday at Hastings. It appears that in this fatal case the rays had been twice used—on both occasions so long ago as last April—on a lady who had met with a cycle accident, resulting in fracture of the thigh bone. Exposure to the rays was followed by the development of a large sloughing wound on the abdomen, which the medical evidence apparently attributed to the action of the rays, or of the apparatus producing them. Acting on a weakened system this wound, conjointly with the result of the cycle accident, caused death. We mention these details in order to show that, although the exposure to Röntgen radiation was undoubtedly the cause of great mischief, there were other complications in the actual cause of death. Nevertheless, the evidence brought forward at the inquest is sufficient to show that great care—perhaps much greater care than is usual—should be taken when exposing to this little understood radiation a patient predisposed, by weakness or disease, to the development of serious *sequelæ*.

Suggestive Criticism.—Our contemporary, the *Electrical World*, of New York, while criticising an induction motor, observes that "it had a tendency to heat at the expense of a tendency to start."

Erratum.—In Mr. J. Elton Young's article on "Submarine Cable Speeds," published in our issue of the 9th inst., the word "millivolt" was inadvertently substituted for "decimillivolt" throughout the calculations at the head of page 92

Society of Arts.—The juvenile lectures at the Society of Arts will be given this session on the afternoons of Wednesday, January 2nd and 9th, by Mr. E. Walter Maunder, F.R.A.S., superintendent of the solardepartment, Greenwich Observatoy. The subject of the course will be "Eclipses."

**The Society of Model Engineers.**—The eighth monthly meeting of the Liverpool branch of the Society of Model Engineers was held on 7th inst., when there was a general discussion on compound engines, &c. The next meeting will take place on December 5th at the Balfour Institute, Liverpool, at 7:45 p.m., when a lecture will be given on model boilers.

**The Cantor Lectures on "Electrical Oscillations."**—Dr. Fleming informs us that, owing to the annual dinner of the Institution of Electrical Engineers having been fixed for the same day as that announced for his second Cantor lecture at the Society of Arts on "Electrical Oscillations," Sir Henry Wood, the secretary of the society, has kindly consented to change the date of the second lecture from Monday, December 3rd to Tuesday, December 4th.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Tangier—Tarifa | Jan. 3, 1900 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Môle St. Nicolas—Cap Haitien | Mar. 7, 1900 | Nov. 14, 1900 |
| Zanzibar—Mombasa | Sept. 20, 1900 | — |
| Paramaribo—Cayenne | Oct. 6, 1900 | Nov. 21, 1900 |
| Havre—Waterville | Nov. 6, 1900 | — |
| Aden—Zanzibar | Nov. 9, 1900 | — |
| Falmouth—Bilbao | Nov. 19, 1900 | — |

**Electrical Engineers (R.E.) Volunteers.**—The whole of the detachment of the Electrical Engineer Volunteers, which has been serving in South Africa is now on its way home. The "Norham Castle" sailed from Cape Town on November 17th with the officers, men and part of the equipment which went out with the contingent. Capt. Leaf, however, and possibly some of the men also, sailed in the "Goth" on the same day; both ships are therefore due at Southampton on or about December 7th or 8th. It has not yet been decided where the men will be quartered, or what will be the most convenient date for the London reception.

The Secretary for War has approved of the corps of Electrical Engineers Volunteers borrowing £6,000 from the Public Works Loan Commissioners for the construction of headquarters' buildings.

**Central London Railway Extension.**—Notice has been given by the Central London Railway Co. that a bill will be presented to Parliament in the next session to enable them to construct an extension of their down tunnel from the Bank station to a new station under the Liverpool-street station of the Great Eastern Railway Co.; also for a small extension at the Shepherd's Bush end of the line. With a view to facilitate the transfer of the trains from the up to the down tunnel, these extensions are to take the form of loops, replacing the cross-over lines now in use, these cross overs being found to occupy more time than is convenient for a rapid service of trains. When the extensions are completed and in use, it is expected that the frequency of the trains will be considerably increased.

**A Smart Telegraphist.**—Mr. H. Leslie Dixon, inspector of overhead wires for the Public Health Department, sends us the following cutting from the *Cape Times* of October 24th:—

When Rouxville was abandoned the postmaster brought away with him the key of the instrument, &c. The next day Capt. Hales, with some 30 Cape Police, went on patrol in that direction, and Mr. Flazington, a young operator in the Aliwal North branch, offered to accompany them. They managed to get into Rouxville, and Flazington at once made for the telegraph office. The instrument was apparently useless, but he secured the office door key, twisted a piece of stout wire round the middle, stuck the wire in the bridge of the instrument, and soon called up "Smithfield." He had just time to send an important message through to the Officer Commanding at Bloemfontein when the alarm was given that a large body of Boers was in sight, and the small party made tracks for the Orange River, crossing into Herschel, and returning home via Lady Grey. The readiness of resource shown by this young telegraphist is worthy of praise.

**The Accident at Manchester-square Station.**—An error occurred in the editorial note on page 110 of our last issue with regard to the switchboard at Manchester-square station of the Metropolitan Electric Supply Co. The company's switchboards at Manchester-square, Rathbone-place and Sardinia-street are built on more or less similar lines, but only one and not "numerous" fires occurred at the first-mentioned, the other fires having been at Sardinia-street and Rathbone-place. The fatal accident two years ago, which we alluded to, also occurred at Rathbone-place at the back of the switchboard, and not at Manchester-square. The Manchester-square switchboard was re-constructed in 1898, after the disastrous fire it had occasioned, an iron frame replacing the original teak framework in which the marble panels were mounted, and bare copper in earthenware tubes was employed instead of rubber-covered cables. The large surface of bare metal at high pressure, alluded to in the editorial note last issue, was allowed to remain. We are informed that the company is now most carefully considering what additional precautions can be taken at its switchboards to prevent accidents.

**Wireless Telegraphy.**—It is reported in the daily press that some new Marconi instruments, intended for installation on Japanese warships, have been exhibited in New York. The *Birmingham Post* says, "They are capable of developing 2,000,000 volts of energy, and are able to transmit a message a distance of 125 miles. A 45in. flash drawn from them bored a hole through 4in. of glass as quickly as an auger could through wood."

In consequence of the recent stormy weather the special topmast erected on the Ostend-Dover packet "Princess Clementine" to suspend the air wire was lowered considerably on Monday. This diminution in height appears to have made little difference to the efficiency of the signalling—a result which indicates that, by some mistake, the height originally demanded was excessive.

With regard to the difficulties which we referred to in our last issue as having arisen in the establishment of communication between certain of the Hawaiian Islands, we are now authorised to announce that these difficulties have been entirely overcome, and that a continuous service has been for some time in operation. It seems that the unfortunate illness of the representative of the Marconi Company was largely responsible for the temporary inefficiency of the service.

**Uganda Railway Telegraphs.**—The erection of the permanent telegraph line of the Uganda State railway keeps pace with the construction of the permanent way. At the end of 1900 it will probably be completed to the length of 500 miles. Iron wire is used weighing 600lb. to the mile, and iron posts weighing about 320lb. complete are employed. Between Mombasa and Nairobi, a distance of 326 miles, three wires are erected, and from thence onwards two only. There are some 45 intermediate stations, all of which are open to the public for telegraph traffic. Between Railhead and Port Florence (the ultimate terminus of the railway), on the shores of Lake Victoria, a temporary telegraph line has been erected. From Port Florence to Entebbe, the capital of the Uganda Protectorate, a semi-permanent line has been erected by the telegraph department of the Uganda railway. No insulators are used on this line and, though its length is 247 miles and the climate is a wet one, communication is successfully maintained by the use of Major Cardew's vibrators. Intermediate stations are opened at Mumias, Sao River, Karangas, Jinja, and Kampala, but most of these stations are for maintenance purposes only. On the completion of the Uganda railway permanent iron poles will probably replace the temporary wooden ones at present in use. These wooden posts are of a somewhat novel kind. The white ant is very numerous in this part of Africa, but it has been noticed that it does not attack living wood. Bark cloth trees, which are very suitable and which readily take root when transplanted, have been placed all along the route, and to these the wire is secured by a binder of ordinary tarred spun-yarn. The branches have to be cleared periodically, but this is a small objection, and the live poles have proved satisfactory in every other way.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY,) November 23rd.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "An Automatic Wheatstone's Bridge," by W. C. D. Whetham; (2) "The Anomalous Dispersion of Carbon," by Prof. R. W. Wood; (3) "The Liquefaction of Hydrogen," by M. W. Travers; (4) "On the Refraction of Sound by Wind," by Dr. E. H. Barton.

**SATURDAY, November 24th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' Visit to the works of Messrs. Siemens Bros. & Co., Woolwich. Trains: 9:20 a.m. from Charing Cross, and 9:30 a.m. from Cannon-street for Charlton Junction.

**MONDAY, November 26th.**

SOCIETY OF ARTS.

*8 p.m.* "Cantor" Lecture I.—"Electric Oscillations and Electric Waves," by Prof. J. A. Fleming, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

Meeting of the Newcastle Local Section in Newcastle-on-Tyne College of Science.

**TUESDAY, November 27th.**

INSTITUTION OF ELECTRICAL ENGINEERS. MANCHESTER SECTION.

*7:30 p.m.* Meeting at Owen's College, Manchester. Paper to be read: "Relative Advantages of Direct-current and Three-phase Distribution for Small Installations," by H. A. Earle.

**WEDNESDAY, November 28th.**

INSTITUTION OF CIVIL ENGINEERS.

*2:30 p.m.* Students' Visit to London and South Western Railway Locomotive Works, Nine Elms. Meet at the Locomotive and Stores Department gate, Wandsworth-road. Nearest Station, Vauxhall.

INSTITUTION OF ELECTRICAL ENGINEERS.

*7.30 p.m.* Students' Meeting at 28, Victoria-street. Papers to be read: (1) "Single-Phase Generators at the Paris Exhibition," by J. T. Irwin; (2) "Polyphase Generators," by C. N. Nettley.

**THURSDAY, November 29th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Extra Meeting, in the rooms of the Institution of Mechanical Engineers, when a Paper will be read on "The Supersession of the Steam by the Electric Locomotive," by W. E. Langdon.

INSTITUTION OF ELECTRICAL ENGINEERS. DUBLIN SECTION.

Conversazione at the Royal Dublin Society.

**FRIDAY, November 30th.**

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel, when Sir Lowthian Bell, F.R.S., delivers his Presidential Address.

**SATURDAY, December 1st.**

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' Visit to the Waterloo and City Railway Co.'s Generating Station.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Contact E.M.F. of Mercury.*—Nernst's theory leads to the conclusion that two normal solutions of sodium chloride and potassium chloride respectively, should show the same difference of potential in contact with mercury or mercury powdered over with calomel. M. Rotté has verified this equality in a very direct manner by means of a capillary electrometer in which he employed the two solutions mentioned. He determined the E.M.F. at various capillary forces, and found the E.M.F. corresponding to a maximum capillary force graphically from the curve. For common salt the maximum E.M.F. was found to be 0·56 volt. For potassium chloride it was found to be 0·562 volt. This is a striking verification of Nernst's theory, especially considering that the same figures were obtained with the apparatus when sulphuric acid was filled in and withdrawn after each determination.

[ROTTÉ, *Jour. de Physique*, October, 1900.]

*Testing of Thermo-couples.*—The Reichsanstalt method of testing thermo-couples intended for pyrometric work is described by S. Lindeck and R. Rothe. The chief innovation in the testing arrangement is an electric oven, consisting of four concentric porcelain tubes, only the outermost of which is glazed and covered with asbestos. The inner tubes are made of a very refractory material devised by Hecht. For temperatures up to 1,400deg. the second tube is wound with a 2mm. pure nickel wire, prevented from rusting by covering it with fireclay paste. For still higher temperatures the wire employed for heating is a platinum-iridium wire, by means of which a temperature as high as 1,600deg. can be attained. When that temperature is exceeded the wire fuses into the porcelain. The temperature can be regulated with great rapidity and precision, the fine regulation being made by means of a sliding contact on a constantan band. The power consumed is 60 watts at 200deg. and 1,510 watts at 1,800deg. A number of couples are tested simultaneously by means of a compensation method, the junctions being fastened by friction into a small circular gapped piece of platino-iridium. The errors of the measurements do not exceed 0·1 per cent.

[LINDECK and ROTHE, *Zeitschr. Instrum.*, October, 1900.]

*Repulsion due to Solar Radiation.*—It was Kepler who endeavoured to explain comets' tails by the repulsion exercised upon certain constituents of comets by the particles constituting light. The general acceptance of the undulatory theory of light has made us lose sight of Kepler's suggestion, but the radiation-pressure postulated by Maxwell's theory of light can be made to bring it forward again very effectually. This is done by S. Arrhenius. He calculates that a cubic body of 1cm. side and specific gravity 1 would, in the immediate neighbourhood of the sun, lose $\frac{1}{10000}$th part of its weight owing to the sun's radiation. If the size of the particle is diminished, the loss becomes comparatively greater, since the volume decreases more rapidly than the surface. Thus the weight of a cube of $10^{-4}$cm. side is exactly balanced by the repulsion due to the radiation, and a particle of half that diameter would be given such a velocity of repulsion that it would describe a path equal to the sun's diameter in one hour. The author applies this theory with great success to the formation of the tails of comets. Their curvature would be due to the variation in the incident radiation, and in the size of the particles repelled. He also proposes to apply this theory to the aurora.

[S. ARRHENIUS, *Physik. Zeitschr.*, November 10, 1900.]

*Nature of Röntgen Rays.*—In a paper distinguished rather for its boldness of suggestion than its accuracy, W. Rollins criticises the corpuscular theory of cathode rays and the impulse-theory of Röntgen rays. He advances two arguments against the supposition that the cathode stream particles are always of the same size, move with the same speed, and carry the same charge. When the cathode in a good X-ray tube is covered with mercury, the X-rays are reduced in intensity, but the whole tube is filled with a brilliant white light. The author supposes that the mercury particles constituting the cathode rays are heavier than other metallic particles, and that therefore their velocity on striking the target is not sufficiently great to produce X-rays. The latter are regarded by the author as due to radiation from the impinging particles of the nature of heat radiation. Another argument put forward against the electron theory is that if the particles were always the same, the loss of weight of a cathode for any given quantity of electricity discharged should be the same whatever the material of the cathode. And that is not the case. Further, the cessation of X-rays at a certain exhaustion receives no probable explanation by the electron theory.

[W. ROLLINS, *Am. Journ. Science*, November, 1900.]

*Limiting Deflection of a Quadrant Electrometer.*—In measuring high potentials with the quadrant electrometer, whose sensitiveness is reduced by the employment of a heavy needle and a considerable distance between the wires of the bifilar suspension, it is found that after a certain difference of potential the sensitiveness decreases rapidly, and that the deflection attains a value beyond which it cannot go. A. B. Chauveau points out that the existence of this limiting deviation is due to the impossibility of practically realising a perfect symmetry of the system formed by the quadrants and the needle, and to the existence of a disturbing electric couple which is proportional to the square of the difference of potential between the quadrants. The author studies, theoretically and practically, the influence of various modifications of the suspension upon the limiting deflection, and shows that, by a careful construction, the limit can be pushed back almost indefinitely, so that the deflections in one direction at all events should show no serious falling off in the sensitiveness for the higher E.M.F.s. With his own instrument, which is now installed for use at the Eiffel Tower Observatory, he has thus succeeded in measuring voltages as high as 2,000, or even higher.

[A. B. CHAUVEAU, *Journ. de Phys.*, October, 1900.]

## THE TELEPHONE SYSTEM OF THE PITTSBURG AND ALLEGHENY TELEPHONE CO.*

BY KEMPSTER B. MILLER.

One of the largest enterprises in the "independent" telephone field in the United States has just been brought to a state of practical completion in the city of Pittsburg and the adjoining boroughs. The Pittsburg and Allegheny Telephone Co. has practically finished the installation of one large exchange and several branch offices, having a total capacity of over 7,000 lines with an ultimate capacity of considerably over 16,000 lines.

The main exchange is located in a large fireproof stone building, built especially for the purpose, at the corner of Seventh Avenue and Fountain-street, and includes all the facilities of a modern up-to-date office building. Special thought has been given in its lay-out to the requirements of a telephone exchange. The building is 100ft. long by about 45ft. wide, with light on all four sides. The entire third floor is used for the exchange and its accessory apparatus, while suitable retiring rooms and offices are provided on the floor below.

The switchboard and all central office apparatus were furnished by the Kellogg Switchboard and Supply Co., of Chicago. It is designed for use on the central battery plan, and is equipped with all the latest features in the way of automatic calling and of supervisory signals. The present capacity of this exchange is 4,080 subscribers' lines, the full equipment for this number of lines being now in place. Provision is made and space left in the operating room for an ultimate capacity of 5,400 lines, which extra capacity may be added as service demands.

* From the *Electrical World* of New York.

The main board is shown in Fig. 1, and consists of 19 sections of multiple switchboard, of which 17 are for local subscribers, and two for incoming trunk lines. Each of the 17 subscribers' sections has a capacity for 300 anwering jacks and drops, as well as for 5,400 multiple jacks. At present, however, only 240 answering jacks are provided on each section, so that during the busiest portion of the day when three operators are seated at each section, the calls of 80 subscribers will be allotted to each operator. Each operator's position, of which there are three to each section, is provided with 10 pairs of cords and plugs, complete with ringing and listenings keys and two supervisory lamps for each pair. The framework of the switchboard is of structural iron, firmly rivetted and bolted together. The switchboard legs are 43in. high, and rest on the true floor of the exchange. Above this floor is placed a false floor 17in. high, so that the height of the key shelf above the false floor is approximately 27in. This arrangement allows the use of a sufficiently long switchboard cord without the necessity of being unduly high above the operating floor. On the back of the legs of each section are provided connecting racks to which all of the local wiring of the section, that is, the wiring from the answering jacks, drops, key shelves, operators' circuits, &c., is led. A better idea of the appearance of the front of the board in detail may be had from Fig. 2, which shows slightly more than one section of the switchboard with one key shelf and one of the sub-panels beneath, opened for inspection. The removal of the sub-panel shows quite clearly the inside of the connecting rack with the various cables leading from the answering jacks and drops down to it. All cabling to the inside of the incoming rack on each section was done in the factory.

In Fig. 3 is shown a rear view of part of one of the sections after its installation was completed. At the extreme bottom of this figure the connecting rack with the cables leading from the distributing board are quite clearly shown. Immediately above this are shown the relay cases, one of which is opened, showing 80 line cut-off relays in its lower portion, and 20 supervisor relays in its upper portion, these relays being all mounted on iron strips secured directly to the iron legs of the switchboard. Immediately above the relay cases are shown the cord racks, and just above them the rear view of answering jacks and signals with their wiring. In the upper portion of the figure are shown the mutliple cables connecting the multiple jacks in each section throughout the board. These multiple cables are, in each case, of 21 twisted pairs of tin-covered copper wire with an insulation of silk and another of cotton, the cotton being coloured distinctively according to a regular code so as to secure the proper selection of wires. These cables are each covered with several layers of paper and with an outside braid of cotton saturated in beeswax. The multiple cables are all formed by the manufacturer and soldered to the spring jacks before leaving the factory, and are then laid up in the switchboard after all sections are in place on the floor. This figure (3) gives an excellent example of one portion of modern telephone work that is rarely seen or appreciated by the public, and the neatness with which the work is done, and the evident system with which it is all laid out and executed, is an evidence of the substantiality and excellence of the plant of this enterprising Pittsburg company.

In Fig. 4 another view of the rear of the switchboard is shown, the enclosing panels being entirely removed from the back of the board, as are also the relay protector cases. This view was taken with special reference to illustrating the multiple cable of the exchange, and an inspection of the right-hand portion of this figure will show the method by which the various wires are led from their respective cables to the spring jack terminals. The frieze boards, key shelves, and trimmings on the front of the switchboard are of seasoned mahogany, the key shelf being made five-ply to prevent its warping. The jacks and drops are mounted on pins projecting from the rear of stile strips and each screwed in place by a hexagonal nut at each end. The front of the stile strips between the jacks is covered by black ebonised finishing stiles, which latter bears the distinctive numbers for the drops and jacks. Each bank of 100 jacks is supported by a central white holly strip ⅛in. in thickness, and all blank panels are filled with ebonised blanks, so that the entire front of the jack and drop space of the board is of a black colour, relieved only by the white designating lines and figures and by the small brass test rings of each jack, which may be seen from the front. The jacks are mounted on ½in. centres, both vertically and horizontally, and the drops are also on ½in. centres horizontally so as to be spaced in exact accordance with the answering jacks. The drops, as may be seen quite clearly in Fig. 2, occupy the space immediately above the plug shelf, and immediately above them are the answering jacks and the multiple jacks. The row of jacks between the answering jacks and the multiple jacks are for outgoing trunk lines, which will be referred to more fully later.

The operation of the system, so far as the local subscribers are concerned, is as follows: The subscriber desiring a connection simply removes his receiver from its hook, this act automatically sending a current over one side of the line to operate the signal on one of the sections. The operator answers in the ordinary manner by plugging into the corresponding answering jack with one of her answering plugs, and this act operates the line cut-off relay of that line, causing it to disconnect the line from the line signal and to connect it

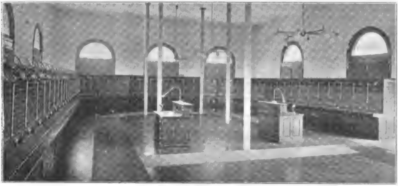


Fig. 1.—Interior of Main Exchange.

with the jacks from which it has hitherto been disconnected. The operation of the line relay also throws the live side of a storage battery into all of the test rings belonging to that line, so that any other operator will be notified that that line is busy during the connection. Having learned the number of the called subscriber, the other plug of the cord circuit is then inserted into the multiple jack in which the line of the called subscriber terminates. The operator then presses the ringing key, which sends a pulsating current over one side of the line of the called subscriber, through his bell to earth. The insertion of this calling plug into the jack also operates the relay of the called subscriber's line, causing it to disconnect that line from the line signal and connect it with the drops.

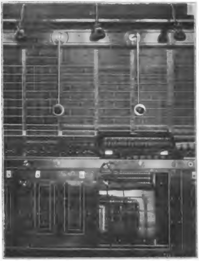


Fig. 2.—Front View of One Section with One Sub-Panel Removed and One Key Shelf Raised.

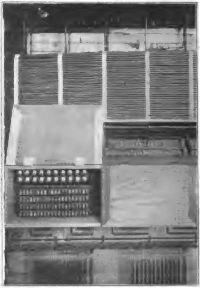


Fig. 3.—Rear View of Part of One Section with One Relay Case Opened.

Fig. 4.—Rear View of a Portion of Switchboard, showing Multiple Cabling.

The supervisory lamp belonging to the plug connected with the subscriber called for is at once lighted upon plugging into the called subscriber's jack, and remains lighted until that subscriber responds, its going out indicating to the operator that he has responded. A corresponding lamp is also connected to the plug inserted in the jack of the calling subscriber. While conversation lasts, both lamps remain out, but as soon as either party hangs up his receiver the corresponding lamp lights up. When both lamps are lighted, the operator knows that the conversation is ended, without breaking into the circuit to inquire, and she immediately pulls out the plugs, breaking the connection. The action of the supervisory lamps is controlled by differentially wound supervisory relays, one of these relays being associated with the circuit of each plug. The circuit conditions are such that the relays are inert as long as the corresponding plug is not in use, and remains inert even while a connection is made until the calling subscriber places his receiver on its hook. These relays are iron-clad, so as to make their magnetic circuit perfect, and also to make them free from cross talk. One interesting feature in connection with the Kellogg central battery system is that a complete supervisory system is obtained with the use of but two contacts on the plug and two strands to the cord.


FIG. 5.—BATTERY ROOM.


FIG. 6.—POWER PLANT.

In Fig. 5 the battery room of the main exchange is shown. Two batteries of 10 cells each are used, these being chloride accumulators, type G, each cell having 11 plates in lead-lined tanks, with a capacity for 21 plates each. The battery room is well ventilated and has a tile floor on a cement foundation. The 'bus bars from the battery may be seen supported on brackets in the left-hand side of the figure, these being of solid copper with a cross section of $\frac{1}{2}$in. by 8in. These batteries furnish current for all talking apparatus and for the operation of the line signals and line and supervisory relays; in fact, for all apparatus in the exchange, except for ringing the subscribers, where alternating or pulsating current is required.

The power plant in the main exchange is show in Fig. 6, and is located in the room immediately adjoining the battery room. The three generators at the left are size 2, double-field, Crocker-Wheeler motor-generators, operating from 210-volt mains and furnishing a current of a suitable voltage for charging the storage cells. The two machines shown in the centre portion of the figure are size 1, single-field ringing machines, furnishing pulsating or alternating current at approximately 50 volts, and operating from the circuit of 210 volts direct. All starting boxes and field rheostats are mounted on the front panels of the enclosing woodwork of the power table, all wiring being concealed within. This affords an extremely convenient method of governing the machines and at the same time utilises the space in the power room to good advantage. The power switchboard, shown at the right-hand portion of the figure, is of Italian marble, mounted in an angle-iron framework and containing all apparatus, other than the starting boxes and rheostats, for the control of the power circuits. This board is provided with two I. T. E. circuit breakers with underload and overload attachment, with four 200-ampere, 250 volt, double-pole, double-throw, all-copper switches for the charge and discharge circuits, with Weston voltmeters and ammeters and all auxiliary switches and fuses for the various minor circuits.

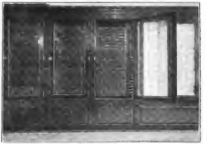


FIG. 7.—FUSE BOARD AND REPEATING COIL RACK.

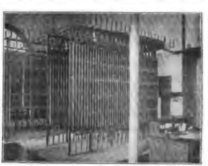


FIG. 8.—DISTRIBUTING AND CABLE TERMINAL ROOM.

In the same room with the power machinery are placed the fuse board and the repeating coil rack. The fuse board forms the distributing point for all circuits leading from the 'bus bars of the battery to the repeating coils and other portions of the board. The fuse board is provided with a fuse for each side of each repeating coil circuit. The fuses are all mounted on the front of the marble slab and are connected to ½in. by 3in. 'bus bars on the back of the board. All 'bus bars from the fuse board to the battery are wrapped with heavy cord, afterwards shellacked, and connected to the batteries by burning them into soldering cups at the end of each 'bus bar of each battery.

In Fig. 7 are shown the fuse board and the repeating coil rack, the marble face of the fuse board being shown at the extreme right of this figure; the iron framework of both the repeating coil rack and the fuse board being enclosed in panel woodwork with glass doors, thus securing as far as possible, immunity from dust. The line cables are led from the cable vault in the basement up through a large cable shaft to the cable heads on the exchange floor. The cable heads were furnished by the Sterling Electric Company, of Chicago, and each has a capacity of 100 pairs. They are equipped with the well-known Cook heat coil and lightning arrester, and are mounted in five rows on an iron framework provided with suitable cable troughs or running boxes composed of iron lattice work. From the cable heads the circuits are continued by means of 21-pair cables to the line side of the distributing frame. This distributing frame is built of iron, and is shown in Fig. 8. It has a capacity for terminals for 6,000 lines and is provided with terminals for 4,800 clips on both the switchboard and the line side. The switchboard terminals and the line terminals are arranged in vertical rows for 100 lines each, the rows for the line terminals alternating with the rows of the switchboard terminals. Cross connecting is accomplished on the back of the distributing frame, which is divided into three portions as shown. Wires from the line terminals are led up or down to large iron rings on the front of the board, through which they are passed to the opposite terminals on the switchboard side, after which they pass down to their respective terminals.

Fig. 9.—Private Branch Exchange Board.

From the switchboard terminals of the distributing frame 20-pair cables lead down under the false floor and through running boxes to the first switchboard section, which in this case is a trunking section. Here the telephone lines terminate in a connecting rack in the rear of this section, while the subscribers' lines and order wires are carried through the two trunk sections to the first subscriber's section. The order-wire circuits terminate at the connecting rack of each subscriber's section, and from the rack they are wired directly to the order-wire keys, placed at the left-hand of the key shelf on each operator's position. These order-wire circuits are, of course, required only for giving instructions concerning a transfer of any connection between the various branch exchanges and the main exchange. The subscribers' lines terminate on a connecting rack on the back of each section, there being, as already stated, 240 lines to each section. From the inside of the connecting rack the wiring is continued, as already described, to the line cut-off relay, and from thence either to the line signals or to the spring jacks, according to whether the line is idle or not.

Trunking between the branch exchanges and the main exchange is carried on by means of 240 incoming and 200 outgoing trunk lines to and from the main exchange. The incoming trunk lines terminate in jacks at the bottom of the switchboard panel on the first two sections, there being 40 to each operator's position. Each incoming trunk section also contains the full number of multiple jacks, so that the incoming trunk operators may complete any connections called for. Two hundred outgoing trunk lines are provided, 100 of which are multipled throughout the first 8 sections and the other 100 are multipled throughout the remaining 9 sections. By means of these, any call originating in the main exchange may be transferred to any of the branch exchanges.

All lines are underground in the entire business section in the heart of the city, and also in a considerable area in East Liberty, South Side, and Allegheny, as well as conduits between these centres. Standard Underground Cable Co.'s cable is used throughout, this being 200 pairs in most cases, although 25, 50, 75, 100, 125, 150, and 175-pair cable is used as required. The conductors are No. 20 B. and S. gauge, double-wrapped with paper for all sizes except the 200-pair, which is single-wrapped. The conduit is of vitrified clay, in 18in. sections, with a 3½in. round opening. All manholes are square, of brick, and on concrete foundations. Extra heavy castings are used for manhole covers, these weighing in most cases 2,600lb. Much of the conduit is laid under the sidewalk on account of peculiar conditions in regard to the re-paving of the streets. Where possible they occur at corners. The longest distance between manholes is 400ft., though the average is much under this. Cook pole-top terminals are widely used, distribution being extensively made from a large ring carrying insulators and secured to the pole by iron brackets just below the pole top. In down-town districts underground distribution is used, a wrought-iron pipe carrying the cable from the manhole to the cable volt or basement of the building. All overhead bare wire is No. 12 B. and S. gauge, hard-drawn copper.

Fig. 10.—Wall Telephone.

Fig. 11.—Desk Telephone.

In addition to the main exchange, six branch exchanges are either completed or well under way. Of these, the

"Bellefield," "South Side," "Lawrenceville," and "Manchester" are of the Kellogg universal type, equipped for common battery throughout, and each has a present equipment of 240 lines, and an ultimate equipment of 1,200 lines, with 20 incoming and 20 outgoing trunk lines. The "East End" and "Allegheny" exchanges are of the same type as the main switchboard, *i.e.*, straight multiple with common battery. The "East End" exchange has a present equipment of 800 lines, with an ultimate capacity of 3,000, with 60 outgoing and 60 incoming trunks. The "Allegheny" exchange has a present equipment of 1,200 lines, and an ultimate capacity of 8,000 lines, with 100 outgoing and 100 incoming trunks. The trunking in all these exchanges is handled in practically the same manner as that of the main exchange. The storage batteries at "Bellefield," "South Side," "Lawrenceville," "Manchester" and "East End" are of the American Storage Battery Co.'s make, there being two batteries of 10 cells each of J4 elements in J7 tanks. At the "Allegheny" exchange, chloride accumulators are used, each consisting of two batteries of F9 cells in F18 tanks.

Beside the large branch exchanges, the company has installed a number of small private branch exchanges in the principal public buildings, these being provided with trunking systems to and from the main exchange. The type of board used on these small exchanges is shown in Fig. 9. This board is provided with rotary self-restoring signals and equipped for common battery service. The desks are finished in mahogany, so as to make an attractive appearance in any office, no matter how elaborately furnished.

The subscribers' wall telephones were made by the Maryland Telephone Manufacturing Co., of Baltimore, Md. These instruments are made under the Kellogg patents and designs. The wall sets are substantially as shown in Fig. 10. The subscribers' desk sets were manufactured by the Kellogg Company, and are shown in Fig. 11.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.

"Manual of Electrical Undertakings." By Emile Garcke. Vol. V. 12s. 6d., net.

"*Proceedings* of the Royal Society." Nos. 436 437, and 438 Vol. LXVII. (London: Harrison & Sons.) 2s. 6d.

"*Proceedings* of the Municipal Electrical Association," 1899 and 1900. (London: Published by the Association). 3s. 6d. each.

"Les Rivières de la Norvège." By G. Saetren. (Christiania: Marius Stammes.) 1kr.

"Science Abstracts." October, 1900. (London: E. & F. N. Spon.) 2s.

"Die Energie oder Arbeit und die Anwendungen des Elektrischen Stromes," by Dr. F. Kohlrausch. (Leipzig: Duncker and Humblot.) 2m. 40.

"The Progress of Invention in the Nineteenth Century," by E. W. Byrn. (New York: Munn & Co.) $3.

"Subject List of Works on the Laws of Industrial Property and Copyright in the Library of the Patent Office." (London: Published by the Patent Office.) 6d.

"La Théorie des Ions et l'Electrolyse." By Auguste Hollard. (Paris: Carré et Naud.) 5fr.

"Jahresbericht des Physikalischen Vereins zu Frankfurt am Main für des Rechnungsjahr, 1898-1899." (Frankfurt am Main: C. Naumann, 1900.)

"English-French-German Technical, Industrial and Commercial Vocabulary." By E. Hospitalier. (Paris: *L'Industrie Electrique.*)

**Therapeutical Treatment with Electric Light.**—According to a Reuter's telegram a recent issue of the *Elektroteknisk Tidsskrift*, of Copenhagen, states that a Danish electrical engineer has invented an electrical lamp which will cause a considerable advance in the therapeutical treatment with light followed by the Danish Professor Finsen. The lamp has been tested at "Finsen's Hospital for Treatment with Light," in Copenhagen, and has been proved to produce in an especial degree those chemical rays which are necessary for the purpose.

## THE WARD-LEONARD SYSTEM OF OPERATING PRINTING MACHINERY BY ELECTRIC MOTORS.

[COMMUNICATED.]

This system has now been in use in the United States for some years and results are reported which are highly satisfactory; many of the users stating that the work accomplished thereby could not be obtained by any other system, electrical or otherwise.

The following account of it may, therefore, be of interest to our readers:—

It is well known that printing machines must be arranged so that they can be driven at any speed varying from full speed down to a very slow speed. To attain this object, when working by electric motors, it is customary to throw in series with the motor a resistance which, at the slowest speed, must be of such size as will absorb very nearly the whole of the energy. This resistance is not only cumbersome and expensive in upkeep, but it absorbs a large portion of the electrical energy.

Further than this, it is necessary to have a massive switch with a large number of contacts, each capable of carrying the whole current, and the contacts, consequently, are continually sparking and wearing away; in fact, the wear and tear of the switch and resistance are very great.

These are some of the disadvantages which the Ward-Leonard system overcomes. In the first place the regulation is done without any resistance whatever in series with the motor, and the only resistance used is a small field rheostat, which, at the most extreme range, absorbs but 2 per cent. of the energy absorbed by the series resistance, while generally it absorbs much less. Further, it is provided with a large number of small contacts, so that, in passing from one to the other, there is not that jump in the speed which is so objectionable when using the ordinary resistance. The accompanying

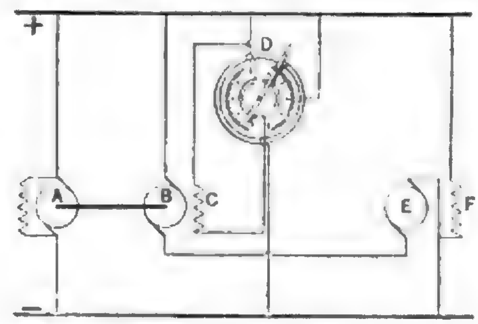


diagram will explain how this extremely fine regulation is obtained. + − are the supply mains, ABC is a motor generator, of which A is the small motor, B the generator armature, and C the generator field, D is a field rheostat for the generator, E is the armature of the driving motor, and F is the field thereof. The motor generator is one-half of the rated power of the driving motor.

It will be observed that each of the fields is excited directly from the mains, independently of its armature. In series with the field C of the generator there is inserted the rheostat D, which can be arranged for reversing as shown in the figure. The motor generator runs at constant speed, but the voltage of the generator armature is varied according to the strength of its field C, so that it can give any voltage from nothing up to its maximum, which, in the particular arrangement shown in the figure, is the same as that between the mains. This armature is connected in series with the armature of the driving motor E so that the current used for driving the motor E always passes through the generator B. It will be seen that, by operating the switch of the rheostat D, the generator B can be made either to assist or to oppose the voltage between the mains + and −; when it is fully excited and opposing the main voltage there is no difference of potential across the motor armature E, and this is the condition when starting. As the rheostat is gradually switched into circuit the opposing voltage of generator B falls, and the armature of the driving motor E rotates at first very slowly, but the current passing may be the same as the maximum load current, so that the torque at starting may be a maximum. This maximum torque, then, is obtained without a resistance in series with the motor armature, for the armature B of the generator has merely a back E.M.F. action which absorbs no energy. As the rheostat is still further switched out of circuit, the opposing E.M.F. of the generator B becomes less and less until it is zero and the motor E is driven at half-speed, having across its terminals the full voltage of the mains. Further, as the field rheostat is reversed and gradually switched out of circuit, the generator B begins to assist the voltage of the mains, and, when the rheostat is finally switched out of circuit, the generator B doubles the voltage of the mains and the motor E works at full speed.

It will thus be seen that the armature of the motor E may always operate with its maximum current, while the voltage supplied thereto varies directly as the speed at which it is desired the motor shall be driven without the use of any resistance or energy wasting device in circuit. It is hardly necessary to point out that, even when the whole resistance of D is in circuit, it is only absorbing a part of the energy in the field circuit C, which, in its turn, is a very small fraction of the total. Indeed, at its worst position, it is absorbing not more than 1 per cent. to 2 per cent. of the total, whereas, with the regulation usually adopted when the resistance is in series with the armature on the motor, the energy wasted in it may be as much as 95 per cent. of the total.

To illustrate this more clearly, let us assume that the voltage across the mains is 200, in which case the motor and dynamo of the motor generator are wound for 200 volts, the armature of the motor E is wound for 400 volts, and its field, F, for 200 volts. If the motor E is for, say, 50 H.P., the motor generator C must be good for 25 H.P. At starting up each of the fields is fully excited across the mains, but the field C of the generator is so excited that the full voltage of the generator armature B, viz., 200 volts, is opposed to that of the mains. Now, as the rheostat D is switched into circuit, the voltage of the armature B falls and allows current to pass through the armature of the motor E, which then starts. When the voltage of the generator B has fallen to zero, the motor E rotates at half speed; the generator field is now reversed and made gradually stronger, so that the voltage is added to that of the mains until there is 400 volts across the motor armature E when it is operating at full load and full speed.

As the current in the field rheostat is very small, it is possible to use a vastly larger amount of contacts than is permissible with the larger resistance above alluded to, there is, consequently, not only a very much smaller current but a less voltage between the adjacent contacts, so that sparking and wear and tear are enormously less. Further than this, removals or repairs are, of course, far less expensive in the case of the smaller article.

For printing purposes, then, it is clear that the Ward-Leonard system is an ideal one, since the machinery has frequently to run at very slow speeds, and it is important to regulate from one speed to the other without any jumps, while the wear-and-tear of the electrical apparatus and the space occupied should be a minimum.

Amongst other places this system has been at work for six years at the calico printing works of the United States Finishing Co., in U.S., where it is found that the work done is all that was claimed by Mr. Ward-Leonard, and that, in fact, the same economical results could not be obtained by any other known system. Another works where it has been in operation for some years is that of the Liondale Bleach, Dye and Print Works, N.J., where the convenience and lack of expense in repairs have fully compensated for the change made from the former system.

Messrs. Geipel and Lange have been appointed sole agents for this system.

## ELECTRICITY WORKS ACCOUNTS.

### Shoreditch Municipal Electric Supply Works.

Our first table this week summarises the accounts of the Shoreditch undertaking for the year to March 25 last. In the form in which they are made up, the relation of the electrical department to that of the dust destructor is accounted for in and referred to, the fuel item. Thus, in addition to the ordinary fuel item for coal (including, as usual, its dues, transport and storing, and amounting this last year to £5,487), there is a corresponding item, being the gross cost (£5,832) of "other fuel" supplied to the destructor, less the income (£3,625) to the destructor, or an additional net charge by the destructor department, on account of fuel, to the electricity department of £2,207. Presumably this charge is the working loss on the destructor after crediting its account with £3,625 charged by the department for the disposal of dust. It does not appear that the amount £2,207 includes capital charges in respect of the destructor works.

To define fairly the reciprocal relations of the electricity and destructor departments is difficult if not impossible, and their joint working, as at Shoreditch, hardly permits of a fair comparison of the electrical department with other electrical undertakings unassociated with refuse works. From the accounts available the charge on account of fuel to the electrical department of £2,207 raises the total fuel cost per unit to a figure—viz., 1·13d. per unit—very slightly in excess of what might have been the fuel item last year were there no destructor.

Criticising the other items of expenditure, those of oil, waste, water, &c., wages at the station, and the collective management and property charges, all present excellent figures even considering the high average load factor of 17·7 per cent. which obtained during the year. The item of repairs and maintenance at the station certainly appears rather high, but with the total costs figure of nearly 2·33d. per unit, little fault can be found—given the fuel item appearing in our table. The output shows the splendid advance of 58·1 per cent. Compared also with the 16·3 per cent. load factor which characterised the year 1898-9 the factor for last year, already referred to, is an excellent sign.

### Islington Vestry Electric Supply Works.

We are glad to find this undertaking making the satisfactory progress it does. Last year material economies were effected in the costs with the result that the aggregate working expenditure fell from 3·23d. per unit to 2·82d. We think the latter figure still leaves room for a possible improvement of, say, 0·4d. per unit, in which the management charges, as well as the works costs, might share. Doubtless the fuel item is little above what might have been expected with the coal prices ruling last year, but are not the oil, &c., and wages items—especially the former, among the generating costs—rather too high?

Good progress is shown by the 38·4 per cent. increase in the equivalent lamp connections and the advance in the output of 47·7 per cent. A most satisfactory change also is that in the load factor of from 13 per cent. to 14·2 per cent. It is interesting to note this factor in relation with the proportion of public lighting, which is nearly half the total output.

Of the total capital expenditure during the year of £71,044, £30,000 was unproductive, £18,000 being in respect of unfinished buildings, and £12,000 for machinery not running at the end of the year.

It may be noticed that substantial reductions have been allowed in the tariff, resulting in an average revenue per unit sold of 4·13d. as against 5·44d. in 1898.

---

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | |
|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 |
| Bath (Municipal) | April 20, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 |
| Belfast (Municipal) | July 6, 1900 |
| Birmingham (Company) | Sept. 15, 1899 |
| Blackburn (Municipal) | Jan. 19, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 |
| Bolton (Municipal) | Nov. 24, 1899 |
| Bradford (Municipal) | June 22, 1900 |
| Brighton (Municipal) | May 4, 1900 |
| Bristol (Municipal) | Aug. 24, 1900 |
| Bromley (Kent) (Co.) | June 15, 1900 |
| Brompton & Kensington (Co.) | Mar. 23, 1900 |
| Barnsley (Municipal) | Aug. 25, 1899 |
| Burton-upon-Trent (Mun.) | April 21, 1899 |
| Bury (Municipal) | Sept. 28, 1900 |
| Cambridge (Company) | April 13, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 |
| Cardiff (Municipal) | Dec. 15, 1899 |
| Charing Cross (Municipal) | Mar. 9, 1900 |
| Chelsea (London) (Co.) | Mar. 23, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 |
| Chester (Municipal) | Aug. 3, 1900 |
| City of London (Company) | June 15, 1900 |
| Clerkenwell (Company) | May 18, 1900 |
| Coventry (Municipal) | Feb. 23, 1900 |
| Croydon (Municipal) | July 20, 1900 |
| Derby (Municipal) | Jan. 26, 1900 |
| Dewsbury (Municipal) | Nov. 24, 1899 |
| Dover (Company) | April 27, 1900 |
| Dundee (Municipal) | Nov. 2, 1900 |
| Eastbourne (Company) | May 4, 1900 |
| Edinburgh (Municipal) | Nov. 17, 1899 |
| Exeter (Municipal) | Aug. 6, 1899 |
| Folkestone (Company) | April 27, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 |
| Guildford (Company) | Oct. 19, 1900 |
| Halifax (Municipal) | Sept. 21, 1900 |
| Hammersmith (Vestry) | June 29, 1900 |
| Hampstead (Vestry) | Oct. 19, 1900 |
| Hanley (Municipal) | July 27, 1900 |
| Harrogate (Municipal) | Oct. 20, 1899 |
| Harrow (Company) | June 16, 1899 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 |
| Hove (Company) | July 6, 1900 |
| Huddersfield (Municipal) | Aug. 17, 1900 |
| Islington (Vestry) | Oct. 27, 1899 |
| Kens'gton & Knightsbr (Co.) | Mar. 16, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 |
| Kingston-on-Thames (Mun.) | July 20, 1900 |
| Lancaster (Municipal) | Jan. 19, 1900 |
| Leeds (Municipal) | Dec. 1, 1899 |
| Leicester (Municipal) | Jan. 26, 1900 |
| Leyton (Municipal) | Sept. 8, 1899 |
| Liverpool (Municipal) | June 22, 1900 |
| London (Company) | June 8, 1900 |
| Londonderry (Municipal) | Feb. 16, 1900 |
| Manchester (Municipal) | Sept. 14, 1900 |
| Newcastle and District (Co.) | Oct. 6, 1899 |
| Newcastle-upon-Tyne (Co.) | Oct. 13, 1899 |
| Newport (Mon.) (Municipal) | Dec. 15, 1899 |
| Northampton (Company) | Oct. 20, 1899 |
| Norwich (Company) | Nov. 17, 1899 |
| Notting Hill (Company) | Mar. 16, 1900 |
| Nottingham (Municipal) | Sept 21, 1900 |
| Oldham (Municipal) | Dec. 1, 1899 |
| Oxford (Company) | April 13, 1900 |
| Pontypool (Company) | Sept. 24, 1900 |
| Portsmouth (Municipal) | Aug. 24, 1900 |
| Prescot (Company) | Dec. 8, 1899 |
| Preston (Company) | Sept. 29, 1899 |
| Reading (Company) | Oct. 13, 1899 |
| Richmond (Company) | June 29, 1900 |
| Salford (Municipal) | Feb. 23, 1900 |
| Scarborough (Company) | July 13, 1900 |
| St. Helens (Municipal) | Dec. 8, 1899 |
| St. James' & Pall Mall (Co.) | Feb. 16, 1900 |
| St. Pancras (Vestry) | June 8, 1900 |
| Sheffield (Municipal) | Dec. 29, 1899 |
| Shoreditch (Vestry) | Oct. 27, 1899 |
| Southampton (Municipal) | Nov. 10, 1899 |
| Southport (Municipal) | July 7, 1899 |
| South Shields (Municipal) | Nov. 9, 1900 |
| Stafford (Municipal) | Aug. 17, 1900 |
| Sunderland (Municipal) | Nov. 9, 1900 |
| Taunton (Municipal) | June 16, 1899 |
| Tunbridge Wells (Mun.) | Sept. 1, 1899 |
| Wakefield (Municipal) | Dec. 1, 1899 |
| Walsall (Municipal) | June 23, 1899 |
| Wandsworth (Company) | May 18, 1900 |
| Westminster (Municipal) | Mar. 9, 1900 |
| Whitehaven (Municipal) | July 28, 1899 |
| Winchester (Company) | Oct. 26, 1900 |
| Windsor (Company) | Dec. 22, 1899 |
| Woking (Company) | Dec. 22, 1899 |
| Wolverhampton (Municipal) | July 27, 1900 |
| Woolwich (Company) | Jan. 12, 1899 |
| Worcester (Municipal) | April 20, 1900 |
| Yarmouth (Municipal) | Nov. 3, 1899 |

| | SHOREDITCH. | | | | ISLINGTON. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Shoreditch Vestry. | | | | Islington Vestry. | | | |
| *Date of Commencement of Supply* | June 23, 1897. | | | | 1896. | | | |
| *System of Supply* | Con. curr. low press. with high-press. motor [trans. in sub-stations. | | | | Alt.-curr. transformer sub-stations and street [transformers. | | | |
| *Chief Engineer* | C. Newton Russell. | | | | Albert Gay. | | | |
| **YEAR ENDED** | MAR. 25, **1899.** | | MAR. 25, **1900.** | | DEC. 31, **1898.** | | DEC. 31, **1899.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 1,276,322 | | 2,135,191 | | — | | — | |
| " SOLD (TOTAL) | 1,031,348 | | 1,630,426 | | 911,571 | | 1,346,437 | |
| " sold to consumers | 892,753 | | 1,263,663 | | 508,559 | | 686,225 | |
| " sold for public lighting, &c. | 138,595 | | 366,763 | | 403,012 | | 660,212 | |
| " used on works | 59,666 | | 234,941[i] | | — | | — | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 46·9 | | 36·0 | | 19·4 | | 28·7 | |
| Maximum supply demanded | 720 kilowatts | | 1,050 kilowatts | | 800 kilowatts | | 1,080 kilowatts | |
| Number of public lamps | 151 arc, 302, 32 c.p. glow | | 169 arc | | 216 arc | | 330 arc | |
| Number of consumers | 333[a] | | 595 | | 341 | | 453 | |
| Connections to mains in 8-c.p. lamps | 40,000[a] | | 53,000[a] | | 27,782[a] | | 38,458[c] | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 22,000 | | 45,300 | | 46,900 | | 46,900 | |
| CAPACITY OF PLANT IN KILOWATTS | 705 | | 1,450 | | 1,500 | | 1,500 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | £85,934 | £122 | £121,364 | £83·7 | £191,300 | £128 | — | — |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 85,934 | 122 | 121,364 | 83·7 | 191,300 | 128 | — | — |
| RECEIVED (TOTAL) | 93,075[b] | 132 | 123,400 | 85·0 | 191,300 | 128 | £240,585 | £160 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 92,842 | 132 | 121,364 | 83·7 | 191,300 | 128 | 240,585 | 160 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | nil | — | nil | — | nil | — | — | — |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | — | — | — | — |
| REPAID (TOTAL) | 1,737 | 2·46 | 2,925 | 2·02 | 3,813 | 2·54 | 6,386 | 4·26 |
| RESERVE OR SINKING FUND | — | — | 1,011 | 0·69 | — | — | — | — |
| DEPRECIATION FUND | — | — | | | — | — | — | — |
| EXPENDED (TOTAL) | 116,032[c] | 165 | 170,383 | 117 | 188,518 | 126 | 259,562 | 173 |
| Lands and buildings | 35,699 | 50·6 | 46,246 | 31·9 | 60,367 | 40·2 | 79,160 | 53·0 |
| Plant | 40,169 | 57·0 | 59,367 | 40·9 | 61,133[b] | 45·4 | 87,871[h] | 58·6 |
| Mains | 36,486 | 51·8 | 58,595 | 40·4 | 59,145 | 39·4 | 91,123 | 60·8 |
| Miscellaneous | 3,677 | 5·22 | 6,175 | 4·26 | 854 | 0·57 | 1,104 | 0·736 |
| BALANCE OF CAPITAL ACCOUNT | − 22,958[d] | 32·6 | 46,983[c] | 32·4 | 2,782 | 1·85 | − 18,977[c] | − 12·7 |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
| TOTAL | £13,769 | 3·206d. | £22,008 | 3·241d. | £21,217 | 5·590d. | £25,332 | 4·515d. |
| Revenue from supply | 10,938[e] | 2·547d. | 16,771 | 2·470d. | 12,274 | 3·230d. | 15,207[f] | 2·713d. |
| " meters, &c. | 25 | 0·006d. | — | — | 296 | 0·078d. | 382 | 0·068d. |
| " public lighting | 2,489 | 0·579d. | 5,144 | 0·758d. | 8,396 | 2·210d. | 9,636[g] | 1·717d. |
| " sale of lamps, &c. | 239 | 0·056d. | 10 | 0·001d. | — | — | — | — |
| " miscellaneous sources | 78 | 0·018d. | 84 | 0·012d. | 250 | 0·066d. | 116 | 0·021d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £6,152 | 1·432d. | £15,802 | 2·327d. | £12,252 | 3·226d. | £15,812 | 2·819d. |
| WORKS COSTS | 4,921 | 1·146d. | 13,732 | 2·023d. | 9,901 | 2·607d. | 12,844 | 2·290d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 1,376 | 0·320d. | 7,691[i] | 1·133d. | 4,614 | 1·215d. | 5,707 | 1·018d. |
| Oil, waste, water, stores | 465 | 0·108d. | [illegible] | [illegible] | 901 | 0·237d. | 1,331 | 0·237d. |
| Wages at station | 1,438 | 0·335d. | 1,687 | 0·248d. | 2,317 | 0·610d. | 2,952 | 0·526d. |
| Repairs and maintenance at station | 751 | 0·175d. | 2,018 | [illegible] | [illegible] | 0·224d. | 917 | 0·164d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 186 | 0·043d. | 559 | 0·082d. | 165 | 0·043d. | 391 | 0·068d. |
| Repairs, renewals of mains, &c. | 319 | 0·074d. | 389 | 0·057d. | 90 | 0·024d. | 228 | 0·041d. |
| *Public lighting* | [illegible] | [illegible] | 716 | 0·105d. | [illegible] | [illegible] | 1,327 | 0·237d. |
| Attendance | 382 | 0·089d. | 716 | 0·105d. | 435 | 0·131d. | 729 | 0·130d. |
| Renewals | 4 | 0·001d. | | | 468 | 0·123d. | 598[l] | 0·107d. |
| MANAGEMENT AND PROPERTY CHARGES | 1,231 | 0·287d. | 2,070 | 0·305d. | 2,351 | 0·619d. | 2,969 | 0·530d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | 76 | 0·018d. | [illegible] | [illegible] | [illegible] | 0·175d. | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | 1,701 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | 596 | 0·139d. | 892 | 0·131d. | 1,045 | 0·275d. | 1,365 | 0·244d. |
| Stationery, &c. | 105 | 0·024d. | 137 | 0·020d. | 168 | 0·044d. | 152 | 0·027d. |
| Establishment charges | 194 | 0·045d. | 271 | 0·040d. | 170 | 0·045d. | 199 | 0·034d. |
| Law charges, &c. | 260[k] | 0·061d. | 401[k] | 0·059d. | 305[c] | 0·080d. | 442[m] | 0·079d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. expended | Total. | % to mean cap. expended | Total. | % to mean cap. expended | Total. | % to mean cap. expended |
| WORKING PROFIT FOR YEAR | £7,619 | 7·47% | £6,206 | 4·33% | £8,965 | 5·39% | £9,521 | 4·25% |
| Sum carried to Depreciation Fund | | — | 1,000 | 0·698% | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 916 | 0·898% | 1,147 | 0·801% | 1,952 | 1·17% | 2,573 | 1·15% |
| Net interest on loans (incl. Debenture charges) | 2,147 | 2·11% | 4,496 | 3·14% | 4,806 | 2·89% | 6,566 | 2·93% |
| BALANCE FROM LAST ACCOUNT | − 1,883 | 1·85 | 6,464 | 4·51 | — | — | — | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 6,461 | 6·34% | 6,027 | 4·21% | 2,207 | 1·33% | 381 | 0·170% |
| *Deficit* | — | — | — | — | | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | — | — | — | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 44·7% | | 71·8% | | 57·8% | | 62·5% | |
| Expenditure per kilowatt capacity | £8. 14s. 7d. | | £10. 18s. 0d. | | £8. 3s. 5d. | | £10. 10s. 10d. | |
| REVENUE PER KILOWATT CAPACITY | £19. 10s. 10d. | | £15. 3s. 7d. | | £14. 2s. 10d. | | £16. 17s. 7d. | |
| Expenditure per 8-c.p. lamp capacity | 5s. 7d. | | 6s. 11d. | | 5s. 2d. | | [illegible] | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 12s. 6½d. | | 9s. 8½d. | | 9s. 0½d. | | 10s. 10d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 6s. 10½d. | | 8s. 3½d. | | 15s. 3½d. | | 13s. 2d. | |
| Price charged for lighting, per unit | 5d. to 2½d. | | 5d. to 2½d. | | [illegible] to 3½d. | | 7d. to 4d. | |
| Price charged for power, per unit | 3d. | | 2d. to 1½d. | | [illegible] | | [illegible] | |
| Price charged for public lighting | — | | 2½d. per unit | | 5d. per unit inclusive | | 3½d. per unit | |

SHOREDITCH.—[illegible] ... expenditure in respect of central station site for three years ... [illegible] ... n Includes insurance [illegible]

ISLINGTON.—[illegible] ... Maximum demand system, [illegible] per unit first hour [illegible] per unit for second hour of maximum demand and [illegible] per unit after. The daylight supply for any purpose [illegible] ... [illegible]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | | HALF-YEAR | | QUARTER | |
|---|---|---|---|---|---|---|
| United Kingdom | 26s. 0d. | ... | 13s. 6d. | ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | ... | 16s. 0d. | ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## ELECTRIC PROPULSION ON CANALS.

Experiments have been conducted from time to time and in various countries with a view to ascertain the applicability of electric propulsion to canal boats. Probably the best known of these experiments is that which was carried on for some time and on a comparatively large scale on the Erie Canal, in the vicinity of Tonawanda, N.Y. But several years have already elapsed since that experiment was abandoned; and it has not yet resulted in any permanent adoption there of electric propulsion. Quite recently, however, trials have been instituted nearer home, the Prussian Government having appointed the well-known firm of Messrs. SIEMENS AND HALSKE to equip electrically a short length of the Finow Canal. The results achieved are stated in a report from H.M. Consul-General at Frankfort to show the system "to be capable of meeting all needs, working as it did with safety and economy." The particular system adopted by Messrs. SIEMENS AND HALSKE is one that comes under the category of electric traction rather than of electric propulsion; for, these engineers have retained the ancient and hitherto essential towpath, and, merely giving the canal horse its *congé*, have equipped the towpath with an electric railway and towing locomotives. Further details of the system are disclosed in the following extract from the report already mentioned:—

The scene of operations was a short length of the Finow Canal, which forms a portion of the waterway between Berlin and Stettin and is traversed every year by about 25,000 to 26,000 boats each way. The craft used are, in the main, barges some 132ft. long by 15ft. 6in. beam, carrying 150 tons to 175 tons. There are also a few steam barges employed, which carry about 150 tons and can tow a second barge. The traffic to Berlin is much heavier than toward Stettin, and, as a consequence, three-fourths of the barges return light from the metropolis. Traction is generally effected by horses, there being a towpath on each bank, but on the down journey man traction is not infrequently relied on. In any case the speed is low and, including stops, does not average more than about 1½ miles per hour.

The section of canal used for the experiments was selected owing to its physical difficulties, presenting as it does several curves, in one of which

with only 328ft. radius the waterway is spanned by a railway bridge. The line laid down for the towing engine was of 1·metre (3·28ft.) gauge, the outer rail weighing 18·2lb. per yard, while the inner, which was fixed on the inner edge of the towpath, weighed 9·1lb. per yard. These rails, which were of the flange type, were laid partly on sleepers ballasted with gravel and partly on blocks of concrete, weighing 220lb. each in the case of the heavier principal rail, and half this in case of the other rail. This arrangement costs more per mile than the sleepers, but has been found less expensive to maintain. Though no wharf actually existed on the length of canal experimented on, the arrangements necessary were fully tested. At one point, the line was raised to a height of 9ft. 6in. above the level of the towpath, being carried on posts and brackets. The carrying posts were 12in. in diameter, and were spaced at 18ft. 8in. A cap piece spanned the gap between posts, and the principal rail was laid directly on this cap piece, while the other was carried by a stringer, supported at each post on brackets.

A modified form of trolley system was used for supplying current to the locomotives, which were 6ft. 10in. in length and 4ft. 10in. wide, and weighed 2 tons each :—

The conductor for the current was supported on pine posts 23ft. long, located 35yds. to 44yds. apart. It consisted of 8mm. wire carried by porcelain insulators. The principal rail served as conductor for the return current. The source of power was a 15 H.P. portable engine, driving a 9kw. dynamo ; and a large storage battery was also provided. . . . . The motor was so placed that only one-fifth of its weight came on the accessory rail. The motor provided was much more powerful than necessary for the work in hand, as it was capable of working at the rate of 14 H.P. to 15 H.P. Since, however, these experiments were merely preliminary ones, intended to test the possibilities of electric traction for large barges, the excess power was supplied intentionally, and the resistance requisite to call forth the full powers of the motors was in some of the experiments provided by rafts.

It has been suggested on more than one occasion that the equipment of British canals for electric traction or propulsion would go far towards arresting the steady decline of inland water traffic which has been noticeable since the development of railways. When we are brought face to face with such experiments as those which have recently been made by the Prussian Government on a portion of the Finow canal, two principal questions naturally arise, viz. :—Is electric propulsion commercially practicable on British canals? and, What is the best electrical system for the purpose? Dealing with these questions in their natural order, we must first of all recognise that the real essence of canal traffic—in a country well supplied with railways—is its cheapness. Only by virtue of the much lower cost at which goods can be sent by canal, as compared with other forms of transportation, can canals have any *raison d'être*. In other respects, such, for instance, as speed and general convenience, canals are hopelessly handicapped. Indeed, one of the main drawbacks to the sending of goods by canal is frequently the great length of time occupied in the journey. Yet, in spite of the fact that the speed is only one-tenth or less that of a goods train on a railway, a considerable volume of traffic is annually carried over these British inland waterways. There is another, and perhaps still more formidable, obstacle to the growth of canal traffic in this country, viz., that nearly all the principal canals are controlled by railway companies, who, recognising in them a serious competitor for certain classes of goods traffic, have done their best to hamper and throttle their more ancient rival. Before the advantages of canals can be freely and fully developed in this country, it will probably be necessary for Parliament to take the matter in hand, and enforce such regulations and rates of charges as will place this mode of transportation on an equitable footing. Bearing all these facts in mind, it will be seen that there is little inducement to a general introduction of electric power on British canals, though here and there throughout the country there may be short lengths of canal presenting sufficiently favourable conditions. With regard to the low speed of canal traffic, it is a mistake to assume that this is merely owing to the use of animal power. Even were electric propulsion or traction to be adopted, only a comparatively small increase of speed would be generally practicable, and there are two main reasons for this state of affairs. In the first place, the majority of canal banks are so constructed that they would not withstand the wash due to increased speed of traffic, and every increase in speed would raise the cost of maintaining the canal throughout its length. In the second place, owing to the limited passageway of a canal boat through a canal, the power required for propulsion increases rapidly as the speed is increased—*i.e.*, it rises in a much greater ratio than would be the case were the canal boat moving in a deep and expansive sheet of water. Both these facts serve to show that any considerable increase in speed must result in serious augmentation of working cost; and, inasmuch as low cost is the one vital qualification in canal traffic, any great increase of speed is thus seen to be prohibitive.

Considerable time is, therefore, likely to elapse before the second question—What is the best electrical system?—presses for serious consideration. If, at the time when that question becomes prominent, the state of the secondary battery industry has not greatly improved, it may safely be predicted that the system favoured by engineers will then be, as it would be to-day, one involving the transmission of electric power through a conductor from a power station to the canal motors. Undoubtedly, the invention of a lighter and more durable storage cell would enormously facilitate the solution of this problem, for it would at once render unnecessary all structural work along the canal bank for the trolley wire or its equivalent, erections which must represent a considerable proportion of the capital outlay. Assuming, however, that something in the nature of a trolley wire is still essential, the problem next resolves itself into a question as to the relative advantages of electric traction and electric propulsion. By the former we mean those systems in which the motor actuates a towing locomotive outside the canal vessel and placed either on the towpath or on a suspended wire; by the latter we mean the use of an electric motor to propel a vessel by the action of a screw or other form of propeller on the water. The broad distinction between these systems lies in the fact that with propulsion the water is disturbed and agitated by the motor, whereas with traction the only agitation of the water arises from the movement of the vessel—a matter of no small importance in minimising wash against the canal banks. But while this consideration is decidedly in favour of the traction method, it will readily be perceived by electric traction engineers that the very low speed at which the locomotive must move is an altogether unusual and undesirable condition in the design of the locomotive, especially where the tractive effort must be very large, as is the case when hauling a train of canal boats. Considering the low speed, it seems a much simpler solution to adopt electric tow-boats, propelled by means of screws of a pitch that would adapt a high-speed motor to a slow-speed barge. Probably the initial cost of the electrical equipment in the latter case would be much lower than in the alternative method adopted by Messrs. SIEMENS AND HALSKE. But, as we have already remarked, the time is not yet ripe for a thorough and final comparison between the relative merits of these two systems, at any rate so far as concerns British canals. Meanwhile electrical engineers will look forward to the continuation of Messrs. SIEMENS AND HALSKE's instructive experiment, from which further valuable information should be forthcoming on a subject that, but for the adverse influence of the railway companies, would be of greater importance than it is to-day.

## NOTES ON THE ELECTRIC AUTO-CAR TRIAL.

BY MERVYN O'GORMAN.

Last year the Automobile Club, or rather that body which was and is incorporated with it, the Liverpool Self-Propelled Traffic Association, held trials in Liverpool on heavy (oil and steam) cars carrying loads of upwards of 5 tons. One of the features was a steep gradient purposely made greasy with soap and water. There was a certain resemblance to this in the electrical trials held under the auspices of the Automobile Club at Chislehurst on November 6th, 7th, 8th, and 9th. There was no necessity for artificial lubrication. Some of the long hills took 20min. to climb, and were covered with a thick layer of mobile cream. The German word aptly describes the surface of the roads, they were *smeary*; but electrical cars, owing to their accumulators, did not develop the fault which was so unexpected a characteristic of the heavy trials at Liverpool—namely, that the *unloaded* vans had not sufficient grip of the ground to climb the gradient. There was a little skidding, but in no instance did a car turn completely round like a shying horse and start downhill despite the steering and all the efforts of the driver.

One of the foremost recommendations of the judges at Liverpool was for more care in fixing split pins, lock-nuts, cotters, &c., and it is to be remarked that either the electrician's experience with high speed machines or the simplicity of the motive mechanism has removed this apparently trivial, yet most frequent cause of trouble. The same authoritative advice in favour of wheel and gear steering was only followed in one or two instances, notably not by the Krieger car (42½cwt.) whose front wheels are moved by a system of levers.

It is well to refer at the outset to the difference between the well-solved tramway engineering problem and the autocar. In the latter we have all the former difficulties *plus* (1) steering (with attendant skidding), (2) varieties of track (with enormous frame strains where there are four wheels), (3) the necessity for carrying the power supply, and (4) trouble with tyres. These are points one unconsciously bears in mind, particularly in the case of larger cars, and they explain the keenness shown by the observers to be entrusted with making the records of the two large cars rather than some of the small ones that competed for the "indefinite distance on one charge" run. Their unusual appearance and their great cell capacity (70 and 80kw. hours) alone would account for this, apart from the fact that they were expected to run some 150 miles, like the B.G.S. electric car in the Paris Exhibition.

One fact was developed by the electrical trials which was not anticipated and which is probably only a coincidence, namely, that with one exception* the heavier the car (viz., from 19cwt. to 60cwt.) the greater was the speed for which it was designed and run. If we eliminate the cars that failed to complete the runs, we find they were handled by the drivers, whether on hill climbing, average road, or long distance runs, as if it had been agreed by common consent to produce a proportionality between pace and weight. This is the more notable as the Club laid no stress on the speeds, and carefully removed from the competition all character of a race.

The present results of 10·92 miles per hour for 59 miles does not compare unfavourably with the speed trial in Paris in July last year, when 23·3 miles per hour were covered for 31 miles in a race won by Mr. Phillipart on a Columbia car with Phœnix accumulators. In the present case, not only were the roads much worse, but the distance was nearly double. It is particularly regrettable that the Columbia Stanhope phaeton, which made an appearance at Chislehurst with a new battery (the Lecoll), was withdrawn almost immediately, as the comparison would have been interesting.

For whatever purpose an "Accumobile" is intended, there is necessarily much difficulty in deciding whether a large or small battery is best. In the present trials we saw competing, without handicap, on the same runs, widely different weights of battery, with results favourable indeed to the larger battery, but by no means convincingly so, for we must remember that, in a country place where one is fortunate enough to get current at 6d. a unit, a charge of 70 units is a ruinous price to pay, even for a 59 miles run, apart from the probable higher cost of upkeep of the larger battery. Besides the doubt as to the best battery, is the graver one as to whether electric cars have any important prospects outside of town work for touring. This doubt is not shaken by the *tour de force* accomplished by the Krieger car which took part in the club run from London to Southsea with the help of a small charge at Guildford.

No one who takes the trouble to examine the results hitherto available of the trial will be surprised to find that the last "unlimited distance run on one charge" was less than the first, both in speed and length. How far this decrease would continue is exactly what the Paris Automobile Club set out to determine at very heavy expense last year in their accumulator trials. The results obtained were valuable, though marred by one or two accidents and mistaken arrangements, and, as it happens, not one of the cells there tried made its appearance at Chislehurst.

There is nothing more remarkable about the Chislehurst trials than the fact that the much-advertised accumulator companies whose names are familiar to all the electrical community were entirely unrepresented. There were no Chloride, E.P.S., Tudor, Phœnix, Pescetto, Fulmen, Blot, Monobloc, or D.P. cells in use. Each car maker or owner ran his own cell. No trouble was anticipated or occurred in the motors or control, with few exceptions, so that the trials (save in so far as the judge's report will take all these matters into consideration) must be looked on practically as accumulator tests, whose value would be rather doubtful were it not that such names as Boys, Holden, Swinburne, Preece and Trotter among the judges are a full guarantee that no erroneous significance will be attached to the results.

No. 1 car, "The Powerful," by Krieger, weighing 42½cwts., and seating two persons, contains 60 Lecoll accumulators, type 80 EE, with deposited zinc negatives and lead peroxide positives in a porous pot. These were able to be charged at 200 volts constant pressure and about 100 amperes. The car is built by the Compagnie Parisienne des Voitures Electriques for the British and Foreign Electrical Vehicle Co. It is fitted with two Krieger motors—one driving each front wheel. These motors are hung on springs, and rise or fall on the arc of a circle, corresponding to the circumference of the spur wheel on the driving wheel. The controller is fitted vertically around the steering shaft, and the controlling lever works horizontally immediately under the steering tiller. There are six speeds forward and one reverse, an electrical brake, recuperation of the batteries in series and in parallel. The car takes 35 amperes on the level road, running from 12 miles to 15 miles an hour, and the capacity of the battery is 270 ampere-hours. It ran 59 miles at 10·9 miles an hour. The other large car, "Toujours Contente," No. 5, was by Lohner (Vienna), and was said to be capable of going some 40 miles an hour; though, of course, it was intended for long distances, and was not built to compete with the celebrated "Jamais Contente," which weighed a ton and ran a kilometre at 65·8 miles an hour. It was so built as to be immediately nick-named the "Torpedo." It has four 2¼ H.P. ungeared hub motors, and, like other electric automobiles hitherto sent up to exhibits and trials, is remarkable for this small horse-power as compared to the 50 H.P. on the motors of tram cars, which do not carry many times this weight nor pretend to such high speeds. On a smaller scale the same was to be noted in the Automobile Club trials (Paris), June, 1898, when five vehicles, all carrying over 30cwt., had an average normal motive power of 3½ H.P. The armatures of the "Toujours Contente" No. 5 (inside which are the commutators) are fixed to the wheels; the field magnets are keyed to the axles. It weighs 3½ tons without passengers, and carries 70 Lecoll cells. The controller gives four speeds ahead, three back, and an electric brake. The wheels are small, measuring only some 30in. diameter, with large pneumatic tyres of Austrian make, 120mm. diameter, containing air at 160lb. pressure. The danger of skidding, which is great with such tyres, is reduced to a minimum in both these cars by the fact that there is power on the front wheels, thus making the steering positive. This steering is effected on the inclined

* The Canadian Motor Co.'s "Still" motor car weighs 18¼cwt.

wheel principle. The frame is throughout made of double tubes having the section of two crushed O's. From it is hung, by means of 16 spiral springs each 8in. high, the box containing the cells. This box also constitutes the four passengers' seat. Mr. Worby Beaumont's criticism that the design, as a whole, of motor cabs has not been reached, "the procedure being to obtain and combine various separate elements as well as these permitted" was in this instance certainly avoided. It is probably safe to say that an upset is out of the question, as the wheel base is exceedingly broad and the weight low down between the axles. Otherwise Tuesday's journey would have been a perilous one.

The starting current on No. 1 did not exceed 160 amperes, and on No. 5 probably not 200 amperes at 80 volts, though unfortunately in the second case the instrument scale did not extend far enough for the top readings. The four hub motors were all switched on and off together, and the battery always used in two halves in parallel, no alteration of the battery arrangement being made by the controller. The distance run by this machine was disappointing—viz., 38 miles. This is ascribed to the copper connections between the sections of the cells being badly screwed up. A 150-ampere arc occurred on a big hill, and the head lugs of two of the cells were fused when their E.M.F. was most wanted. Besides this, dirt got into the right-hand rear band brake when going up the severest of the hills, the brake seized, the locked wheel was dragged up some 20 yards by the other three, and eventually the voltage was so lowered as to be insufficient to surmount the Orpington-Chislehurst hill. In spite of this, both performances do some credit to the new cell without of course showing anything as to its endurance, efficiency, or cost of upkeep. The weights of the completed cars show that special lightness is not claimed for it.

There is but little information available in regard to lead-zinc batteries. The 25 per cent. increase in E.M.F. is a clear gain. The dissolution of the zinc, even when amalgamated, on open circuit is a countervailing disadvantage which appears to have been got rid of at any rate in Regnier's battery by Werner's use of cadmium sulphate in the electrolyte together with a little magnesium. The *Eclairage Electrique* published results in 1898 which showed that with pure zinc sulphate the lead positive was not fully peroxidised; with cadmium sulphate the watt-hour capacity was diminished, but the addition of magnesium sulphate to both the other sulphates for some unexplained reason restored the balance and gave good results. The exact procedure in the Lecoll battery is not yet published, but it apparently does not attempt to obtain the 16 watt-hours per pound of total cell claimed for Werner's accumulator.

A very creditable performance on the first day was made by a voiturette for two persons and weighing 19 cwt., by Joel (No. 8) (described in last week's *Electrician*), the distance on one charge being 34¾ miles at 6·6 miles per hour.* The voltage on the Rosenthal and Sussman battery at the start was 33, and at the finish 30 (when giving the normal output). A further distance was possible, but the driver refused to run his cell down lower than 1·9 volts. Considering the enormous difference in size and weight between this and No. 5 car, and that it did more than half the useful work, namely, the conveyance of two passengers, this performance makes some case for avoiding unwieldy batteries when pace is not required as well as distance.

No. 11, a waggonette car by the Electric Motive Power Co., also described in last week's *Electrician*, ran the 34¾ miles of the first part of the course, but the driver was obliged on the next charge to ask permission to change three or four of the cells, a fact which must necessarily detract a little from the merits of their run. From the average voltage of 2·35 per cell this one also contains zinc. It was said that one of the new cells was accidentally connected in opposition during the first part of the charge, so that the car was not proportionately advantaged on the next or hill-climbing trial on Wednesday.

Previous to the first charge, all cells were specified to be run down to 1·8 volts (or 2 volts, the corresponding E.M.F. for zinc-lead cells) and the energy put in was measured by Mr. Llewellyn Preece, who kindly undertook the work, and has earned for it the thanks of the Automobile Club. Mr. Preece proposes to plot curves showing the watts put out by each car on each part of the route, and these results, which involve a considerable amount of work, will doubtless be published by the Club in due course.

The bad roads on the long-distance trial had so aggravated the difficulties of the hills that the gradients of the climbing trials were thought comparatively little of. The Austrian who drove the "Toujours Contente" (No. 5) had been so awed by his mishap on the long-distance run, that when an unofficial but officious friend told him that it was "nothing to what he would have to do on the hill trials," he promptly withdrew the car, and was much mortified when he saw that the hill trial was after all very reasonable. His petition to be re-entered was very naturally refused by the judges, who could not establish a precedent by which cars could be withdrawn from their supervision in the course of the tests and then re-entered on the same footing as competitors who had not such opportunity of effecting unrecorded alterations. As a matter of fact, Mr. Cozens Hardy's services were enlisted to act as an unofficial but independent observer on the third day. Several interesting feats were performed, amongst others, that of moving the 3½ tons at 40 miles an hour on the road for considerable distances; the same route as the other cars was followed, and only departed from because of a burst tyre, which ended its proceedings temporarily at Dunton Green, whence it humbly crawled on the following day behind two horses to the nearest electricity supply.

The hill trial run was of 21½ miles, through Orpington, Cudham, Knockholt, and Blacksmith's Hill, with an additional steep bit through Foots Cray. Cars Nos. 1, 8, 11, 12, 13, completed, as was expected, the first circuit. The electrical world has long known that any hill can be negotiated with even moderately skilful design if only the current is available, and more than one accumulator expert is convinced that accumobiles have suffered terribly in reputation from the ignorance of their users in discharging their cells too fast and too low. This same ignorance or excessive hopefulness in the designers is accountable for the absence of two-speed gear in almost all the cars at the trial. It is true that abnormal power can be got from a motor at an abnormally low speed, but this is not a sufficient reason for sacrificing the life of both motors and cells to save the weight of the extra gear. There can be little question that mechanical gear allowing a small movement of the car to correspond to the full normal speed of the motor would have greatly helped most of the competitors. One car, Joel's, actually claims this as a *special* feature.

The brakes, which naturally came into prominence on the hill trials, showed a good deal of faulty design. The band brake, which only acts for rotation in one direction, is often a snare, and the important bell-crank arrangement by which the ends of the band are fastened each to one limb of the crank in such a manner that both are tightened simultaneously, has not yet sunk into the minds of some designers. The necessity for the braking effect on each brake wheel being identical has also failed to be universally recognised, and in a dangerous place we saw a car, of which one wheel was stopped before the other, swing round on the fixed wheel as pivot till it was completely out of control, and then start to skate down into an open drain—from which it was only saved by removing the brakes, and applying the power at a time when farther pace was the last thing those on board would naturally desire.

Some of the controllers divided their battery into a large number of small units in parallel for hill work; this device, useful at first, is most pernicious after the cells have had a little rough usage. The voltage of some of the cells gets lower than others, and heavy balancing currents are taken from the good cells just at the time when all their energy is required on the road. This is particularly important when a cell has had to be cut out, as occurred at Chislehurst more than once.

Joel's car was hampered by losing the use of one of its motors through its chain riding over the pinion. The Krieger car missed one of the steepest hills by losing its way, and the "Still" motor (No. 18) carried four persons round the 21½ miles in two hours.

[* See letter from Mr. Joel in our correspondence columns this week.—Ed. *E.*]

On the fourth day operations were commenced by officially weighing the empty cars at Joynson's paper mills. Although most of the cars were being run by their designers, owners, or other responsible persons, it was more than remarkable what ignorance was displayed of this absolutely cardinal quality. Most competitors imagined their cars to weigh 30 per cent. and 50 per cent. less than they were found to be. Some were tempted to cast a doubt upon the weighbridge. Onlookers could not but feel critical about a design which was meant to bear 12cwt. instead of an actual 19cwt.

No. 8, the Joel carriage, had considerable ill luck, having four consecutive tyre bursts or punctures, which practically limited its run to the distance of the weighbridge station and back. The accident to one of its chains on the previous day had reduced it to one one-horse motor instead of two, so that its energetic owner was reluctantly driven to return home with the falling light without having used more than a fraction of his accumulator charge.

The road records of these runs were published in last week's *Electrician*.

## THE MANUFACTURE OF CALCIUM CARBIDE.

BY JOHN B. C. KERSHAW, F.I.C.

### I.—COMPARATIVE FURNACE EFFICIENCIES.

I. Introduction.—In the issue of *The Electrician* for the 27th of September last will be found an abstract of a Paper read by M. Keller before the Paris Congress of electro-chemists and electro-metallurgists. This Paper dealt with the subject of electric furnaces, and details were given relating to the efficiency and output of some of the latest forms of carbide furnace. In the editorial notes upon this Paper, appearing in the same issue, the discrepancy between the theoretical yield of carbide per kilowatt day, as calculated by different authorities, was pointed out, and it was shown that, taking M. Keller's best figures (6·2kgs. carbide per kilowatt day), the furnace efficiency according to some estimates was only 62 per cent. of that theoretically possible.

In view of the important position which the carbide industry has now attained in Europe and America, it is of interest to examine the various figures relating to the theoretical and actual yield of carbide furnaces more closely. Competition has now become very keen in this new electro-metallurgical industry, and the break in price of the product which has already commenced and is likely to continue, will operate to crush out all the badly-managed and inefficient factories. The cost of electrical energy is the chief factor in determining the cost of carbide production, and to obtain the highest possible electrical efficiency in the furnace will therefore be a *sine quâ non* of the continued operation of the majority of carbide works.

In the middle sections of this article the writer has therefore brought together all the available information relating to the efficiency and yield of carbide furnaces, and in the concluding section he has formulated the chief lessons which may be derived from a study of these figures. No doubt each carbide manufacturer will decide that the special circumstances which govern the operation of his own works, render an increased output of carbide per kilowatt day impossible. It will stimulate a desire to improve, however, if he can be convinced that vastly superior results are being attained in other works operating under somewhat similar conditions; and as already pointed out, failure to attain the maximum output per kilowatt day may lead to the financial failure of his factory. In the early days of a new industry, inefficient working of the process may be expected and tolerated, but when competition has had time to make itself felt, inefficiency is a very short and certain road to the Bankruptcy Court.

II. Calculations of the Theoretical Yield of Carbide Furnaces.—1. Pictet calculates from thermal data that the expenditure of electrical energy should be equal to 2,856 calories per kilogramme carbide.—*Le Carbure*, 1896, p. 28.

2. Sieber calculates from similar data that the electrical horse-power day should yield 9·38kgs. carbide.—*Chemiker Zeitung*, Vol. 22, p. 308.

3. Wolff gives 7kgs. carbide per electrical horse power day as theoretical yield.—*Zeits. f. Angew. Chemie.*, 1898, p. 919.

4. Haber calculates from thermal data that 4,480 horse-power-hours yield 1 ton carbide—"Elektrochemie," Chapter X.

5. Gin, from similar data, calculates that 3,837 kilowatt-hours should yield 1 ton carbide.—*Éclairage Électrique*, May 6, 1899.

6. Allen calculates, from thermal data, that 4,117 B.T. units are required to produce 1 ton carbide.—*Electrical Review*, January 5, 1900.

7. Bredel calculates that 2,117 calories are required to yield 1kg. carbide.—*American Gaslight Journal*, 1895, p. 261.

8. Lewes calculates that 2,813 calories are required per kilogram—80 per cent. carbide.—"Acetylene," 1900, p. 301.

9. Addicks calculates that the theoretical yield of carbide is 16·22lbs. per electrical horse-power day.—*Mineral Industry*, Vol. VI.

Taking these nine estimates and reducing them to comparable form, we obtain the figures given in Table I.

Table I.—*Kilowatt Hours theoretically necessary to produce 1 Metric ton (2,204lbs.) of Calcium Carbide containing 80 per cent. Carbide.*

| Authority. | Reference No. | Kilowatt hours. |
|---|---|---|
| Sieber | 2 | 1,523 |
| Addicks | 9 | 1,941 |
| Bredel | 7 | 1,960 |
| Wolff | 3 | 2,043 |
| Pictet | 1 | 2,640 |
| Haber | 4 | 2,670 |
| Gin | 5 | 3,069 |
| Lewes | 8 | 3,290 |
| Allen | 6 | 3,293 |

These results show such wide variations that it is evident they are based in some cases upon incorrect data. Lewes has pointed out in his recently published work upon acetylene * that the sources of error in such calculations are numerous. In the majority of instances, no allowance has been made for the waste of materials in the furnace. In the case of the lowest estimate given above (that of Sieber) the low total of 1,523 kilowatt-hours is arrived at by neglecting to allow for the heat required to raise the raw materials to the temperature at which the reaction takes place—that is, by neglecting between 30 per cent. and 50 per cent. of the heat-energy required.

The specific heats of the materials used, however, undergo change during the reaction, and it is almost impossible to fix upon any value that shall represent the mean specific heat for the two extremes of temperature—namely, 15 C. and 3,000 C. Weber† has shown that the specific heat of wood charcoal increases with the temperature, and his experiments yielded the following values for temperatures up to 900°C.:—

| Temperature. | Specific heat. |
|---|---|
| 0·0°C. | 0·150 |
| 100°C. | 0·230 |
| 200°C. | 0·290 |
| 600°C. | 0·440 |
| 900°C. | 0·460 |

Whether this increase of specific heat continues at temperatures above 1,000 C. it is impossible to say. The increase in the specific heat of calcium oxide, the other raw material of carbide manufacture, has, so far as the writer is aware, never been experimentally determined; and the value 0·20 which is used in most of these thermal calculations may be widely different from the correct figure.

The thermal nature of the reaction which occurs when the calcium and carbon unite at a temperature in the neighbourhood of 3,000°C. to form calcium carbide is also somewhat problematical, and although Lewes‡ has stated that it is endothermic and absorbs 0·65 cal. per gramme molecule of carbide produced, this figure must be accepted with some reserve.

On these and other grounds, the writer considers that all thermal calculations made to ascertain the theoretical yield of

* "Acetylene," Constable & Co., 1900.

† "Grundlagen der Chemie," Mendelejef (1891), p. 627.

‡ "Acetylene," Constable & Co., p. 301.

carbide furnaces are at present of little value. The very great difficulty attending observations of the physical constants of solids and gases at high temperatures, also checks experimental work in this direction, and the constants for calculation of the theoretical yield in carbide manufacture will not be available until much greater time and energy have been devoted to this field of research.

The writer will therefore spare the technical literature of carbide production a new thermal calculation based on incorrect or problematical data, and will content himself with giving the details of one of the most reliable of the existing calculations, namely, that made by M. Gin, and published in the issue of *L' Eclairage Electrique*, May 6, 1899.

The temperature of the reaction is taken as 3,800° C., and the following formulæ are used for calculating the specific heats of the carbon and lime at 3,800° C. :—

C. (atomic heat) $4{\cdot}26 + 0{\cdot}00072t$.
CaO. (gramme molecule) $11{\cdot}4 + 0{\cdot}001t$.

Using these data, the following figures are obtained for the production of the gram molecule of calcium carbide.

| | | |
|---|---|---|
| Heat necessary to raise 56grms. lime to 3,300°C. | 43,060 | cal. |
| Heat necessary to raise 36grms. carbon to 3,300°C. | 53,940 | „ |
| Heat necessary to split up 56grms. lime into calcium and oxygen | 145,000 | „ |
| Total | 242,000 | „ |
| *Less.*—Heat produced by formation of 28grms. carb. mon-oxide | 26,100 | „ |
| Heat produced by formation of 64grms. calcium carbide | 3,900 | „ |
| Net heat required | 212,000 | „ |

212,000 cal. = 245·5 watt hours electrical energy = 3,887kw. hours per ton of carbide.

(*To be continued.*)

## THE MANCHESTER EXTRA HIGH-PRESSURE REGULATIONS.

Considerable attention has been directed of late to the employment, for large schemes in this country, of high-pressure current, coming under the category of "extra high-pressure" (over 3,000 volts) in the Board of Trade regulations. This department only permits "extra high-pressure" to be employed under certain conditions which it prescribes for each special case. This is laid down in Rule 8 as follows :—

An extra high-pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe.

As many of our readers will be interested to know the nature of these extra regulations and conditions, we publish below those which have been issued in connection with the new extension scheme of the Manchester Corporation electricity supply, which will probably be one of the next extra high-pressure schemes to come into operation. The following is the official description of the system to be adopted under the Manchester Electric Lighting Orders, 1890 and 1896, the Levenshulme Electric Lighting Order, 1897, the Moss Side Electric Lighting Order, 1897, and the Withington Electric Lighting Order, 1897 :—

An extra high-pressure supply to distributing stations from which a low-pressure direct continuous-current supply at constant pressure will be given to consumers by means of distributing mains, consisting of three separate conductors differing from each other in electrical potential, one of these conductors being maintained by suitable means at or near the potential of the earth, one being positive to the earth and one negative, the steps of potential being slightly above 200 volts each.

The distributing mains will be in part bare conductors, supported on insulators in a concrete conduit, and in part separately insulated cables laid in a wooden trough filled up solid with bitumen.

The system of transmission to the distributing stations from the generating station will be an extra high-pressure three-phase alternating-current supply at constant pressure, each main consisting of three separate conductors, differing from one another in electrical potential by 6,500 volts. The pressure of transmission will be lowered at the distributing stations by means of static transformers, which will give out three-phase alternating current to three conductors, differing from one another in electrical potential by about 260 volts when used for supplying the lighting and general power network, and by about 325 volts when used for supplying the traction system. This current will be supplied to rotatory converters, which will transform it into low-pressure continuous current at a pressure of about 400 volts for supply to the low-pressure distributing network for lighting and general power, and at a pressure of about 500 volts for supply to the traction network.

The extra high-pressure mains will be entirely contained within a strong metal casing, efficiently connected with earth, and electrically continuous throughout : each main will comprise three conductors suitably insulated, twisted together, and completely surrounded with Trinidad bitumen. The armouring and the troughing will be permanently connected to earth, and the middle point of both three-phase windings on each static transformer will also be connected to earth.

The distributing stations will be suitable buildings erected on private property.

The extra regulations and conditions are :—

1. The extra high pressure shall not exceed a pressure of 6,500 volts by more than 10 per cent. under any conditions of working, and the supply at that pressure shall not be given except through the trunk mains—that is to say, the mains laid between a generating station and a distributing station.

2. At least two trunk mains shall be laid to each distributing station.

3. Each trunk may be used for the transmission of electrical power not exceeding 1,000kw., provided that efficient means are adopted to prevent this limit being at any time exceeded, and that at all times when the load is sufficiently reduced the main is protected at the generating station by means of cutouts set to act at a current corresponding to an output of 500kw.

4. The trunk mains throughout such portions of their length as are laid outside the generating and distributing stations of the undertakers shall be formed of three conductors, separately insulated, and twisted together to form one cable, which will be further protected by braiding, and by an armour of steel wire. This cable will be laid in a cast-iron trough with a wrought-iron cover, and the trough will then be filled up entirely with Trinidad bitumen.

The whole will then be sealed with a layer of bitumen to preserve the wrought iron. The trough will be supported and protected by concrete where necessary.

The armouring of the cable will be electrically connected to each length of the trough.

5. The extra high pressure will be transformed to a pressure not exceeding 300 volts for lighting and general power, or 350 volts for traction, by means of stationary three-phase transformers in each distributing station ; and the middle or neutral point of both windings on each transformer in the case of those used for transforming current for lighting and general power purposes, and of the high-pressure winding in the case of current used for traction purposes, will be connected with earth, such earth connection being made by a connection to the cast-iron trough containing the extra high-pressure trunk mains entering the distributing station by means of a conductor possessing a mechanical strength and offering a passage to electrical discharges equal to that of a strand of 19 No. 12 copper wires.

6. The efficiency of all earth connections made as described in the preceding regulation shall be tested at least once in every week, and a record shall be kept of the results of such tests.

7. All conductors and apparatus within the distributing stations will be so constructed, protected, and placed as to avoid danger of fire or of electrical shock ; the handles of the switch-gear will be formed of metal efficiently connected with earth and covered with insulating material.

8. The metallic portions, other than the conductors of every transformer used in connection with the extra high-pressure supply and the casing thereof, shall be efficiently connected with earth.

9. All test and joint-boxes used in connection with the extra high-pressure trunk mains shall be formed of strong metal, which shall be in good electrical connection with the armouring of the mains on each side, and every such test box shall be placed in such a position that persons cannot be brought into accidental contact with it.

10. Each distributing station shall be under the sole charge of the undertakers, and a properly qualified electrician employed by them shall be in constant attendance at each such station to regulate and control the extra high pressure supply of energy.

11. Each distributing station shall be in direct telegraphic or telephonic connection with every generating station from which it is supplied.

12. The officers of the Board of Trade shall at all times have the right of entry into any of the generating or distributing stations of the undertakers, and they shall be permitted to make any examination or tests of the mains, dynamos, transformers, and other apparatus in use in such stations as may appear to them necessary, and the undertakers shall afford all due facilities for any such examination and tests.

13. The undertakers shall bring to the notice of the Board of Trade any failure or abnormal action in any part of their supply system, or any accidental injury to persons or property caused thereby.

14. Nothing herein shall exempt the undertakers from the provisions of the general regulations, save in so far as the same are modified by these regulations.

**Electricity and Water Mains.**—A recent number of the *Electrical Review*, of New York, reports the occurrence of a rather novel accident to a water main at St. Paul, Minnesota. On digging down to investigate a leak the workmen discovered that an earth-lead from the local tram service had been wrapped round the main. The leak was found to be directly due to a part of the pipe near a brass shut-off cock having been melted to such an extent that a very considerable stream of water was escaping.

## TELEGRAPHS AND TELEPHONES AT THE PARIS EXHIBITION.*

BY J. GAVEY.

The successful universal exhibitions that have been held in Paris since the year 1878 may not inappropriately be regarded as milestones along the road of progress in telegraphic and telephonic industries, for each in its time has not only afforded unrivalled opportunities for the study of new work, but collectively they offer conclusive evidence of the value of the various discoveries or fresh departures that have been made from time to time in various fields of research, and the degree of success that has been achieved by past inventors and workers may usefully be laid to heart by those engaged in similar efforts at the present moment. Thus, for example, glancing back at the reports of the Paris Exhibition of 1878, there will be found in the list of telegraphic exhibits the Hughes type-printing, the Baudot Multiple, the Duplex, the Quadruplex, the Wheatstone, and other systems which have achieved permanent success, as is forcibly illustrated by the State telegraphic exhibits of working apparatus in the 1900 exhibition, in which they all appear as instruments in daily use. On the other hand, many apparently promising inventions which were prominent in the 1878 and in successive exhibitions have either dropped out of sight altogether or are still in the course of development—so far, at all events, as actual practical use is concerned.

Class 26 in the catalogue includes telegraphs, telephones, and phonographs, and I propose to deal with the sub-divisions in this order. Further, I may add that in the brief review of the exhibits in this class that I have undertaken I propose to dwell only on those which show considerable novelty, or which illustrate the progress made during the last decade, rather than to attempt an exhaustive description of the class as a whole. Under the head of telegraphs there are three distinct systems of telegraphy which deserve special mention, each exhibiting considerable merit from the scientific point of view, although possibly they may be unequal from the practical standpoint. They are designed either with a view of increasing the amount of traffic which can be carried by a telegraph circuit, or of abolishing the transcription at the receiving instruments necessary with Morse methods; but they are based on very different principles.

*Rowland's Multiplex.*—The Rowland's Telegraphic Company of Baltimore, Maryland, exhibited an apparatus of the multiplex type of working which will admit of eight messages being sent simultaneously, four in each direction. The apparatus was at work in the exhibition, and we were told that satisfactory results had been obtained over a distance of 600 miles of actual line in America. This is so far in excess of the mileage over which we have been able to work in this country with Delany's multiplex, that a brief explanation of the principle of multiplex working generally may fitly precede a description of the new invention.

Multiplex telegraphy is based on the fact that the carrying capacity of an overhead telegraph circuit is far in excess of the speed at which a telegraphist can manipulate his key. For example, a wire which, worked by automatic Wheatstone, could dispose of 300 words per minute, if worked by hand can only carry on an average 30 words per minute. The inventors of the Delany system of Morse multiplex have therefore designed a method of increasing the carrying capacity of a wire while retaining the ordinary method of key manipulation, which is based on the following general principles:—Two commutators, each divided into a considerable number of separate segments, are fitted at opposite ends of a circuit. Groups of these segments are connected in proper sequence to the number of instruments to be worked simultaneously, while between each group certain segments are reserved for the maintenance of synchronism. The brushes to which the line wire is connected are caused to revolve synchronously by suitable means, and as they sweep over the segments they complete the telegraphic circuit for a very brief interval through three, four, or six corresponding pairs of instruments manned by separate operators—first, No. 1 instrument of one terminal station being connected to No. 1 instrument of the other; next, No. 2 to No. 2, and so on. These successive connections follow one another so rapidly that, although the initial current necessary to signal a dot or a dash in the Morse system from No. 1 instrument at one end to No. 1 instrument at the other may be interrupted four or five or six times, these interruptions are of such brief duration that they do not affect the continuity of the signal received, any tendency in that direction being counterbalanced by suitable methods. In this manner, with the Post Office Delany system, six messages may be simultaneously in course of transmission over the same wire without the signals interfering with each other, so long as the synchronism of the revolving brushes is maintained. This being premised, if the electric current traversed the line from end to end without retardation, there would be no limit to the distance over which this method of signalling would be available. Unfortunately, however, the current is retarded between the forwarding and receiving stations, this retardation being largely due to the electrostatic capacity of the line, in combination with its resistance, and although in practice suitable arrangements provide for a certain amount of retardation of the line current, still in practice a point is soon reached beyond which satisfactory working of the existing multiplex system becomes practically impossible, the current, say from No. 1 instrument at one end, arriving at the other end after the line has left No. 1 instrument and been connected to No. 2.

* Paper read last night at the Institution of Electrical Engineers.

A modification of the above system, designed by Mr. Pollock, of the General Post Office, is intended to obviate to some extent this difficulty. By an improvement in the method of synchronising which abolishes hunting, and by dividing the commutators into two concentric series, one for transmitting and the other for receiving, and mounting them so that one series may be revolved relatively to the other by a variable adjustment, it is possible to arrange that the receiving contacts shall lag behind the transmitting ones for exactly the period taken by the current in traversing the line. This method is still under experimental trial, but it is at present only adapted for Morse signalling.

The Rowland's apparatus has the following promising characteristics:—

Messages are transmitted from several sets of keyboards of the typewriting character, and any typewriting clerks should, with a little practice, be able to manipulate them. The messages are received on instruments which print them in ordinary type on a long roll of paper, which is perforated at convenient intervals to facilitate division when the received messages are printed. The electrical apparatus consists of an alternate current dynamo as the source of power from which a continuous series of electrical undulations traverse the circuit when no printing signals are being sent.

The synchronism between the receiving apparatus and the alternating currents on their arrival from the distant office is provided for by means of a small continuous-current motor, to which is rigidly geared a little alternator, both fixed on a shaft in the same axial line as the main driving shaft of the receiver. A circuit in which are two condensers which are alternately charged and discharged from a battery by the to-and-fro movement of the main relay tongue, actuated by the received alternations, is so connected up with the alternating motor on the receiver, that when the received undulations from the line and those due to the local alternator on the receiver are in unison, only a continuous uniform beat is heard in a telephone used as a synchronising detector. The speed of the receiving alternator is varied by the insertion of resistance in the motor driving it until this result is arrived at. Once attained, synchronism is maintained automatically by the local alternator acting either as a dynamo or motor according as the speed of the shaft tends to advance or recede. The main driving shaft on which the printing mechanism is mounted is revolved by a second independent motor, and by suitable adjustments of the resistance in this motor circuit the correct speed is arrived at. So long as the two shafts run with absolute uniformity a little jockey wheel connected to the first rides on a small insulated point in a disc attached to the second. If the main driving shaft lags, the jockey wheel makes a brief contact which reduces the resistance in the circuit of the driving motor, thereby increasing its speed, whereas if it advances a second contact is made which energises an electro-magnet and establishes a magnetic break by the generation of eddy currents in a copper disc revolving between its poles. The synchronising of the two sets of apparatus, therefore, is a relatively simple matter; and as the receiving apparatus is synchronised so as to run in unison, not with the distributing discs at the forwarding end but with the retarded currents which arrive at the receiving end, there is no reason to doubt the possibility of working for much longer distances than is possible with the original Delany system.

Geared on to the shaft of the sending alternator is a distributing commutator with 52 segments, and four groups of 11 consecutive sections are connected each to a set of 11 levers actuated by the transmitting keys. The odd segments serve other purposes. A second series of four equal segments are connected each to one of the four sets of keys, and these acting on a special electro-magnet on the keyboards admit of any depressed type key actuating the corresponding levers at the right periods only. When no type keys are depressed, the alternator sends a continuous series of undulations to line, whilst the depression of a key by actuating two out of the 11 levers on the keyboard causes two half waves, always with a complete undulation between them, to be cut off, and this suppression of current actuates the receiving apparatus.

The receiving relay has two tongues—one, already referred to above, serving to establish and maintain synchronism; the other actuating either the printing relays or those for shifting the paper. Each of the four type receivers has 11 electro-magnets in the local circuit of the second tongue of the line relay, each electromagnet being connected to a segment of the receiving commutator which corresponds with, and revolves in synchronism with, the main commutator on the transmitting dynamo. When no signals are being sent, the currents from the line relay pass through the local relays in such a

direction as to keep the tongues against the spacing side, but the omission of two half-waves causes the tongues of the two corresponding relays to drop over to the marking side, and this acts on the electromagnets which print the corresponding letters, or which shift the paper, as the case may be. A revolving cylinder, with a transverse mark on the transmitting keyboards, keeps the typewriter at the far end informed of the position of the receiving roll, and advises her when to advance it vertically and shift it horizontally so as to commence a fresh line.

It is stated that each operator can send at the rate of 30 words a minute, so that with duplex arrangements a speed of 240 words should be obtained, with the advantage that the messages are detached from the receiving instrument in a condition to be sent out for delivery, without the necessity for transcription that the existing method of multiple Morse working, of course, involves.

*Mercardier's.*—Monsieur Ernest Mercardier, of Paris, exhibits his multiple telegraph system, in which it is said that 24 messages can be simultaneously transmitted over one circuit, 12 in each direction. It is based on the harmonic system of telegraphy, one form of which was devised by Elisha Gray many years ago. Mercardier's method, however, is not a copy of Gray's, as by the use of telephone receivers and transmitters combined in various ways he has designed an absolutely independent method. Harmonic telegraphy depends on the fact that if a number of vibrating reeds, each differing by a certain defined period, say of a musical note, be so connected that each in the course of its vibrations causes a series of currents to be sent into a line wire, the resulting current so formed consists of a series of irregular but well-defined curves, which are due to the combination of the whole series of vibrations emitted by the different reeds, just as in a musical note the sound curve is not a simple one, but is that due to the fundamental note on which are super-imposed the overtones. At first sight it would appear as though it would be impossible to dissect the combined current curves, due to the superimposed currents, into their initial undulations. In practice, however, if each of the receiving reeds or telephones, joined up at the receiving end, be tuned to exactly the same pitch as its corresponding transmitting reed at the far end, the receiving reed will respond to the current of the corresponding transmitting reed and to no other, and even though the whole of the transmitting reeds are worked simultaneously, each being used for sending separate Morse characters, the respective receiving reeds select the Morse characters of the right note and disregard all others.

As transmitters, Mercardier uses electrical vibrating reeds of a well-known character, and as receivers he uses a combination of a telephone and a microphone, the latter sending out a powerful series of undulations into the local circuit, these undulations being selected by suitably designed telephones, which only respond to the vibrations to which they are tuned. The method, therefore, is a Morse method pure and simple, in which, so far as the operating is concerned, the telegraphist uses a Morse key for signalling, and the receiving telegraphist uses telephones as sounders. I learnt, whilst in Paris, that the apparatus had, in the course of certain trials, worked satisfactorily between Paris and Bordeaux, but it requires a metallic loop for thoroughly satisfactory working.

*Virág and Pollák.*—Messrs. Virág and Pollák exhibit their photo-autographic telegraphic apparatus, in reference to which so much has appeared in the public press. The original system, as exhibited in the Hungarian section of the exhibition, consists of a telephonic receiver, to the centre of the diaphragm of which is attached an arm which conveys the vibrations of the diaphragm to a small mirror. A spot of light falling on the mirror is reflected on to a photographic band, and when the instrument is started any movement of the mirror is photographed on the band. Morse signals are transmitted by an automatic method at a high rate of speed, and the record is impressed on the photographic band, in a series of curves representing the Morse alphabet. It is claimed that an abnormally high rate of speed can be attained, but the system had this disadvantage, in common with ordinary Morse methods, that the whole of the transmitted matter has to be deciphered and written out by the receiving telegraphist. During the meeting of the Electrical Congress held in the month of August, however, a Paper was read describing a most ingenious modification of this system, by means of which the telegram is received not merely in arbitrary Morse signals, but in ordinary written characters.

In the modified system a metallic loop is employed, but it is joined up so as to form two circuits, Fig. 5, one being the ordinary metallic circuit, and the second a bridged and superimposed earth circuit of the type well known in telephony. To each of these separate electrical circuits is connected a telephone with a mounted mirror, which is vibrated by the movement of the diaphragm. These mirrors are so placed in relation to one another that a spot of light is reflected first on one, then on the other, and lastly on the photographic record. The function of one of the mirrors is to receive impulses representing the vertical component of ordinary written Latin characters, whilst the second mirror receives the horizontal components. The transmitting is arranged by means of a punched slip with five series of perforations; the first three transmitting currents to the vertical component mirror, and the second two to the horizontal one. The line of perforations marked 1 (Fig. 1), transmits a negative current of a defined voltage; row 2, a positive current of the same voltage; and row 3, a positive current of double the voltage. Rows 4 and 5 transmit through the horizontal component telephone simple reversals.

Two sizes of holes may be perforated along either of the rows, thus admitting of long or short contacts, and by means of a specially designed combination of perforations the vertical and horizontal components are so co-ordinated as to admit of the reproduction of written characters at the receiving end. In the diagram, Fig. 1 illustrates the perforations necessary for the transmission of the word "Telegraph"; Fig. 2 shows the vertical components; Fig. 3 the horizontal; and Fig. 4 the resultant.

PERFORATIONS.

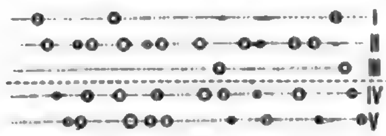


Fig. 1.

VERTICAL.

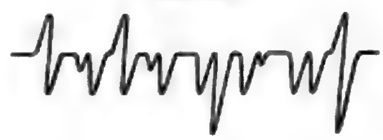


Fig. 2.

HORIZONTAL.

Fig. 3.

RESULTANT

Fig. 4.

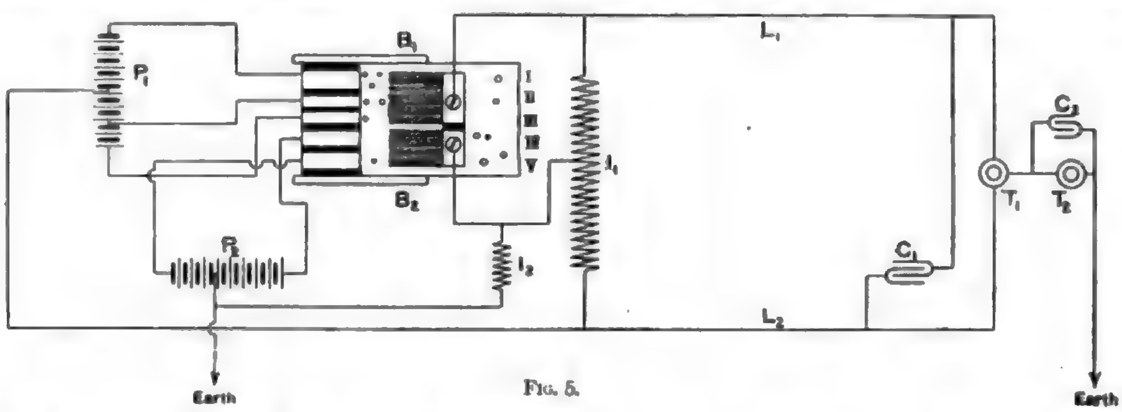


Fig. 5.

### TELEPHONES.

The advance in telephonic practice has, on the whole, been greater than in the branch of telegraphs devoted to the transmission of public messages. The invention and perfection of the manufacture of dry-core paper insulated cables has resulted in the more important of the telephonic administrations, both in the Old and New Worlds, undertaking the substitution of metallic for earth circuits for telephonic intercommunication. With the means at their command at an earlier period telephonic engineers were practically restricted to overhead work at their large exchanges, and although they all realised the disadvantage of earth circuits, few of them could face with equanimity the doubling of the huge number of overhead wires necessary for metallic loops. Now a dry-core cable which will serve 200 subscribers may be drawn into a 3in. pipe, and in the course of a few short years an earth circuit telephone will be a thing of the past. Not only has this resulted in a silent and undisturbed subscriber's circuit, but it has admitted of the introduction of improved telephones and improved switching arrangements. With an earth circuit a low-power microphone had necessarily to be used in order to diminish the disturbance on neighbouring wires, but with metallic loops improved telephones of the granular type have been generally introduced. The placing of the wires underground has likewise admitted of enlarging the number of subscribers connected to the central switches, and this has led to improved methods of automatic signalling.

There is, perhaps, one point in modern telephone work which may here be referred to with advantage, and that is the general tendency in the direction of the introduction of automatic signalling in modern exchanges. When first the Post Office opened its local exchanges in the provinces Sir William Preece insisted on the need for this method in order not only to simplify the work of the subscriber, but to ensure the sending of a ring-off signal to indicate the close of a conversation. At that date automatic signalling could only be effected by the use of primary batteries at the subscriber's office, and objection was taken to the method on account of the alleged expense of these batteries. Given, however, the necessity for maintaining a couple of speaking cells at each subscriber's instrument, the extra cost involved by the addition of two or three more cells for signalling purposes was not so great as was imagined, for a considerable portion of the total maintenance cost arose from the loss of the men's time in locomotion. The principle has, however, spread, and most modern installations at present comprise some method of automatic calling and clearing signals. The diminution in the work thrown on the operator by the use of a well-designed method of signalling, which reduces the speaking to the mere words, "Number, please," "through," or "busy," is highly advantageous in respect both of economy of working and in facility of manipulation.

*Central Battery Telephone Switches.*—A central battery automatic signalling exchange switch, exhibited by the Western Electric Co., illustrates the system that is being rapidly extended throughout the whole of the United States, and which has been adopted by the British Post Office in London, by the National Telephone Co. in some of its centres, and by the Belgian Administration in Brussels. The system has been described recently by myself and others, and space forbids a complete technical description which would demand a separate Paper for due consideration. For the purpose of discussion, however, it may be stated generally that the advantages claimed in favour of the system are broadly of the following character :—

1. The generation of current in an economical manner at the central exchange for speaking and signalling purposes.
2. Uniformity in the character and volume of articulate speech owing to the speaking current being always necessarily maintained at the point of highest efficiency.
3. Economy of maintenance owing to the absence of primary batteries and the reduction of the parts liable to get out of order at the subscriber's office to the minimum.
4. A complete system of automatic signalling which reduces the need for the operator's intervention to the lowest degree.
5. The use of small glow-lamp signalling indicators which admits of each indicator being placed in immediate proximity to the jacks or cords to which the indications refer.
6. The possibility of using coloured lights to indicate special rights, such as toll rates, flat rates, deposit accounts for trunk conversations, &c.
7. The use of a telephone meter for registering the number of conversations initiated by toll-subscribers. This method is not necessarily confined to central energy switches.

*Postel-Vinay Switches.*—The French firm of Postel-Vinay exhibit a system recently introduced at the newest of the Paris exchanges at the Avenue Breteuil, the most striking feature of which is a remarkably small and well-designed automatic indicator, which can be placed immediately over the jack for working the junction circuits. A set of these is shown on the table, but I think that signalling lamps are on the whole preferable to electro-magnetic indicators.

*Siemens and Halske.*—The firm of Siemens and Halske likewise exhibit a flat board of considerable capacity with certain details of signalling which are of interest. Time does not admit of a general description, but there is one point of novelty to which reference should be made—that is a combined local subscriber's jack and indicator. The call is indicated by the appearance of a small disc at the mouth of the jack. The disc is attached to the extremity of the armature of a Hughes electro-magnet. It is held in position by the magnetism of the core, is released by the reversing action of the current indicating the call, and is restored to its normal position by the mechanical insertion of the answering peg. It is, of course, again held in position by the permanent magnetism of the retaining electromagnet.

*Party-line Telephones.*—Several forms of party-line telephone circuits have been designed and exhibited, *i.e.*, arrangements designed to serve several offices on one circuit. These are used largely on light railways to provide communication between the headquarters and the various stations on a circuit, each being called by a step-by-step arrangement at will, without disturbing the others. The step-by-step switches which are placed at each office are actuated by battery currents of one polarity, and when these switches are in the position indicating the number of the office required, a reverse current is used for ringing up the "Wanted" subscriber. A needle on each of the dials indicates the number of the office that has been called, and by so doing it further announces the fact that the line is engaged.

There are likewise one or two automatic telephone switches which provide for subscribers to a small telephone system obtaining connection with other subscribers without the intervention of a switching operator. So far these systems have a limited use where a service designed to provide for special conditions is required.

A neat little switchboard for private use is shown by the Société par Actions du Bureau Electrique, in which connection between any two lines is effected by pressing a button which makes the necessary line contacts, and remains depressed until on the receipt of the ring-off signal it is released by giving it a quarter revolution on its axis. It then springs back automatically into the position of rest, and restores everything to the normal condition. The use of pegs and cords is thereby dispensed with.

*Carbons for Microphones.*—The manufacture of carbon granules for microphones has received considerable attention. These appear in two forms—one the irregular granule that so far has been most generally used in this country, the other consisting of small spheres varying in size from ordinary dust-shot to the $\frac{1}{16}$th of an inch in diameter. There appears to be little to choose between the two forms of granules for microphone purposes.

### WIRELESS TELEGRAPHY.

There are four exhibits of wireless telegraphy in the exhibition.

*Post Office System.*—An illustration by means of coils of the Post Office electro-magnetic method originated by Sir William Preece appears in the Post Office exhibit.

*Ducretet and Popoff.*—Monsieur Ducretet exhibits his Hertzian system, which it is understood he designed in conjunction with Monsieur Popoff, the Russian inventor, and which has been adopted in the French Navy and, it is believed, in the Dutch. There was nothing to specially distinguish it from the Marconi system in this country.

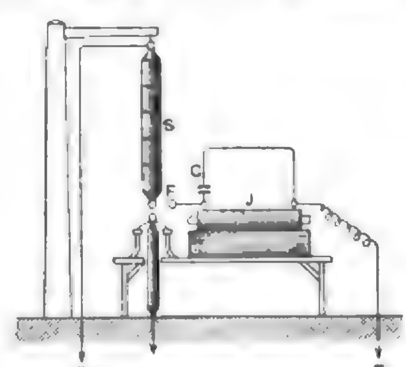


FIG. 6.

*Slaby and D'Arco.*—The Allgemeine Elektricitats Gesellschaft exhibits a system designed by Slaby and D'Arco in Berlin, and this deserves a little consideration, as the inventors have replaced the usual vertical insulated wire, so well known in connection with wireless systems in this country by a vertical cage, the upper end of which is connected to earth. This is illustrated in Fig. 6. At first sight it would appear as if the effect of the cage would to some extent be neutralised by the waves emanating from the return wire to earth, but probably the self-induction of the earth wire practically confines the oscillations to the cage. This, however, is an interesting subject for speculation and investigation.

The American Wireless Telegraph Co. exhibits a system in which a pneumatic arrangement has been designed for decohering, the object being to reduce the number of relays and magnets in the combination, with a consequent diminution of the local Hertzian waves which tend to interfere with accurate reception.

*Poulsen Microphonograph.*—Perhaps the invention of the greatest scientific interest is the Poulsen microphonograph, by which a telephone conversation can be permanently recorded on a steel wire, and reproduced at any time. In this apparatus a steel wire, or a steel band, is moved by any suitable means with considerable velocity between the poles of a small electro-magnet. On speaking into a telephone transmitter joined on the circuit, the undulatory currents set up in the transmitter react upon the electro-magnet, and cause a continuous variation in the direction and in the degree of magnetism at the poles of the electro-magnet. These variations are permanently recorded on the steel wire as it rushes by, and when the message is complete the steel wire retains a definite record of what has taken place in the shape of a continuous series of transverse magnetised lines varying throughout in their polarity and in their strength. On connecting a telephone receiver to the electro-magnet, and again starting the wire on its course, this magnetised wire generates electric currents in the coils of the superimposed magnet as it passes between its poles, and these electric currents, which are the exact counterpart of those generated by the original voice, cause the telephone to repeat what was said in an almost absolutely perfect manner. In one variation of the instrument an endless steel band was caused to revolve at a high rate of speed around two wheels which stretched it out to its full extent. On one portion of the band was placed a magnet connected with a microphone; further on were half-a-dozen electro-magnets connected with as many telephones; and finally an electro-magnet through which circulated a permanent current. As the band rushed by in the course of its revolutions it picked up the magnetism from the speaking microphone circuit, next it reacted on the electro-magnets connected to the telephones and caused them to speak, and, finally, on passing under the electro-magnet through which a steady current was flowing, the whole of the impressed magnetism was neutralised and the band wiped clean, so to speak, and rendered ready to receive a fresh impression.

At present this invention is in the early stage of scientific discovery. It may be used by a telephone subscriber to record an important communication, and it promises to afford means of obtaining a telephone repeater, a problem which has been before the electrical world for the last 12 years, and which so far has not been solved in a satisfactory manner. A telephone repeater would increase the range of telephonic speech and decrease the cost of long lines. The president of one of the American telephone companies some time ago offered publicly a reward of 1,000,000dols. for a thoroughly satisfactory telephone repeater, but the money has not yet been earned.

*Telephone Hirmondo.*—Amongst the miscellaneous exhibits is one by the "Telephone Hirmondo," which provides news and musical transmission alone, but without telephone intercommunication, in the city of Buda Pesth. Technically there is very little information to be derived from the exhibit, which is rather statistical than technical, but I was rather surprised to learn that the number of subscribers to the system had increased from 3,750 on January 1, 1895, to 7,560 on January 1, 1900, all the wires being overhead. In practice items of news are spoken into the main transmitting telephones at the central station every quarter of an hour, and such items are repeated until a fresh batch is started. So far it is an electrical substitute for an evening paper combined with a theatrophone installation.

I came across a novelty in telephone administration. In the capital of Mexico they have absolutely free trade in telephone exchanges, which may be erected by any body or company with the sole proviso that there must be intercommunication between the systems. There are eight separate companies at work, with an aggregate of 4,000 subscribers, the average rate of payment being 12½f. per subscriber per month.

At the meeting of the Electrical Congress various Papers were read which have been or will be published. A committee was likewise formed to consider the question of units, and some radical proposals were brought forward, which would have involved an entire change in the existing methods of electrical measurement. The whole subject was very keenly debated, and anything in the nature of a radical alteration was outvoted. The committee restricted itself to giving definite names to two of the existing units, which up to the present had been known as the "C.G.S. unit of magnetic field," and the "C.G.S. unit of magnetic flux." These propositions were then submitted to a meeting of the official delegates, and were practically carried unanimously. A further proposition was submitted to the delegates to the effect that electrical energy was property, and that its theft should be punishable by law. This was also carried. In Great Britain existing Acts of Parliament define electrical energy and provide against its theft, but in certain countries it has been argued that electricity cannot be weighed, and that no punishment can be inflicted for stealing it, hence the above resolution.

In the foregoing curtailed review it is, of course, impossible even to refer to many of the excellent exhibits of working apparatus, line stores, cable exhibits, and other modern and up-to-date telegraphic and telephonic materials and appliances that were to be seen at the exhibition. If I have had occasion to omit even a casual reference to many beautiful and elaborate exhibits, this is not due to want of appreciation, but to the fact that to do justice to all would involve a complete treatise on telegraphs and telephones. It is hoped that the few remarks I have made on the most striking developments will be of sufficient interest to have justified the presentation of this Paper.

## ELECTRICITY SUPPLY.

BY W. A. CHAMEN.

**The following is an abstract of the discussion on Mr. Chamen's Paper on "Electricity Supply," read before the Glasgow Section of the Institution of Electrical Engineers, and reprinted on p. 134 of our last issue:—**

Mr. W. B. SAYERS said that he quite agreed with Mr. Chamen that continuous current is the most satisfactory supply for a consumer. Beyond the reasons for this given by Mr. Chamen there was the additional reason that continuous-current motors may be made with variable speeds economically. Until recently difficulties of commutation made it impracticable to work a continuous-current motor at anything below its normal excitation without loss of power and destruction of the commutator, but recent improvements had rendered it possible to vary the speed of a motor. This the speaker thought was a very great advantage. Motors which were installed for continuous current might be [illegible] to drive a machine not at *nearly* the correct speed, but at *exactly* the correct speed. With reference to the question of voltage of supply as sup[illegible] to consumers, 250 volts is an absolutely fixed supply, and if the supply [illegible] either by Mr. Chamen or any other engineer were within 4 per cent. of [illegible] declared pressure Mr. Sayers did not see why the Board of Trade should [illegible] themselves any more about it. With regard to Mr. Chamen's reference to the firm of Messrs. Mavor and Coulson, he (Mr. Sayers) did not think that they had been sufficiently remembered for their enterprise and the pecuniary loss they had sustained when the supply was [illegible] at scrap value.

Mr. PICKSTONE referred to the variation [illegible] of continuous-current motors, and said that it could economically [illegible] attained, and with good efficiency, to a greater extent than that mentioned by Mr. Sayers. His firm has succeeded in running the 400-volt [illegible] at 500 volts, and, in fact, it seemed to him that the only point was [illegible] of the consumers' lamps, and so far as the station was concerned there was every possible advantage in it for the higher pressure. He [illegible] spoken to Mr. Chamen some time before about the possibility and [illegible] extent to which the field of a machine could be weakened and still [illegible] of its maximum being extracted from it, and Mr. Chamen expressed the opinion that he could weaken the field down to zero and still [illegible] full current from the machine. He had recently been experim[illegible] with continuous-current motors, and not only had he to diminish the [illegible] of the motor to zero, but he had to excite it to its full [illegible] in the opposite direction. For printing work and such like it was [illegible] to get a range of speed from zero to full speed at good efficiency.

Mr. J. M. MUNRO said that the Paper just read by Mr. Chamen was one of great interest. He had carefully [illegible] the question as to whether it was worth while to adopt the 2[illegible], and had gone carefully into the various arguments *pro* and *con*. [illegible] a slightly decreased efficiency in incandescent lamps with a res[illegible] in copper, but the conclusion at which he arrived was that [illegible] was quite right in adopting a 250-volt declared pressure. [illegible] with Mr. Chamen that the Tramways Department station was [illegible] situated. It should either have been further away for a [illegible] system or nearer at hand for a low-tension one. A three-wire [illegible] volt supply was also the correct pressure for tramway work.

Lord KELVIN asked Mr. Chamen if [illegible] possible to increase the pressure of an installation from, say, 200 [illegible] 250 volts by simply increasing the speed of the engines and [illegible]. He wished to know if the fittings now in use for 100 volts [illegible] volts were suitable for 250 volts. Lord Kelvin had himself said [illegible] years ago that he did not think it would be safe to allow a higher [illegible] than 300 volts inside a consumer's premises. His lordship also [illegible] reference to the development of the incandescent lamp [illegible] and Edison. He mentioned that Swan had started by making [illegible] 45 volts pressure, and that Edison had doubled this pressure, making his lamps suitable for 90 volts. Since then the pressure of supply had gradually risen, and he was pleased to know that satisfactory 250 [illegible] could now be made. It appeared to him that the lamp manufact[illegible] the prime movers in all increases of pressure.

Mr. P. D. IONIDES made brief referen[illegible] flexibility of a three-phase transmission and distribution.

Mr. SAM MAVOR wished to thank [illegible] for the kind references that had been made to Messrs. Ma[illegible] Coulson as the pioneers of electric lighting in Glasgow. Lord K[illegible] as their consulting engineer, had advised them to commence [illegible] high-tension alternating current supply to the few large consum[illegible] over a considerable area. A number of years afterwards [illegible] had recommended the Corporation, when consumers began to [illegible] numerous and nearer to each other, to adopt a low-tension supply.

Prof. MACLEAN gave two tables, show[illegible] number of stations and the pressure of supply in 90 low-tension stations and 76 high pressure stations.

Mr. JAMES COATS communicated the following: "With reference to the number of electricity supply compani[illegible] high-voltage continuous

current, Dr. Magnus Maclean mentioned there were only three of 250 volts —viz., Glasgow, Govan, and Greenock. I may mention, however, that the Scottish Co-operative Wholesale Society (Ltd.), of Glasgow (while not a public supply company, yet having a larger output than many public companies), were among the first in Scotland to adopt the higher pressures. It is now about five years since I observed the St. Pancras Vestry had raised their voltage to 220, Glasgow at that time being 100 volts. About that time I laid down a fair-sized lighting installation at a pressure of 220 volts, which has now been working for four years without having to renew a switch. Two years ago a larger installation was required for lighting and transmission of power in connection with six large factories, having over 30 motors, ranging from ½ H.P. to 20 H.P. I decided to follow in the lines of Mr. Chamen, and the plant accordingly was laid down for 250 volts. This has now been running for 16 months amongst all classes of workpeople, and so far everything has been very satisfactory. Apart from the considerable saving in the cables, my main object in going up to this voltage was to be in keeping with the Glasgow Corporation supply, so that there should be no difficulty in changing over at any time that the Corporation were able to supply the current cheaper than we could produce it. It seems to me it is most absurd for the Board of Trade to issue vague regulations which apparently can only be read by lawyers."

Mr. WILLIAM McWHIRTER communicated the following: "I must first of all congratulate the Glasgow Local Section on having a Paper brought before them dealing so admirably with electricity supply so far as Glasgow is concerned. With the arguments put forward by Mr. Chamen in favour of low-tension continuous current as against alternating high-tension in compact areas, I think everyone must agree that it is surprising that in face of all the experience gained with low-tension working that even now engineers are to be found who have the courage to advise the adoption of alternating currents in such areas. No fault can be found with Mr. Chamen's decision to adopt the full pressure allowed by the Board of Trade, and in my opinion it is a grievous mistake that the Board of Trade should now step in, making an alteration of only a few volts, which, however, are sufficient to interfere with what was most likely in the future to be a universal standard of pressure, viz., 500 volts on a three-wire system, and surely the time is come when the electrical trades should take up a position and bring pressure to bear upon the Board of Trade in such a way that so unreasonable a proposal as this alteration should not take effect. Other trades and industries have had before now to bring such pressure to bear upon a Government department, and surely now is the time for the electrical industry to be up and doing. Supposing the Board of Trade argument to be that 500 volts plus the drop in the feeder is dangerous, then surely one and all will admit that 500 volts cannot be safe. That being so, it is much the same as passing an alternating current supply at 1,000 volts, but refusing to pass it at 10,000 volts. Mr. Chamen uses a very clever argument in favour of the increased pressure when he defines 'Who are the Corporation?' There is no doubt whatever that, with all deference to such an authority, the pressure of 250 volts is not so convenient for the user as a rule; but at the same time there is every prospect that this will be only a temporary objection, as no doubt very shortly lamps will be found (especially arc lamps) which will work as well on the higher pressure and as economically as they have hitherto on the lower. Failing this, there is no reason why the reduced pressure of electricity, when used in motors, should not be utilised in many instances for driving small motor generators, and so getting in pressure that may be found most convenient."

## THE DESIGNING OF LARGE TRAMWAY GENERATORS.*

BY HORACE PARSHALL.

From a commercial point of view the process of dynamo designing may fairly be said to consist of determining the different dimensions so that some one abnormal condition, brought about by inconsistency of speed, current output or voltage, may be balanced against some other condition, so as to make the result as a whole satisfactory, although the individual constants chosen do not in themselves make for highest efficiency. I propose to limit the scope of the present article to the consideration of the designing of dynamos where there is no inconsistency between speed, voltage and current output, and where the individual values as to magnetic flux or electrical current are normal and make for highest efficiency. The surfaces of a dynamo are determined from thermal considerations. Particular dimensions, however, have reference to the magnetic limit of output. Experience has now become so extended, that in the design of large generators the process can be greatly shortened by fixing in advance the efficiency as regards energy loss and allocating the individual loss to the several parts. Thus, for large street railway generators the efficiency may be taken to be between 94 per cent. and 95 per cent. and the losses allocated as follows:—

| | Per cent. |
|---|---|
| $C^2R$ loss in armature | 2·25 |
| Armature core loss | 2·25 |
| Field-magnet loss | 0·75 |
| Commutator loss, $C^2R$ and mechanical friction | 0·75 |

The pole-piece loss is here included as a part of the core loss.

* From the *Street Railway Journal*, of New York.

From the temperature rise per watt per square inch, as found in practice, and the permissible increase of temperature, the surface of the different parts for a given output is determined by the energy loss. The increase of temperature per watt per square inch at the periphery of an armature should be from 10°C. to 15°C. A 10°C. rise would be a very well ventilated armature; 15°C. for one that is not carefully ventilated, and 12½°C. is a good average value to assume for the purpose of calculation. This is at a speed of 2,500ft. per min., which is normal, but calculations are not apt to lead to wrong results if the peripheral speed varies considerably from this result, since, as between 2,000ft. and 3,000ft. per min. there is not more than 10 per cent. variation of temperature rise. These figures refer particularly to the armature core, where the watt loss per square inch is about double that at the cylindrical end connections. In the normal case about 35 per cent. $C^2R$ loss is at the periphery of the core, and the remaining 65 per cent. at the end connections. The above increase is by temperature thermometrically measured at the periphery of the armature. If the increase in temperature is to be calculated from the increase of resistance, the corresponding temperatures would be 15°C. and 22°C., respectively, measured from the increase of resistance of the armature as a whole.

In the field magnets, the temperature increase per watt per square inch external surface is about 60°C. by thermometer and 120°C. by resistance. In the commutator, the increase of temperature in the normal case is about 15°C. per watt per square inch. In the best practice it is the custom to limit the temperature increase of any part of a dynamo to 30°C. by thermometric test, or 45°C. by increase of resistance, the datum being 25°C. Experience conclusively shows this to be a satisfactory value. Hence, an approximate series of constants as to the requisite radiating surface for a given temperature increase per kilowatt output can be fixed thus:—

For the field, the radiating surface per kilowatt output would be 15 sq. in.

For the armature, the radiating surface per kilowatt output would be 18·75 sq. in.

For the commutator, the radiating surface per kilowatt output would be 3·75 sq. in.

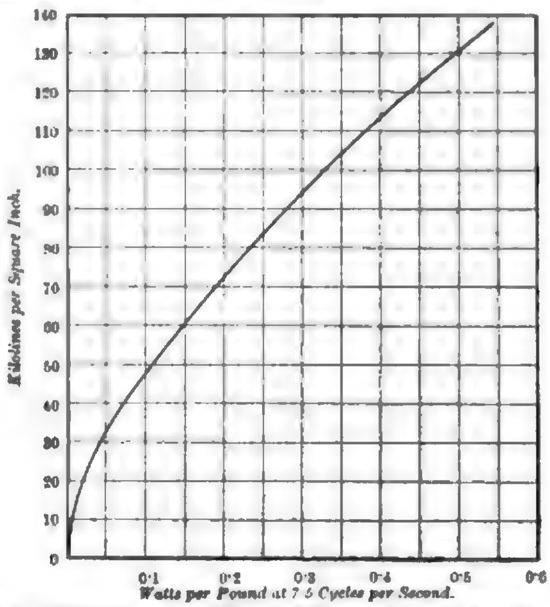


FIG. 1.—Testing Laboratory Values for Hysteresis Loss in Good Commercial Sheet Steel.

Referring to the specific method of calculating, the $C^2R$ loss in the armature needs no specific discussion, although it is the usual practice to limit the current density in large generators to about 1,500 amperes per square inch, the rate of generation by heat at 40°C. being 5·1 watts per pound loss in copper.

As regards the core loss, this can be calculated on assumptions from tests made on samples of iron as to hysteretic loss. Fig. 1 shows results of such tests on good commercial sheet steel. In practice, however, it is more expedient to establish a curve as shown in Fig. 2. In the process of calculation of the core loss, the effect of distortion, which in good practice may increase the maximum density 30 per cent. should not be lost sight of, since the loss in the projections and core increases very considerably with such an increase in density. In a well-designed dynamo I should expect the densities to be taken so that the average loss in the armature core is less than 1 watt per pound.

Referring next to the commutator, with carbon brushes the current density should not exceed 40 amperes per square inch at full load. The contact resistance varies considerably according to

the condition of the commutator, but a good average result is 0·03 ohms per square inch of contact; in other words, there may be 1·2 volts drop from contact resistance at full load. An ordinary pressure of contact is 1·5lb. per square inch, in which case at a peripheral speed of 2,000ft. per minute the mechanical friction is about 50 per cent. of the $C^2R$ loss.

As regards the losses in the field magnet coils, these have been given in extent. It is usual to calculate the amount of copper, assuming 600 amperes per square inch current density; 750 amperes per square inch is commonly accepted as the limit in good practice in large generators.

Referring next to the design of the field magnets, it may be remarked that the function of the field magnets may be considered that of supplying at minimum cost of magnetic and electrical material, a magnetic flux of a certain magnitude and stability, and the maximum armature reaction permissible, which is determined by the conditions of commutation. In the normal dynamo circuit, the following values at no load and full load are typical of a steel field-magnet, multipolar dynamo:—

| | Percentage of total m.m.f. | Densities. (C.G.S. lines per sq. in.) |
|---|---|---|
| *No Load.* | | |
| Armature core | 2·75 | 60,000 |
| Teeth | 5 | 120,000 apparent |
| Air-gap | 70 | 40,000 |
| Magnet core | 12 | 80,000 |
| Yoke | 10 | 65,000 |
| *Full Rated Output.* | | |
| Armature core | 3 | 60,000 |
| Teeth | 12 | 138,000 apparent |
| Air-gap | 60 | 46,000 |
| Magnet core | 15 | 102,000 |
| Yoke | 10 | 75,000 |

It will be noticed that nearly 80 per cent. of the total m.m.f. is concerned with reference to the conditions to be maintained in commutation. The most economical densities in the field magnetic

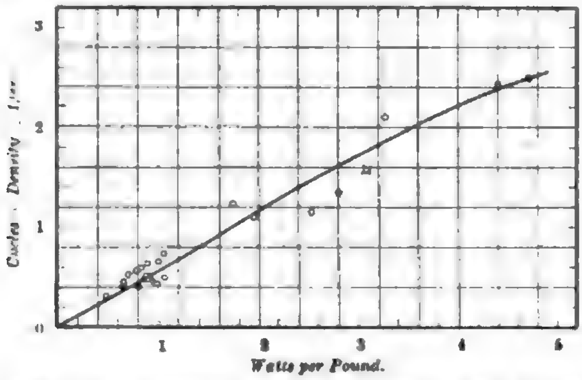


FIG. 2.—Curve Exhibiting the Relation between Cycles per Second × Kilolines Density below Slots ÷ 1,000, and Watts per Second in Armature Core, based on Observed Results in twenty-three large Multipolar Commutating Machines.

circuit will, of course, vary somewhat according to the relative market value of iron and copper. The surface of the field magnets, assuming reasonable depth of winding, as stated above, is determined from the $C^2R$ loss, the increase of temperature per watt per square inch and permissible increase of temperature. The cross-section of the field magnet cores is determined particularly with reference to the magnitude of the magnetic flux and the most economical density. The magnetic flux is, as stated above, fixed from the maximum permissible armature reactions, and the density from the properties of the materials. The general dimensions, therefore, of the magnet coils, as to length and diameter, are within the limits of good practice determined by these factors. The amount of copper in the field magnet coils can be conveniently calculated from the following formula:—

$$\text{Weight of copper per spool} = 31 \times \left(\frac{\text{ampere-feet}}{1{,}000}\right)^2.$$

Curves 3, 4, and 5 show the magnetic properties of commercial wrought-iron, cast-iron, and cast-steel. The cores should always be of wrought iron or steel, but the yoke may be of cast-iron or steel, according to the market value of material. Laminated poles have not been a particular success, since they tend to make the flux at the pole face unstable as to surging on change of load from the coils under commutation. The leakage or ratio of effective to maximum flux varies somewhat, but with large ring multipolar dynamos does not exceed 15 per cent., which may be safely assumed in calculation. Their leakage does not increase more than 20 per cent. between no load and full load, or 3 per cent. of the total flux, so, with normal magnetisations, does not greatly influence the amount of compounding. The number of poles with multiple-circuit armature windings is determined by the maximum armature reaction consistent with commutation, the minimum number of commutator segments, and the maximum permissible reactance of an armature coil, and the

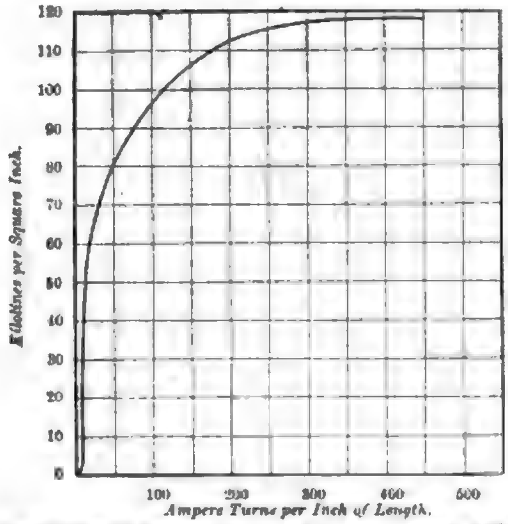


FIG. 3.—Curve for Good Quality of Wrought Iron and Sheet Steel.

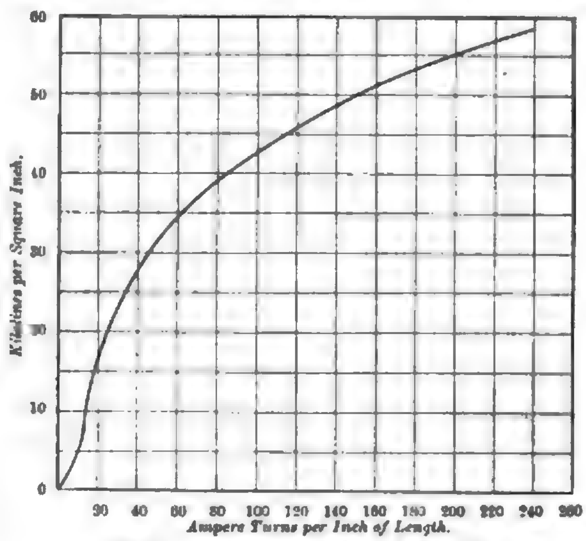


FIG. 4.—Curve for Good Quality of Cast Iron.

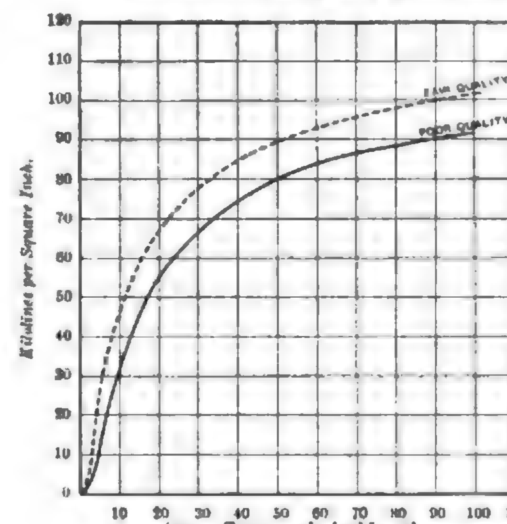


FIG. 5.—Curves for Cast Steel.

greatest economical contact resistance, and is therefore determined from the condition determining the maximum current which can be collected at a set of brushes, which in the kind of practice under consideration does not exceed 300 amperes at rated capacity.

*Magnetic Limit of Output.*

The limit of output of a commutating dynamo from a magnetic point of view is determined from the maximum value; that having regard to heating can be assigned to three independent variables. The first has reference to the m.m.f. underneath the pole piece, acting to produce distortion in the air-gap, the amount of distortion being determined, as was shown by Hopkinson, by the m.m.f. under the pole piece (equal to the number of conductors multiplied by the current) and the magnetic reluctance around which this m.m.f. acts. The amount of distortion can be limited by making this reluctance comparatively great, and in the case of projection armatures can be made to increase very slowly with the m.m.f. or current in the armature by making the initial magnetisation in the projections high, so that the reluctance increases greatly with the increase of magnetic density.

Secondly, the resistance of the collecting brushes, which, with dynamos with brushes at fixed lead for variable load, plays a most important part. Since the reversing field is only of proper value for one current output, this resistance acts (1) to prevent abnormal current when the coils are short-circuited in strength of field not corresponding to the current output, (2) to increase the rate at which the current falls off in the coils when short-circuited, and (3) to shunt into a short-circuited coil a portion of the reverse current, so that on leaving a brush the current is in phase with the current in the main circuit. The contact resistance may be varied according to the quality of carbon used, which varies from $599 \times 10^{-6}$ ohms per cubic inch to $3,900 \times 10^{-6}$ ohms per cubic inch, but in ordinary practice it is found advisable to limit the contact resistance so that the drop in the brushes at full load amounts to not more than half per cent., otherwise the commutator becomes excessively large and costly and efficient collection difficult.

Thirdly, the self-induction of the individual armature coils, which is a measure of the maximum field strength required for current reversal, as also the amount of distortion produced locally in the line of commutation, this distortion being backward for diminishing current, and forward for increasing current. This inductance voltage, which may be calculated from the laws of the magnetic circuit or on the basis of 20 C.G.S. to 25 C.G.S. lines per ampere per inch length of armature iron, has been limited in value in terms of the volt drop in the brushes, with full load current density, and in terms of the average strength of magnetic field as expressed by the average voltage in the commutator segments under a pole piece. Neither method by itself is entirely satisfactory theoretically, but practically the results are fairly consistent when the calculated inductance voltage does not exceed three or four times the drop in the brushes at full load, or require more than one-third average strength for reversal. The self-inductance acts at no-load to prevent the generation or abnormal currents in the short-circuited coils, but at full load acts to prevent commutation, not necessarily by setting up a magnetic field, since this may be nullified by the m.m.f. of the field magnets, but by distortion of the magnetic field, so that the current in the coils is not properly reversed as it passes from under the collecting brush into the open-circuit position. The frequency of commutation varies in ordinary practice from 200 cycles to 300 cycles per second. The reactance voltage is a measure of the damage that can be done by a coil when not in proper field strength, and may, therefore, be increased if the contact resistance be increased to a corresponding extent.

The absolute frequency of the reversal is dependent on the distribution and strength of the reversing field. In practice the brushes generally cover 3½ commutator segments, and are moved forward to a position such that the self-induced field at approximately full load is overcome by the field of the field magnets. With the inductance limited as above the light load induced currents in the short-circuited coils will not be more than one-quarter or one-fifth of the full-load current. The limiting value for distorting m.m.f. is determined by the initial magnetisations, consistent with heating in the projections and conductors, but results of practice indicate that the m.m.f. acting under the pole-piece should not exceed 2½ times the entire m.m.f. of the magnetic circuit, or 7½ times the initial m.m.f. acting in the air-gap and teeth. As will be seen, however, from the observations made *re* the influence of highly magnetised projections and latitude in ventilation, these projections can vary widely.

As regards compounding, in good practice the pole pieces cover about 80 per cent. of the circumference of the armature. The strength of the reversing field, as given above, corresponds in a projection armature to a position of the brushes approximately up to the pole, in which case the power of the armature for demagnetisation is the number of conductors between the poles multiplied by the number of amperes in each conductor. The length of the armature being determined by the inductance per unit of length and the total permissible inductance, this dimension divided into the surface gives the diameter. The remaining dimensions follow from the various constants set down above. The number of commutator segments follows the inductance per coil, and the maximum permissible armature reaction. The thickness of the brushes is determined from the contact resistance and the width of the magnetic zone of approximate uniformity, generally corresponding to the thickness of three to four segments. Thick brushes lessen the frequency of commutation, hence, *inter alia*, the advantage of shaping the pole pieces so as to have the reversing zone as wide as possible.

By the courtesy of E. W. Rice, Jun., I am able to give the following particulars of a generator designed by the engineers of the General Electric Co. a number of years ago. It was particularly remarked at the time that the various constants were ideal from a designer's point of view. The practical results in the working of the generator have been so satisfactory that it may be fairly stated that this dynamo attains as near perfection as is possible in commercial practice.

| | |
|---|---|
| *Description.* | |
| Number of poles | 10 |
| Kilowatts | 550 |
| R. P. M. | 90 |
| Terminal volts, full load | 550 |
| Terminal volts, no load | 500 |
| Amperes | 1,000 |
| *Electrical.* | |
| Armature—Terminal volts, full load | 550 |
| Total internal volts | 569 |
| No load volts | 500 |
| Number of circuits | 10 |
| Style of winding | Single |
| Times re-entrant | Singly |
| Total parallel paths through armature | 10 |
| Conductors in series between brushes | 180 |
| Type of construction of winding | Barrel wound |
| Number of face conductors | 1,800 |
| Number of slots | 300 |
| Number of conductors per slot | 6 |
| Arrangement of conductors in slot | 3 wide by 2 deep |
| Resistance between brushes, 60 C. | 0·0125 ohms |
| CR drop in armature at 60°C | 12·6 volts |
| CR drop in brush-contact surface | 2·4 volts |
| Total CR drop | 19 |
| Amperes per square inch armature conductors | 1,560 |
| *Commutation.* | |
| Volts between segments, average | 6·1 |
| Armature turns per pole | 90 |
| Amperes per turn | 100 |
| Armature ampere turns per pole | 18,000 |
| Lead of brushes (number of segments) | 9 |
| Lead of brushes (per cent. | 10 |
| Demagnetising ampere turns (per cent.) | 20 |
| Demagnetising ampere turns (per pole) | 3,600 |
| Distorting ampere turns per pole | 14,400 |
| Frequency of commutation, cycles per second | 254 |
| Coils short-circuited together per brush | 3 |
| Turns per coil | 1 |
| Turns short-circuited together per brush | 3 |
| Conductors per group commutated together | 6 |
| Reactance voltage, one coil (volts) | 3·9 |
| *Magnetic.* | |
| Megalines, from one pole no load and 500 volts | 1·85 |
| Coefficient. of magnetic leakage | 1·125 |
| Megalines in one pole, no load | 2·08 |
| Megalines in one pole, full load | 2·36 |
| Armature—Density no load (kilolines) | 59 |
| Density full load | 67 |
| Ampere turns, no load | 190 |
| Ampere turns, full load | 320 |
| Teeth—Apparent density, no load (kilolines) | 108 |
| Apparent density, full load (kilolines) | 123 |
| Corrected density, no load (kilolines) | 108 |
| Corrected density, full load (kilolines) | 119 |
| Ampere turns, no load | 340 |
| Ampere turns, full load | 900 |
| Gap—Density at pole face, no load (kilolines) | 42·5 |
| Density at pole face, full load (kilolines) | 48·5 |
| Ampere turns, no load | 5,000 |
| Ampere turns, full load | 5,700 |
| Magnet Core—Density, no load (kilolines) | 78 |
| Density, full load (kilolines) | 88 |
| Ampere turns, no load | 880 |
| Ampere turns, full load | 1,530 |
| Yoke—Density, no load (kilolines) | 69 |
| Density, full load (kilolines) | 79 |
| Ampere turns, no load | 640 |
| Ampere turns, full load | 1,000 |
| Saturation ampere turns for no load and 569 internal volts | 9,450 |
| Total ampere turns for full load and 550 volts | 12,350 |

The density in the core = 67 kilolines.

$$\frac{C \times D}{1,000} = \frac{7{\cdot}5 \times 67}{1,000} = 0{\cdot}50$$

and from the curve the value of 0·83 watts per pound is derived for the specific weight of dissipation of energy in core loss.

The total weight of sheet iron in the armature = 12,600lb.

Hence, core loss = 12,600 × 0·88 = 11,100 watts.

The experimentally observed value was 11,000 watts.

*Thermal Calculations.*

| | |
|---|---|
| Armature—$C^2R$ loss at 60 C. = $1{,}000^2 \times 0{\cdot}013$ = 12,600 watts. | |
| Core loss, 11,000 watts. | |
| Total loss in armature at full load = 23,600 watts. | |
| Peripheral radiating surface of armature = 12,000 sq. in. | |
| Watts per square inch of peripheral radiating surface ...... | 1·97. |
| Peripheral speed of armature (feet per minute)............... | 2,250 |
| Observed rise in temperature after eight hours' full load run, as determined by thermometer on armature surface | 26°C. |
| Observed rise determined from increase in armature winding resistance ............... | 38 C. |
| *Thermometric* temperature rise per watt per square inch *peripheral* radiating surface ............... | 13°C. |
| *True* temperatue rise per watt per square inch *peripheral* radiating surface............... | 19°C. |
| Spool windings—Total $C^2R$ loss per spool at 60 C. ..... ...... | 422 watts |
| Total external cylindrical radiating surface of one field spool | 1,350 watts |
| Watts per square inch of external cylindrical radiating surface ... ............... | 0·312 |
| Observed increase of temperature by thermometer on surface of shunt winding after eight hours' full-load run ... | 26°C. |
| Mean rise of thermometer............... | 19°C |
| Thermometric temperature rise (mean) per watt per square inch of radiating surface............... | 61°C. |
| Rise of temperature by observed increase in resistance of shunt winding.. ............... | 45°C. |
| Rise of temperature by observed increase in resistance of series winding ............... | 31°C. |
| Mean rise of temperature of spool winding from resistance measurements ............... | 38 C. |
| Temperature rise by resistance measurements (mean) per watt per square inch of radiating surface ............... | 122 C. |

*Commutator Losses and Heating.*

| | |
|---|---|
| Commutator—Amperes per square inch contact surface ...... | 40 |
| Brush resistance, positive and negative ............... | 0·0024 ohm |
| $C^2R$ loss at brush contacts, watts............... | 2,400 |
| Peripheral speed, feet per minute............... | 2,040 |
| Total watts lost in commutator ............... | 3,670 |
| Radiating surface, square inches ............... | 2,400 |
| Watts per square inch radiating surface ............... | 1·53 |
| Observed rise of temperature after eight hours' run at full load | 22 C. |
| Observed rise of temperature per watt per square inch of *peripheral* radiating surface ............... | 14·5 C. |

## PHYSICAL SOCIETY.

At an ordinary meeting held Nov. 9, Prof. A. W. Reinold, F.R.S., Vice-President, in the chair, Dr. R. A. LEHFELDT read a Paper on

### "Electromotive Force and Osmotic Pressure."

This Paper is an attempt to explain a difficulty in the interpretation of the ordinary logarithmic formula for the E.M.F. between a metal and solution pointed out by the author at the Dover meeting of the British Association. An expression for the E.M.F. of a concentration cell is obtained thermo-dynamically upon the assumption that the electrolyte is only partially dissociated. A partition is used which is permeable to water, but not to the salt or its ions, and the conclusion follows that the E.M.F. depends not on the osmotic pressure of the metallic ions, but on that of the solution as a whole. A graphical representation is given plotting osmotic pressure against dilution assuming Boyle's law to hold, and it is shown that the E.M.F. is not proportional to the integral $\int PdV$, but to the converse integral $\int VdP$. Assuming further that the osmotic pressure changes according to Van der Naals's equation the E.M.F. is greater than that calculated from Boyle's law. If the electrolytic solution pressure is calculated from the integral $\int PdV$ it comes out $10^{19}$ atmospheres, but if from the converse integral the value obtained is about 20,000 atmospheres. A comparison between actual E.M.F.s, and those derived from the equation given by the author should afford, if the formula is correctly deduced from the assumptions made, a measure of how far the osmotic pressure deviates from that indicated by Boyle's law. Experiments upon concentration cells have been made by Helmholtz, Wright and Thomson, Moser, Lussana, and Goodwin; but as their work was performed upon cells with migration of ions, the calculation of the osmotic pressure is rendered uncertain by the introduction of the transference ratio. Accordingly the author has measured the E.M.F.s of cells without migration, using zinc as electrodes and chloride and sulphate of zinc as salts. The E.M.F. was measured by the compensation method, using a Post Office box through which a current was sent by an accumulator. The accumulator kept up a constant potential difference, and was standardised daily by means of a Clarke cell. The experimental results agree with the calculated over the range centi- to deci-normal, showing that the deviation from the value given by the logarithmic formula is accounted for by the incomplete dissociation of the salts. The osmotic pressures are then calculated from the E.M.F.s and the values of PV plotted. They show irregularities due to the combined effect of the decreasing dissociation of the salt and the increasing departure from Boyle's law. Dividing the product PV by Van't Hoff's factor, determined from conductivity values, curves are obtained showing variations similar to those observed in the behaviour of gases when subjected to high-pressure.

Mr. WHETHAM said there was one form of membrane which is quite permeable to water, and yet does not allow either salts or the ions to get through. He referred to the free surface of the solution itself. The water being volatile can get out, but the salt cannot.

Dr. DONNAN said the author seemed to have discovered things well known; for instance, the integral $\int VdP$ is generally taken as proportional to E.M.F. He expressed his interest in the explanation of the difficulty in the logarithmic formula.

Dr. LEHFELDT, in reply, said Goodwin had used the integral $\int VdP$, but had not made any numerical calculations by means of it.

Mr. R. J. SOWTER read a Paper on

### "Astigmatic Lenses."

An astigmatic lens is one which so acts on rays of light falling on it as to produce in general two focal lines in the refracted ray system. A lens derived from a quadric surface is the general elementary type of astigmatic lens, and in the Paper an ellipsoidal lens is selected and considered. The focal lines are parallel to the elliptic axes and correspond to the lens powers in these directions. These powers are proportional to the inverse squares of the axes. A curve drawn through all points on a lens where the material thickness is constant may be said to determine a natural aperture for that lens. A method of natural apertures is employed to establish the various relations set out in the Paper. An ellipse is the natural aperture for an ellipsoidal lens, a circle for a spherical lens and an infinitely long rectangle for a cylindrical lens. It is shown that two cylindrical lenses crossed at right angles are equivalent to an ellipsoidal lens and the power of the combination in any direction is the same as that of the ellipsoidal lens in that direction. It is also shown that two obliquely crossed cylindrical lenses are also equivalent to an ellipsoidal lens, or to two cylindrical lenses of definite powers crossed at right angles, or to a cylindrical and a spherical lens, for a spherical lens may be replaced by two equal cylindrical lenses crossed at right angles.

Prof. S. P. THOMPSON said he had never seen this treatment of an ellipsoidal lens before, although the extreme case of a paraboloidal lens had been considered. The author's method was, as far as he knew, new, and would be very convenient to work with.

Mr. A. CAMPBELL then read the following Papers:—

### (a) "On a Phase-Turning Apparatus for use with Electrostatic Voltmeters."

Electrostatic voltmeters are particularly insensitive at the lower parts of their ranges, the divisions closing in very much towards the zero point. When measurements of small direct-current potential differences have to be made it is an easy matter to add to the voltage to be measured a constant voltage large enough to bring the deflection to an open part of the scale. If the small voltage to be measured is an alternating one it is necessary that the auxiliary voltage should alternate with the same frequency and be in phase with it. The apparatus described enables the phase of the auxiliary voltage to be turned until it agrees with the one to be measured. The phase difference referred to is not the time lag, but the angle whose cosine is the power factor, and may be called the power lag. The method is to get two independent equal voltages $U_1$ and $U_2$, differing in power phase by $\pi/2$ and to add together suitable fractions of these, such as $U_1 \sin\phi$, $U_2 \cos\phi$. The resultant is equal to $U_1$, but with the power phase turned through $\phi$. The unknown small voltage is connected in series with an auxiliary voltage and a voltmeter, and the phase of the latter voltage is turned until the maximum deflection is obtained.

### (b) "On a Method of Measuring Power in Alternating Current Circuits."

The circuit in which the power is to be measured is connected across the supply circuit in series with a small non-inductive resistance. By means of a transformer the small voltage on this resistance may be transformed into one whose power phase is $\pi$ behind the voltage on the resistance. This is added to the voltage on the circuit to be measured, and then reversed and added again. The difference of the squares of these effective resultants is shown to be equal to a constant into the power to be measured. If there is any direct current it must be measured separately by a Weston voltmeter or other suitable instrument.

### (c) "Note on Obtaining Alternating Currents and Voltages in the Same Phase for Fictitious Loads."

When testing instruments for the measurement of large amounts of electrical power or energy, it is usually desirable to do so by means of fictitious loads, *i.e.*, by applying to the instrument under test current and potential difference representing the required load. In order to obtain a fictitious non-inductive load with alternating

currents, the potential difference and currents should be in the same phase. The current for the instrument under test is got by means of a transformer worked on a 100-volt circuit. The potential difference in the same phase is got by allowing the current to flow through a non-inductive resistance, and increasing the voltage at the ends of the resistance to the required amount by means of another transformer.

The Society then adjourned until to-day (Friday).

## CORRESPONDENCE.

### ELECTRIC TRACTION AND MAGNETIC RECORDS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When Sir Courtenay Boyle closed the abortive conference reported in your last issue, he announced that the Board of Trade would take in hand the drafting of regulations with a view to the reasonable protection of observatories against the disturbances likely to arise from neighbouring electric tramways.

In framing such regulations we may be sure that an effort will be made to discriminate between the essential and the non-essential work carried on at our national observatories: in other words, to draw a line between the work of truly national importance on the one hand, and work of purely scientific interest on the other. The determination and maintenance of the fundamental standards of measurement, and the comparison and certification of sub-standards comes clearly within the scope of a State-aided observatory, and nothing, it seems to me, ought to be allowed to imperil the continuity and accuracy of such work. When, however, those interested in observatory work ask for protection for scientific work in general it becomes necessary to examine the nature and probable outcome of the researches upon which our observatories are engaged. As a pertinent example, take the continuous records of the direction and strength of the earth's magnetic force which have been made for so many years at Greenwich and Kew. No one disputes their great interest and scientific value in the past, but are they likely to prove useful in the future? That is the question for which the tax-payer may legitimately demand an answer. He pays the piper; let the more intelligent part of him call the tune.

Sixty years ago, when Greenwich began its magnetic record, we were still in the dark about nearly everything. We had not enough facts to generalise upon. Any research that promised facts was equally likely to lead to scientifically useful discoveries. To-day the case is entirely different. We suffer rather from a plethora of undigested facts—the world is waiting for someone to co-ordinate them. Such co-ordination has of course taken place to some extent as we went along, and together with most other branches of science, magnetism has made enormous strides; meanwhile Greenwich has steadily collected records.

What have those records contributed as their share in the great advance? Two—and, I think, only two—wholly isolated facts, namely, the secular changes of magnetic force and direction, and the disturbances due to solar phenomena. But from this 60 years' patient and wholly admirable work an inference should now be drawn which has, I fear, been overlooked from excessive zeal for facts. We may safely infer that no facts of a novel character will be forthcoming, no matter how long and how carefully the record is continued. Nature does not reveal her secrets to those who, in gathering the myriad flowers of the field, forget to look for traces of the path. Do not misunderstand me. The facts to which I have referred were of such a nature as necessitated an enormously long series of observations, and the work has been done with a regularity and precision which could, perhaps, only be secured in a Government observatory. But the research has already achieved the end for which it was set on foot, and its further continuance, although desirable and interesting enough, is, in my opinion, no longer a matter of primary importance. The secret of the earth's magnetism will be discovered in the laboratory. The secret of the sun's magnetic influence awaits the man who will unlock the door. The key lies ready to his hand where Maxwell left it, and perhaps if I indicate where, in my view, that key is to be found, my argument against the mere multiplication of facts of one species will gain a little force.

We have traced solar radiation down through the spectrum until it could no longer be detected by Langley's bolometer. But we have no reason to believe there is any sudden limit to the wave lengths the sun is capable of emitting, nor does it necessarily follow that his emission is uniform. A solar disturbance may quite conceivably start short trains of waves, of varying amplitude. A sudden electric discharge in the sun would give rise to a train of waves of gradually diminishing amplitude, much like those from a discharging condenser. Such trains would quite naturally be more frequently initiated in the centres of solar disturbances—sun spots—and would as naturally lead to magnetic disturbances here on the earth.

I am told there is a well-authenticated instance of a brilliant line of light being seen to flash across the centre of a sun spot and vanish; and that at the proper interval a measured magnetic disturbance was recorded here.

There is the key; but it is useless to hunt for alternating waves with a magnetometer. All you can ever hope to obtain is a minute differential effect due to a want of symmetry and a varying amplitude of wave. Sixty years ago electromagnetic waves had not been heard of; a magnetometer measured magnetism, therefore let us watch the earth's magnetism with it: a perfectly scientific method 60 years ago. But in the time that has elapsed since they started a record at Greenwich Maxwell has lived, and we now know that radiation from the sun must be of an alternating-wave type. There may be other kinds also, but that at least must exist. What we have to do now is to hunt for it with tuned coils and condensers with sensitive alternate-current detectors in circuit. Whoever does this and discovers one novel fact will not have laboured in vain, and with two facts to his credit he will have equalled the 60 years' record of the magnetometer.

Judged by the considerations advanced in this letter, the future continuity of magnetometer records is hardly a matter of vital consequence either to the nation or to science. Such value as the records might possess in the future is not sufficient to warrant any extensive restriction of the means of locomotion rendered necessary by our rapidly-growing urban population, and it cannot be denied that the protective measures put forward at the conference would, if adopted, constitute a severe tax upon electric tramways, and, indirectly, upon those who use them.

In conclusion, let me remind the eminent men who held briefs for the observatories that the mere collecting of facts, apart from constant co-ordination with our advancing knowledge, so far from remaining a truly scientific method may easily tend to degenerate into something verging on the pedantic.—Yours, &c., SYDNEY EVERSHED.

London, Nov. 21, 1900.

### PROF. PERRY'S PRESIDENTIAL ADDRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In replying to a request to join in a discussion on some of the questions raised by Prof. Perry in his recent address, it seems necessary to limit oneself to a few remarks on one or two points only, as the attempt to do more would occupy too much of your space. Broadly speaking, I think Prof. Perry's address may be considered to be an entreaty for greater originality and effectiveness in British electrical engineering. Electrical engineering as an applied science is remarkable for its illimitable possibilities and rapid advances. Things we thought new and wonderful in 1882 are long ago on the scrap heap. Every year sees some unexpected development. Hence an electrical engineer cannot stand still. He must keep moving, or else fall out of the procession. The problems presented to him are always new ones, and, accordingly, if he is not an investigator he becomes only an imitator. If British electrical engineers are not to become simply salesmen and factors of ideas and plant imported from abroad they must be inventors, originators, investigators, and makers of new things, not simply dealers in second-hand knowledge and machinery. To do this they must become and remain before all things scientific men and

experts in theoretical and experimental investigation. The young electrical engineer's intellectual outfit must therefore include the power of tackling new problems with the best tools. At the bottom of all this lies his school education. It is impossible to deny that one great fault of our public school teaching is the small real knowledge resulting from an enormous expenditure of time, because methods of instruction are faulty. Mental energy is frittered away in trying to do too many things at once, and nothing is, therefore, done very well. The public school boy spends years over Latin, Greek, German, French, and English grammar, and a smattering of mathematics and science thrown in. He then, perhaps, comes, at 17, 18, or 19 years old, to a technical college to be trained for the engineering profession. It is then very frequently found that he has not the slightest knowledge of mechanical drawing. His school mathematical master has never taught him to plot curves from equations. He has never seen a slide rule. He cannot handle a table of logarithms. His trigonometry hardly extends beyond a little symbol juggling with sin A and cos B. His knowledge of the elements of differential or integral calculus is nil. He has not the ghost of a notion how to solve simultaneous linear equations by determinants or made any beginning in the study of mechanics. His hand has never been trained to dexterity in the physical or chemical laboratory. His observational and originative faculties are dormant, and he can speak no language but his own. He has probably not any idea what really hard study has to be given to a subject to become proficient in it. With this inefficient school training the college time has to be spent in beginning to learn things that ought to have been taught at school.

The time at the technical college has, in consequence, to be taken up in acquiring the merest elements of science. Students who ought to be conducting research and training themselves in conquering difficulties when left alone are, for the most part, learning the use of the simplest instruments of investigation. Too much time is given to attending lectures and writing down things heard with a fountain pen in a notebook; far too little to real private study and serious reading. In some colleges much of the student's day is taken up with flitting about from one lecture room and subject to another. The only way to master a subject is to give the mind up wholly to that subject for a time.

The personnel of our electrical factories and firms is drawn to a considerable extent from the ranks of the students in technical colleges. Hence the degree of skill brought to bear by them in solving the problems presented in electrical manufacture will depend greatly on the completeness of their training in the art of scientific investigation. If they are badly equipped in this respect, or are amateurish, superficial, or without powers of initiative, the consequences are seen in want of originality or unscientific manufacture.

Whilst, therefore, thoroughly agreeing with the claim which Prof. Perry makes for higher scientific training for men intending to enter the electrical engineering profession, and admitting the necessity for improved methods, improved appliances, improved laboratories, improved teaching in technical subjects, I say that we have to go further back still and insist on reforms in public school teaching which shall enable the boy between 14 and 18 to get more real attainment, more actual practical knowledge and skill, more intellectual strength than as a rule he does obtain for the expense and pains spent in teaching him during these four important years. To do this we may have to curtail a little the excessive devotion to athletics and the hours spent in amusements; but the time has come when Britons have to look certain facts squarely in the face, and one of these is that the scientific education for the technical professions is more thorough in other countries than in our own.—Yours, &c., J. A. Fleming.

University College, London.

### THE AUTOMOBILE CLUB TRIALS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your last issue you give figures relating to the Tuesday's run of the National Motor Carriage Syndicate's Joel car (No. 8), which are not in accordance with the observer's results. The figures should be: Distance travelled 37 miles, not 34¾; time, 5 hours; average speed, 7·4 miles per hour; highest current noted, 119 amperes; lowest, 35 amperes recuperating—*i.e.*, charging down hill; average of 61 readings, 46·75 amperes; volts at starting 83, and 30 at finish, taken whilst running. The batteries are in parallel, so that 23 amperes is the average per cell.—Yours, &c., Henry F. Joel.

London, Nov. 20.

The figures we published were sent us by the secretary of the Automobile Club. Probably the difference in the two figures is accounted for by the 2-mile detour mentioned in our report.—Ed. *E.*

### MEMORIAL TO THE LATE MR. G. J. SYMONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: On May 31 a meeting was held at the Rooms of the Royal Meteorological Society to consider the question of a memorial to the late Mr. G. J. Symons, F.R.S., the distinguished meteorologist and founder of the British Rainfall Organisation. It was resolved unanimously that the memorial should take the form of a gold medal, to be awarded from time to time by the Council of the Royal Meteorological Society for distinguished work in connection with meteorological science.

An Executive committee was appointed to take the necessary steps to raise a fund for that purpose. We have now much pleasure in stating that their appeal has been very heartily responded to, not only by meteorologists, engineers, and representatives of other branches of science and industry, but also by personal friends and admirers of the late Mr. Symons in all classes.

The committee have decided to keep the list open until the end of January, 1901, in order to allow all who have in any benefited by Mr. Symons' advice and assistance to contribute to the memorial fund.—Yours, &c.,

C. Theodore Williams, M.D., Treasurer.
R. Meldola, F.R.S., } Secretaries.
Wm. Marriott, }

70, Victoria street, Westminster, S.W.

## LEGAL INTELLIGENCE.

**Chamberlain and Hookham v. the Bradford Corporation.**

In the Chancery Division, on Tuesday, Mr. Justice Kekewich had before him the case of Chamberlain and Hookham (Ltd.) *v.* the Corporation of Bradford by way of appeal by plaintiffs from a decision of the taxing master as to the principle on which the costs in the recent action should be taxed.

Mr. FLETCHER MOULTON, Q.C., appeared in support of the appeal, and said the action was brought by plaintiffs for alleged infringement of a patent for an electricity meter. The action was tried before Mr. Justice Farwell, who decided in favour of defendants. When the matter came before the taxing master he decided that defendants, being a public body, were entitled to have their costs of the action as between solicitor and clients. As a matter of fact, the real defendants were the British Thomson-Houston Company. The Bradford Corporation were only nominal defendants, the fight being really between Chamberlain and Hookham and the Thomson Houston Co. That being so, he contended that the case did not come within the provisions of sec. 1 of the Public Authorities Protection Act, 1893. As the letting out of these meters by the Corporation was only a permissive act by the terms of their provisional order, the act did not apply, and the Corporation were only entitled to have their costs taxed in the usual way. He submitted that the 1893 Act was never intended to apply to such a case as the present. There was a great difference in a public body being "compelled" to do something by reason of its provisional order and being "permitted" to do it as in this case.

His LORDSHIP, without calling on defendants' counsel, said he had not the slightest doubt about the point raised. The defendant Corporation were empowered by their Act of Parliament or provisional order to maintain electric power, and, among other things, to let out meters for hire. In those circumstances, he thought the case came within the terms of sec. 1 of the Public Authorities Protection Act, 1893, and that the taxing master was right in holding that the Corporation were entitled to their costs as between solicitor and client. The appeal must be dismissed, with costs.

Leave to appeal was granted.

### Phibbs v. Allam.

In the City of London Court, on Tuesday, before Judge Snagge, an action was brought by Mr. J. Pullar Phibbs, electrical engineer, to recover £24. 11s. 7d. for electrical fittings supplied to Messrs. E. P. Allam & Co., electrical engineers.

Mr. NICHOLLS, plaintiff's counsel, said that just before the opening of the Paris Exhibition defendants were employed to supply and fit up certain electrical fittings in the exhibition. Defendants knew plaintiff had a representative in Paris, and as they wished to be supplied in Paris with what electrical fittings they required, they asked plaintiff to permit them to order the goods of the firm with which plaintiff was connected (the Société de Central Electrique). That was agreed to, it being understood that plaintiff was to pay for the goods so ordered, and defendants were to re-purchase the goods of plaintiff. That was done, and plaintiff asked to be reimbursed the sum he had paid, together with some small additions by way of profit. Defendants, however, objected to pay. The plaintiff had taken the risk of the matter, and had paid for the goods. He was allowed certain trade discounts, and those he had practically halved with defendants. In all £36 had been paid, and plaintiff was charging £8 for profit. It was absurd for defendants to suggest that plaintiff ought to be content with the prices which similar goods would have cost in London, as everybody knew that electrical fittings were more expensive in Paris than in London. The French Board of Trade requirements were more severe, and materials cost more. Plaintiff repudiated the suggestion that he was simply an agent for the French company, and that he was to be satisfied with the ordinary commission by way of discount. In some of the invoices he was allowed 35 per cent. discount by the French house, but in those instances he only allowed defendants 15 per cent. He had charged the defendants 20 per cent. profit all round, thinking that fair and reasonable. There was no definite bargain made. Twenty per cent. profit was very much below the ordinary custom of the electrical trade. Defendants had paid plaintiff £35. 13s. 1d., which was £1. 15s. 5d. less than he had sent to the French house.

Defendants urged that plaintiff had paid too much for the goods which were ordered by defendants. Electrical goods were much cheaper in France than in England. The electrical fittings were to be supplied at ordinary trade prices. In England they obtained the usual trade discount for all electrical goods ordered. They (defendants) could have bought for cash the same goods which plaintiff had supplied them with through the French house for less money than plaintiff was now charging them. Electric cable was certainly cheaper in France than in England. The standard of quality was not so high abroad as at home.

Judge SNAGGE considered plaintiff's charges were not unreasonable, and there would be judgment for plaintiff for the full amount claimed and costs.

### National Telephone Co. v. Gulliver & Co.

In the Westminster (London) County Court, on Monday, Judge Lumley Smith and a jury heard a claim for £17 (a year's telephone rental in advance). Defendants counter claimed £20 damages against the company for failing to carry out their contract to give a telephone service. Plaintiffs' case was that an ordinary agreement was entered into in 1898, under which defendants' works at Belvedere-road, S.E., and their stores and office premises at Argyll-street, W., were connected with the company's servic at a rental of £17 per annum, payable in advance from Dec. 12, 1898. There was a difficulty at first, and the company consented to make a rebate by starting the year from Feb. 14, 1899. The first year's rent was paid, and defendants, when the next payment became due in February, 1900, demanded that the date for payment should be altered to April 1. The company refused, and now sued for the rental. Defendants had been taken off the service. The contract was, as usual, for five years.

On the counter-claim evidence was called to show that plaintiffs never had supplied a complete service. Under the first clause of the agreement they were to "erect and maintain in good working order the subscriber's exchange line and instrument," and under the second clause to "repair and restore the line and use every endeavour to speedily restore communication in the event of breakdowns." Defendants pleaded that their telephone used to ring up every five minutes "for nobody," and when required was found to be out of order.

Plaintiffs, in reply, contended that every effort was made to give defendants the best service possible in telephonic and electric knowledge.

Counsel for plaintiffs pointed out that the contract set out that the conditions were "subject to the performance by the subscriber of the conditions herein named." Defendants did not perform their part of the contract, as they did not pay their rent. Therefore plaintiffs were justified in stopping the service.

The jury found for plaintiffs on both the claim and counter-claim, the latter by the judge's direction.

### "Electric" Belt Case.

At Westminster (London) County Court, on Tuesday, Judge Lumley Smith, Q.C., tried an action brought by Messrs. Pulvermacher (Ltd.), belt makers, to recover £4. 4s., balance of the cost of an "electric" belt. Defendant was a Mr. H. Mott. Plaintiffs' case was that in September they sent defendant a "concentrated electric belt," price five guineas. Several months after the belt was returned by post with a request that a portion of the amount paid should be returned. This was refused, and the present proceedings instituted. Defendant admitted ordering the belt, which was required for a special purpose, and it had failed to effect that object. After wearing it for a little time his head ached, and gradually pains became severe, and he left it off every other day. Later he became so bad that a doctor had to be called in. A great portion of that time he was unconscious, and had never been well since.

The MANAGING DIRECTOR of plaintiff company said there were many thousands of these belts sold. They generated oxygen and hydrogen in the muscles.

The learned JUDGE wanted to know all about it, and invited witness to explain, which he did by saying that "galvanism produces oxygen and hydrogen through the circulation, through the liquid matter, the blood, and the moisture and the nerve matter." The term "concentrated" meant every half an inch there was a battery of cells; "not concentrated" meant a battery of cells every inch.

The JUDGE: How do you spell cells? (Laughter.)

WITNESS went on to say that these belts would cure headache in two minutes.

The JUDGE remarked that plaintiffs issued a book, on page 19 of which was printed: "besides having the widest range of curative efficiency in all the ailments flesh is heir to."

WITNESS: We do not guarantee to cure anyone. We can prove it will cure.

The JUDGE: Defendant says it did not do him any good, and I dare say sometimes they do not.

WITNESS: If he had written to say how it had answered we should have told him what to do. These belts lasted about 18 months, or until the zinc was eaten away.

The JUDGE: What is the manufacturing cost of these belts?

WITNESS: I cannot say.

The JUDGE: About half a guinea?

WITNESS: I cannot say.

DEFENDANT said he had purchased the belt as it was represented it would do him good. He kept it for a month and then returned it.

The JUDGE said the order for this belt was given in reliance upon a statement in a book published by plaintiffs that the belt "had the widest range of curative efficiency in the ailments flesh is heir to." Defendant filled up their form, describing his state of health as "low spirited, irritable, loss of strength and overwork." He received the belt, and, so far from doing him any good, he now stated its effect was to make him seriously ill. He (the judge) held that the legal position was that the warranty given with the belt was that it would do defendant good, and defendant was therefore entitled to say that the belt was no good to him, and that he would pay no more than the one guinea which he had deposited with his application for this thing to be supplied. There would be judgment for defendant, but without costs.

### Cameron's Trustees and Others v. P. C. Middleton & Co.

Sheriff Burnet has issued an interlocutor in this action, which was for an interdict against the defendants from carrying on their electricity works at Cults, Aberdeen, on the ground that the works were a nuisance to the inhabitants, and diminished the value of property in the vicinity. Sheriff Burnet finds that the noise of the working of the engines at the station is such as to cause the pursuers material discomfort and annoyance, and to sensibly restrict and diminish the use and enjoyment by them of their respective properties adjoining the electric lighting station, and that the noise tends materially to diminish, and has diminished, the value of the pursuers' properties. He finds in law that the noise is a nuisance, and the defenders are to lodge, within 14 days, a minute stating what measures they are willing to adopt for abating the nuisance, and the pursuers have 14 days thereafter to reply to the defendants' suggestions. Leave to appeal was given.

### Mercier's Patent (Ltd.) v. New Flint Colliery Co.

At the Manchester Assizes last week plaintiffs sought to recover £120, balance due for work done and goods supplied in connection with putting up in the colliery electric and telephonic installations and supplying certain spare parts of machinery. The colliery company pleaded that nothing was done, no goods were supplied, prices were excessive, and the apparatus was defective. They had, however, paid on account £175 out of £295. Mr. M. Mercier, managing director of the plaintiff company, said it was true that when the telephone was erected it frequently failed to act, but this was due to an unusual amount of water in the pit and to the mishandling by employés of the Colliery Company. In the result, judgment was given for plaintiff for £90 and costs.

### Recording Telegraphs (Ltd.).

Mr. Justice Wright, on Wednesday, in a creditors petition asking for a supervision order, made the order asked for.

Counsel stated the accounts of the company consisted chiefly of shares which, if judiciously placed on the market, would, it was thought, realise sufficient to meet the claims of creditors, leaving something probably for the shareholders.

### Toppin v. Sanderson.

In the Lord Mayor's Court (London), on Friday, Sir Forrest Fulton and a special jury heard an action in which Mr. E. Toppin, a surveyor, sued Mr. A. J. Sanderson, managing director of the Electrical Inkless Printing Syndicate (Ltd.), to recover £200 cash and 4,300 fully-paid £1 shares in the syndicate under a commission note. The case has been previously reported (*The Electrician* for Oct. 26. The jury found verdict for plaintiff, and judgment was given for £4,500, to be reduced to £200 on 4,300 shares being transferred to plaintiff.

**Taff Vale Railway Co. v. Amalgamated Society of Railway Servants and Others.**

An appeal against the recent decision of Mr. Justice Farwell (in the Vacation Court) was heard last week before the Master of the Rolls, Lords Justices Collins and Stirling.

It will be remembered that Mr. Justice Farwell gave judgment for the plaintiffs in an injunction action to restrain the Amalgamated Society of Railway Servants and Richard Bell and James Holmes, their servants, from watching or besetting the Great Western Railway Station at Cardiff during the recent strike of railway employés in that town. It was against this decision that the present appeal action was brought and the Master of the Rolls read the judgment of the Court granting the appeal with costs against the Taff Vale Co. in both the upper and lower Courts.

Leave to appeal to the House of Lords was asked and granted.

**Crompton & Co. (Ltd.) v. Albright.**

This was a case in the list for hearing before Mr. Justice Farwell in the Chancery Division on Wednesday, when counsel informed his lordship that the parties had come to terms and the action would not proceed.

**Workmen's Compensation.**

**Cropper v. Tay Spinning Co.**—Recently, at Oldham County Court, Judge Bradbury delivered judgment in an action which raised an important question under the Workmen's Compensation Act, which, he said, had not, so far as he knew, been previously decided. The Court of Appeal had held that where a workman entered the employment less than two weeks before an accident the act did not apply. In Cropper v. Tay Spinning Co. the plaintiff had been altogether over six months in the employ of the company, but that employment had not been continuous, and he had only been working eight days without a break before the accident occurred. Plaintiff first entered respondents' employ in August, 1899, and left on Dec. 18 to work for another firm. He returned to respondents' employ on Jan. 11, 1900, and worked to March 15, when he was injured, and was away until April 6, when he returned and worked until the 14th, when the accident, which was the subject of this arbitration, occurred. Now there was no doubt the break in the employ from December to January put an end to the continuous employment, and the previous period of employment was clearly shut out from the claim. The evidence was that the applicant was paid 17s. a week of 55 hours, and by the terms of the employment no notice was required. When the first accident occurred, on March 15, applicant was paid off, and the third week after was paid 8s. 6d., not as wages but as compensation, and when he went back on April 6 the foreman swore that he was re-engaged. These facts led him (the judge) to the conclusion that the employment ceased on March 15. The legal effect of this was determined by two decisions of the Appeal Court that two weeks' employment was necessary to ascertain the average weekly earnings as a basis of award. There were also a number of decisions, which established the principle that the Courts must only take into consideration the last continuous employment, and were not entitled to consider previous terms of employment. He was therefore forced to decide that the applicant in this case was not entitled to compensation, and there must be a decision for the respondents. If, however, the case of Lyons v. Knowles was reversed by the House of Lords, it would apply to this action, and his award, therefore, would not be drawn up until the Lords' decision in that action was given.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

An engineer-in-charge is wanted immediately for a high-tension alternating station. Applications to Mr. C. D. Copland, borough electrical engineer, Newport (Mon.). See advertisement.

Middlesbrough Corporation require an assistant engineer at their electricity works; also a cable jointer. Further particulars are given in advertisements, and applications must be sent to the town clerk by 29th inst.

An experienced tramways engineer is required for a large tramway system. See advertisement.

Colchester Electric Light and Power committee require a jointer. Applications by 30th inst. See advertisement.

An assistant engineer, experienced in preparing plans for construction of electric tramway track, is required by the Rochdale borough engineer. Applications by 26th inst.

Worcester Electricity committee require a mains superintendent. Applications to electrical engineer by 28th inst.

Mr. William Henry Grimsdale has been appointed borough electrical engineer at Warrington. He served his apprenticeship with Messrs. J. G. Statter & Co. at West Drayton, and afterwards went into the shops of Messrs. James Swinburne & Co. at Teddington, with whom he stayed nearly two years. Theoretical training was obtained in the laboratories of University College, London, where Mr. Grimsdale studied under Prof. Fleming for two sessions, and in the final examination gained the prize for electrical engineering and the certificate of honour for machine design and construction. During a stay of 2½ years with Mr. A. H. Preece, Mr. Grimsdale was engaged in the design of several stations and in testing and inspecting the plants. Afterwards he was assistant engineer and clerk of works to Mr. G. G. Bell at Hammersmith for twelve months, and since December, 1899, has been engaged under the Electric Light committee of Warrington in supervising the erection of the plant and mains for their electric lighting scheme.

Mr. Wm. Sillery, A.I.E.E., has been selected by the Wrexham Electricity committee for the position of borough electrical engineer. The committee's choice has not yet been formally ratified by the Council.

Mr. J. E. Symonds, of the Kimberley Telegraph Department, has been appointed inspector of telegraphs in the Transvaal.

Mr. Dryburgh has been appointed assistant engineer at Doncaster at a salary of £2 per week.

**Argentina.**—The *Review of the River Plate* announces that an English syndicate is negotiating at Tucumán for a concession for utilising the waters of the River Lules for generating electricity.

The calcium carbide factory of Messrs. Mann, George & Co. (representing Visconde E. de Boismenu) was recently inaugurated in Córdoba, current being obtained from the Córdoba Electric Light and Power Co. at Rio Cuarto.

The tender of the Compañia Transatlantica Alemana has been accepted for 78 arc lamps to be placed in certain streets in Buenos Ayres.

**Ashington.**—A complete new electric lighting plant has just been put down in duplicate for the Ashington Co-operative Society by the Gateshead Electric and Mechanical Supply Co., under the supervision of Mr. J. A. M. Collier, managing director of the company. The plant consists of a Tangye oil engine driving a Taunton dynamo, giving an output of 100 amperes at 110 volts.

**Bangor.**—Already the Council have had to consider the question of extensions. The electrical engineer (Mr. P. F. White) reported that they were supplying current to about 4,900 8 c.p., and as the station was originally designed to supply only 4,000 lights, it was recommended to put down an additional 200kw. steam dynamo. In supporting the recommendation of the Lighting committee, the chairman (Dr. Gray Edwards) said it was estimated that by Christmas they would be called upon to supply current for 6,000 lamps. No one dreamt that the electric light would be taken up so well in the first year; he did not himself anticipate that 4,000 lights would be taken up before the end of three years. Their present plant was not capable of meeting such a demand. No firm would deliver the new unit of plant under less than 10 months, and it was, therefore, a matter of great urgency that the committee should have power to borrow the necessary moneys. By an expenditure of about £2,500 they would get additional plant which would double the present capacity of the works. Their total capital expenditure amounted to about £16,000, and by providing a new unit of plant they would raise the capacity of the works to nearly 12,000 lights. He believed the works would be a perfect success, and that they would realise a good profit after they had started to work properly. The proposal was adopted.

**Barnsley.**—Application is to be made for sanction to borrow £20,000 for extensions of the electricity works. At the Council meeting on Tuesday, the chairman of the Lighting committee (Councillor Brady) said they had already exhausted their present powers, and owing to the increasing demand for current it was necessary to have further powers. All the money would not be spent at once, probably not more than £7,000 in the financial year, but before the end of 1902 nearly the whole of it would be expended. They commenced supplying electric current on Feb. 17 last to 48 consumers with an equivalent of 3,800 8 c.p. lamps, but now they had 177 consumers, equivalent to 12,000 8 c.p. lamps. The committee's report on the subject was adopted.

**Bournemouth.**—The Council have received certain proposals from the Bournemouth and Poole Electricity Supply Co. in regard to the purchase of the company's undertaking by the Council, and an expert is to be called in to advise the Council.

**Bradford.**—The electrical equipment of the new Whetley Hill and Thornbury-Stanningley electric tramway routes have been inspected by Mr. A. P. Trotter and are now open for traffic.

**Bray.**—Mr. Thomas Tomlinson took up his position as electrical engineer to the District Council on the 5th inst., and in a report which has just been presented to the Council he states that the plant was overloaded and that the reserve was not of sufficient capacity. Additional plant is therefore being put down.

**Bromsgrove.**—The company which recently obtained an order to construct a light railway in Bromsgrove and district are applying for a provisional electric lighting order. Messrs. Pritchard, Green & Co., Birmingham, are acting as engineers.

**Canal Haulage.**—In the report of the Compagnie Générale de Traction Electrique sur Voies Navigables, of Brussels, it is stated that the company's system of electrical haulage on canals is now in successful operation on the Brussels-Charleroi canal between

Ruysbroeck and Virginal, a distance of 22 kilometres. The company has also secured concessions to furnish current for electric lighting to 11 towns and villages on the line of the canal.

**Cleethorpes.**—The consulting engineer (Mr. C. S. Vesey Brown), in a recent communication to the Electrical committee, said there had been a considerable advance in the prices of electric cables and electrical machinery since his report last year, amounting to as much as 30 per cent. for cables. He submitted estimates of three schemes, amounting to £19,129, £20,072, and £17,388 respectively. The committee have decided to erect 48 arc lamps instead of 44, but as to the estimates no recommendation was made, as the local tramways company had not complied with the request for particulars of contracts entered into in relation to their power station.

**Colne.**—An inquiry was held here last week into the application of the council to borrow £30,000 for electrical works. The town clerk (Mr. A. Varley) appeared in support of the application, and said it was the intention to supply current for public and private electric lighting and also for operating the Colne and Trawden light railway, which is to be constructed by Messrs. Greenwood and Batley. The borough electrical engineer (Mr. A. G. Cooper) submitted plans and estimates. He put the total income at £3,000 per annum, and anticipates a net profit of £279 on the first year's working. The chairman of the Electrical committee (Councillor J. P. Hewitt) also gave evidence in support of the application, which was unopposed.

**Customs Dues.**—Under the tariff now in operation in Bermuda electric cable and electric cable machinery and apparatus imported by any company or person under contract with Her Majesty's Government with a view to establishing and maintaining telegraphic communication with places beyond sea is admitted free of duty.

**Dartford.**—An unanimous resolution to apply for a provisional order to authorise the construction of electric tramways has been passed by the Council.

**Death from Electric Shock.**—At Cape Town, on Oct. 23, Mr. C. Shaw Nicholson, resident magistrate, assisted by Mr. J. Denham, electrical engineer to the Cape Government Railways, acting as assessor, completed an enquiry into the death of a European, named Leopold J. Smith, aged 52, who was killed by contact with some live broken tramway trolley wire at Claremont. Evidence was given that a tree to which the trolley wire was connected had been blown down during a gale. In a statement handed in by Mr. W. Macmuldrow, managing engineer to the Cape Town Electric Lighting Syndicate, he locates the accident in the following way:—

From the transforming station 12 wires cross the road at a height of 27ft. from a standard outside the transformer-house to an extended tramway pole directly opposite. From this pole the distributing lines run up and down the main road, and also two No. 9 S.W.G. wires used for street lighting only, crossed the road to an arm fixed in a tree. One of these lines broke during the gale and so fell upon the telephone lines underneath, breaking two of them, and as these fell they would draw back in coils towards the posts to which they were affixed, and there can be little doubt that the man became entangled in one, if not both, of these. In the next telephone span three wires were standing, all in metallic contact. It would seem that as two of the telephone wires were still standing they would support the fallen street lighting lines, which, owing to the sag, came into intermittent electrical contact with the tramway central conductor, and so converging the tram current to the telephone lines which were down by reason of the contact in the next span. The potential difference between the street lighting wires was 220 volts; that of the house lighting wires 110 and 220 volts, it being a three-wire system. The tramway company's potential wire was broken, and the free end was lying on the footpath, and arcing, when disturbed, with the ground and also with the lighting wires.

J. W. ANDERSON, a despatcher in the employ of the Cape Electric Tramways Co., stated that when he consulted the engineer as to the wires being down he was informed that the line was quite clear. He was aware there were other electric lines crossing the trolley lines at Claremont, but it did not occur to him that the arcing might have been from the other wires. He had not sufficient electrical knowledge to know that an accident could happen to the general public without it affecting the running of the tramways. He thought some indication of any accident to the lines would have been shown in the engine room.

Mr. SHAW NICHOLSON, in giving a verdict of accidental death, said deceased was killed by an electric shock due to the escaping current from the electric tramway trolley wires, conveyed by means of a fallen electric lighting cable to fallen telephone wires with which deceased came in contact. In order to avoid similar accidents the Court recommended (1) That the use of trees for the support of electric wires, either directly or indirectly, should be prohibited; 2 that all overhead wires crossing other wires of a potential of 440 volts (or more) above the earth should be effectually insulated. The Court found that in this case the electric light wires attached to a tree snapped, probably owing to the wind swaying the tree; that the span (nearly 171ft.) was too long for the small-sized wires used; that these wires fell across the telephone wires and broke them; that the wind caused intermittent contact between the electric lighting cable and the trolley wires; and that the electric current was conveyed by means of the electric lighting cable from the trolley wires to the broken telephone wires.

The police were credited with all promptness when the accident became known, but the tramway company were blamed for not attaching sufficient importance to a request by the police to have the current switched off.

**Dublin.**—The Local Government Board auditor (Mr. J. W. Drury) sat in Dublin on Monday to hear objections from ratepayers to certain payments made by the Corporation in connection with electricity supply to private consumers in Dublin. Objection was taken in the first instance to a sum of £58 1s. 7d. paid for fittings on September 27, 1899, the ground of objection being that the Dublin Corporation had at that date no power to supply electricity except under their provisional order, and under the acts incorporated with the order. Therefore, the objector urged, this payment on September 27 was illegal. The objector relied upon the provisions of the Electric Lighting Clauses Act, 1899. Further payments had been made in connection with electric lighting matters after October 1, and these were clearly governed by the Electric Lighting Clauses Act, 1899. It was provided that the provisions of this act should be incorporated in every provisional order, and the objector submitted that these provisions clearly define the interpretation to be put upon the existing state of the law as regards the powers of corporations. The provisions of sec. 27 give power to the corporations to put up lines, and express provision is made that the owner or occupier must pay the cost, but nowhere in that section were the corporations empowered to put up fittings for the convenience of consumers and to pay for these fittings out of the city rates. The objector stated that a sum of between £3,000 and £4,000 had been spent in this way. The Local Government Board auditor was therefore asked before these accounts were passed for payment to satisfy himself that they were legal. Mr. S. Bushe, Q.C., for the Corporation, urged that under sec. 10 of the Electric Lighting Act, 1882, the Corporation had the fullest powers for supplying electricity and doing any such acts as might be necessary and incidental to such supply. He quite admitted that the original idea of the Act of 1882 was that the undertakers task ended with their taking the electric mains to consumers' premises, leaving the consumer to make connection and to provide whatever fittings he might require. He desired to point out to the auditor that the Corporation supply was originally given at a voltage of 100 and consumers had fitted up their premises for this voltage, but the Corporation received a report from Prof. A. B. W. Kennedy in October, 1897, advising a change to a 200 voltage. Advice from such a quarter was considered by the Corporation as beyond question and it was consequently promptly acted upon, the Corporation feeling the necessity for indemnifying consumers for the outlay which would be necessitated by the change. The Corporation was bound to supply its consumers with electric current, and there were only two alternatives—either to "fire the 200 voltage into the 100 voltage fittings and blow up the consumer's premises or cut off the consumer's supply," which would expose the Corporation to an action at law. The auditor said he had searched the files carefully and found that the change-over from a 100 to a 200 voltage was to have been effected by transformers, and the subject of re-wiring of premises by corporations had never come before the Local Government Board officially or unofficially. Mr. D. O'C. Miley, solicitor, who appeared for the objector, quoted from the Board of Trade regulations as to standard pressure, and especially the regulation which set out that the standard pressure shall not be altered except by permission of the Board of Trade, and upon such terms and conditions as the Board may impose. He contended that the permission of the Board of Trade to alter the voltage was not given until December 27, 1899, and that the three last payments to which he objected were made on that day for work which he considered himself right in saying was done before that date and therefore was done illegally. By altering the pressure without the consent of the Board of Trade the Corporation were violating the charter under which they were working. The auditor promised to consider the points raised and to give his decision at an early date.

**Electrically-operated Bridge.**—A company has been formed, with a capital of £130,000 to erect a suspension bridge over the Tyne at the harbour mouth between North and South Shields. The idea is to erect a bridge at a sufficient altitude for the largest ship to pass safely underneath. The scheme, which is looked upon with favour in local circles, and has the support of the Corporations of Tynemouth and South Shields, embraces the erection of an aerial bridge 200ft. high between the foot of Howard street, North Shields, and Mile End-road, South Shields. The engineers are Mr. C. H. Gadsby, consulting engineer, Westminster, and M. Arnodin, of Paris. The bridge will have a clear span of 640ft., will be on the principle of a platform suspended by cables, which will be sufficiently large to accommodate tramcars, horses and carts, and 200 passengers, and the whole will be worked by electricity. A five minutes' service will be established, and the necessary electric current will be purchased from the above-mentioned corporations.

**Exhibition.**—An exhibition of fire prevention and extinguishing apparatus methods, and appliances is to be held in Berlin in the summer of 1901. The exhibition will be open for about two months. Electrical apparatus in connection with this branch of work is, we

understand, to be a prominent feature of the exhibition, and electric current will be supplied as motive power where required. Herr Emile Jacob, 41, Lindenstrasse, Berlin, S.W., is managing director.

**Electric Lighting Notices.**—Notice of intention to apply for provisional orders has been given by the following :—

*Local Authorities.*—Aberavon, Beverley, Faversham, Kilmarnock, Lichfield, Neath and Widnes Corporations; Abertillery, Burgess Hill, Chesham, Ebbw Vale, Faversham, Felling, Northfleet (Kent), Rhondda, Royton, Ruislip (Uxbridge), Teddington, and Wellington (Salop) District Councils.

*Companies.*—Lyndhurst (Lyndhurst Electric Lighting and Traction Co.), Middleton, Denton and Ilkley (Mr. A. H. Gibbings), Ross (Mr. John Parker), and Watford and Rickmansworth (Northwood Electric Lighting and Power Co., Ltd.).

In the following cases procedure by Bill has been decided on :—

The Board of Trade intimate that they will apply for powers to alter and readjust the areas of electricity supply in London, under the London Government Act, 1899, so as to make the boundaries of the several areas coterminous as far as may be with the areas of local government fixed by the 1899 Act and Orders in Council. In the schedule attached to the notice, particulars are given of the companies and local authorities affected by the bill.

The Metropolitan Electric Supply Co. are applying for power to include the area added to the Paddington parish by the Local Government Act of 1899 in their area of supply.

Notting Hill Electric Lighting Co. are promoting a bill to empower them to compulsorily acquire land for generating and transforming stations.

In an omnibus bill the Brighton Corporation seek powers to supply, sell, and let on hire, &c., electric motors and apparatus for cooking, heating and ventilating motive power, &c., and to fix, alter, and repair, and charge for same, and also to exempt motors or apparatus so let from distraint or execution. Powers are also sought to establish a fire insurance fund for municipal buildings, works, &c.

The District Councils of Edmonton, Enfield, Southgate, Tottenham, and Wood Green seek powers to incorporate and constitute a joint board, and to confer on such board powers for the generation, storage, and distribution of electricity in the districts named.

Handsworth (Staffs.) District Council seek powers for supplying electrical fittings and making by-laws in respect to same.

Crawley Gas Co. are seeking, *inter alia*, authority to apply for a licence or provisional order under the Electric Lighting Acts.

Richmond Gas Co. and Stroud Gas Light and Coke Co. seek powers to enable them to apply for a provisional order or other authority to establish electricity works, and also to construct subways for telegraph, telephone, tramway and electric lighting cables, &c.

The British Schuckert Electric Co. are promoting a bill for powers to incorporate a company to generate and supply electricity for public and private lighting, motive power, &c., within the area of the city of Dublin and the urban districts of New Kilmainham, Drumcondra, Clonliffe, Glasnevin and Clontarf, in the county of Dublin, to acquire land compulsorily for generating stations, &c.

Power is sought by bill to incorporate a company to supply electricity for lighting, power, traction, &c., purposes, in the West Riding of Yorkshire, and to acquire land in Thornhill Lees, Ferry Fryston and Wombwell, for generating stations, &c.

The Caledonian Electric Power Co. seeks powers to generate and distribute electric energy both "in bulk" and generally for power and other purposes throughout a large and important manufacturing district in the West of Scotland, including the whole of the county of Renfrew, the industrial portion of the County of Lanarkshire, and portions of the counties of Dumbarton, Stirling and Ayr. The city of Glasgow is excluded from the operations of the proposed scheme, which is upon similar lines to the Lancashire, South Wales and Durham Power bills of last session. Messrs. Maclay, Murray and Spens, Glasgow, are solicitors, and Mr. A. A. Campbell Swinton, M.Inst.C.E., 66, Victoria-street, Westminster, is engineer to the scheme, which has the support of leading manufacturers in the district.

Notice is also given that application is to be made by petition to the Secretary for Scotland for power to incorporate a company to generate, supply and sell electric energy for public and private lighting, traction, power, &c., in the County of Lanark, including the parishes of Calder, New Monkland, Old Monkland, Barony, Shotts, Bothwell, Rutherglen, Calton, Cambuslang, Dalzell, Cambusnethan, Cathcart, Carmunnock, Blantyre, Hamilton, East Kilbride, Carluke, Dalserf, Glassford, Lanark, Stonehouse, the city parish of Glasgow, Govan, Gorbals, Maryhill, Springburn, and Shettleston; so much of the county of Renfrew as is included in the parishes of Abbey, Paisley, Cathcart, Eaglesham, Eastwood, Erskine, Govan, Houston, Inchinnan, Kilbarchan, Kilmalcolm, Lochwinnoch, Mearns, Neilston, Port Glasgow, and Renfrew; so much of the county of Dumbarton as is included in the parishes of Bonhill, Cardross, Dumbarton, Old Kilpatrick, New Kilpatrick and Kirkintilloch; and so much of the county of Stirling as is included in the parishes of Baldernock, Campsie and Strathblane; also to enable the company to compulsorily acquire lands for generating stations, &c. The solicitor for the promoters are Messrs. Wright, Johnston, Mackenzie and Roxburgh, 150, St. Vincent-street, Glasgow, and the parliamentary agents are Messrs. Sherwood & Co., 7, Great George-street, Westminster, S.W.

In the omnibus bill of the Pembroke (Dublin) District Council power is sought to borrow money for electricity supply, &c.

**Electric Traction Notices.**—The following notices of intention to apply for electric traction powers have appeared :—

The Devonport Corporation are applying for a provisional order to revive and extend the Devonport Tramway Order of 1899; Hyde Corporation to construct and work electric tramways, to enter into agreements as to sale and lease of same, &c.; the Urban Electric Supply Co. seek powers to construct electric tramways in Glossop; and the National Electric Traction Co. wish to amend the Wrexham Tramways Order of 1899.

Procedure by bill has been decided upon in the following cases :—

Power is sought to incorporate a company to construct an electric railway from the north end of Gracechurch-street, E.C., to Walthamstow, Epping Forest, and Waltham Abbey, Essex, to authorise the company to acquire lands compulsorily for generating stations, and also to permit the London County Council, the Great Eastern Railway Co., the City and South London Railway Co., or other local authority or company to contribute towards the capital.

The Central London Railway Co. are applying for parliamentary powers to construct five additional lengths of electric railway, viz.: (1) A loop line in Hammersmith; (2) connecting the existing railway under Old Broad-street, and terminating under the Liverpool-street station of the G. E. R. Co.; (3) a loop line commencing by a junction with (2) and terminating by a junction with the same railway under the western entrance to Liverpool-street station; (4) A loop line commencing by a junction with the existing railway under Old Broad-street, and terminating by a junction with the same railway under Threadneedle-street; (5) a siding commencing by a junction with the existing railway under Old Broad-street, and terminating at a point 86yds. north of that street and Throgmorton-street.

The Charing Cross, Euston and Hampstead Railway Co. are also promoting a bill to authorise the construction of the following new railways, viz., a line from Kentish Town to Highgate; a line commencing at Highgate terminating in Hornsey; a line from the Charing Cross-road to Parliament-square, Westminster, also from Parliament square to Victoria.

The Company also seek powers to extend their authorised railway to Golder's Green (Finchley) Middlesex, to construct new subways, enlarge tunnels, acquire lands, to enter into agreements with other railway companies, &c.

Bills are also to be introduced to authorise the construction of an electric railway from Westminster to Cannon-street, near Dowgate-hill, thence to Peckham, S.E.; to construct an electric railway from the terminus of the Brompton and Piccadilly Circus Railway at Piccadilly Circus to Cannon-street, E.C.; to authorise the construction of the West and South London Junction Railway from Paddington to Vauxhall via Victoria.

The North-East London Electric Railway is to run from the Monument to the north-eastern suburbs; the Brompton and Piccadilly Circus Railway Co. are seeking powers for an extension of their line to the "Angel" at Islington; and there is also a scheme for the construction of an electric railway from Cannon-street to Hammersmith, which seems to be a revival of the 1897 scheme.

Power will also be sought to construct an electric railway from Victoria station to Fulham.

Bournemouth Corporation are promoting a bill to construct additional electric tramways in the borough, and in Winton; Brighton Corporation seek powers (in their omnibus bill) to alter the position of the tramways authorised by the Act of 1900; Burton-on-Trent Corporation to construct, work and lease electric tramways, to enter into agreements as to purchase, working and leasing tramways, and also to enter into agreements for the supply of electricity, &c.; Chester Corporation to construct new and alter existing tramways, to adopt electric traction, &c.; Handsworth (Staffs.) District Council to construct, work or lease electric tramways, to enter into agreements with local authorities and companies, to run omnibuses, &c.; Sheffield Corporation (in their omnibus bill) seek powers to construct electric tramways, &c.

The South Western and Isle of Wight Junction Railway are promoting a bill to incorporate a company to construct a railway from the London and South-Western Railway, near Lymington, under the Solent to the Freshwater, Yarmouth and Newport Railway (Isle of Wight), to employ electric traction, to acquire land in Milford (Lymington) for a generating station, also to enable the London and South-Western Railway Co. to subscribe towards capital, &c.

The General Electric Co. of Ireland are applying for powers to construct and work light (electric) railways or tramways in the townships of Pembroke, Rathmines and Rathgar, &c., in the county of Dublin, and Powerscourt and Bray, in the county of Wicklow, Ireland.

Messrs. Arthur Guinness, Son & Co. are promoting a bill for power to construct 19 lengths of electric tramway. The lines, which are wholly for business purposes, will be single track, and the gauge 1ft. 10in.

The Clyde Navigation Trustees are seeking, *inter alia*, powers to work any of their existing or authorised tramways by electricity or other mechanical system of traction.

**Hong Kong.**—The entire telegraphic and telephonic systems of this colony have been disorganised by the typhoon which visited Hong Kong a few days back.

**Inverness.**—Having abandoned their municipal electricity scheme and settled their differences with the late consulting engineer (Mr. E. G. Craven), the Council are now considering the question of transferring the order to a company. Two offers have been received, one being a payment of £1,000 and taking over the liabilities and indebtedness to Mr. Craven.

**Inquests.**—An inquest was held at Cheltenham last week on the body of Richard Edwards, electrical jointer, who recently died at the Manchester-street sub-station. The coroner (Mr. Waghorne) said the place where death occurred was probably a "factory" within the meaning of the acts, and those acts required of the Cheltenham Corporation and their borough electrical engineer that Her Majesty's Inspector of Factories for the district should be given the opportunity to attend the inquiry into the circumstances of death. The inspector for this district, who lived at Bristol, had

been communicated with, and that official considered it desirable that he should be present. Legal notice of at least four days was required and accordingly he (the coroner) proposed, after hearing evidence of identification, to adjourn the inquest for a week. He had directed a post-mortem examination to be held, as there was some suggestion that death was due to heart disease or natural causes. The report, however, was to the effect that the body was in a fairly healthy condition, and that, in the opinion of Mr. Powell, who conducted the autopsy, death was due to an electric shock, the result of coming into contact with an electric current or of some other cause. Formal evidence of identification having been given, the inquiry was adjourned until Wednesday, when, after hearing further evidence, a verdict of accidental death through contact with a transformer was returned.

On Wednesday the inquest was also resumed on the body of Thomas W. Griffiths, assistant engineer at Newport, Mon., who on Monday last week met with a fatal accident at the electricity works. Some particulars were given in our last issue.

F. A. WATKINS, switchboard attendant, stated that he was assisting deceased behind the switchboard to hold the end of a "dead" cable whilst a repair was made. Deceased had misplaced a spanner, which he needed, and said, "Where's the spanner?" At this time he was in a crouching position. Witness then saw a flash, and deceased rolled over on his back. He must have touched with his knee a "live" terminal. Witness ran for assistance, and artificial respiration was resorted to for 35min., but without success. Deceased had not got on the insulating gloves at the time, although he was contravening the regulations by not wearing them.

Mr. C. D. COPLAND, borough electrical engineer of Monmouth, stated that deceased was thoroughly experienced in the work he had to do. Death would not, in his opinion, have occurred had deceased used insulating gloves, which should have been used according to rules.

Mr. T. O. EDWARDS, factory inspector, said he had visited the works upon several occasions, and the precautions which were taken to prevent accidents were quite satisfactory.

The medical evidence showed that there were three marks or scars on the body—one on the knee, another on the abdomen, and the third on the left breast. The post-mortem showed that death was due to paralysis of the heart caused by electric shock. The jury returned a verdict in accordance with the medical opinion, and exonerated the management from blame.

**Leadgate.**—In consequence of complaints as to the inefficient gas lighting the Council will, at its next meeting, consider the question of establishing electricity supply.

**Light Railway.**—Lyndhurst Electric Lighting and Traction Co. (Ltd.) are applying for powers to construct light (electric) railways in Lyndhurst and district.

**Limitations of Municipal Enterprise.**—Mr. Emile Garcke, on Oct. 24, read a Paper before the Political and Economic Circle of the National Liberal Club on "The Limitations of Municipal Enterprise." This Paper is now obtainable from Messrs. P. S. King & Son, Great Smith-street, Westminster, price 6d. Mr. Garcké (*sic*) reviews the recent growth of all municipal enterprise, and the coincidental growth of local rates and local debts, and calls particular attention to the fact that municipal undertakings of an industrial character, after payment of working expenses, interest, and instalments of borrowed capital, show a profit balance of less than ½ per cent. on the sum of £87,581,000, the amount of the outstanding debt for the purposes of these industrial works. The Paper dwells particularly upon the fact that this advance of municipal enterprise has proceeded without definite ideals and unguided by any sound principle, practically without serious discussion on the part of the public or of Parliament, and certainly without due consideration of its far-reaching effects. Comparing municipal with State undertakings, Mr. Garcke urges that the latter have been entered upon exclusively from the point of view of public convenience and necessity, and in order that isolated districts shall share with the more central the advantages of the postal, telegraph, and telephone services, these works having hitherto been the only ones undertaken by the State. Municipal enterprise, on the other hand, is charged with undue preference for the supply of public necessities which are local in character and eminently suited to private industrial enterprise, and which should be open to healthy competition. Among the advantages of municipal enterprise upon which Mr. Garcke dilates is the rendering of certain public services more cheaply and more efficiently than can be effected by private capital, including water, sanitation, highways, education, order, protection of life and property, and burial; but Mr. Garcke contests the claim of the municipalities that other branches of industrial work can be better effected in municipal than in private hands. The author declaims against the profit-earning tendency of modern rate aided undertakings, and points to the danger to healthy municipal life of the desire of town councillors to stand well with their constituents, of whom the numerous employés of these municipal undertakings form a considerable proportion. The financial aspect of this important question is also discussed, and its bearing upon our colonial and foreign trade; and finally the author suggests that Parliament, in its wisdom, should take the earliest opportunity of clearly defining the limitations of the socialistic tendency of municipal trading. Mr. Garcke should enter Parliament and push his views to their logical issue.

**Liverpool.**—Mr. S. W. Higginbottom, M.P., has been re-elected chairman of the Electric Power and Lighting committee. On taking the chair Mr. Higginbottom announced that during the year there would be three-fourths of the machinery and plant in position at the Pumpfields station and half of the machinery at Lister Drive.

**London County Council.**—At Tuesday's meeting, Mr. BAKER moved:—

That, in view of the desirableness of no longer withholding from North and East London the advantages of electric tramway traction, and of the importance of providing a complete and united system of electric tramway intercommunication between the different parts of the metropolis, the Highways committee be instructed to ascertain from the North Metropolitan Tramways Co. at what price they will surrender the lease now held from the Council, which expires in July, 1910.

He said the lease to the North Metropolitan Co. had had his heartiest opposition from the time it was first conceived. He thought the result which they had arrived at in connection with their tramway enterprise on the other side of the Thames had ably proved that the whole of the tramways in London should be not only the property of the Council, but should be worked by the Council for the benefit of the ratepayer. The fact was that with their 24 miles of tramways on the south side they made for the ratepayers as much as they did with the 48 miles on the north side, had given a six days' week, a 10 hours day, and had ½d. fares. He thought that justified them in trying, if possible, to obtain the re-purchase of the lease granted to the North Metropolitan Company in 1896. It was, however, the question of the system of traction that caused him to move the motion, for he believed it was their duty to lay down electric traction in all parts of London. It would be practically impossible that the Council, as a business body, should put into the hands of tenants plant for traction like the conduit system, for example. They could not put down machinery costing £1,000,000 to £1,500,000, and have it worked by tenants whose lease would be of very short duration. They would not have any interest in keeping up that property as it should be kept up, and from a business point of view he did not believe there was a single man in that Council, if he was in the position of the London County Council and owned the tramways, who would think of putting into force the electric traction clause in the North Metropolitan lease. When the lease was before them in 1896 the Highways committee had very definite instructions from the Council to report as to what the advantage would be to the Council of electric or mechanical traction as compared with horse traction. But that instruction was never carried out at all. The Highways committee never reported to the Council as to what the probable profit would be if the lines were worked electrically or by mechanical traction. He believed that it was on that account that the lease was eventually passed through. He had taken the trouble to find out what had been done in other cities, and they had a very notable one in Liverpool, where the Corporation leased their lines to a company for 21 years, but they soon found out that a mistake had been made, and the Corporation re-purchased the 18 years' lease from the company at its full commercial value, and the result had fully justified that step. They had a duty to London to do everything in their power to lay down electric tramlines wherever it was possible to lay them down. They had now obtained Parliamentary powers which would enable them to convert the existing lines both on the north and the south and they ought to move in the matter for the good of London.

Mr. BEACHCROFT moved an amendment that it be referred to the Highways committee to consider whether it was desirable to negotiate with the North Metropolitan Company for the purchase of the lease.

Mr. WESTACOTT said Mr. Baker had said a great deal about electric traction, but they knew they had enough work in South London to last them five or six years. At the present moment they had not even approved the plans for electric traction in South London. They had gone again to the Board of Trade for approval, and each locality had the opportunity of going before the Board of Trade and expressing their approval or disapproval. Until they had got their experimental line in working order he considered it unwise of them to be trying to do too much. He was told on the best authority that the system they were going to adopt in South London would be found very expensive, not only in capital cost, but in maintenance, and that there would be difficulty surrounding the working in the locality. He thought they ought to see whether it turned out well or not. If they had the power to do the work on the north side they could not do it for a considerable time. He, personally, would like to see a line working in London before he voted for an enormous expenditure such as was now proposed.

Mr. BENN said if any justification was required for the motion they had it in the speech of Mr. Westacott, who had told them they were to go on experimenting for five or six years.

Mr. WESTACOTT: What I said was, that after you have laid the experimental line we shall have enough to occupy us five or six years

in converting the tramways on the south from horse to electric traction.

Mr. BENN said if that was so where did the north come in. To tell that Council that the north would have to wait five or six years was a monstrous thing. He protested against such a dilatory policy. They had ample evidence of the earning power of a system which might be installed in London at once. At present they had their plans ready for submission to the Board of Trade, but they were compelled to wait for the new borough councils because the Government gave them the power to appear before the Board of Trade on their plans. Whenever the borough councils were ready the Council was ready to settle the system which should be applied to London, and there was no reason why North London should not be treated as speedily as South London in the matter of electric traction.

Mr. BEACHCROFT: You can do it under the lease, the terms of which we are discussing.

Mr. BENN: The years of the lease were running out, and they could not expect people with a short life to take interest in their experiments. The clauses in the lease regarding electric traction were introduced under pressure, and they were not worth the paper they were written on. Liverpool had electric traction, and large dividends were accruing to the people of Liverpool. Why should not London do the same? It would not be wise to state what the sum was which should be offered, but no doubt the North Metropolitan Co. would want a considerable sum for the surrender of their lease, which was worth half a million of money when it was before the Council.

The amendment was lost, and the motion by Mr. Baker carried.

Mr. PARKER's motion that—

It be referred to the General Purposes committee to consider the best manner of bringing before the new borough councils the imperative necessity of making subways under, at least, all the leading thoroughfares of the metropolis to contain all the gas and water pipes and telephone and telegraph wires,

was not discussed, as the Council was counted out.

**Manchester.**—At a meeting of the Electricity and Tramway committees on Tuesday it was decided to call in an expert to consider the electrical situation generally, and to advise the committees as to the best course to take. In December, 1898, the Tramways committee requested the Electricity committee to state what was being done to provide the necessary electric power for the tramcars on Jan. 1, 1901. The latter committee replied in Jan., 1899, that they hoped to have the plans and specifications for the plant required at the Stuart street station ready by Feb., 1899. Subsequently the question as to whether a separate power station should be erected arose, and on this matter Mr. C. H. Wordingham, the city electrical engineer, presented a report on the subject of the price per unit to be charged by the Electricity committee, provided the combined station, as recommended by him, was carried out. In July, 1899, the Tramways committee inquired of the Electricity committee if, in certain contingencies, that committee would be in a position to supply energy for working the tramways by dates named, and the Electricity committee's answer was in the affirmative. Acting on this assurance, negotiations, which may possibly involve onerous obligations, were concluded with the Manchester Carriage Co., whose lines were being taken over by agreement. This agreement provides for the taking over of the tramways by the Corporation in instalments, and the company's profits are guaranteed to them by the Corporation up to May 31, 1902. In order to carry out this obligation the Tramways committee will have to borrow large sums in respect of which interest and sinking fund will have to be provided. Financial obligations have also been entered into with several local authorities. Five hundred men are already employed by the Tramways committee in relaying the permanent way. Of the 430 cars ordered last January, 190 are in course of construction.

**Marylebone (London).**—Last week, on the motion of Ald. Brooke-Hitching, it was decided to call a statutory meeting to take the necessary steps for applying for a provisional order.

**Mexborough.**—An inquiry was held here on Tuesday into the application of the Council to borrow £13,400 for electric lighting and £4,600 for refuse destructor works. In support of the application the clerk, Mr. J. W. Hattersley, pointed out that the Council had been forced to take up electric lighting owing to the action of the General Power Distributing Co. The Council obtained a provisional order last year, and after some negotiations a site for generating works had been acquired. The consulting engineer (Mr. Waring) submitted plans and estimates. It was proposed to give a supply of current for lighting at 5d. per unit.

**Municipal Telephony.**—The National Telephone Co. recently applied to the Grimsby Corporation for authority to change the present overhead into an underground system, but before giving consent the question of a municipal telephone exchange is to be fully considered.

At a meeting of the executive committee of the National Chamber of Trade, at Manchester, on Wednesday, the president (Mr. R. Thornton-Varley), of Hull, referred to the question of municipal telephony. Especial attention had, he said, been given to the question of permanent charges and the royalty payable to the Post Office, and there was a consensus of opinion that the royalty of 10 per cent. on the gross receipts now charged ought to be considerably reduced, especially in view of the fact that the smaller the royalty the greater the amount of revenue the Post Office would receive. As to the permanent charges, that was a matter still under consideration. A difficulty arose as to the delivery of messages to National Telephone subscribers spoken to over the trunk wire. At present the National Company could charge 6d. per message, but it was hoped that Parliament would come to a satisfactory solution of this difficulty.

**Municipal Trading.**—At the autumn conference of the Ironmongers' Federated Association, on Thursday last, the following resolution was passed:—

That this conference having heard the evidence given by their secretary (Mr. Smith) on the subject of municipal trading before the Joint Committee of the House of Lords and Commons, heartily approves the same, and strongly opposes any additional powers being granted to municipal bodies, and condemns the principal of employing the ratepayers' money in competition with private traders.

**North Ormesby.**—In reply to a request for a supply of electricity "in bulk" the Council have been informed by the Middlesbrough Corporation that they are not in a position and do not possess the necessary powers to give such a supply.

**Nottingham.**—A trial trip took place on the Great Market-place-Sherwood electric tramway route on Friday last.

**Pernambuco.**—The U.S. Consul at this city, Mr. E. N. Gunsaulus, describes Pernambuco as in the first rank as a submarine cable station in South America. It possesses no less than 10 cables to various parts of the world. The lines are owned by the Western Telegraph Co. and the South American Cable Co. The report continues: "The first-named company has a very complete system, and is now completing two or three new lines to Brazilian ports. One of these is a through line to Para, another to Para touching at local points, and still another to Rio de Janeiro. It now has separate cables running to Para, Ceara, Rio and Bahia, two to St. Vincent (Cape Verde Islands), and one to Europe via Lisbon. Several of these cables are duplexed, while another line to Rio is being triplicated to Montevideo. These lines are constructed with all the latest scientific improvements, and some of them have a carrying capacity of 200 letters a minute. The Western Company has a permanent staff of 50 persons constantly employed as an office force. The South American cables touch several South American points, going thence to the Canary Islands, Cadiz, Spain, and Africa."

**Salisbury.**—The Close is now lighted electrically.

**Sandown.**—A meeting of ratepayers has been held to consider the proposal to light the streets electrically, in accordance with the plans submitted by the Isle of Wight Electric Light and Power Co. A resolution in favour of electric lighting was passed.

**Sedgley.**—The Board of Trade having sanctioned the substitution of electric for steam traction on the tramway between Sedgley and the Fighting Cocks, near Wolverhampton (about 3 miles), the Sedgley Council have requested the British Electric Traction Co. to electrically equip the line.

**Smethwick.**—The Council have arranged terms with the British Electric Traction Co. with regard to the supply of current for lighting and power. The Council's consulting engineer (Mr. J. G. Aldridge) has reported favourably upon the agreement. The Council are promoting a bill to acquire control over the local lines.

**Southend.**—The Council have adopted an electric lighting scheme prepared by the borough engineer. The initial capital expenditure is estimated at £36,030, and the anticipated profit on the first year's working is put at £698. 15s. It was reported last week that the electric tramways would be completed by May 1. Alterations to the Pier electric tramway will entail an expenditure of £2,660, reduced by the sale of old plant by about £500.

**Standish-with-Langtree (Lancs.).**—A report on electric lighting is being prepared for the District Council by Messrs. Lacey, Clirehugh and Sillar, of Westminster and Manchester.

**Stoke Newington (London).**—This is a particularly sleepy district so far as electrical enterprise is concerned. No sign whatever of the early adoption of electric lighting is in evidence, and, apparently the newly elected borough council is disposed to go slowly. A special committee was some time ago appointed to consider the question, and has now reported that "no immediate urgency exists for the establishment of electricity supply." To avoid the charge of want of energy in connection with this important matter the committee has been instructed to consider the matter further and to again report.

**Sunderland.**—The new Chester-road electric tramway route was inspected by Col. Von Donop on behalf of the Board of Trade on Tuesday. Mr. A. P. Trotter inspected the electrical equipment on Wednesday, and the line is now open for traffic.

**Teddington.**—Mr. J. E. Edgcome, borough electrical engineer at Kingston, has been engaged as consulting engineer, at a fee of 50 guineas, in connection with the Teddington Council's application for a provisional order.

**Telephone in Egypt.**—The construction of a trunk telephone line between Cairo and Alexandria has been decided upon.

**Thornley (Durham).**—This village was lighted electrically for the first time on 16th inst. The street lighting is effected by 50 incandescents, current for which is supplied by the Weardale Iron and Coal Co.

**Transvaal Concessions.**—Amongst the joint-stock undertakings owning concessions granted by the late government of the Transvaal, which are the subject of enquiry by the Commission now sitting at Pretoria, are the Rand Electric Power Co. and of the Rand Central Electric Works (Ltd.). In the former case it was stated that this was an enterprise inaugurated by the Simmer and Jack Gold Mining Co. for the purpose of supplying their parent and subsidiary companies with electric power. All that had been granted by the late Transvaal Government was the right to cross public roads and properties, this right being limited to the parent and subsidiary companies included in the Simmer and Jack enterprise. Upon this explanation it was decided by the Commission not to inquire further into the concession. With regard to the Rand Central Electric Works Ltd.), this concession was of a similar character to that granted to the Power Company. Under this concession it might be held that the company was entitled to carry its lighting cables overhead through the streets of Johannesburg, but as a matter of fact this city is supplied with current from a point below the limitations of the town. The company is an English one, having its offices in London, the board of directors in the Transvaal being appointed for purely administrative purposes. A decision, similar to that in the first-mentioned case, was given by the Commission in regard to the Rand Central Electric Works (Ltd.)

**Tunbridge Wells.**—The borough electrical engineer (Mr. Horace L. P. Boot) has presented his fourth annual report on the working of the Electricity department. When the present extensions to the station buildings are completed there will be space for plant of a capacity of 94,200 8 c.p. lamps, which, at the present rate of increase, would suffice for 12 years. Condensing plant is being added at a cost of £5,221. Efforts are being made to cope with the smoke and vibration nuisance; and the report refers to the difficulties in connection with the coal contracts, and the unsuitability of the local water for steam-raising purposes. Management expenses have increased, but this is partly due to an apportionment of part of the revenue to the town hall expenses. But for the reduction in price of current the net profit would have been £3,130, while the capital outlay to date is £42 813. The profit for the year which would be available for dividend if the undertaking were owned by a company is £3.120, against £3 964 for the previous year, and, after paying interest and sinking fund on borrowed capital, there remains a net profit of £764. The average price obtained from private consumers was 4·8d. and for public lighting 1·19d per unit, the latter (the report states) being lower than any other town in the kingdom. The previous year the average prices were 5·68d. and 2 93d. per unit respectively. The total units generated were 620,558, and more than 40 per cent. was sold to private consumers at 3d. per unit under the maximum demand system. Mr. Boot suggests that, to avoid complaints arising from consumers using inferior lamps, the committee should undertake their supply at cost price; and the extension of electricity supply to neighbouring villages is another matter mentioned for consideration, as well as the letting out on hire of motors, &c.

The question of tramways is dealt with in an appendix to the report. Mr. Boot estimates that 3 miles of tramway, with six cars running, would cost £33,000, while the annual working cost, including capital charges at 6 per cent., would be £4,484. Estimating four cars to run, each earning £10 per day, there would be an annual income of £12,520, or a net profit of £8,036. Mr. Boot adds that he estimates the revenue at a very modest figure compared with other towns, as he considers Tunbridge Wells "will never patronise tramways like other towns."

**Underground Railway Electric Schemes.**—In one of the halfpenny London journals this week there appeared a grandiose account of a scheme (attributed to Sir William Preece) involving an expenditure of about £5,000,000. There was that percentage of truth in this statement as we are accustomed to find in statements made in the halfpenny London papers on electrical subjects—one-fifth. The true state of the case is that the scheme which Sir William Preece and Sir John Wolfe Barry have in hand for the conversion of the Metropolitan and District Underground Railways to electric traction may involve an expenditure of over £1,000,000. According to the Central News the British Westinghouse Co. and the Metropolitan and District Railway Companies will jointly promote a bill in Parliament for powers to effect this conversion, the British Westinghouse Co. finding the capital for the scheme in the first instance, and taking over the working of the whole or a portion of the lines during the progress of conversion.

**Watford.**—The Council have decided to order a 300kw. steam alternator for the electricity works at an estimated cost of £1,350.

**Waterford.**—The Public Lighting committee recommend the Council to apply for a provisional electric lighting order. The Council obtained an order in 1892, which was revoked on Aug. 4, 1899.

**Water Power in Spain.**—Application has been made to the Spanish Government for a concession to utilise the water power of the River Arlanzon, between Villorobe and Pineda de la Sierra, for the generation of electrical energy.

**Workhouse Lighting.** The Local Government Board have sanctioned a further expenditure of £1,875 on the electric lighting of the West Ham Union buildings and schools, bringing the total expenditure to £6,500.

**Yarmouth.** At present there are 442 customers of the electricity department, representing an equivalent of 23,141 8 c.p. lamps connected. The receipts for the midsummer quarter were £955. 10s. 3½d., and the expenditure £794. 0s. 1d., leaving £161. 10s. 2½d to meet sinking fund repayment and interest (£650), resulting in a loss of £488. 9s. 9d. In the Michaelmas quarter the receipts were £1,845 16s. 4d., showing a surplus of £83. 2s. 6d., but leaving a net deficit on the two quarters of £105.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Ayr* Tramways committee require tenders for the supply, delivery and erection of (Sec. 2) poles, centre and side brackets, section boxes, &c., and the complete overhead electrical equipment of the tramways, (Sec. 3), supply of feeders, distributors, telephone cables, conduits, trenching, &c., for underground work. Specifications, &c., can be obtained at the office of the Burgh electrical engineer, Electricity Works, Ayr, on and after Nov. 24, and tenders must be sent to Mr. A. G. Young, town clerk, Council Chambers, Ayr, N.B., not later than Friday, Dec. 7. An advertisement gives further particulars.

*Hendon* Urban District Council invite tenders for the supply and erection of generating plant and apparatus as set out in Sections A to I in an advertisement elsewhere. Specifications, &c., can be obtained by manufacturers at the offices of Mr. Robt. Hammond, consulting engineer to the Council, 64, Victoria-street, Westminster, London, S.W., on and after Monday next, and tenders must be addressed to Mr. Henry Humphris, clerk to the Council, Public Offices, The Burroughs, Hendon, by 4 p.m. of Dec. 31.

The Electric Light committee of the Borough of *Southwark* (London) require tenders for the supply and erection of certain Back E.M.F. cells at the Corporation electric light station, Penrose-street, Walworth-road, S.E. Specifications, &c., can be obtained of the engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, and tenders must be sent in to Mr. L. J. Dunham, acting town clerk, Town Hall, Walworth-road, S.E., before noon of Dec. 3.

*Blackpool* Corporation require tenders for arc lamp carbons and oils for one year. An advertisement contains further particulars, and specifications may be obtained from the borough electrical and tramways engineer (Mr. Robert C. Quin), to whom tenders must be sent by Dec. 17.

*Manchester* Tramways committee invite tenders for 12 workmen's electric tramcar bodies. Specification may be obtained from the general manager (Mr. J. M. McElroy), and tenders (addressed chairman of committee) must be in by Dec. 1. An advertisement gives additional particulars.

*Birkenhead* Corporation invite tenders for a switchboard and instruments for the Craven-street generating station. Specifications, &c., can be obtained from the borough electrical engineer (Mr. Wm Bates), Corporation electricity works, Bentinck-street. An advertisement gives further particulars, and tenders must be sent to the town clerk (Mr. Alfred Gill), Town Hall, Birkenhead, by 4 p.m. of Dec. 4.

The directors of the *North Eastern Railway Co.* invite tenders for telegraph apparatus, telegraph wire and line stores for the six months ending June 30, 1901. Further particulars are set out in an advertisement, and forms of tender may be obtained from Mr. A. Graves, Telegraph Department, York. Tenders must be sent to the secretary (Mr. C. N. Wilkinson), by noon of Dec. 10.

The directors of the *Great Northern Railway Co.* invite tenders for the supply of new, and the purchase of old, stores for 12 months from Jan. 1. A list of the contracts and forms of tender may be obtained from the stores superintendent (Mr. Weeks), Doncaster. Further particulars are set out in an advertisement, and tenders, addressed to Stores committee, must be sent to the company's offices at King's Cross, London, N., by 10 a.m. of Dec. 4. Mr. Wm. Latta is secretary of the company.

*Partick* Burgh Commissioners require tenders for electricity meters, demand indicators, and fuses. Specifications may be obtained at the offices of the town clerk (Mr. James Donaldson), 97, West Regent-street, Glasgow, or at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Further particulars are given in an advertisement, and tenders must be received by Mr. Donaldson before noon of Dec. 4.

*Portsmouth* Corporation invite tenders for the permanent way construction and underground feeders in connection with the electrical equipment of their tramways. Specifications may be obtained from the tramways engineer (Mr. E. Rotter), and tenders must be delivered to the town clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, by 10 a.m. of Dec. 7. An advertisement gives further particulars.

*Portsmouth* Corporation also require tenders for the overhead electrical equipment of the tramways in the borough and Cosham extension. Specifications may be obtained from the tramways engineer (Mr. E. Rotter), and tenders may be delivered to the town clerk (Mr. Alex. Hellard) by 10 a.m. Dec. 7. An advertisement gives further particulars.

*Bexhill* District Council invite tenders for the supply and erection of water-tube boiler and pipework and a 150kw. steam dynamo. An advertisement gives further particulars, and specifications may be obtained after 26th inst. at the office of the consulting engineer (Mr. A. H. Preece), 13, Queen Anne's-gate, Westminster, S.W. Tenders, addressed to the clerk (Mr. E. Sholto Douglas), must be delivered at the Council offices, Bexhill, before noon of Dec. 10.

The trustees of the Hightown Wesleyan Church (*Crewe*) require tenders for the electric lighting of the church. Specifications, &c., may be obtained from the Town Clerk, Crewe, to whom tenders must be sent by Dec. 10. An advertisement gives further particulars.

*Bermondsey* (London) Vestry invite tenders for 71 cast-iron arc lamp columns, arc and incandescent lamps, automatic switches and fittings. Tenders to Mr. F. Ryall, Town Hall, Bermondsey, before noon Dec. 3.

*Tyne Improvement Commission* require tenders for electric lighting of Northumberland and Albert Edward Docks. Tenders by 30th inst.

*Cardiff* Corporation require tenders for a 75kw. motor generator and Tudor storage battery, lead-covered cables and a 20-ton travelling crane. Tenders to town clerk before 28th inst.

*Oldham* Electricity Committee invite tenders for an extension of the tramway switchboard. Tenders to Mr. A. Andrew, Gas and Water Offices, before 27th inst.

*Brighton* Corporation invite tenders for points and crossings, sole plates, manhole covers, tie bars, fish bolts, &c. Tenders by Dec. 6.

*Brighton* Corporation also require tenders for the construction of the permanent way of their electric tramways. Tenders by Dec 13.

*Cheshire Lines Committee* invite tenders for stores for 1901, including telegraph materials, instruments, wire, &c. Tenders to secretary, Central Station, Liverpool, by 30th inst.

Tenders are invited for lead-covered, concentric cable, cast-iron conduit and watertight junction boxes for District Asylum, *Mullingar* (Ireland). Tenders to joint committee of management, before Dec. 1.

The joint committee of the Metropolitan and Metropolitan District Railway Companies (London) invite tenders for the electrical equipment of the Inner Circle Railway. Tenders by Dec. 1.

*Kendal* Corporation invite tenders for electricity generating plant, &c. Tenders to town clerk's office by Dec. 8.

*Londonderry* Corporation require tenders for the supply of carbons for one year from Jan. 1 next. Tenders to town clerk by Dec. 1.

*Halifax* Corporation require 36 tramcars, trucks, motors and electrical equipments. Tenders by 27th inst.

*Wolverhampton* Tramways committee require tenders for electric motor tramcars. Tenders to town clerk by noon of 26th inst.

*Hornsey* Council require tenders for telephone pit covers, &c. Tenders by 26th inst.

*Walker* Council require tenders for erecting refuse destructor buildings, &c. Tenders by Dec. 8.

*West Ham* Council require tenders for electric lighting plant for Dagenham Hospital. Tenders by noon of 30th inst.

## TENDERS RECEIVED AND ACCEPTED.

Grimsby Corporation have accepted the tender of Messrs. Chamberlain and Hookham for the supply of 5, 10, 25 and 50 ampere electricity meters, at £4. 7s. 6d. The tender of Messrs. Mackenzie Bros. has also been accepted for arc lamp-posts and brackets, as follows: Lamp-posts (with 3ft. brackets), £10. 18s. 0d. each; with 7ft. brackets, £16. 2s. each; with centre carrier, £13. 5s. each. Wall brackets (3ft. projection), £2. 5s. each; 7ft. projection, £4. 8s. each. Grimsby Corporation have also accepted the following tenders: Crowther & Co. (wiring electricity works), £235. 11s. 3d.; A. C. Dickins (wiring free library), £72. 12s. The lowest tender was accepted in each case. Eight tenders were received for the first and 16 for the second, the highest tenders being £892. 8s. 11d. and £220 respectively.

Tunbridge Wells Town Council have received the following tenders for the supply of high and low-tension electricity cables, the quotations being per 1,000 yards in each case. The amounts in bold figures are the accepted tenders:—

*High Tension.*

| | 0·025 £ | s. | 0·034 £ | s. | 0·05 £ | s. | 0·1 £ | s. |
|---|---|---|---|---|---|---|---|---|
| Callender's Co. | 113 | 0 | 131 | 0 | 175 | 0 | **257** | 0 |
| Polland & Co. | 163 | 4 | 232 | 6 | 250 | 19 | 321 | 17 |
| British Insulated Wire Co. | 144 | 0 | **154** | 0 | 210 | 0 | 290 | 0 |
| Western Electric Co. | 124 | 0 | 140 | 0 | 186 | 0 | 263 | 0 |
| St. Helens Cable Co. | 122 | 10 | 140 | 0 | 190 | 0 | 276 | 0 |
| W. T. Glover & Co. | 118 | 15 | 137 | 10 | 191 | 13½ | 272 | 18½ |
| Johnson and Phillips | 116 | 0 | 138 | 0 | 188 | 0 | 272 | 0 |
| Siemens Bros. & Co. | 116 | 0 | 130 | 0 | 175 | 0 | 257 | 0 |
| J. Littauer | 115 | 10 | 130 | 0 | 171 | 0 | 250 | 0 |
| W. T. Henley's Co. | 113 | 10 | 129 | 12½ | 178 | 2½ | 265 | 0 |

*Low Tension.*

| | 0·34 £ | s. | 0·06 £ | s. | 0·1 £ | s. | 0·15 £ | s. | 0·2 £ | s. | Twin. £ | s. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Callender's Co. | 109 | 0 | 168 | 0 | 223 | 0 | 236 | 0 | 354 | 0 | 70 | 0 |
| W. T. Henley's Co. | 106 | 5 | 165 | 17½ | 229 | 5 | 305 | 0 | 375 | 16 | **45** | 10 |
| Brit. Ins. Wire Co. | 135 | 0 | 193 | 0 | 246 | 0 | 322 | 0 | 384 | 0 | 65 | 0 |
| Polland & Co. | 126 | 8 | 187 | 6 | 256 | 8 | 336 | 17 | 409 | 15 | 78 | 4 |
| St. Helens C'ble Co. | 115 | 10 | 173 | 0 | 238 | 0 | 311 | 0 | 375 | 0 | 66 | 8 |
| West. Elec. Co. | 115 | 0 | 168 | 0 | 230 | 0 | 296 | 0 | 362 | 0 | 62 | 0 |
| W. T. Glover & Co. | 114 | 11½ | 175 | 0 | 237 | 10 | 312 | 10 | 389 | 11½ | 68 | 15 |
| Johnson & Phillips | 107 | 0 | 166 | 0 | 233 | 0 | 312 | 0 | 378 | 0 | 50 | 0 |
| Siemens Bros. & Co. | 109 | 0 | 161 | 0 | 222 | 0 | 295 | 0 | 354 | 0 | 60 | 0 |
| J. Littauer | 103 | 11 | 164 | 10 | 228 | 6 | 306 | 10 | 375 | 1 | 25 | 10 |

Dublin Corporation on Tuesday accepted the tender of the British Insulated Wire Co. for the supply of electric lighting cables and mains for their electricity supply scheme at £109,447. 10s 8d. There were nine tenders, but three were declared informal. The remaining tenders were:—

| | £ | s. | d. |
|---|---|---|---|
| Brit. Insulated Wire Co. (*accepted*) | £109,447 | 10 | 8 |
| Callender's Co. | 125,542 | 12 | 0 |
| W. T. Henley's Co. | 120,965 | 3 | 8 |
| Siemens Bros. & Co. | £113,687 | 12 | 1 |
| Western Elec. Co. | 113,004 | 13 | 9 |
| St. Helens Cable Co. | 108,039 | 15 | 0 |

Sunderland Town Council has placed a contract for 24 motor cars of the top-seat type, together with track cleaner and traverser, with Messrs. Dick, Kerr & Co., at £675 per car. The cars are to be equipped with standard air brakes.

The London County Council has accepted tenders from the following firms for the supply of engineers' goods and electrical stores:— Edison & Swan Co., Heaton & Smith, Simon, Berry & Co., J. Dickson, M. Wilson & Co., Pryke & Palmer, Buck and Hickman, Russell & Co., and Turner and Hudson.

The Asylums committee of the London County Council have accepted the following tenders for the central station for the supply of water and electricity at Horton Asylum:—

| | £ | s. | d. |
|---|---|---|---|
| Edmundson's Electricity Corporation (boilers, engines, dynamos, &c.) | £17,825 | 0 | 0 |
| R. Warner & Co. (pumps, pumping machinery, &c.) | 1,674 | 10 | 0 |
| Doulton & Co. (water softening plant) | 1,259 | 12 | 0 |

A second 250kw. turbo-dynamo complete, with surface condenser, air and circulating pumps, has been ordered from Messrs. C. A. Parsons & Co. for the Woolwich electricity station to provide for the increasing demand for current in this district.

Bradford Corporation have accepted the tender of Messrs. T. Broadbent & Sons (Ltd.) for a 30-ton electric travelling crane for the new generating station, subject to the requisite borrowing powers being obtained.

Barnsley Town Council have accepted the tender of Messrs. Venner & Co. for the supply of Hookham electricity meters at £4. 10s. each.

Hants. County Council have accepted the tender of Messrs. Dick & Sons for wiring the Judge's lodgings at £162.

We learn that, in answer to the advertisement inviting tenders for the hire of mechanically-propelled dust-collecting carts by the Corporation of the City of London, several tenders were received offering steam driven vehicles for sale, but no tender was sent in offering the hire to the Corporation of mechanically-propelled vehicles.

## BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of F. Metcalfe, electrical engineer, Leeds, the trustee (Mr. J. Bowling, 22, Park-row, Leeds) has been released.

In the failure of W. H. F. Bowman, electrical engineer, &c., Gainsborough, the trustee (Mr. R. J. Ward, 31, Silver street, Lincoln) has been released.

A meeting of Cuttriss, Wallis & Co. (Ltd.) will be held at Prudential-buildings, Park-row, Leeds, on Dec. 19 to receive an account of the winding-up.

Richard Aylmer, electrical engineer, late 47, Victoria-street, now residing at 11, Pinfold-road, Streatham, S.W., has executed an

assignment upon trust, release being conditional on payment of 5s. in the £ within three months. Mr. G. Wreford, 6, Dowgate-hill, E.C., is trustee. The liabilities are returned at £691. 2s. 8d., and assets £94. The creditors include :—Leclanché Cie (Paris) £317 ; General Electric Co., £58 ; Wood & Co., £14 ; Gabriel and Angenault, £13 ; Keene & Sons, £10.

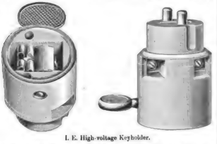
**Sales by Auction.**—Messrs. Wheatley Kirk, Price & Co. announce in our advertisement columns the sale by auction on Wednesday, Dec. 5, at 10 for 11 o'clock prompt, of the important freehold land and works lately occupied by the Aluminium Co. (Ltd.) at Oldbury, near Birmingham. Details of the extent of the land and the modern character of the works are given in the advertisement, and further particulars, plans and conditions of sale will be obtainable in a few days of the auctioneers, 46, Watling-street, Queen Victoria-street, London, E.C., and Albert Chambers, Albert-square, Manchester ; or of Messrs. Baker, Blaker and Hawes, solicitors, 117, Cannon-street, London.

Messrs. Wheatley Kirk, Price & Co. will also sell by auction on the same day and at the same time the valuable electric light and power plant installed at the above works. Some particulars of this plant are given on another page, and the attention of municipal corporations, electrical contractors and others is especially called to the importance of this collection of high-class machinery and apparatus. Catalogues will be ready in a few days, and these and all further particulars can be obtained of the auctioneers and solicitors as above.

**Plant for Sale.**—An advertisement contains particulars of electric lighting plant—consisting of a 3 H.P. Priestman oil engine, dynamo and spare parts, accumulators, &c.—which is for sale. Applications to Mr. G. Jarmay, Hartford, Cheshire.

**To Let.**—A suitable site for electricity works adjoining Shepperton station is advertised in another column.

**High-voltage Keyholder.**—The International Electric Co., 55, Redcross-street, Barbican, London, are supplying a new high-voltage keyholder, for which the chief claims are high insulation, as the switching movement is entirely enclosed by the china body ; impossibility of arcing ; and that the switching on and off is done in one direction only. When the handle is turned to the left the switch remains inoperative. The size of the new holder is not greater than that of the ordinary low-voltage holder.

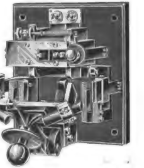


I. E. High-voltage Keyholder.

**Spiral Globes.**—A well-illustrated catalogue is issued by the Spiral Globe (Ltd.), 28, Bush-lane, Cannon-street, London, E.C., setting out, in particular, the economies in electric lighting effected by the adoption of these globes. It is claimed that whereas an ordinary 16 c.p. incandescent hung vertically, as is usually the case, illuminates with an effective light of only 10 c.p., the same lamp when enclosed in a "Spiral" globe produces an effective light equal to about 23 c.p. with the same consumption of current, effecting an economy of over 50 per cent. Spiral Globe lamps are supplied with various patterns of terminals, and can be obtained with half opal reflectors. Special patterns are shown, suitable for marine fittings, train lighting, and underground railway stations. The catalogue contains the special terms upon which the company are prepared to contract to furnish Spiral Globe lamps and maintain same, and other interesting information.

**Electrically-driven Pumps.**—Messrs. Merryweather & Sons (Ltd.) have ready a pamphlet describing and illustrating the "Hatfield" reciprocating pump, constructed to be driven direct by an electric motor. The pump has three single-acting barrels, insuring a steady pressure of water, and rendering the use of an air vessel almost superfluous. The comparatively constant delivery of water obviates freedom from shocks in the delivery pipe, and avoids reaction on the motor. Two of these pumps, coupled and electrically-driven, are installed at the Bristol Electricity Works for boiler feeding. At Bristol the motor runs at 400 revs. per min., and each pump is capable of delivering 60,000lb. of water per hour against a pressure of 130lb. per square inch.

**Knife Switches.**—In price list No. 9 just issued by the Electrical Co., 122 124, Charing Cross-road, London, W.C., there is described and illustrated a large variety of single, double and treble-pole knife switches for various voltages. The accompanying illustration shows an automatic maximum current single-pole cutout up to 200 amperes, 550 volts with carbon break. The net weight of this apparatus is 12·50kgs. In addition to price list No. 9, the Electrical Co. have forwarded price lists Nos. 13 and 16, the former dealing with lightning arresters and sundry safety devices (including fuses for telephone and signalling circuits), and the latter giving full textual particulars, diagrams of connections and dimensions, &c., of the direct-current electricity meters manufactured and supplied by the company. All these lists are well got up, and very fully illustrated.



**B.T.H. Apparatus.**—A number of Thomson astatic instruments for continuous-current switchboards are described and illustrated in pamphlet No. 79 issued by the British Thomson-Houston Co.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 14 to Nov. 20, with the ports of destination :—

*Africa*—Cape Town, £195 ; Durban, £121. East London, £134 ; Port Elizabeth, £236. *Argentina*—Buenos Ayres, £762 (including £690 telegraph material). *Australasia*—Auckland, £42 ; Christchurch, £260 ; Fremantle, £12 ; Lyttleton, £270 ; Otago, £182 ; Port Chalmers, £15 ; Sydney, £1,542 ; Wellington, £125. *Belgium*—Ostend, £2,312 (including £102 telegraph material). *Ceylon*—Colombo, £101 (telegraph material). *Chili*—Valparaiso, £12. *China*—Shanghai, £36. *Germany*—Hamburg, £818 ((including £800 telegraph material). *Holland*—Amsterdam, £267. *India*—Bombay, £651 (including £301 telegraph wire) ; Calcutta, £318. *Japan*—Hiogo, £683 (telegraph cable) ; Yokohama, £10,558 (including £8,835 telegraph cable). *Mauritius*, £60. *Philippine Islands*—Manila, £315 (including £289 telegraph material). *Portugal*—Lisbon, £40 (telegraph material). *Spain*—Bilbao, £402. *Turkey*—Constantinople £250 (including £88 telegraph wire). Total, £20,719, against £13,762 in the corresponding week last year (Nov. 15 to Nov. 21).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

September 17, 1900.

16,500. A. ECKSTEIN and A. J. D. KRAUSE. Manchester. An improved high-voltage electric cutout.

16,501. A. ECKSTEIN and A. E. ANGOLD. Manchester. Improvements in arc lamp suspension apparatus applicable also to other purposes.

16,507. W. L. SPENCE and THE BRITISH ELECTRIC PLANT CO. (LTD.). Glasgow. Improvements in or connected with the regulation and control of electric motors.

16,508 J. LENDERYON and E. F. SMART. Newport. An electric motor switch gear.

16,527. A. M. Morin. London. Improvements in rotary motors.
16,528. E. P. Barfield. London. An automatic safety clutch and ceiling rose for electric arc lamps.
16,529. B. J. B. Mills. London. Processes for manufacturing abrasive material from bauxite or other hydrous oxides of aluminium. (The General Electro-Chemical Co., United States.)*
16,534. F. W. Buhne. London. Manufacture of porous metal plates for electric accumulators.
16,541. J. G. Lorrain. London. Improvements in electric switching and motoring apparatus. (H. A. Macdonald, France.)
16,543. K. N. von Szoporl. London. Improvements in or relating to telephonic switchboards and the like.
16,545. C. F. W. Dudding. London. Improvements in arc lamps.
16,562. H. Oppermann. London. Improved process for the production of magnesium peroxide.
16,567. W. Buchner. London. Improvements in or connected with thermo-electric batteries or thermo piles.

September 18, 1900.

16,590. P. Maclellan and T. R. Small. Glasgow. Improved ear-piece for telephone receivers.
16,600. C. Adams-Randall. London. Electro-mechanical sound-augmenting apparatus applicable for use as an aid to the deaf.
16,644. S. Z. de Ferranti. London. Improvements in electricity meters.
16,656. H. J. Ryan. London. Improvements in electrically-propelled motor vehicles.*

September 19, 1900.

16,667. W. J. Stewart. Glasgow. Improvements in and relating to the working of electric or other tramway or railway points.
16,695. H. W. H. Vaughan and F. R. Wade. London. Improvements in clutches for the transmission or retardation of power.
16,696. C. M. Johnson. Redhill. Improved method of treating the animal or human body by electric forces.
16,697. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (E. W. Rice, jun., United States.)*
16,698. The British Thomson-Houston Co. (Ltd.). London. Improvements in conduit plows for electric railways. (J. Hoffmann, United States.)*
16,699. The British Thomson-Houston Co. (Ltd.). London. Improvements in lightning arresters. (L. Bell, United States.)*
16,700. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*
16,701. The British Thomson-Houston Co. (Ltd.). London. Improvements in electrically-operated pumps. (E. M. Hewlett, United States.)*
16,702. The British Thomson-Houston Co. (Ltd.). London. Improvements in dynamo-electric machines. (E. W. Rice, Jun., United States.)*
16,703. The British Thomson-Houston Co. (Ltd.). London. Improvements in controlling electric motors. (M. W. Day, United States.)*
16,704. The British Thomson-Houston Co. (Ltd.). London. Improvements for adjusting brush holders for electric machines. (H. G. Reist, United States.)*
16,705. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of train control for electric railways. (C. E. Barry, United States.)*
16,706. The British Thomson-Houston Co. (Ltd.). London. Improvements in means for preventing hunting of dynamo-electric machines. (H. W. Buck, United States.)*
16,738. F. Saldana. London. An improved electric energy meter.

September 20, 1900.

16,777. J. S. Stafford. London. Improvements in or connected with electrically ignited motor cars, cycles or the like, applicable for other analogous purposes.
16,798. J. Zapfe. London. Improvements in underground conduits for electric conductors.*
16,801. A. J. de B. e Cunha. London. Process and apparatus for the electrolytic decomposition of alkaline salt solutions.

September 21, 1900.

16,808. R. J. Houghton and W. E. Cooke. Manchester. Improvements in and relating to the method of and apparatus for electrolytically depositing metal.
16,845. J. M. Ricard and F. C. Gaby. London. Improvements relating to electric igniters for explosion motors.*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

19,189. Siemens Bros. & Co. (Ltd.) (Siemens and Halske Aktien-gesellschaft). Means and apparatus for electrically working vacuum and air-pressure railway brakes.
20,751. Andreas. Device for steering electrically-driven motor cars.
20,793. Richardson and Highton. Apparatus for regulating the speed of gas and light engines driving dynamo-electric machines.
20,906. Munro, Wood, Brecknell and Rogers. Trolley standards used on cars or wagons electrically propelled from an overhead wire.
21,076. Willcox. (Columbus Elecktricitäts Gesellschaft mit Beschränkter, Haftung.) Electric cells or batteries.
21,082. Wright. Electric circuit-breakers. (Date applied for under International Convention, March 23, 1899.)
21,083. Davis and Wright. Controllers for electric motors. (Date applied for under International Convention, March 24, 1899.)
21,276. Clark (Courtney). Magnetic separators.
21,562. Leitner. Separator for plates of secondary batteries.
21,670. British Thomson-Houston Co. (Ltd.). (Everest.) Alternating electric current transformers.
21,720. Bell and Berry. Switches for electric light.
21,810. Davis and Conrad. Electrical measuring instruments. (Date applied for under International Convention, April 1, 1899.)
21,877. Vosmaer. Electric arc lighting.
21,881. Lake. (Soc. de Commentry-Fourchambault et Decazeville.) Electric incandescent lamps.
21,990. Oppenheimer. (Actien-Gesellschaft Mix and Genest.) Cord grips for electrical apparatus.
21,991. Oppenheimer. (Actien-Gesellschaft Mix and Genest.) Porcelain interiors for electrical incandescent lampholders.
22,102. Buchanan. Electric cables.
22,164. Thompson. (Sturm.) Electro-magnetic ignition device with revolving armatures for gas, petroleum and similar motor engines.
22,271. Voigt. Manufacture of electrical heating appliances of high electrical resistance capable of sustaining high temperatures.
22,338. Evered & Co. (Ltd.) and Evered. Electrical switches.
22,517. Pidgeon. Electrical influence machines.
22,754. Davy. Alternating arc lamps.
22,960. Lake (McCarthy). Electric insulating devices.
23,102. Weissmann and Wydts. Contact breakers especially applicable to induction coils. (Date applied for under International Convention, April 25, 1899.)
23,293. British Thomson-Houston Co. (Ltd.) and Samuelson. Trolley stands for electric railways.
23,830. Pohl. Process of manufacturing carbons for electrical and electrochemical and other purposes.
24,116. Perrin. Electric accumulators.
24,437. British Thomson-Houston Co. (Ltd.). (Cox.) Coin-controlled mechanism for use in connection with prepayment electric meters or the like.
24,514. Boult (Saldana). Electricity meters.
24,629. Wise (Universal Talking Machine Co.). Talking machines.
24,740. Eley. Electric switches.
25,701. Stevens and Haigh. Controlling apparatus for electric motors.
25,767. Rowntree. Electric motors.

# COMPANIES' MEETINGS AND REPORTS.

## British Westinghouse Electric and Manufacturing Co. (Ltd.).

The first annual report of this company and balance sheet for the period from July 10, 1899, to July 31, 1900, has been issued. In addition to the orders and contracts taken over from the vendors, amounting to £279,000, orders have been received and contracts have been entered into since the incorporation of the company amounting to £550,000. The net profit for the period, exclusive of amount guaranteed by vendors, is £10,777. 7s. 7d., after providing for management expenses, directors' fees, and all other charges, which is considered satisfactory, seeing that the works at Trafford Park are still in course of construction. Out of this profit, supplemented by the guarantee, the directors distributed an interim dividend on the 6 per cent. preference shares in May last, amounting to £7,551. 2s., and now recommend the payment of the final dividend for the six months ending July 31, amounting to £15,000.

The directors report that the works at Trafford Park, Manchester, are making good progress, the agreement for the purchase of the land having been concluded, the plans for the entire works having been prepared by Mr. T. Rodd, of Pittsburg, U.S.A., from information and drawings supplied by the American Westinghouse Electric and Manufacturing Co. under their agreement, and the principal contracts for the construction work have been placed. The requisite connections between the works and the principal railways have also been completed.

In view of the large staff which will necessarily be required in connection with the works a number of young English engineers had been sent to serve an apprenticeship in the works of the American company at Pittsburg. By this method of forming the staff the directors believe that the principles of manufacture, which have been so successfully worked out in the United States, will be reproduced in the works at Manchester. Arrangements are being made to provide suitable dwellings for the operatives to be employed in the works, in which the men and their families will be well housed at reasonable rates with great advantage to the company. Technical and commercial managers have also been appointed, and are making themselves familiar with the approved methods adopted at the works at Pittsburg, which, as is well known, are equipped with the most modern plant and appliances, and where about 7,000 men are employed.

**Aron Electricity Meter (Ltd.).**—In the report for the year ended Sept. 30, the directors state that they are highly gratified with the result of the year's working, which marks a considerable further improvement on previous satisfactory progress. The balance to credit of profit and loss for the year amounts to £23,915. 0s. 10d., and after adding £2,522. 13s. 11d. from the previous year there is a total of £26,437. 14s. 9d. to distribute. The directors propose the payment of the dividend on the 6 per cent. preference shares (absorbing £7,493. 15s. 2d., and of £980. 6s. 5d. as bonus to preference shareholders, of which it is proposed to carry £355. 16s. 10d.

to credit of preference shareholders for next year, and to declare an additional ½ per cent. per annum for the present year, making a total dividend of 6½ per cent. on the preference shares; and also a dividend of 12 per cent. on the ordinary shares (taking £15,000) leaving £2,963. 13s. 2d. to be carried forward. The business of the company continues to prosper, and the outlook is, says the report, brighter than ever. The Aron meter is being adopted in the principal supply stations of the United Kingdom, the Continent of Europe, and the Colonies, and this has necessitated the adoption of means for the extension of manufacturing resources.

The transfer books of the ordinary and preference shares will be closed from 26th inst. to Dec. 15 inclusive.

---

**EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH CO. (LTD.)**—An extraordinary meeting of this company was held yesterday, under the presidency of Sir John Wolfe Barry, to confirm a special resolution passed at the extraordinary general meeting of the company held on the 7th inst. The manager and secretary (Mr. F. E. Hesse) having read the notice convening the meeting, the chairman put the resolution confirming the alteration in the articles of association, and this having been seconded by the Marquis of Tweeddale, was carried unanimously.

---

**WESTERN UNION TELEGRAPH CO.**—The annual report of the president for the year ended June 30 states that the capital stock outstanding remains the same ($97,370,000.00), and the bonded debt at the close of the year was $19,502,330.46. The lines of the company were increased during the year by 2,849 miles of poles and 28,520 miles of wire. There was an increase of 615 offices. The number of messages transmitted was 1,769,626 greater than for 1899. The increase of $804,257.50 in the revenues for the year was made up principally of $457,864.77 from regular commercial messages, $76,628.06 from press despatches, and $197,665.12 from leased wires, and the balance ($72,099.55) from minor sources of income. Compared with the preceding year, operating and general expenses increased $265,243.89, incident to the larger number of messages transmitted and delivered, and to the operation of more offices; maintenance and reconstruction of lines increased $206,585.94, partly for cable repairs in the Atlantic, but chiefly for the replacement of old and defective lines with new poles and copper wires; and equipment increased $48,163.46, on account of new wires and offices. The total increase in expenses was $507,626.68. The net profit for the year was $6,165,363.68. After paying interest on bonds and the dividend of 5 per cent., there was added to the surplus account $391,277.33, or $237,584.92 more than in 1899. The average tolls received were 30·8 cents per message, and the average cost per message 25·1 cents, the same as for 1899. During the year $1,199,587 was expended for the purchase of sundry lines and the construction of new property, and $70,000 was paid out for patents.

---

## NEW COMPANIES, STATUTORY RETURNS, &c.

**CLAUD HAMILTON (ABERDEEN) (LTD.)**—This company has been registered with a capital of £5,000, in £1 shares, to take over the business of electrical engineers and contractors carried on at Aberdeen and Inverness by P. C. Middleton & Co. Ltd. The subscribers are Claud Hamilton (electrical engineer), A. Ferguson, G. Watson, D. Alexander (electrical engineer), R. C. Boyd, J. Y. Collie, and P. C. Middleton (electrical engineer). The first directors are Claud Hamilton, J. Y. Collie, A. Ferguson, and P. C. Middleton.

**ELECTRIC LIGHTING BOARDS BRITISH MANUFACTURING CO. (LTD.)**—This company was registered on Nov. 8, with a capital of £75,000, in £1 shares, to enter into an agreement with the Electric Lighting Boards (Ltd.), and to acquire and work any patents and inventions connected with electric lighting boards, particularly relating to luminous advertisements. The subscribers are W. G. Gadsden, A. Tibbits, H. L. Pring, W. Brittain, J. W. Stickland, E. Newroy, and A. H. Lister.

**FOUNDERS' SYNDICATE (LTD.)**—This company was registered on Nov. 5, with a capital of £60,000 in £10 shares, to carry on the business of electric and other tramway constructors and proprietors, electrical and general engineers, &c.

**FRENCH ELECTRIC LIGHTING BOARDS (LTD.)**—This company was registered on Nov. 15, with a capital of £4,000 in £1 shares, to acquire from Mr. E. O. Sachs the benefit of certain inventions relating to electric lighting boards for luminous advertisements, &c.

**GENERAL ELECTRIC CO. OF IRELAND (LTD.)**—This company was registered in Dublin on Nov. 15, with a capital of £2,000 in £1 shares, to construct or acquire and maintain tramways in or near the counties of Dublin and Wicklow, and to carry on the business of electrical and mechanical engineers, electricians, &c.

**IMPERIAL ELECTRIC SUPPLIES CO. (LTD.)**—This company was registered on Nov. 5, with a capital of £50,000 in £1 shares, to carry on the business of electrical and general engineers, electricians, manufacturers of and dealers in electrical and other appliances and accessories, &c. The first directors are: G. Bargate, G. S. Hertslet, H. W. Knott, and E. P. Harvey.

**PERFECT LIGHT CO. (LTD.)**—This company was registered on Nov. 13, with a capital of £25,000 in £1 shares, to carry on the business of electrical and other lamp fittings and apparatus manufacturers, and to adopt an agreement with the Scott-Snell-Phillips Syndicate (Ltd.) and M. Lachman. The first directors are C. S. Snell, C. W. Phillips, and M. Lachman.

**RAWFOLDS WIRE CO. (LTD.)**—This company was registered on Nov. 6, with a capital of £5,000, in £1 shares, to acquire the business carried on as the Rawfolds Wire Co., and to carry on the business of wire drawers, wire, copper and metal merchants, metal workers, &c.

**ROSS ELECTRIC LIGHT AND POWER CO. (LTD.)**—This company was registered on Nov. 16, with a capital of £8,000, in £1 shares, to carry on in and near Ross, Hereford, the business of electricians, electrical and general engineers, suppliers of electric light and power, &c. The subscribers are J. Mackay, J.P., C. Allmond, and J. Parker, consulting engineer (each with 100 shares), A. Johnson, J.P., consulting engineer, and E. C. Gurney (each with 50 shares), and H. Southall and F. W. Wintle (with 10 shares each). The first directors are J. Mackay (chairman), E. C. Gurney, C. Allmond, and A. Johnson.

**WILLIAM DOUGLAS LTD.**—This company was registered in Edinburgh on Nov. 7, with a capital of £1,000, in £1 shares, to take over the business of W. Douglas, and to carry on the business of telephone and electrical engineers, &c. The subscribers include W. Douglas (electrician) and James McCall (engineer).

---

**MATHER AND PLATT (LTD.)**—According to the annual return to Sept. 14 the capital is £775,000, in 37,500 preference and 40,000 ordinary shares of £10 each, of which 32,505 preference and 40,000 ordinary shares have been taken up. £10 has been called up on each of 21,705 preference and 2,500 ordinary shares. £483,000 is considered as paid on 10,800 preference and 37,500 ordinary shares.

**TYPEWRITING TELEGRAPH CORPORATION (LTD.)**—The annual return to Oct. 18 gives the capital as £100,000 in £1 shares, 56,651 of which have been taken up. 10s. has been called up on each of 19,662, and 1s. on each of 7,138 shares. 29,851 shares are considered as fully paid.

**WINDERMERE AND DISTRICT ELECTRICITY SUPPLY CO. (LTD.)**—The annual return to Sept. 10 has been filed. The capital is £50,000, in 5,000 preference and 5,000 ordinary shares of £5 each, of which 5,000 preference and 2,663 ordinary have been taken up. £5 has been called up on each of 3,010 preference and 1,497 ordinary, and 10s. per share on 231 ordinary shares. £14,475 is considered as paid on 1,960 preference and 935 ordinary shares.

---

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29 7/16d. per oz. (Nov. 22). Consols (2¾ per cent.) 98¾—98⅞ for money, 98 15/16—99 1/16 for account; 2½ per cent. 98½—98¾ (Nov. 22). Stocks and Shares Continuation Days, Nov. 27 and Dec. 11; Ticket Days, Nov. 28 and Dec. 12; Pay Days, Nov. 29 and Dec. 13; Mining Share Carry-over Days, Nov. 26 and Dec. 10.

---

**BAKER STREET AND WATERLOO RAILWAY CO.**—It is announced that allotment letters in the issue of this company's capital have been posted.

**DIRECT WEST INDIA CABLE CO. (LTD.)**—The trustees for the debenture-holders will receive offers of debentures for purchase at noon on Dec. 4. If the number offered is not sufficient to absorb the amount to be applied, a drawing will follow.

**HALIFAX AND BERMUDAS CABLE CO. (LTD.)**—The trustees for the debenture-holders will receive offers of debentures for purchase at noon on Dec. 4. If the number offered is not sufficient to absorb the amount to be applied, a drawing will follow.

**JAMAICA ELECTRIC LIGHT AND POWER CO. (LTD.)**—The directors' report stated that the profit on the past year's working amounted to £800. 11s. 7d. No dividend is declared.

---

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Nov. 10 | 575 | + 111 | 23 | 16,917 | + 2,310 |
| *Birmingham Tramways | „ 17 | 4,338 | + 562 | 19 | 86,851 | + 4,225 |
| Blackpool Corporation ... | „ 15 | 204 | + 53 | 33 | 26,956 | + 7,103 |
| Blackpool and Fleetwood | „ 17 | 156 | − 6 | 20 | 19,413 | − 2 |
| Bolton Corporation ...... | ... | ... | ... | ... | ... | ... |
| Bradford Corporation... | „ 18 | 747 | + 399 | 33 | 17,690 | + 4,529 |
| Brisbane Trams ......... | Oct. 3 | 1,836 | + 385 | 13 | 24,108 | + 4,785 |
| *Bristol Trams & Carriage | Nov. 16 | 2,850† | − 2,037 | [illegible] | 67,570 | − 1,594 |
| *Buenos Ayres & Belgrano | Oct. 21 | 2,794 | + 542 | 16 | 37,031 | + 1,511 |
| Central London Railway | Nov. 17 | 5,406 | ... | 16 | 82,167 | ... |
| City & South London Ry. | „ 18 | 1,866 | + 820 | 20 | 33,108 | + 12,636 |
| Cork Elec. Trams ......... | „ 15 | 351 | − 8 | 46 | 18,995 | + 1,494 |
| Dover Corporation ...... | „ 17 | 170 | + 11 | 33 | 7,731 | + 426 |
| Dublin & Lucan Rly. | „ 17 | 65 | + 10 | 20 | 2,036 | + 361 |
| Dublin United ............ | „ 16 | 3,345 | + 354 | 20 | 75,335 | + 10,042 |
| Dublin Southern Dist.... | „ 16 | 683 | + 12 | 20 | 20,007 | |
| *Dundee Corporation ... | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation ... | „ 17 | 9,057 | + 201 | ... | ... | ... |
| Hull Corporation ......... | „ 17 | 1,360 | + 729 | 20 | 27,670 | + 14,710 |
| *Liverpool Corporation... | „ 10 | 8,619 | + 1,263 | [illegible] | 356,376 | + 46,127 |
| Liverpool Overhead Rly. | „ 18 | 1,553 | + 115 | 20 | 33,549 | + 750 |
| *Sheffield Tramways ...... | „ 18 | 2,579 | + 815 | 46 | 104,116 | + 36,299 |

* Partly electrical. † Queen's visit last year.

**NEW BROTHERTON TUBE CO. (LTD.)**—At the annual meeting on Thursday last the chairman (Mr. E. Lisle) proposed the adoption of the report and balance sheet, and that a dividend of 3 per cent. be paid on Dec. 3. This was approved.

**PERSONAL.**—Mr. Emile Garcke calls attention, in a circular to shareholders of the British Electric Traction Co. (Ltd.), of which he is managing director, to an attack made upon him in a London financial journal, the editor of which had, without troubling to make himself acquainted with the facts of the case, seen fit to call attention to the number of directorships which Mr. Garcke holds. In order that there may be no misunderstanding, Mr. Garcke points out that, with one exception, these companies are all closely associated with the British Electric Traction Co., and that the directorships are held not only with the sanction but at the express wish of the directors of that company. The fees voted for Mr. Garcke's services in connection with these directorships are paid over to the British Electric Traction Co. The exception mentioned is the Electric and General Investment Co., of which Mr. Garcke has been a director since its formation 10 years back. With the growing requirements of the British Electric Traction group, Mr. Garcke has severed his directorial connection with the Brush Company, the Chelsea Electricity Supply Co., the County of London and Brush Co. and the Immisch Electric Launch Co. It was unnecessary for Mr. Garcke to have made this explanation, except that those unacquainted with the circumstances might be misled by this tirade, the *motif* for which is not far to seek. The ignorance of the penny-a-liner is shown throughout the attack.

**REDUCTION OF CAPITAL.**—The petition of the Mirrlees, Watson and Yaryan Co. (Ltd.) has been granted for authority to reduce the capital of the company. The company was incorporated in July, 1889, and its capital was £500,000, divided into 50,000 £10 shares. It was proposed to cancel £375,000, which is unrepresented by available assets, reducing the capital to £125,000, divided into £1 shares credited as fully paid.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has ordered 11,000 £5 fully-paid shares (Nos. 1 to 11,000) of the *Hove Electric Lighting Co. (Ltd.)* to be quoted in the official list. The committee have also been asked to allow the provisional certificates for £200,000 4½ per cent. second debenture stock of the *City of London Electric Lighting Co. (Ltd.)* to be quoted in the official list.

**WESTERN TELEGRAPH CO. (LTD.)**—An extraordinary general meeting will be held at Winchester House, Old Broad-street, E.C., on 26th inst., to confirm the resolution passed at the extraordinary meeting on Oct. 30.

**WILLANS AND ROBINSON (LTD.)**—The registers of debenture stockholders and of transfers are closed from 17th to 30th inst., inclusive.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 14. | | Price Wednesday, Nov 21. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 21. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd. | ¾ | 1 | ¾ | 1 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13¾ | 13½ | 13¾ | 3 14 1 | ... | ... | ... |
| 5,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 19/9 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 16 0 | ... | 7½ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 30,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) ... x | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | 10½ | ... |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | 5¾ | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6 | 6½ | 6½ | 6¾ | 4 9 11 | March | 6⅞ | 6½ |
| £150,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December... | ... | ... |
| $1,100,000 | $1,000 | 5% | Chicago Edison 1stMort.5% 30 yr.Gold Bonds(red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 9 | 10 | 4 0 0 | February and August | 9⅛ | 9½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 13½ | 13 | 13½ | 4 9 0 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December ... | ... | ... |
| 40,000 | 10 | 6/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 14 | 11 | 12 | 5 0 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs.(all pd.) (red.) | 103 | 111 | 103 | 111 | 4 1 10 | ... | ... | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | ... | | 5 | 6 | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1¾ | 2¼ | 1¾ | 2¼ | ... | ... | ... | ... |
| 40,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | ... | ... |
| £150,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 13 | 14 | 13 | 14 | 3 15 10 | April and October | 13 | ... |
| £230,000 | Stock | 4½% | Do. 4½ per Cent. Deb.Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 7 | June and December ... | 113½ | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 101 | 97 | 101 | 3 10 7 | ... | 99 | 97½ |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ¾ | 1 | ¾ | 1 | 12 16 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate E.L. & Tr'ct'n, Ltd., 5% 1st Mor.Deb. | 75 | 85 | 75 | 85 | 6 13 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 180 | 200 | 180 | 200 | 4 0 0 | April and October | ... | ... |
| £115,600 | 100 | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 9 | February and August | 15½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | " " | 9 | 8½ |
| £100,000 | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 99 | 101 | 101 | 103 | ... | ... | 101½ | 102½ |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 29,437 | 5 | ... | Do. Do. | 11½ | 12½ | 11½ | 12½ | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 16 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 103 | 105 | 103 | 105 | 4 17 1 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 23 | 24 | 23½ | 24½ | 3 8 11 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 13,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10⅛ | 10 |
| 46,000 | 10 | 11/0 | British Elec. Trac. Ord. | 13½ | 14½ | 13½ | 14½ | 6 17 11 | ... | 14½ | 14½ |
| 50,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 5 9 | February and August | 12½ | 12½ |
| £300,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 122 | 120½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4 | 4½ | 4 | 4½ | ... | ... | 4¼ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 105 | 107 | 105 | 107 | 4 13 5 | ... | ... | ... |
| £130,000 | Stock | 13/9 | Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) | 90 | 91 | 90 | 91 | 5 1 0 | ... | ... | ... |
| 270,297 | 10 | 3/0 | Central London Ordinary | 10½ | 10¾ | 10½ | 10¾ | 2 15 10 | June and December | 10½ | 10½ |
| £466,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 54 | 58 | 54 | 58 | 2 7 5 | February and August | 54½ | 54 |
| 17,500 | 10 | 1/0 | Do. Ordinary (Nos. 23,541 to 41,040) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | 5½ | ... |
| £100,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1890) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £244,215 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 118 | 123 | 118 | 123 | 3 5 1 | May and November ... | ... | ... |
| [illegible] | 10 | ... | Dublin United Tramways (1896) Ltd., Ordinary | 17½ | 18 | 17 | 18 | ... | ... | ... | ... |
| [illegible] | 10 | ... | Do. 6 per Cent. Preference | 16 | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| [illegible] | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| [illegible] | 10 | 7½% | †Imperial Tramways Ordinary | 21 | 22 | 21 | 22 | 3 12 6 | March and September | ... | ... |
| [illegible] | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 8 | " " | ... | ... |
| [illegible] | Stock | 4½% | † Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| [illegible] | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | 10 | 11 | ... | | 4 17 7 | May and November | ... | ... |
| 37,000 | 10 | 3% | Liverpool Overhead Railway Ordinary | 6½ | 7 | 6½ | 7 | 4 8 9 | February and August | ... | ... |
| [illegible] | 10 | 5% | Do. 5 per Cent. Preference | 11 | 11½ | 11 | 11½ | 3 15 6 | " " | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debentures | 104 | 106 | 104 | 106 | 3 16 6 | January and July | ... | ... |
| [illegible] | 100 | 5% | Montreal Street Railway Co. 5% Mor. Debs. (1908) | 104 | 106 | 104 | 106 | 4 16 1 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 4 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 24,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 10½ | 11½ | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | 11½ | 12½ | ... | | 4 13 9 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11 | 12 | 11 | 12 | ... | ... | ... | ... |
| 30,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 9½ | 10½ | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £135,000 | Stock | ... | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | ... | ... |
| £40,000 | Stock | 3% | Waterloo and City Ordinary | 92 | 94 | 92 | 95 | 3 3 2 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 14. | Price Wednesday, Nov. 21. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 21 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | Highest | Lowest |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 103 | 99 103 | 3 17 8 | January and July | ... | ... |
| 26,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 90 | 85 90 | 5 11 1 | ... | ... | ... |
| £823,720 | Stock | 15/0 | Anglo-American | 53 56 | 53 55 | 5 11 2 | Feb., May, Aug., Nov. | 55½ | ... |
| £3,[illegible],640 | Stock | 30/0 | Do. Preferred | 99 101 | 99 100 | 6 0 3 | " " | 100 | 99½ |
| £3,[illegible],640 | Stock | 27/0 | Do. Deferred | 10½ 11 | 10½ 11½ | 12 0 0 | " " | 11 | 10½ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 165 175 | 165 175 | 4 11 5 | Jan., Apr., July, Oct. | ... | ... |
| £1,[illegible] | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 104 | 102 104 | 3 17 4 | " " | 103½ | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ 7½ | 6½ 7½ | 7 17 0 | February and August | 6¾ | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ 15½ | 14½ 15½ | 6 9 0 | " " | ... | ... |
| 12,931 | 5 | 3/0 | Direct Spanish Ordinary | 3½ 4½ | 3½ 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ 11½ | 10½ 10½ | 5 10 0 | Jan., Apr., July, Oct. | 10½ | ... |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 102 | 99 102 | 4 4 0 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 143 145 | 143 145 | 4 14 11 | Jan., Apr., July, Oct. | 144 | 143 |
| £1,836,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 96 101 | 97 100 | 3 10 1 | " " | 97 | ... |
| £1,432,398 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 116 | 113 116 | 3 [illegible] [illegible] | May and November | 113½ | 113 |
| 150,000 | 10 | 2/6 | Eastern Extension | 14½ 15½ | 14½ 14½ | 4 14 11 | Jan., Apr., July, Oct. | 15 | 14⅞ |
| 30,000 | 10 | ... | Do. New Shares [illegible] £3 paid | 6½ 7 | 6½ 7 | ... | " | 6⅞ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 114 116 | 114 116 | 3 7 10 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 103 | 100 103 | 3 17 9 | February and August | ... | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% 101% | 99% 101% | 3 15 5 | May and November | ... | ... |
| 1[illegible],227 | 10 | 1/0 | Globe Telegraph and Trust | 10½ 11 | 10½ 10½ | 4 17 8 | Jan., Apr., July, Oct. | 10½ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 15½ | 15 15½ | 3 17 5 | " " | 15½ | 15½ |
| 160,000 | 10 | 5/0 | Great Northern (Copenhagen) | 31 33 | 31 32 | 3 15 7 | January and July | 31½ | 31½ |
| £81,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 101 | 99 101 | 4 10 0 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 63 65 | 63 65 | 4 14 4 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino Brazilian 6 per Cent. Debs., 1904 | 104 107 | 104 107 | 5 13 1 | March and September | 105½ | 105 |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 100 103 | 101 101 | 3 18 3 | June and December | ... | ... |
| 11,839 | 5 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October | ... | ... |
| 3,391 | £100 Cert. | 6% | Submarine Cables Trust | 125 130 | 125 130 | 4 12 6 | " " | 125 | ... |
| 15,000 | 10 | ... | West African Telegraph | 3½ 3½ | 3½ 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 98 101 | 98 101 | 4 19 0 | March and September | 100½ | 99½ |
| 20,000 | 3½ | ... | West Coast of America | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 103 | 100 103 | 3 14 4 | January and July | 100½ | ... |
| 89,321 | 10 | 1/0 | West India and Panama | ¾ 1 | ¾ 1 | ... | May and November | 1½ | ¾ |
| 34,665 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ 7½ | 6½ 7½ | 8 0 0 | " " | 7 | 6½ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 108 | 105 108 | 4 13 6 | January and July | 107 | ... |
| 307,000 | 10 | 7/0 | Western Telegraph (late Brazilian Submarine) £10 | 14½ 14½ | 14 14½ | 4 15 7 | Mar., June, Oct., Dec. | 14½ | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 106 | 103 106 | 4 14 4 | June and December | ... | ... |
| £[illegible],777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 3½ | 3 3½ | 5 16 4 | August | ... | ... |
| 2[illegible],[illegible] | 10/0 | 1[illegible] | [illegible] Telephone Con. and Manfg. | [illegible] [illegible] | [illegible] [illegible] | ... | July | ... | ... |
| 72,600 | 1 | 3½% | Monte Video Telephone Ordinary | ¾ 1 | ¾ 1 | 5 0 0 | November | ... | ... |
| 66,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 3/0 | National | 4½ 4½ | 4½ 4½ | 6 [illegible] [illegible] | February and August | 4½ | 4⁷⁄₁₆ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 15 | 13 15 | 4 0 0 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 13 15 | 13 15 | 4 0 0 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 5½ | 5 5½ | 4 15 3 | " " | ... | ... |
| £[illegible],000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 [illegible] | 95 [illegible] | 3 11 5 | June and December | 97½ | 96 |
| £[illegible] | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 104 | 101 104 | ... | ... | 103 | 102½ |
| 171,99[illegible] | 1 | 0/8 | Oriental | ½ 1¼ | ½ 1¼ | 5 [illegible] 9 | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 4½ 5½ | 4½ 5 | 7 [illegible] [illegible] | July | 4½ | ... |
| 16,[illegible] | 5 | 2/6 | Do. 5% Cumulative Preference (fully paid) | 4½ 5½ | 5 5½ | 4 10 11 | June and December | ... | ... |
| 53,[illegible] | 5 | ... | Do. do. (£3 10s. paid) | 3½ [illegible] | 3½ [illegible] | ... | " | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 107 | 104 107 | 4 13 8 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 2d. | Alliance Electric [illegible] Cum. Pref. | 1 1½ | 1 1½ | 4 8 11 | ... | ... | ... |
| 125,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ¾ ⅞ | ¾ ⅞ | 7 7 5 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Ordinary | ¼ ½ | ¼ ½ | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ¼ ½ | ¼ ½ | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 9 9½ | [illegible] 9½ | 4 4 2 | ... | ... | ... |
| [illegible],000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ 11½ | 10½ 11½ | 4 4 11 | June and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ 6½ | 5½ 6½ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 1/6½ | British Westinghouse Preference | 4½ 5½ | 4½ 5½ | ... | ... | 4½ | ... |
| 90,000 | 2 | 1/1½ | Brush Electrical Engineering | 1½ 1½ | 1½ 1½ | 6 8 4 | September | ... | ... |
| 16,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2½ | 2 2½ | 5 6 8 | " | 2⅛ | 2⅟₁₆ |
| 15,731 | 2 | ... | Do. £ paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 108 111 | 108 111 | 4 0 11 | March and September | ... | ... |
| £1[illegible],000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 105 | 103 105 | 4 7 0 | January and July | 105 | ... |
| 30,000 | 5 | [illegible]/0 | Callender's Cable Construction Ord. | 12½ 13½ | 12½ 13½ | 6 11 1 | " " | 13½ | 12½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 5½ | 5 5½ | 4 10 11 | " " | 5½ | 5 |
| £30,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 114 | 110 114 | 3 15 11 | November and May | ... | ... |
| 300,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 1½ | 1 1½ | 6 [illegible] 9 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½ First Mort. Deb. (red.) | 97 100 | 97 100 | 4 10 1 | ... | 9[illegible] | ... |
| 60,000 | 1 | 0/7½ | Chatham's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 19 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | 1 1½ | 1 1½ | 5 5 8 | ... | ... | ... |
| 54,000 | 3 | 2/[illegible] | Crompton and Co. Nos. 1 to 52,[illegible] | 3½ 4 | 3½ 4 | 5 1[illegible] 4 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 102 | 99 102 | 4 19 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | 1 1½ | 1 1½ | 5 6 [illegible] | ... | ... | ... |
| 99,[illegible] | 5 | 1/[illegible] | Edison and Swan United ("A" Shares, £3 paid) | 1½ 2½ | 1½ 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/[illegible] | Do. (£5 paid) | 3½ 4½ | 3½ 4½ | 6 13 4 | " " | ... | ... |
| £344,[illegible] | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 92 | 90 92 | 4 7 6 | June and December | ... | ... |
| £1[illegible],000 | Stock | [illegible] | Do. [illegible] | 9[illegible] 1[illegible] | 9[illegible] 1[illegible] | ... | ... | ... | ... |
| 3[illegible],[illegible] | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ 5 | 4½ 5 | 6 0 0 | Half-yearly | 4½ | 4½ |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 103½ | 101 103 | 4 7 6 | ... | ... | ... |
| 11[illegible],000 | 2 | 1/2½ | Electric Construction Co. [illegible] | 2 2½ | 2 2½ | 5 6 [illegible] | January and July | ... | ... |
| 2[illegible],000 | 2 | 2/[illegible] | Do. 7 per Cent. Cumulative Preference | 2½ 3½ | 2½ 3½ | 4 6 2 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 105 | 102 105 | 3 16 1 | January and July | 103½ | ... |
| 11[illegible],[illegible] | 1 | ... | [illegible] | ... | ... | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 12½ 13½ | 12½ 13½ | 5 11 1 | February and August | 13 | 12½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6½ | 5½ 6½ | 3 18 3 | " " | 5½ | 5½ |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 111 | 108 111 | 4 0 4 | " " | ... | ... |
| 30,000 | 10 | 3/0 | India Rubber, Gutta Percha, &c., Works | 20½ 21½ | 20½ 21½ | 3 9 9 | " " | 21½ | 20½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 102 | 100 102 | 3 18 5 | March and September | 102½ | 101½ |
| 37,350 | 12 | 11/0 | Telegraph Construction and Maintenance | 36 40 | 37 [illegible] | 4 [illegible] [illegible] | March and July | 39½ | 37 |
| £15[illegible],000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 10[illegible] 10[illegible] | 10[illegible] 10[illegible] | 3 16 11 | January and July | ... | ... |
| [illegible],000 | 5 | 9/0 | Do. Manufacturing Ordinary | 10½ 11½ | 10½ 11½ | 6 4 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6½ | 5½ 6½ | 4 6 1 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ 11½ | 10½ 11½ | 6 2 9 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ 7½ | 6½ 7½ | 4 2 9 | " " | 7½ | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 4 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote them.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED. First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,176. [No. 6. Vol. XLVI.] FRIDAY, NOVEMBER 30, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

A COURSE of four Cantor lectures on "Electric Oscillations and Electric Waves" was commenced last Monday, by Prof. J. A. FLEMING, at the Society of Arts. This, the initial lecture, dealt with the production and characteristics of electrical oscillations; and the lecturer adopted from the outset the judicious course of assuming in his audience a knowledge of electrical terminology and a fair acquaintance with fundamental phenomena. There is often a proneness to reiterate on such occasions the weak and beggarly elements of the science, with the result that valuable time is wasted. For, although the lecture may be ostensibly addressed to the general public, as a matter of fact very few, if any, of the listeners are quite ignorant of the subject—the fact of their presence arguing, indeed, a prepared and intelligent interest. Plunging thus *in medias res*, Prof. FLEMING was able, in his first lecture, to carry his audience well forward into the fuller and most recent development of the subject, paving the way for a consideration of its practical bearings in later discourses.

COMMENCING with an explanation of the conditions essential to the production of rapid oscillatory discharges, the lecturer passed on to describe the various arrangements of apparatus by which these conditions were to be realised. With regard to the extremely brief duration of the actual oscillatory condition, contrasted with the intermitting periods of quiescence, he used an apt and striking analogy: "Just as would be the state of affairs if a clock were to tick for 10sec. or 12sec., and then cease to tick for 24 hours, so," he said, "is the proportionate duration of the alternate conditions of oscillation and quiescence." Discussing the influence upon oscillatory discharges of the presence of metallic bodies in the neighbourhood, Prof. FLEMING entered on an explanation of skin effect in conductors, and stated that there were three well-defined kinds of resistance. There was ordinary ohmic resistance; there was the resistance to alternating currents expressed by Lord RAYLEIGH's formula; and there was a third kind, which was greater than either of the others, and the magnitude of which was not expressed by RAYLEIGH's formula.

This he termed "oscillatory resistance." The cause of its being of even greater magnitude than ordinary alternating resistance was attributed to the dissipation of energy in electromagnetic radiation. If our readers will refer to the Paper by Dr. BARTON in the *Proceedings* of the Physical Society (Vol. XVI., p. 409, June, 1899), on the equivalent resistance and inductance of a wire to an electric discharge, they will see that Dr. BARTON proves that when the charge is oscillatory and *damped* the effective resistance of the discharge circuit is greater than that which would be given by Lord RAYLEIGH's formula for alternating resistance, on the assumption that the alternations of current are steadily periodic and of the same frequency. And if the oscillations are very much damped, this effective oscillatory resistance may be many times greater than the resistance as calculated by Lord RAYLEIGH's formula for alternating currents. The suggestion that Prof. FLEMING made in explanation of this —which suggestion is not furnished by Dr BARTON—was that the existence of these damped oscillations implies a loss of energy by radiation as well as a dissipation by the true resistance, and that as both these are irreversible, we may look upon the total dissipation of energy as due to a greater *effective* resistance than would be the case if there were no radiation, the loss by radiation being reckoned as due to an additional resistance.

THE law's delays are often a subject of bitter complaint in this country with those who find themselves driven into litigation; but in America, where most things are done with expedition, the mill of justice seems to grind quite as slowly as our own. There has just been finally decided in that country a very important patent case, which has been

going on now for several years, and a glance at the steps of progress is interesting. It was brought by the Electric Smelting and Aluminium Co., of Cleveland, against the Carborundum Co., of Niagara Falls, and was first heard in the United States Circuit Court for the Western District of Pennsylvania. The decision of this Court was given in favour of defendants on July 26, 1897. The plaintiffs appealed, and the case was argued anew before the United States Circuit Court of Appeals some time in the year 1898. On January 30, 1899, that Court *ordered a re-argument*, but this second hearing did not take place till September 19 and 20, 1899, and the decision—this time in favour of the plaintiffs—was not given till May 28, 1900—that is eight months after the second hearing. The defendants then petitioned the United States Supreme Court for a writ of certiorari, and this has just been denied to them. It is curious to note that, contrary to the state of affairs here, the Supreme Court has been the most expeditious of all. Strange as it seems to us to find the Appeal Court demanding a re-argument of the case, it is perhaps even more strange that when they did order a re-argument they allowed eight months to pass before hearing it. After all, they do not seem to manage these matters so well in the States as we do here.

THE case in itself was one of great commercial importance, dealing, as it did, with practically the master patents for electrical processes of smelting ores; and the decision of the Supreme Court may even affect several industries in this country. For it is stated that the plant of the defendant company is the only one of its kind in the world, and that this decision will suppress the entire industry; and carborundum is used largely in steel making, and in granite polishing, for which latter it supplies over 90 per cent. of the abrasive material used in America and in Scotland; it is used also by the dental profession, in the manufacture of domestic hollow-ware, in machine fitting, and in the manufacture of pearl buttons. Several industries, therefore, are indirectly or directly concerned in the result of this lawsuit. This very fact, however, renders it extremely improbable that the company will cease to manufacture. The more likely course will be for them to try to obtain a licence from the plaintiff company to work their plant. This would at once be a source of profit to the Electric Smelting Company and would allow the Carborundum Company to continue their industry.

MR. W. D. WANSBROUGH contributes an article on "Continental Steam Engine Practice" to the current number of *Cassier's Magazine* in the sketchy and popular style characteristic of our contemporary. The text for Mr. WANSBROUGH'S article he discovered in the Paris Exhibition; and, after a close survey of the steam engines exhibited at that great show, he concludes that "British-made steam engines, in their essential parts, are at least the equals of any in the world." But the happiness that might be induced by this bit of praise is rather suddenly damped by the reflection that immediately follows it: "Add," he writes, "but the Continental finish and attention to small details to the British characteristics of simplicity and solidity, and Great Britain will always hold her own."

WE really cannot allow MR. WANSBROUGH to damn with such faint praise our home-made steam engines, nor can we concede to them such merely qualified reputation and prospects. Leaving out of consideration the agricultural and similar sections of the Exhibition, which do not appear to have affected Mr. WANSBROUGH'S conclusions, British steam-engine building cannot be said to have been very extensively represented. Two or three firms in the front rank, however, did make a good show, as will be gathered from the account given by our Special Correspondent in our issue of August 3rd (Vol. XLV., p. 550). On the other hand, several British firms who have developed the stationary engine on the lines of the best modern practice, and with as close an "attention to small details" as will be found in the choicest of Continental engines, were conspicuous by their absence. Not that this justifies the criticisms with which Mr. WANSBROUGH dilutes and well-nigh neutralises his commendations; for it would be impossible to find better workmanship and finish anywhere than in the workshops from which some of the British exhibits emanated. But, what does Mr. WANSBROUGH mean by "finish"? Can it be that he means only paint and nickel plating? "The first thing which strikes the observer about the Continental engines," he says, "is the way in which they are almost uniformly finished off in what may be called an arrangement in black and silver." And again: "One brilliant exception . . . . is painted a blazing scarlet." After setting up such a gaudy criterion of excellence, it is superfluous for Mr. WANSBROUGH to say "there is no use in gilding the pill which the British engineer . . . . will have to swallow." Pill, gilded or ungilded, and Continental silver-plating are alike unneeded by the British engineer.

PROF. J. A. FLEMING has addressed himself to a non-technical evening paper suggesting that the present is an opportune time for re-opening the question of Post Office telegraph monopoly. A very natural enthusiasm for "electrical invention" impels him to seek for some weak spot in that monopoly, so that the most recent of these inventions—wireless telegraphy—may be "practised for profit," that is to say, may enter into competition with the Post Office as carrier of electric telegrams. It would be cruel to suggest that wireless telegraphy could start business to-morrow if it were sure of the "profit." Anyway, there is an open field for it in the United States, where there are no monopolies of the British Post Office type. Prof. FLEMING seems to overlook the fact that where the State has assumed a monopoly it covers the transmission for profit of messages by any electrical means whatsoever. In Europe we know of no country where any unrestricted competition with the State-owned telegraphs would be permitted. The British Post Office has its faults; but as regards its exclusive rights—which are national, and maintained for the benefit of the community, not for the advantage of shareholders backing up a particular inventor—it differs in no way from the Government departments of other European and Colonial administrations. Nor do we see that the existing monopolies hamper the inventor now more than did the old telegraph companies.

The pioneers of "electrical invention" got their price from the companies who took them up, but nothing more. We hope and believe that the inventor of wireless telegraphy will, in the long run, get his price too—that is to say, the price that his invention is worth in whatever field of practical telegraphy it may be of proved utility.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | | Date of Repair. |
|---|---|---|---|
| Latakia—Cyprus | June 21, 1899 | ... | — |
| Tangier—Tarifa | Jan. 3, 1900 | ... | — |
| Pará—Maranham | Mar. 2, 1900 | ... | — |
| Zanzibar—Mombasa | Sept. 20, 1900 | ... | — |
| Havre—Waterville | Nov. 8, 1900 | ... | Nov. 21, 1900 |
| Aden—Zanzibar | Nov. 9, 1900 | ... | Nov. 26, 1900 |
| Falmouth—Bilbao | Nov. 19, 1900 | ... | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | ... | — |

**Students' Section of the Institution of Electrical Engineers.**—We are informed that a special visit for student members, who are not attending any of the London technical colleges, will take place at 4:0 p.m. on Friday, December 7th, to the Electrical Standards Laboratory of the Board of Trade, 8, Richmond-terrace, Whitehall. The number of the party is strictly limited to six. Students desirous of participating in this visit should send in their names before the 6th prox. to Mr. Ll. R. Lester, hon. sec. of the Students' committee.

**An "Electrocution" at the Zoo.**—The following entertaining letter appeared in *The Times* yesterday from the pen of Mr. C. J. Cornish:—

At the Zoological Gardens on Saturday I witnessed an unrehearsed incident in animal life which is, perhaps, worth noting. A large electric eel was swimming in its tank with more activity than usual, these being generally sluggish creatures, when one of the big foreign cockroaches now established as a kind of pest in the houses where a high temperature is maintained dropped into the water. It began to swim vigorously across the tank, spreading out its wing cases and making a disturbance on the surface of the water. The eel turned round, swam past it, discharged its battery at about 8in. off, and the cockroach instantly stopped stone dead. It did not even move its antennæ after. The eel afterwards swallowed it, though I imagine that cockroach, even when electrocuted, cannot be palatable. But it is not a little curious that a fish weighing at least 12lb. should choose to fire its heavy artillery at an insect 1½in. long instead of swallowing it *sans façon*.

**Sawing Steel by the Electric Arc.**—As an addition to our recent note on the use of the arc for sawing through steel and iron structural work we quote from a recent number of the New York *Electrical World* the following dispatch from Pomeroy, Ohio:—

A peculiar accident occurred at Middleport the other day, and the full effects of it have just dawned upon the injured parties. The big iron safe in the Middleport shoe factory refused to open, and the bookkeeper, Louis Jaquith, and engineer Walter H. Rice conceived the idea that they could burn out the combination by use of carbon and electric wire. It took several hours to accomplish their purpose, but they finally succeeded, but not until they had stood for several hours in the glare of the electric light, taking turns at holding the wire and carbon. When the work was over both complained of a dizziness and pain in the head, which increased as the hours passed, and in a short time both went suddenly blind at about the same time. All efforts to restore their sight have been unavailing, for while the eyeballs appear all right, the sight is destroyed.

**Time Limit Cut-outs.**—In connection with our recent editorial note on "time limit" or "time element" cut-outs, an interesting suggestion is made in the *Industrie Electrique*. It is to shunt an ordinary maximum current circuit-breaker with a wire of metal having a high temperature coefficient for resistance. If an excess current only lasts a short time, the wire does not heat, and its resistance is low enough to take a fair proportion of the current. If the short circuit lasts long enough, the wire heats and increases in resistance so that a greater current flows through the circuit-breaker itself, and suffices to throw the cutout. It is doubtful, however, whether, in the case of a momentary short circuit, the iron wire would not increase so quickly in temperature as to do away with the time lag. It is also questionable whether the resistance between the contacts of the circuit-breaker would not be too variable to allow of accurately dimensioning the iron wire.

**Electricity at the Roumanian Oil Wells.**—In our contemporary *Petroleum* we notice that the Roumanian Electric Company has commenced to transmit power to the Bustinari and Campina oil centres from their central electric station at Sinaia. During the past month, four of the oil wells of the Steana Romana Co. have been worked by electric power. The line pressure is 11,000 volts. At Campina the current is transformed down to 500 volts, and distributed to the motors. The experience of the last month has proved so satisfactory that the Steana Romana Co. has decided to alter its entire installation and to replace steam engines with upwards of 100 motors. They estimate that the substitution will cost about 2,000,000fr., that the cost of working will then be reduced to one-half, and that the saving of time will amount to 83 per cent. Another and very important advantage that will accrue from the substitution is the reduction of the risk of firing the wells, a risk always accompanying the employment of steam boilers near wells which may spout.

**Return of the Active Service Contingent of Electrical Engineers Volunteers.**—We understand that the group of gentlemen who organised the send-off dinner at the Princes' Restaurant in February are arranging for (as far as may be possible) the same hosts to give a welcome-home dinner at the same restaurant. The date as at present fixed will be Monday, December 17th, and any alteration (if any be necessary) will be announced. Mr. Henry Edmunds, of 2, Queen Anne's-gate, is hon. treasurer, and will be glad to receive the names of gentlemen who wish to act as hosts in place of any of the orignal hosts who may be unable to attend. The subscription of each host, covering the cost of his own dinner, inclusive of wine, will be two guineas.

It has also been arranged by the corps to entertain the detachment on their return at a dinner and smoking concert, to be held at the Trocadero Resturant on Saturday, December 15th. A committee has been formed to make the necessary arrangements. The price of a dinner ticket is fixed at 7s. 6d., exclusive of wine. Members of the corps may introduce guests if the accommodation will permit.

**Trolley Wire Accidents.**—We read in the *Elektrotechnische Anzeiger* that on the 13th of this month the following curious regulations to provide against the dangers of overhead tramway wires were agreed upon at a meeting in Vienna, presided over by the Austrian Minister of Railways: (1) Telephone and telegraph wires, which at present cross the overhead tramway lines at numerous places, must be altered as soon as possible so that they only cross the tramway underground in cables. Crossing overhead is to be allowed, however, in exceptional cases, and with the employment of special safety devices. (2) Until this re-laying of telegraph and telephone lines can be carried out, in all cases where such wires cross the overhead tramway lines, a guard wire is to be erected at once about 40cm. (16in.) over the overhead wire and connected to earth. (3) The public is to be informed by numerous notices what to do in case of breakages of wire on the electric tramway routes, and this is also to be taught in the schools. (4) It is considered desirable that the police should carry insulated pliers, with which they can cut away any fallen wire. The Fire Brigade and the Salvage Corps are also to be provided with such insulated pliers. (5) Those streets in which overhead wires are suspended shall be illuminated as much as possible at night-time in order that traction wires can be seen with greater facility. (6) Those section switches which can only be operated by means of a pole are to be replaced by switches within reach. (7) The Ministry of Trade will carry out a thorough revision of the telegraph and telephone lines crossing the electric tram lines in Vienna, and will remedy any defects in them.

**An American Street Lighting Plant.**—Under the name of "A Modern Street Lighting Plant," Mr. G. A. Damon describes in the *American Electrician* a municipal arc lighting system at Grand Rapids, Michigan. This city has a population of about 100,000, and its streets are lighted with 500 arc lamps, *i.e.*, one lamp to every 200 inhabitants. The plant was installed at a cost of £36,000, and has been in operation since Jan. 1, 1900. The lamps are connected to 84 miles of overhead "weatherproof" wire and 4 miles of underground lead-covered cable, there being eight circuits. As the city contains 288 miles of streets, and covers an area of 17½ square miles, there is an

average of 28 lamps per square mile, and less than 2 lamps per mile of street, so that it is to be presumed that some other system of lighting is employed as well. The lamps are of the enclosed type, using 6·6 amperes continuous current at a pressure of 70 volts per lamp. The majority are suspended over the centre of the streets from span wires, others are fixed upon ornamental poles, and there are 40 towers which appear by an illustration in the article to be some 70ft. or 80ft. in height, and from which lamps are also suspended. The circuits are protected by 64 Garton-Daniels lightning arresters connected two in series on account of the high voltage. Brush arc lighters are employed, belt-driven in pairs from horizontal tandem engines. These engines run at 135 revs. per min., and the generators at 500 revs. per min. The latter develop 10,500 volts at 6·5 amperes. The eight circuits mentioned above are connected two in series to one machine, and are controlled by one regulator, so that there are in reality four series circuits each of 150 lamps or less. The engines run condensing, and are supplied with steam by four 150 H.P. horizontal water-tube boilers.

**Grounding of Low-Potential Circuits.**—The following extract from our American contemporary, the *Electrical World*, will serve to indicate the present and prospective condition of American electric supply mains in regard to this important question :—

In the report of the special committee of the Underwriters' National Electric Association on this subject, dated Aug. 1, 1900, and to be referred to the December meeting of the Association, it is proposed to permit the neutral point of low-potential systems to be connected permanently to ground, and this we consider a good and judicious recommendation. In the first place, the neutral point of a well insulated system is, *ipso facto*, a point which is normally at the potential of the earth, so that the permanent connection of this point to the earth in no way alters the normal electrical condition of the system. If the system is not normally well insulated, or, if although normally well insulated, it becomes abnormally and temporarily grounded, then the risk of short circuits is reduced by the permanent ground connection, because the pressure at which such short circuit can take place is only half the pressure employed in the system, and therefore half of the pressure which might be active if no ground connection were employed. Whether the conductors of Edison three-wire systems are on poles, as in the country towns, and, therefore, liable to crosses with high-pressure conductors, or whether they are in buried pipes, as in the cities, and are supplied through converters from high-pressure generating stations, it is equally important that the low-pressure system be prevented from attaining the voltage of the high pressure system if temporarily and accidentally brought into connection therewith. Similarly, in alternating-current systems, it is important that each secondary distribution system or house wiring should be incapable of rising to the primary high pressure by reason of any accidental fault in the transformer due to lightning or imperfect insulation between the windings. If the secondary wiring and lamp mains should accidentally become connected with the high-pressure distributing mains, a danger to life, not to speak of danger to property, might ensue at any moment when a leak was momentarily made to ground from the lamp circuit, either through a person standing on a cellar floor or through a defective lamp cord coming into intimate contact with a gas pipe. The permission to ground the neutral point of secondary systems would be welcomed by all those who have the welfare of the electric industry at heart, and who desire to see the greatest use of electricity, accompanied by the minimum risk in its use.

**London Fires and Electric Light.**—Mr. John Bate is sending the following circular letter to mayors and town clerks :—

The annual report of the London Fire Brigade to the London County Council for the year 1899, lately published, is a great advance upon previous issues, and enters more minutely into the details as to the cause of fires; in many cases, it states, that it has not been possible to trace their origin. The tabulated form in which the report is compiled enables anyone to see at a glance the whole area of the work of the brigade, and it is a very creditable performance, and well deserving the study of every one of the municipalities of London. The report recites that there were 216 serious fires and 3,630 slight fires. The number of lives imperilled is 291, of which 172 were saved and 119 perished, this last being the highest record for the past 10 years. Referring to a letter published last year on the subject of fires arising from the use of electric current in 1898, I am now enabled to confirm that the use of electricity for light and power is beginning to be recognised as one of the *greatest factors in life preservation and prolongation*; it is admitted by the chiefs of public departments, as well as by the heads of many of the largest London factories where electricity is used, that not only is there immunity, almost entire, from the danger of fire, but that the health of all the workers is sustained, and that they are able to perform their duties in a way never obtainable where gas was the only illuminant.

The report states that the number of fires caused by gas was 312, and from the use of mineral oil lamps 292, and the number arising from the use of electric current was only 18. It must be borne in mind that last year showed an enormous increase in the use of electricity in all parts of London. Shoreditch and Hammersmith stand pre-eminent in advanced enterprise. The former, it is stated, is supplying current for light and power to some large factories at from 1½d. to 2d. per unit.

Fire risks upon insurance is a matter which must command the attention of our municipalities. It cannot long be tolerated that insurance companies may maintain heavy risk rates upon warehouses, factories, and shops where electricity is the illuminant. Combined insurance by corporations will certainly step in to satisfy the just requirements of ratepayers. It was hoped, and expected that some initiatory step would have been taken and made known by the County Council and the Corporation of the City of London to bring pressure to bear upon the great insurance companies, who are now reaping an abundant harvest in the lessened and lessening danger of fires and great conflagrations from the use of electricity. A little more than 10 years ago it was regarded as a fearful danger by many in the internal economy of great cities, insurance corporations wisely taking the most extreme and drastic precautions to safeguard themselves from the peril of Jove's thunderbolt. Hence it is that we are now enjoying the peace and consolation of knowing that the electric spirit is even helping us upon our journey to heaven.

The marvellous uses to which the power of electric current is now being applied, through the development of scientific investigation, may well lift up our minds to the possibilities of the future. Its extensive application in tunnelling and coal cutting, in agriculture, and machinery for iron manufacturers, saw mills, furniture making, printing machines, preserved provisions of all kinds, cotton mills, railway carriage works, which are in extensive use in London and in most large manufacturing towns, is evidence of a revolution which is taking place in every branch of human industry on land and sea, and which must eventually tend to a large supersession of manual labour and at the same time of industrial extension throughout the world.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY,) November 30th**

ROYAL SOCIETY.

*4 p.m.* Anniversary Meeting at Burlington House.

THE FARADIAN CLUB.

*8 p.m.* Lecture at 8, Charing Cross-road, W.C., by Prof. C. A. Carus-Wilson on "Swiss Polyphase Railways."

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel. Sir Lowthian Bell, F.R.S., will deliver his presidential address.

**MONDAY, December 3rd.**

ROYAL INSTITUTION.

*5 p.m.* General Monthly Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS. NEWCASTLE SECTION.

Meeting at the College of Science, Newcastle-on-Tyne.

LIVERPOOL SELF-PROPELLED TRAFFIC ASSOCIATION.

*8 p.m.* An Address will be delivered at the Royal Institution, Liverpool, by M. G. Forestier on "Heavy Motor Traffic in France."

**TUESDAY, December 4th.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture II. on "Electric Oscillations and Electric Waves," by Prof. J. A. Fleming, F.R.S.

**WEDNESDAY, December 5th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*7.30 p.m.* Students' Meeting at 28, Victoria-street, S.W. Papers to be read: (1) "Bipolar Machines at the Paris Exhibition," by R. L. Pearson. (2) "Direct-current Multipolar Generators at the Paris Exhibition," by C. J. Stephenson.

INSTITUTION OF CIVIL ENGINEERS.

*8 p.m.* Ordinary Meeting. The following Papers will be read, time permitting: (1) "Signalling on the Waterloo and City Railway," and (2) "Note on the Signalling of Outlying Siding Connections," by A. W. Szlumper. (3) "Signalling on the Liverpool Overhead Railway," by S. B. Cottrell.

SOCIETY OF ARTS.

*8 p.m.* Ordinary Meeting. Paper to be read: "Road Traction," by Prof. H. S. Hele-Shaw, F.R.S.

**THURSDAY, December 6th.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Extra Meeting at the Institution of Mechanical Engineers in the event of the discussion on Mr. Langdon's Paper being adjourned.

RÖNTGEN SOCIETY.

*8 p.m.* Ordinary General Meeting at 20, Hanover-square, W. Mr. J. Mackenzie Davidson will give an exhibition and description of his Stereoscopic Fluoroscope and a new Rotary Mercury Break.

**FRIDAY, December 7th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*4 p.m.* Special Students visit to the Electrical Standards Laboratory of the Board of Trade, 8, Richmond-terrace, Whitehall.

**SATURDAY, December 8th.**

INSTITUTION OF JUNIOR ENGINEERS.

*3 p.m.* Visit to the electric generating station of the London United Tramways Co., 88, High-road, Chiswick.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' Visit to the Manchester-square station of the Metropolitan Electric Supply Co.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Genesis of the Aurora.*—S. Arrhenius has pushed his solar radiation hypothesis (see last number) a good deal further into the problems of the higher atmosphere. The negative electrons dispensed by the sun impart negative charges to the planets and satellites of the solar system. These charges are subject to fluctuations in accordance with the intensity of the solar radiation, the proximity of the planet to the sun, and its position with respect to the sun's equatorial plane. Any superfluous negative discharge is got rid of by the cathode rays, which produce the phenomenon of the aurora; and the author accounts with great success for the intensity periods of the aurora as affected by the sun and the intense negative charge of the moon. The aurora is distributed all over the earth, but is chiefly visible near the poles, because there, owing to the vertical direction of the earth's magnetic lines of force, the rays enter regions of greater atmospheric pressure, and are therefore more luminous. All the planets have tails, like the comets, consisting of particles mostly negatively charged, but of course much less brilliant. That of the moon can be dimly seen during a lunar eclipse when the earth's shadow extends a little beyond the disc. There is a constant interchange of matter between all heavenly bodies.

[S. Arrhenius, *Phys. Zeitschr.*, November 17, 1900.]

*Magnetic Field due to a Moving Electric Charge.*—To make assurance doubly sure, V. Crémieu has repeated the experiments of Rowland and Himstedt, who claimed to have shown the generation of a magnetic field by a moving electric charge. An ebonite disc, covered over with gilt sectors, was mounted inside a hollow wheel. The interior of the wheel was lined on both sides of the ebonite with brass, covered with sheets of mica, on which sectors of tinfoil were stuck. An astatic magnetic needle was used for detecting any magnetic field created by the revolution of the ebonite disc when the disc and the brass lining were given opposite charges. No deflection was observed, and thus Rowland and Himstedt's positive result is directly contradicted. But there is an important difference of detail in the arrangement, for the latter stuck the tinfoil sectors on glass, and had no brass lining. When the latter is removed, a deflection is actually obtained, but it remains far inferior to what should be expected if the charges on the moving sectors were equivalent to a current. The author attributes it to small impulsive currents which are produced in the tinfoil sectors as the gilt sectors pass them. These impulsive currents are absorbed when the brass lining is introduced, or rather they induce opposite currents in the latter which neutralise the effect upon the astatic needle.

[V. Crémieu, *Comptes Rendus*, November 12, 1900.]

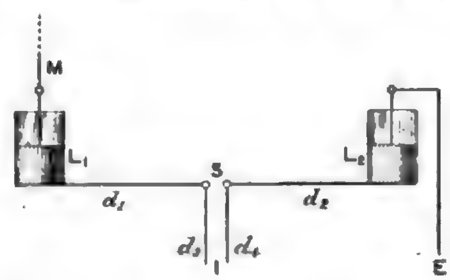
*Distribution of Molecular Energy.*—An interesting attempt to obtain an insight into the intimate structure of radiant molecules has been made by J. H. Jeans. He first considers the molecules to be loaded spheres, in which the centre of mass is at a small distance from the geometrical centre. After an infinite time, the energy will distribute itself equally between the five degrees of freedom, but when a wave of sound is passed through the gas, the energy will never have sufficient time to attain its equilibrium distribution. This leads to variations in the experimental ratio of the two specific heats with the length of the experiment. An escape from this dilemma is possible by regarding the molecules as forming an incomplete dynamical system, of which the ether is the remaining part—a view with which we are already familiar in the electron theory. For purpose of illustration, it is imagined that the interaction between the two parts of this complete system consists of a frictional force which retards the rotation of the molecules. If a gas is heated, the radiation and internal energies increase much more rapidly than the temperature, until finally, at infinite temperature, the energy is distributed equally between all degrees of freedom. This would imply that ordinary thermodynamics break down above the temperature of incandescence.

[J. H. Jeans, *Proc.* Roy. Soc., November 14, 1900.]

*Magnetic Lines of Induction.*—A new method of studying and illustrating lines of induction in a magnetic field has been devised by H. S. Hele-Shaw and A. Hay. When a viscous liquid flows in a thin layer between close parallel walls, the motion takes place along stream-lines identical with those of a perfect liquid. The course of the stream-lines may be rendered evident by injecting into the clear liquid thin bands of coloured liquid. If at any point the thickness of the layer is increased, there will be a decrease of resistance, and the stream-lines will converge upon that point, just as is seen in a magnetic field of force when a magnetic substance is introduced, or in an electric field of force on introducing a conductor. The correspondence is not merely apparent, but accurate. The authors obtained a number of curvilinear figures illustrating two-dimensional magnetic problems of interest to electrical engineers. The magnetic intensity corresponds to the pressure gradient, the magnetic induction to the rate of flow per unit width, and the permeability to the ratio of the latter to the former. The permeability is numerically represented by the ratio of the cubes of the two thicknesses. The method described is the only one which enables us to determine the lines of induction within the substance of a solid magnetic body.

[Hele-Shaw and Hay, *Proc.* Roy. Soc., November 14, 1900.]

*Simple Oscillator.*—A simplified form of oscillator has been devised for wave telegraphy by W. B. von Czudnochowski. It is shown in the annexed diagram. $L_1$, $L_2$ are two Leyden jars 26cm. high, the inner coating of one of them being connected to the mast-wire M, while the inner coating of the other is put to earth. Two wires, $d_1$, $d_2$, connect the outer coatings with the spark-gap S, and the latter is connected to



an induction coil at I by means of the wires $d_3$, $d_4$. A voltage of 4 suffices for signals over a distance of 50 yards, using the author's simplified relay, and without taking care to tune the oscillator to the receiver.

[W. B. von Czudnochowski, *Phys. Zeitschr.*, November 17, 1900.]

*Silent Electric Discharge.*—M. Berthelot has co-ordinated three phenomena of apparently diverse nature, and shown that they involve essentially the same processes. They are the "electric effluvium," familiarly known as a means of generating ozone, silent atmospheric electricity, and the chemical action exhibited in a tube with walls at different temperatures and potentials. The reactions common to all the three cases are the formation of ozone and the fixation of nitrogen, but a number of other chemical reactions are noticed, both endothermic and exothermic. The author shows that the fixation of nitrogen by plants 25cm. high requires only a difference of potential of some 7 volts. It may be experimentally demonstrated by exposing paper (cellulose) to the action of atmospheric electricity for a couple of months. As regards the thermal phenomena above referred to, it is found that whenever a gas is contained in an enclosure whose walls are at different temperatures, an electric field is produced, which in its turn brings about a silent electric discharge resembling that in an ozone tube or in the atmosphere. By means of a "hot-and-cold tube," carbonic acid may be decomposed into carbonic oxide and oxygen. It is very likely that the great majority of chemical and vital reactions produced in the atmosphere may be repeated in the laboratory by means of enclosures kept at suitable temperatures and potentials.

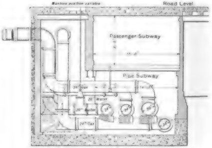
[Berthelot, *Comptes Rendus*, November 12, 1900.]

# THE CITY OF LONDON SUBWAYS.

In a leading article a few weeks ago,* we referred to the proposal of the Corporation of the City of London to construct subways under the streets for the reception of gas, water, hydraulic power and electric mains. Incidentally we mentioned that a few miles of such subway already existed in the City, and it has occurred to us that our readers would find a short description of these interesting. The main part of the subways is situated between Holborn Circus and Ludgate Circus, running under part of Holborn Viaduct, Snow-hill, Charterhouse-street, Shoe-lane, &c., and the main entrance to these is under the Holborn Viaduct itself. Then there is a subway, recently completed, beneath the passenger subway under the large Bank-Mansion House corner in the centre of the City, and in addition a couple of hundred yards in the neighbourhood of Fenchurch-street and some 1,500 yards of private subway—aggregating about 2½ miles in all. In this there are already over 2 miles of gas main, nearly the same length of water mains, 5 miles or 6 miles of electric light cable (which is being added to daily), nearly a mile each of hydraulic power mains and Post Office pneumatic tubes, and about 450 miles of wire for telegraphic and telephonic purposes, the last-mentioned also belonging to the Post Office telegraphic department. To complete these statistics we may add that no less than 8,000 workmen entered the subways during last year.

PERSPECTIVE SKETCH OF SUBWAY UNDER HOLBORN VIADUCT.

The subways are, for the most part, built with their crown only a short distance below the surface of the roadway or footway, and with their floor above the sewer. They vary in height, the one under Holborn-viaduct being about 7in. wide by 12ft. 6in. high, and they have vaulted roofs. Under the Mansion House corner the design is somewhat different to the older portions. This is seen in one of our illustrations, and another is a perspective sketch of the subway under Holborn Viaduct. The walls are of brick—in the case of the length under Holborn Viaduct of white Burnham brick, but in other parts ordinary brick. Stone floors have been employed, and these are drained by shallow channels cut in the stone and leading to gratings placed every 8 yards or so. These gratings cover bell traps, through which there is communication with the sewer beneath. In this way the subway is kept quite clean and dry. Immediately above each of these gulleys is a narrow ventilating shaft, terminating in a grating on the surface of the roadway or footway. To avoid splashing, and



SECTION OF MANSION HOUSE SUBWAY.

ELECTRIC LIGHT JUNCTION BOX AT A STREET CORNER.

---

* *The Electrician*, Vol. XLV., p. 962.

to collect the mud and water which come down, large pans on tripods are placed beneath these roadway gratings, and these pans are emptied once a week. One of these is seen in the illustration, taken under Holborn-circus, and showing the turning under Charterhouse-street to the right over the bridge. This is the end of the subway under Holborn Viaduct, the main subway turning down to the left. In this illustration the large pipes are gas, water, and hydraulic power mains, and the troughing seen on the left wall contains telegraph and telephone wires. The troughing containing the City of London Electric Lighting Co.'s cables is also seen, leading up at the end to just below the pavement, where the mains continue westwards. The gas main rises parallel to the electric cable casing. On the extreme left at the back is a Post Office inspection box, and the figure seen near it is that of Mr. W. J. Liberty, the City inspector of subways.

Under Holborn Circus.

Another illustration shows a large manhole on the City of London Electric Lighting Co.'s mains, in which are a considerable number of network boxes, and our last photographic view was taken while one of the mains of the Charing Cross and Strand Electricity Supply Corporation was being pulled in. There are in all 14 cables being laid at present by this company down Shoe-lane and to Ludgate-circus, and they will be placed in four tiers of cast-iron troughing somewhat similar to that employed by the Post Office for their wires (seen on the left in the illustration). Three separate plain lead-covered cables are laid [for each of three wires, and they vary in size from 0·1 sq. in. and 0·05 sq. in. for the smaller feeders to 0·5 sq. in. and 0·25 sq. in. for the distributors, the smaller section in each case referring to the middle wire. Cables up to 1 sq. in. section are, we believe, to be laid. The fourteen cables are four sets of three and two cables of pilot wires. At one or two of the crossings under the footway Doulton six-way ducts are used, and for a small distance also the mains are laid "solid" in bitumen. The City of London Company's mains originally put down were in Callender-Webber troughs in the floor of the subway, but later ones have been in cast-iron troughs.

Drawing-in Electric Lighting Mains under St. Bride Street.

Services are taken off through cast-iron "service shoes" which are built into the walls of consumers' cellars. These are large enough to take gas, water, hydraulic power and electric services, and they are filled in with cement around the pipes or cables. The services from the City of London Electric Lighting Co.'s mains have been taken off by boxes placed on the trough. In those streets where subways run under both pavements (as in Holborn Viaduct) the "service shoes" are in the main wall of the subway, which then forms the wall of the house cellar; and where the subway is in the centre of the roadway laterals run from the main subway to each house, the service shoes being built in at the ends of these.

As seen in our illustrations, the lighting of the subways is by gas. The Mansion House subway is an exception, however, electric light being employed there, obtained from one of the electric railway companies. Precautions to avoid explosions from gas escapes are taken on opening the subways every morning. For the first inspection safety lamps only are used, and if a gas leakage is detected immediate steps are taken to have it remedied. It is important to notice that so far there has been no trouble from gas escapes or from the leakage of water mains; for it is this question and the question of ease of making service connections which will weigh most with the electrical engineer in deciding whether he shall favour the laying of electric light and power mains in subways in common with mains of other services, instead of in the roadway or footway. That the general public would prefer this system there can be little doubt. One has only to observe the condition of the London streets at present and listen to the comments on it. But, unfortunately it is now almost too late to plan a complete system. By the time such a system had been completed, the number of pipes still to be laid might not be enough to fill it.

Our thanks are due to Mr. D. J. Ross, the City engineer, for permission to view the subways and photograph them, and we are also indebted to Mr. W. J. Liberty, his inspector of subways, who acted as our guide and gave us much of the information that is embodied in this article.

# THE PARIS EXHIBITION.—XIII.*

(BY OUR SPECIAL CORRESPONDENT.)

During the course of these articles, allusion has been made here and there to the construction of the high-pressure switching gear. The enormous dimensions of the switches and fuses employed in some of our extra high-pressure stations in this country lead one to express surprise at the more compact ones successfully employed abroad. Those who visited the electrical works in Switzerland last year had an opportunity of observing the apparatus adopted there on the high-pressure switchboards, and at the Paris Exhibition also there appears to have been no difficulty in extinguishing high-pressure arcs with breaks of a moderate size and without special devices of an intricate nature.

The main alternating-current switchboard, which received the current from the generators and distributed it to the various circuits, was fitted by the Société Industrielle des Téléphones, and the switches made by this company presented a good workmanlike appearance, and gave little or no trouble during the period of the exhibition. Following the lines usually employed on the Continent, the contacts are behind the board and are worked by a handwheel on the face of the board, there being no live metal at all in front. At the back of the board was plenty of temptation to anyone afflicted with suicidal mania, but it must be remembered that the work could only be of a temporary nature, and that the door through which it was accessible was locked. Fig. 85 is a section showing the arrangement of the board, which it is seen is mounted on insulators, and Fig. 86 shows the construction of a high-pressure switch for 3,000 volts and 200 amperes on the three-phase circuits. As seen in the figure, a spiral spring is pulled out on turning the handle, and as soon as its extremity passes the dead centre the spring pulls back and pulls the switch off or on. In Fig. 86 only one set of switch contacts are shown, the other two being indicated by centre lines. Fig. 87 is a two-pole throw-over switch for high pressures designed on more or less similar lines. The break is 22cm. long on each side, and a carbon roller is fitted, in accordance with all modern practice, to take the spark. The blades are insulated from one another by vulcanised fibre.

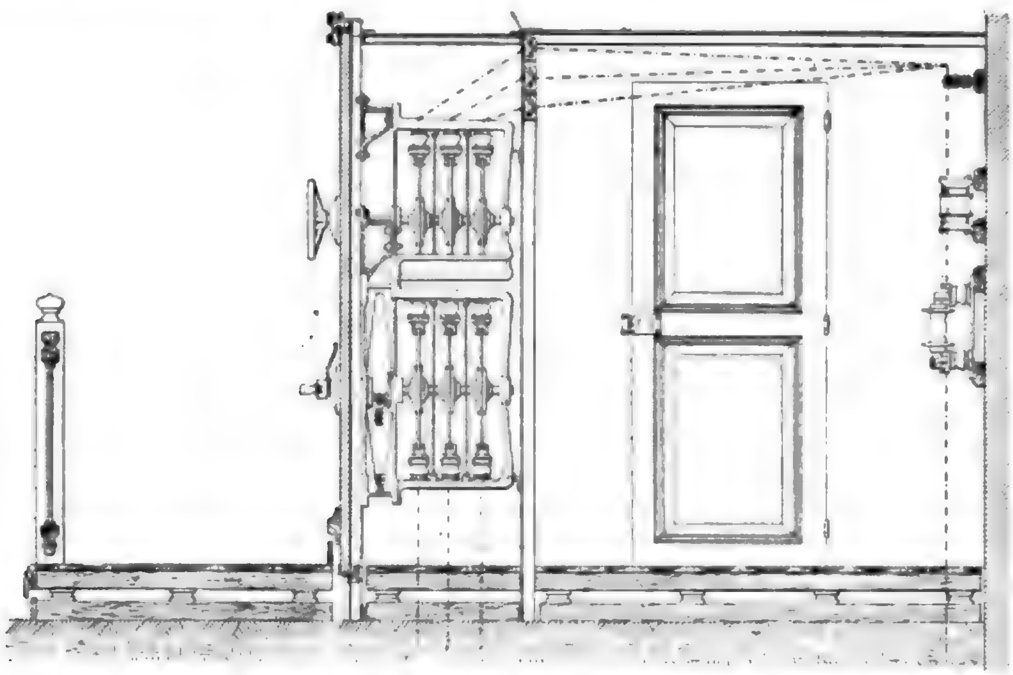


FIG. 85.—SECTION OF HIGH-PRESSURE SWITCHBOARD, SHOWING GENERAL ARRANGEMENT. SCALE 1 : 30.

A fuse, resembling outwardly the Bates or Brown-Boveri, fuse, was fitted at the back of the board in the position shown in Fig. 85. This fuse is illustrated in Fig. 88, and it is a cross between a Bates and Mordey fuse. The porcelain reel contains three fuse-wires, one of which is finer than its fellows, and is contained in a glass tube filled with powder. It is seen that one end of the fuse has an open hinge, which facilitates its replacement after a new wire has been inserted. The break is only 9in., this, I was told, being found to be amply sufficient for the maximum pressure of 5,000 volts. The fuses were always replaced during working, the man who did so wearing a rubber glove.

The frame of the switchboard was of iron, with marble panels, and the ends of the switch partitions behind the board were closed in with asbestos. At the back of the board the passage-way was 2 metres wide, which is none too much considering the quantity of charged metal and the necessity of replacing fuses there. In all, 20 machines were controlled from the switchboard, and these were mostly arranged in pairs so that either of two machines could be chosen for each feeder, parallel running being, of course, out of the question with a number of machines of different makes and at considerable distances from the switchboard. The ammeters and voltmeters were low-pressure ones on the secondaries of instrument transformers, and there was nothing but these and the switch handwheels on the board. I was informed that the price paid for the switchboard and its erection was 35,000f. (£1,400).

Sub-stations were scattered about the exhibition, being provided by the firms who supplied the alternators. In one of these was to be seen a rotatory converter with no less than 16 poles, built by the Alioth Company. It was rated at 800kw., two-phase, reducing the voltage from 2,000 volts to 550 volts at 42 ∼ per second. An illustration of it is given in Fig. 89.

The continuous-current switchboard also formed merely the connecting link between the dynamos and the feeders, no regulating being done there except by telephone. It was constructed by the Compagnie Générale de Travaux d'Eclairage et de Force. Each circuit had fuses, and four circuits were grouped together to each panel through a Thomson-Houston automatic cut-out. As already explained the continuous-current circuits were on the 3-wire system

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24, and 31, September 14 and 28, October 5, 12, and 26, and November 2 and 16.

and some of the machines delivered 440 volts, while others served as steam-driven balancers and generated 220 volts. No boosters or accumulators were used, and as each machine was required, it was run up to voltage and then switched on to the 'bus bars of the circuit it was to supply.

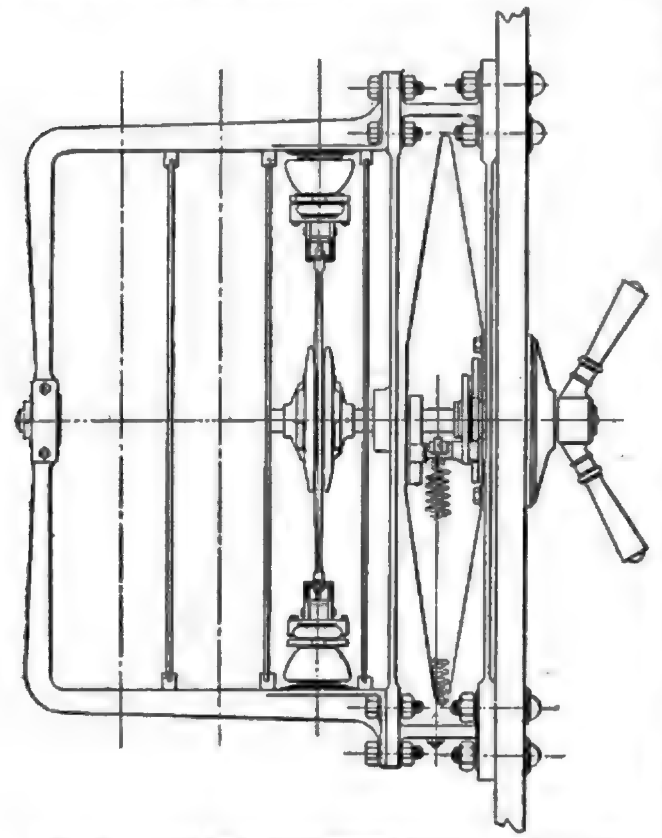


Fig. 86.—Three-Pole High-Pressure Switch. (Scale, 1 : 10.)

It has been seen that both in the case of the main high-pressure switchboard and the switches erected by the dynamo makers for the machines generating current for the light and power supply in the exhibition, the working parts were carefully enclosed. Only privileged visitors like myself were able to view them, therefore, and the ordinary observer might have thought that there were but few of these important appliances exhibited. Thus, again, in the space underground, beneath their exhibit, the Oerlikon Co. had high-pressure switches of the plunger and cylinder type. The contact is made between the plunger and cylinder, and on the withdrawal of the former a vacuum of about 250mm. is first created, and then, as the plunger leaves the cylinder the in-rushing air blows out the arc. An exception, however, was the exhibit of Messrs. Voigt and Haeffner in the gallery. There, in a small space, were gathered a number of electric light and power switchboards, typical of good German practice. A fine high-pressure switch was on view at this stand, but unfortunately at the time of my visit there was something the matter with it, so that the good impression conveyed by its appearance was destroyed by observing the extreme difficulty the operator found in switching the apparatus on and off.

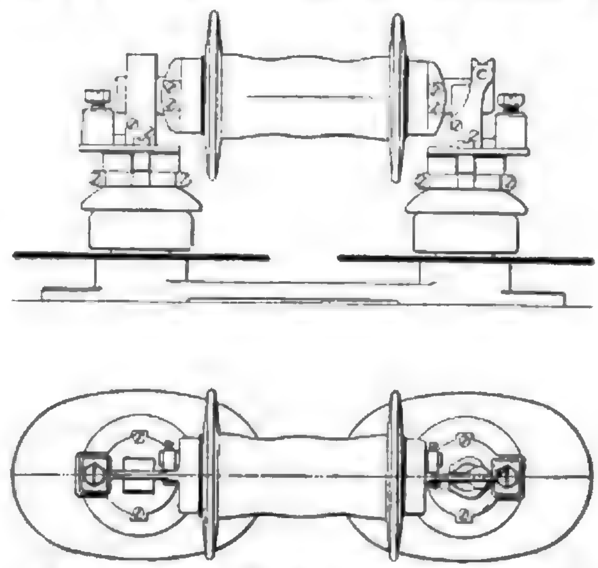


Fig. 88.—High-Pressure Fuse. (Scale, one-sixth full size.)

Low-pressure switches, on the other hand, were numerous, but chiefly of French and German manufacture, and the German firms especially, showed a large number of well-finished tramway power-station automatic cutouts. In this, as in many other branches, the British industry was hardly represented at all, Messrs. Siemens Bros. switch and cut-out in connection with their generating set in operation (already described) and a small portion of Messrs James White's exhibit being the only items of importance I noticed. The latter firm showed a tramway generator panel and a Board of Trade panel, both of its standard design, and also a circuit breaker designed to act either as a maximum or minimum

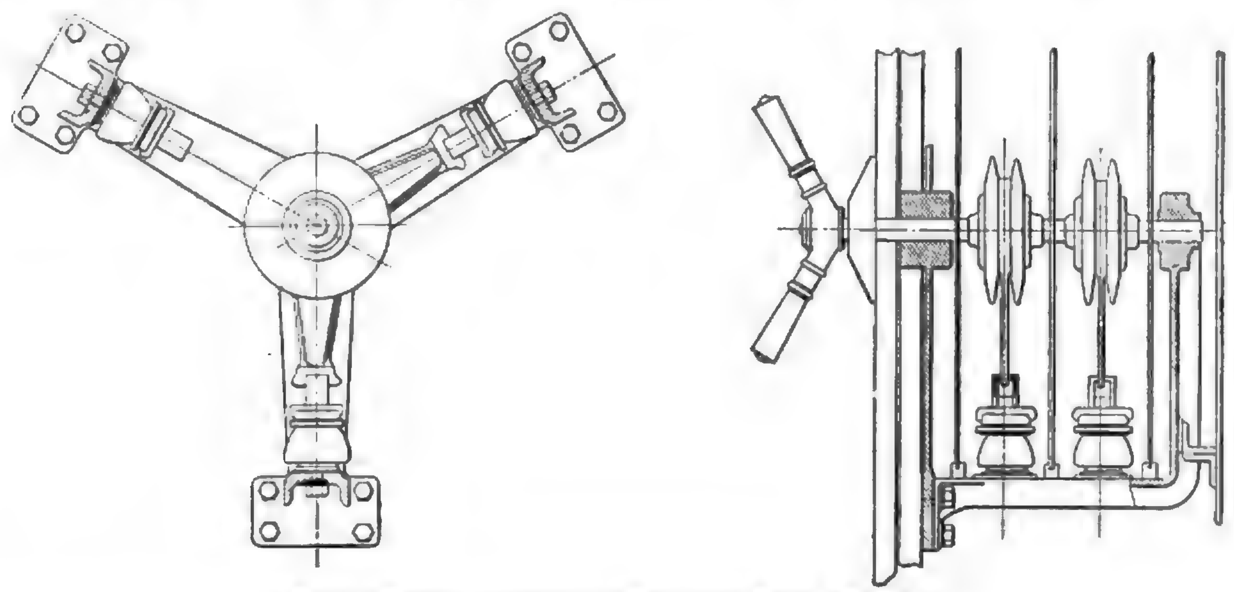


Fig. 87.—Two-Pole High-Pressure Throw-Over Switch. (Scale, 1 : 10.)

cut-out. This cut-out is so designed that it can be changed from a maximum to a minimum instrument merely by turning a small handle. Thus a circuit-breaker, ordinarily employed to break with maximum current, can be changed to a minimum current cutout just for shutting down the machine it protects. The apparatus has, in addition, a locking arrangement which prevents the replacement of the contact so long as the current exceeds the maximum rated current. Another feature of the cut-out is what the firm calls a "blow-out screen," of asbestos, which wipes out the spark on break.

In the second article of this series I alluded to the disadvantage of the switching arrangements on the continuous-current circuits at the exhibition. If a cutout of one of the main circuits fell, it was necessary to give the consumers 5min. to switch off their motors, which were mostly of the shunt type, to prevent the armatures being burned on resumption of supply. A few consumers, very few only, had employed the form of motor switches now coming into vogue, which open automatically when the current was interrupted, and one or two firms exhibited switches for this purpose. The usual construction employed was with a piece of iron on the switch arm, which, at its extreme "on" position, was held up by an electromagnet shunted to the motor. When the supply of current is interrupted, the switch arm is released, and is pulled back by a spring. Some forms have, in addition, a series magnet which acts as a cut-out by short-circuiting the shunt magnet when the maximum permissible current is exceeded, and thus causing the arm to be released. In moving on and off, the switch arm passes over a series of rheostat contacts. These switches have the disadvantage that the switch arm cannot be left in an intermediate position on the rheostat. A switch in which this defect is removed was exhibited by the Compagnie Française d'Appareillage Electrique. The arm is controlled by a spring in the usual manner, but the force of the spring is counteracted by the attraction of a magnetised iron plate for a piece of iron fitted to the arm and in contact with the plate. As soon as the current is interrupted the arm flies back to the off position, no matter at what point of the rheostat it was.

FIG. 89.—ALIOTH TWO-PHASE ROTATORY CONVERTER. (300 kw., 320 revs. per min., 550 volts, 16 poles, 42 ∽ per sec.)

An amusing and ingenious idea, put into effect by the same company, was an excess demand indicator, intended not for the information of the supply company, but as a warning of excess demand to the consumer who is supplied on a "contract" or "flat" rate. If the current taken by the consumer exceeds what is contracted for, a slow vibrator is set into action, which extinguishes the light a few times per second until the demand again sinks to the normal.

The same firm showed me a compact 5-minutes' time switch, intended for watchmen, stairways, cupboards, closets, &c. As the handle is turned to switch on, a simple clockwork movement is wound up, and turns the switching-off cam slowly. The price of this piece of apparatus is 45fr., so your readers can calculate whether the interest and depreciation on this increased capital outlay would be greater or less than the probable waste if ordinary switches were employed.

Coming more or less in the category of switches was a burglar alarm of almost ideal simplicity shown by the Société Anonyme des Avertisseurs Electriques. It consisted of a brass ball suspended on a pieceof flexible wire which passed through a brass loop or ring, with a slight clearance. This device was to be screwed to the door or window to be protected, the flexible wire and the ball forming one terminal of the contact and the ring the other. The least motion of the door or window set the ball swinging and closed the alarm bell circuit.

## A NEW TELEPHONE METER.

With the adoption of the toll system of charging for telephonic service, the need of a meter or counter to record the number of conversations is being felt. Several meters have been devised for this purpose, especially in Germany, the majority of them being based on the motion of the switch-hook on removing the receiver. The difficulties of this method, owing to the necessity of making allowance for ineffectual calls, are obvious. The following system has been devised by Mr. H. D. Stroud, of Chicago, and is described in the *Electrical World* of New York :—

At each subscriber's instrument is placed a small register box which has a push button on top, and register figures exposed at one side of the box, indicating the total number of calls made since the subscriber's telephone was put in service. When a subscriber wishes to call central, he does so in the usual manner, but before the central office operator will give him the desired connection he must press the button on his recording instrument, which accomplishes three results, one being to record his call on the register or counter, one to close a vibrator circuit which makes a buzzer signify to the operator that the subscriber has registered, and the third to wind the spring which stores the call. The connection is then made by the operator, and talking proceeds as usual. The subscriber's register now evidently shows the number of calls he has made since the telephone was put in.

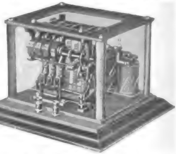


FIG. 1.—Central Office Record Taker.

At the end of each month the register clerk at the central office takes a portable registering device, Fig. 1, and connects it with each subscriber in turn, making the request of the subscriber to press the button of his register, and also to announce to the central office clerk the number of calls indicated on his register. When the proper connection is established between the subscriber's register and the automatic call counter at the central office, the call counter will, in a few seconds, indicate a duplicate of the number recorded on the subscriber's register. The subscriber and clerk then compare numbers, and the clerk is free to go on with the next subscriber. In this way, in a short time a few clerks at the central office can take the register readings of the entire exchange. No extra sub-

scriber's wires are required, the only additional instrument at the subscriber's station being the small and simple register. One or two portable record-takers will do the work for an entire large exchange. The plan is applicable to both local and common battery systems and party lines, this being one of the advantages of this system over some others. The record-taker will act so rapidly that even where the number of calls registered is as high as 1,000, the record will be transmitted in a few seconds.

The electrical method of accomplishing this is shown in Fig. 2, which is a diagram of circuits for the system. A represents the subscriber's register and telephone, and B the portable counter with its battery at the central station. This portable counter may be plugged in at any of the multiple jacks, but in practice it would be more desirable to plug in outside of the multiple board entirely, say, at the distributing racks, so as to be free from central office interference, during the time of taking the register reading. The switchboard should be preferably cut off entirely, as indicated by K, Fig. 2. The subscriber at A, desiring to make a call, removes his receiver (the diagram indicating the instrument used on the usual Bell common battery system), and gives his order to the operator, who completes the connection and calls the party wanted. As soon as the called party responds, the operator requests the calling party to press the register button *a*, which must be done before conversation begins. The operation of pressing the button sounds the buzzer *b*, by closing the circuit from $L_1$ to *c* through *b* and *a* and by *d* being brought in contact with *e* and thence completing the circuit to $L_2$. This same motion of the button *a* moves the counter $S_2$ one number forward and rotates the cam wheel *g*, winding up a spiral spring, similar to a watch spring, and thus, as it were, storing the call. When it is desired to take the reading of the subscriber's register, the clerk at central office plugs in his reading instrument at K, as before mentioned, and rings the party at A, requesting him to press the button at *a*, which closes the

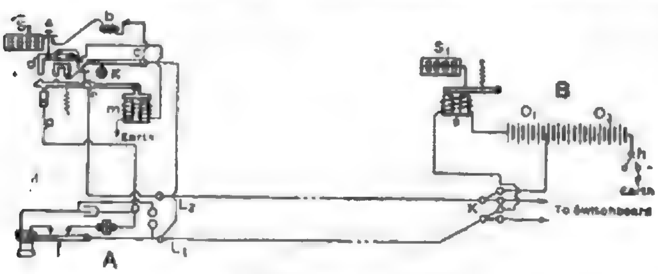


Fig. 2.—Diagram of Circuits.

controlling circuit at *a*, through coil *m*, through *d*, *e* and to $L_2$, thence to *k* and through limb $O_2$ of battery and switch *h* to ground, completing the controlling circuit, and energising magnet *m*, which draws down its armature, and closes together the contacts at *s* and *r*, also maintaining the connection made at *e* and *d* by the act of pressing the button. The energising of magnet *m* also releases pawls which check the spring connected with *g* and the latter rotates backward, giving motion to the arm *c*, which intermittently closes circuit through *r*. The number of strokes of the arm *c* represents the number of calls stored on the spring. Thus the closing of the circuit at *c* and *r* gives an impulse over the line, which actuates the call-counter magnet *s* at B, operating the counter $S_1$, thus transferring the registered calls to the reading instrument at the central office. After each reading the counter $S_1$ is restored to zero by turning a button on the counter. The counter $S_2$ at the sub station does not re set, but continues to count to 9,999 and then reverts to zero, thus making it possible for the subscriber to see how many calls he has used from time to time, and giving the company a positive record of actual calls made should any trouble arise in the transmission of the reading to the central office counter. The number on the receiving instrument $S_1$, after reading, added to the previous total, should equal the number indicated at the sub-station. The diagram shows the application of the counter to the regular Bell common battery subscriber's station. The clerk's telephone outfit at the central office, used in connection with the counter, is not indicated in the diagram. The instruments will be manufactured by a new company, which has been formed under the name of the National Measured Service Co.

**A New Lightning Guard.**—According to *Electricity*, of New York, successful experiments were made on several trolley lines last summer with a lightning guard consisting of a glass tube about a foot long filled with small shot, the shot having been treated chemically before use to give it a slight coating of lead carbonate. This tube is connected between the trolley wire and earth, and it is said that the lead carbonate, which is an insulator, permits the passage of the lightning discharge but does not allow the trolley wire current to follow it.

## ON THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.*

BY W. LANGDON.

Probably one of the most interesting questions associated with the application of electrical energy to railway work is its eventual supersession of the steam locomotive. Electric locomotives of a capacity equal to that of the steam locomotive, doing similar work, and possessing certain marked advantages, are an accomplished fact, and to many it may seem that the days of the steam locomotive are numbered. We must not, however, forget that which has been done has its *raison d'être*. Its employment has hitherto been generally confined to localities where the effects of steam and smoke would exercise a baneful influence. Because it has been so employed, and its employment has been attended with such marked success, it does not follow, however much it may appear desirable, than in overland lines of railway electricity will in future prove to be the element of power. Railways are commercial undertakings, in which vast sums of money have been embarked, all of which, investors expect, will produce a certain annual return. The supersession of the steam by the electric locomotive thus resolves itself, primarily, into one of profit and loss. If its adoption will enable railways to be worked more economically than is the case under steam, then it will, with its attendant advantages, sooner or later, be adopted—if not by the whole, certainly by the greater portion of the railways of this country; but, whatever the ulterior advantages may be, unattended by this result, its adoption will remain doubtful.

The first question to be asked is: Are we in a position to consider the subject? Is the data at our disposal such as to admit of a reasonable treatment of it? I think we are. The primary factors are well known. We know how many pounds of steam we can obtain from a given quantity of coal. The efficiencies of prime movers and electrical generators, the loss in transmission, transformation, and distribution are all determinable. Any advantages yet to come must be looked for in the steam generator and in the simplification and consequent ultimate increase of efficiency in the electrical apparatus. In each, no doubt, the future will see production cheapened. Labour may advance, but competition will grow, and in the price of the manufactured article we may reasonably look to the future to produce some advantage.

Having then the material at hand, it is reasonable to conclude that the consideration of the subject can only be attended with good; for, if it should be shown that advantage is to be anticipated from such a change, it will help us to grasp that which has to be attempted, and perhaps to evolve from the data at our disposal the course most desirable to follow. The railways of the United Kingdom comprised on Dec. 31, 1899,† the following mileage of line:—

| | |
|---|---|
| Double line or more | 11,977 |
| Single line | 9,723 |
| Total mileage | 21,700 |

The number of locomotives employed for working these railways was 20,461. The total number of vehicles of all descriptions was rendered as 752,930. The year's cost for locomotive power, including stationary engines, was £16,491,377. The number of miles travelled by trains was 396,241,265. Number of passengers—exclusive of season tickets—1,106,691,991. The tonnage of minerals, 296,611,190; and of general merchandise, 117,011,835.

In dealing with a question of this nature it seems desirable to produce these figures; but they are, in fact, except to afford some idea of the magnitude of the subject, of very little use. The length of the passenger journeys is not stated, nor are the journeys taken by season ticket holders included. To be of value the per passenger mileage, including, of course, the journeys made by season ticket holders, should be given. The same objection applies to the mineral and goods tonnage statement. It records the tonnage declared as placed upon the railway, but whether it is carried 1 mile or 100 miles is not shown. In fact, the returns as rendered aid the consideration of the subject very little, and I am sorry to say the information in the hands of the railway companies themselves carries us no further. Under these circumstances the establishment of a common basis upon which to consider the relative cost presents much difficulty. The only manner in which it can be approached is by averaging the data obtainable, or by examining the work of a particular section of line.

In Table I. I furnish extracts from the Board of Trade return for the year 1899, showing the mileage of line, cost of locomotive power, train mileage worked, &c., for England and Wales, Scotland and Ireland, together with certain deductions therefrom applicable to these results; as also similar data in reference to six of the most important English companies. In considering the mileage of line quoted, it should be mentioned that the figures do not disclose the *mileage of roads*. Over many sections of the several lines of railway there are

* Paper read last night before the Institution of Electrical Engineers.
† Board of Trade Railway Returns, 1899.

E

**Table I.** —*Mileage of Line, Cost of Locomotive Power, Train Mileage, &c., for Year Ending December 31, 1899.*

| — (a) | Length of line in miles open on Dec. 31, 1899. Double or more. | Single. | Total. (b) | Cost of locomotive power, including stationary engines. (c) | No. of locomotives. (d) | Number of miles travelled by trains. By passenger trains. (e) | By goods and minerals. (f) | Total. (g) | (h) Cost per train mile for locomotive c/g | (k) No. of miles travelled by trains per hour during year of 365 days. g/8,760 | (l) No. of trains per mile per hour (365 days to the year). k/b |
|---|---|---|---|---|---|---|---|---|---|---|---|
| England and Wales | 9,933 | 5,111 | 15,044 | £14,101,842 | 17,411 | 178,684,803 | 151,377,966 | 330,062,769 | 10·253d. | 37,678 | 2·505 |
| Scotland | 1,423 | 2,057 | 3,480 | 1,811,552 | 2,241 | 27,588,633 | 21,473,089 | 49,061,722 | 8·862d. | 5,601 | 1·609 |
| Ireland | 621 | 2,556 | 3,176 | 577,983 | 809 | 10,367,617 | 6,749,157 | 17,116,774 | 8·104d. | 1,954 | 0·615 |
| Total—United Kingdom | 11,977 | 9,723 | 21,700 | 16,401,377 | 20,461 | 216,641,053 | 179,600,212 | 396,241,265 | Av. 9·988d. | 45,233 | Av. 2·084 |
| *Railway Companies.* | | | | | | | | | | | |
| Great Northern | ... | ... | 825 | £955,690 | 1,259 | 11,729,522 | 12,426,497 | 24,156,019 | 9·892d. | 2,757 | 3·3 |
| Great Western | ... | .. | 2,602 | 1,884,032 | 1,933 | 23,085,637 | 22,561,470 | 45,647,157 | 9·905d. | 5,210 | 2·0 |
| London and North-Western | ... | ... | 1,924 | 1,927,049 | 2,959 | 26,285,278 | 22,515,697 | 48,800,975 | 9·477d. | 5,570 | 2·9 |
| London and South Western | ... | ... | 900 | 709,110 | 728 | 12,598,390 | 4,689,644 | 17,288,034 | 9·844d. | 1,973 | 2·2 |
| Midland | ... | ... | 1,431 | 2,016,816 | 2,507 | 18,979,594 | 28,387,090 | 47,366,684 | 10·218d. | 5,407 | 3·7 |
| North-Eastern | ... | ... | 1,632 | 1,632,967 | 2,047 | 14,641,572 | 17,307,802 | 31,949,374 | 12·266d. | 3,647 | 2·2 |
| | | | | | | | | | Av. 10·267d. | | |

**Table II.**—*Luton.—Statement of the Number of Trains recorded in the Block Book for the 24 hours ending midnight on Thursday, July 19, 1900.*

| Hours. | Express passenger. | Ordinary passenger. | Coaches. | Fish and milk. | Express goods. Class "A." | Express goods. Class "B." | Ordinary goods. | Minerals. | Light engines. | Total No. of trains each hr. |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 to 1 a.m. | 2 | ... | ... | ... | 1 | 5 | ... | 3 | ... | 11 |
| 1 ,, 2 ,, | ... | ... | 1 | ... | ... | 10 | ... | 2 | ... | 13 |
| 2 ,, 3 ,, | ... | ... | 1 | 3 | 1 | 3 | ... | 5 | ... | 13 |
| 3 ,, 4 ,, | 1 | ... | ... | ... | ... | 3 | ... | 6 | ... | 10 |
| 4 ,, 5 ,, | 1 | ... | ... | ... | 3 | 5 | ... | 6 | ... | 15 |
| 5 ,, 6 ,, | 2 | ... | ... | ... | 2 | 4 | 1 | 2 | ... | 11 |
| 6 ,, 7 ,, | 1 | 1 | ... | ... | 3 | ... | 1 | 5 | ... | 11 |
| 7 ,, 8 ,, | 1 | 1 | 4 | ... | 2 | 4 | 1 | 3 | ... | 16 |
| 8 ,, 9 ,, | 1 | 1 | ... | ... | 1 | 2 | ... | 2 | ... | 7 |
| 9 ,, 10 ,, | 4 | ... | ... | ... | ... | [illegible] | ... | 4 | ... | 10 |
| 10 ,, 11 ,, | 4 | 1 | ... | ... | .. | 1 | 1 | 4 | ... | 11 |
| 11 ,, 12* | 3 | ... | ... | ... | 1 | 1 | 1 | 3 | ... | 9 |
| 12 ,, 1 p.m. | 4 | 1 | ... | ... | ... | 1 | 2 | 6 | ... | 13 |
| 1 ,, 2 ,, | 4 | 1 | 1 | ... | ... | 2 | ... | 4 | ... | 12 |
| 2 ,, 3 ,, | 6 | 2 | 3 | ... | ... | ... | ... | 8 | ... | 19 |
| 3 ,, 4 ,, | 2 | 3 | ... | ... | 1 | | 3 | 5 | ... | 14 |
| 4 ,, 5 ,, | 4 | ... | 1 | ... | ... | ... | 1 | 5 | ... | 11 |
| 5 ,, 6 ,, | 4 | 2 | ... | ... | . | ... | 2 | 3 | ... | 11 |
| 6 ,, 7 ,, | 5 | 1 | ... | ... | ... | ... | ... | 4 | ... | 10 |
| 7 ,, 8 ,, | 4 | 2 | 1 | ... | ... | ... | ... | 5 | ... | 12 |
| 8 ,, 9 ,, | ... | 2 | 1 | ... | 3 | ... | ... | 1 | ... | 7 |
| 9 ,, 10 ,, | 2 | ... | ... | ... | 1 | 2 | .. | 4 | ... | 9 |
| 10 ,, 11 ,, | 5 | 2 | ... | ... | . | . | 2 | 7 | ... | 16 |
| 11 ,, 12† | 2 | 1 | 2 | ... | 1 | 6 | 3 | 1 | ... | 16 |

* Noon. † Midnight.

*Classification.*

| | | |
|---|---|---|
| Express passenger | | 62 |
| Ordinary passenger | 21 | 36 |
| Coaches | 15 | |
| Fish and milk | 3 | 74 |
| Express goods—Class "A." 20 | 71 | |
| Do. Class "B." 51 | | |
| Ordinary goods | 18 | 115 |
| Minerals | 97 | |
| Total number of trains during the 24 hours | | 287 |
| Maximum number of trains in 1 hour | | 16 |
| Minimum do. do. | | 7 |

**Table III.**—*Harpenden.—Statement of the Number of Trains recorded in the Block Book for the 24 hours ending midnight on Thursday, July 19, 1900.*

| Hours. | Express passenger | passenger. | Coaches. | Fish and milk. | Express goods. Class "A." | Express goods. Class "B." | Ordinary goods. | Minerals. | Light engines. | Total No. of trains each hr. |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 to 1 a.m | 2 | ... | ... | ... | 3 | 3 | 1 | 4 | ... | 13 |
| 1 ,, 2 ,, | ... | ... | 1 | ... | | 9 | 2 | 2 | ... | 14 |
| 2 ,, 3 ,, | ... | ... | 1 | 3 | 1 | 3 | 2 | 1 | ... | 11 |
| 3 ,, 4 ,, | ... | ... | ... | ... | 2 | 3 | 3 | 3 | ... | 11 |
| 4 ,, 5 ,, | 1 | ... | ... | ... | 2 | 5 | 4 | 1 | ... | 13 |
| 5 ,, 6 ,, | 3 | 1 | ... | ... | 2 | 4 | 2 | 1 | 1 | 14 |
| 6 ,, 7 ,, | ... | ... | .. | ... | | 2 | 5 | 1 | 1 | 9 |
| 7 ,, 8 ,, | 2 | 3 | 2 | ... | 2 | 5 | ... | ... | 1 | 15 |
| 8 ,, 9 ,, | 4 | 1 | ... | ... | 1 | ... | 5 | 3 | ... | 14 |
| 9 ,, 10 ,, | 5 | 2 | ... | ... | | 1 | 3 | 1 | ... | 12 |
| 10 ,, 11 ,, | 3 | 1 | ... | ... | 1 | 1 | ... | 1 | ... | 7 |
| 11 ,, 12* | 5 | ... | . | ... | . | 2 | 2 | 2 | . | 11 |
| 12 ,, 1 p.m. | 5 | 2 | 1 | ... | . | 1 | 1 | 2 | ... | 12 |
| 1 ,, 2 ,, | 3 | 2 | . | ... | | 1 | 6 | 3 | 1 | 16 |
| 2 ,, 3 ,, | 5 | 3 | 1 | ... | | 1 | 3 | 2 | 1 | 16 |
| 3 ,, 4 ,, | 4 | 1 | 1 | ... | | 1 | 2 | 3 | 1 | 13 |
| 4 ,, 5 ,, | 3 | 5 | ... | ... | | ... | 2 | 2 | ... | 12 |
| 5 ,, 6 ,, | 5 | 1 | ... | ... | | ... | 2 | 2 | ... | 10 |
| 6 ,, 7 ,, | 3 | 1 | ... | ... | | | 2 | 2 | 1 | 9 |
| 7 ,, 8 ,, | 6 | 2 | ... | ... | 2 | ... | 1 | ... | ... | 11 |
| 8 ,, 9 ,, | 2 | 3 | ... | ... | 1 | 2 | 1 | 3 | 1 | 13 |
| 9 ,, 10 ,, | 3 | 2 | ... | .. | ... | 3 | 3 | 3 | 1 | 15 |
| 10 ,, 11 ,, | 3 | 2 | ... | 1 | 1 | 1 | 1 | 2 | 1 | 12 |
| 11 ,, 12† | . | 1 | 1 | .. | 4 | 4 | 2 | 2 | ... | 14 |

* Noon. † Midnight.

*Classification.*

| | | |
|---|---|---|
| Express passenger | | 67 |
| Ordinary passenger | 33 | 41 |
| Coaches | 8 | |
| Fish and milk | 4 | 73 |
| Express goods—Class "A" 22 | 74 | |
| Do. Class "B" 52 | | |
| Ordinary goods | 55 | 111 |
| Minerals | 46 | |
| Light engines | 10 | |
| Total number of trains during the 24 hours | 297 | |
| Maximum number of trains in 1 hour | | 16 |
| Minimum do. do. | | 7 |

more than two roads. Most main routes working out of London possess four, and even six roads, for a considerable distance; and the same applies to other busy portions of the chief railway systems.

The table indicated shows that the cost of locomotive power for the United Kingdom, including stationary engines for pumping and other purposes, works out at 9·988d. per train mile. That the cost for England and Wales is 10·253d., for Scotland 8·862d., and for Ireland 8·104d.; and that this cost varies with the several companies quoted as follows: London and North-Western 9·477d., London and South-Western 9·844d., Great Northern 9·892d., Great Western 9·905d., Midland 10·218d., and North-Eastern 12·266d.—their average cost being 10·267d. Column *l* indicates the number of trains, per mile per hour, based upon the mileage of line of railway shown by the returns. Bearing in mind that there are, over many portions of the railways indicated, several lines, or roads, the number of trains travelling per mile per hour is, perhaps, surprisingly small. Ireland claims but 0·615; Scotland, 1·609; England and Wales, 2·505. Of the railways individualised, the Great Western has an average of but 2; the London and South-Western and the North-Eastern each 2·2; London and North-Western, 2·9; Great Northern, 3·3; and the Midland, 3·7 (that is, the Midland, for instance, has, on an average, 3·7 trains passing over each *mile of line of railway*, each hour; not that the mile of line is occupied by these 3·7 trains during the entire hour, but that that is the average number of trains worked over the mile of line of railway—quite irrespective of the number of lines of rails—within that period of time).

**Table IV.**—*Basis of Calculation.—Showing Number of Trains, classified, passing certain points of a 50-mile Section of Line of Railway calculated Mechanical Horse-power and Electrical power for working the same, together with Apportioned Speed, Load, &c.*

| Class of train. | No. of trains per day of 24 hrs. passing. | | Basis of Calculation. | | | | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Luton. | Harpenden. | Apportioned No. of trains per hour. | Speed, miles per hour. | Train miles per hour. | Load, including engine. Tons. | Total tractive effort per train.* | Mechanical H.P. per train hour. | Equivalent in kw. hours. | Mechanical H.P. per hour. | Equivalent in kw. per hour. |
| 1. Express passenger | 62 | 67 | 3 | 50 | 150 | 275 | 3,675 | 477 | 356 | 1,431 | 1,068 |
| 2. Ordinary passenger and empty coaches | 36 | 41 | 2 | 32 | 64 | 300 | 2,130 | 182 | 136 | 364 | 272 |
| 3. Express goods and perishables | 74 | 78 | 4 | 35 | 140 | 400 | 3,160 | 295 | 220 | 1,180 | 880 |
| 4. Ordinary goods and minerals | 115 | 111 | 5 | 25 | 125 | 500 | 2,750 | 183 | 137 | 915 | 685 |
| Totals | 287 | 297 | 14 | ... | 479 | ... | ... | ... | ... | 3,890 | 2,905 |
| Average per hour | 11·9 | 12·4 | ... | ... | ... | ... | ... | ... | ... | ... | ... |

* Tractive effort × load tons = total tractive effort per train.

Tractive effort per ton $= 3 + \frac{V^2}{250}$ where V = speed in miles per hour. $\text{H.P.} = \frac{\text{Tractive effort pounds} \times \text{miles per hour}}{375}$.

If trains were, in practice, so distributed, this might form a basis on which to found a comparison of cost for the entire railway system; but we know that this is not so—that trains are much more frequent on certain portions and less frequent on other portions of the lines of railway, and although it is a kind of basis, affording some very interesting figures, it is not, as it stands, a practical one for the purpose in view. To effect this it is necessary to consider the work of an individual section of some line of railway; and with this view I have taken that portion of the Midland Company's main line between London (St. Pancras) and Bedford—omitting the suburban and local traffic applicable to the Metropolitan and Tottenham lines.

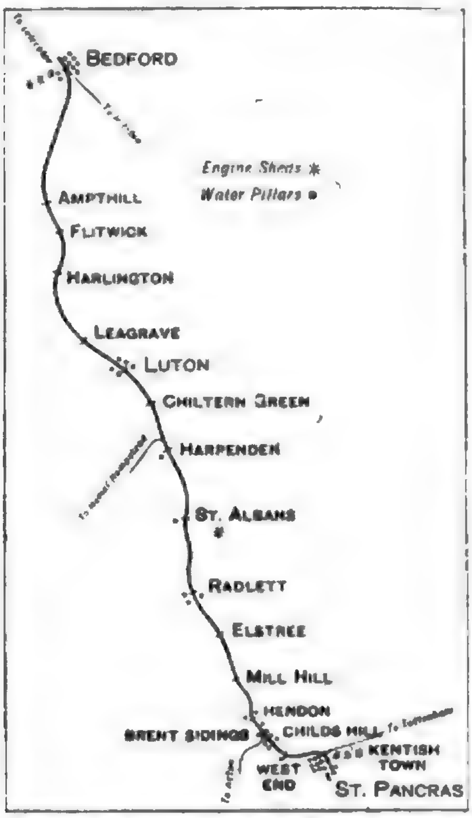


FIG. 1.—London-Bedford Section. Midland Railway.

The length of line of railway is 49·5 miles—practically 50 miles; and the number of lines of rails applicable to the traffic under consideration may be taken as four—it is not less. In order to ascertain the number and character of trains to be taken into consideration, I have obtained returns (Tables II. and III.; extracted from the Block Book, of those trains passing two points—Luton and Harpenden—each hour, during a day of 24 hours in the month of July, 1900, which I have summarised and classified so as to bring the subject within reasonable scope. These details are carried forward to Table IV., which forms the basis of calculation for comparison of cost for power to work the traffic indicated.

The classification adopted is necessarily somewhat arbitrary, but in its construction I have endeavoured to err on the right side—for instance, I have debited each train of its class as a loaded train, whereas some would certainly be light trains. Again, I have, I believe, accorded to each their full merit of speed, although there is reason to assume that, in many instances, certain goods and minerals would not observe that allotted to them. From this table we get the tractive effort per train, and the consequent mechanical and electrical power required to deal with *one hour's work*. The work may, and of course does vary from one hour to another; indeed, that is clearly shown by Tables II. and III.; for instance, the trains passing Harpenden vary per hour from 7 to 16, and Luton from 7 to 19, but the section of line chosen may be regarded as a full line, a line well occupied by trains both night and day, Sundays and week days. The returns show an average of 11·9 trains passing Luton and of

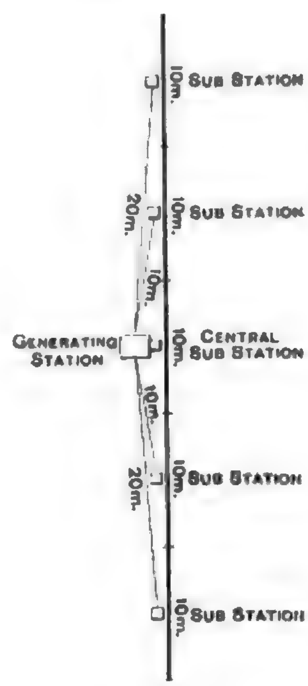


FIG. 2.

12·4 passing Harpenden per hour. In taking an average, however, I have apportioned no less than 14 trains to the hour. This number divided between the four lines of metals gives a result of 3·5 trains per mile per hour per line of metals. It may here, however, be as well to point out that, so long as the appropriated number of trains is fairly that in practice, the number applied is, for comparison purposes, immaterial, for the comparison I draw is based upon the train mileage cost.

Fig. 1 illustrates the section of line under consideration. The position of engine-sheds is shown by stars (*); of water-cranes by dots (·). The short or suburban traffic between St. Pancras and Hendon, and the Tottenham line, &c., is not included in my schedules, for the reason that, viewing the section of line as if actually subject to electrical working, there would be little doubt that this immediate London-suburban traffic would demand a generating station nearer home than that indicated in the scheme I have adopted

**Table V.**—*Estimated Cost of Generation and Distribution of Current.*

| Details of charges. | | Per annum. | Per kw. hr. |
|---|---|---|---|
| | | £ | Pence. |
| 1. Capital outlay. £470,000. Interest at 3½ per cent. | | 16,450 | 0·0901 |
| 2. *Generating Station.* Salaries and wages:— | | | |
| 1 chief engineer | £500 | | |
| 1 assistant ditto | 260 | | |
| 3 switchroom attendants, at £150 each | 450 | | |
| 1 clerk | 120 | | |
| 7 engine-room att'nd'nts, at 40s. each per week | 728 | | |
| 7 assistant ditto, at 35s. each per week | 637 | | |
| 12 stokers, at 30s. each per week | 936 | | |
| 15 labourers and cleaners, at 22s. each per week | 853 | | |
| | | 4,479 | 0·0245 |
| *Coal*—At 3·0lb. of coal per kilowatt hour = 58·667 tons, at 7s. 11½d. per ton | | 23,345 | 0·1279 |
| *Water*—At 25lb. per kilowatt hour, and 2d. per 1,000 gallons | | 913 | 0·0050 |
| | | 28,737 | 0·1574 |
| 3. *Sub-stations* (5). Salaries and wages:— | | | |
| 5 assistant engineers, at £200 each | £1,000 | | |
| 20 attendants at 40s. each per week | 2,080 | | |
| 20 assistants at 35s. each per week | 1,820 | | |
| 10 cleaners at 22s. each per week | 572 | | |
| | | 5,472 | 0·0299 |
| 4. *Outdoor Service.* | | | |
| 5 rail-jointers and fitters, at 40s. each per week | £520 | | |
| Material, &c. | 230 | | |
| | | 750 | 0·0041 |
| 5. Oil, waste, and sundries. | | 2,000 | 0·0109 |
| Total estimated cost of generation and distribution of current | | £36,959 | 0·2023 |

as my basis for the comparison of costs for working a 50 miles section of line. The plant scheme is roughly outlined in Fig. 2. Midway in the 50 miles of railway is the central station, containing four 2,500kw, three-phase, or other characteristic, 100,000 volt generators. At this pressure current is distributed to sub-stations, each serving 10 miles of railway, where the potential is converted to 600, from whence it is carried to the contact rail. Or the centre 10-mile section may be provided for by direct-current generators served from the same steam plant.

The efficiencies of the various parts are assumed as follows:—

| | Loss. Per cent. | Efficiency. |
|---|---|---|
| Motors | 15 | 0·85 |
| Ohmic loss in rails | 10 | 0·90 |
| Leakage | 2½ | 0·975 |
| Rotary converters | 10 | 0·90 |
| Static transformers | 7 | 0·93 |
| H.T. transmission | 10 | 0·90 |

The total kilowatts required on the train-wheels (Table IV.) is 2,905 per hour, and the number of trains is 14. Therefore $(2,905/14)$ 207·5 will be the average kilowatts per train hour; and assuming the efficiency of the motors at 85 per cent. $(207·5/0·85)$ 244kw. will be the average power required to be supplied to each train. If now we allow 10 per cent. loss in the rails which supply and return the current, a pressure of 540 only will be available at either end of a section of 10 miles. Therefore the amperes per train that will be required will be $(244 \times 1,000/540)$ 452.

As there are 14 trains per hour in the total 50 miles section, there will be $14/5 = 2·8$, say 3 trains in one section of 10 miles to be supplied by one sub-station.

$$452 \times 3 = 1,356 \text{ amperes.}$$

Adding 2½ per cent. for leakage, we have 1,390 amperes as the current to be supplied by each sub-station at 600 volts. The efficiency of the converters and static transformers is taken at, respectively, 90 per cent. and 93 per cent., and the three-phase transmission at 90 per cent.

$$\therefore \frac{1,390 \times 600}{1,000 \times 0·9 \times 0·93 \times 0·9} = 1,107\text{kw. to be delivered to the trains}$$

for each section containing 3 trains.

As there are 14 trains, there will be 4 sections with 3 each, and 1 section with 2 trains.

Now the 4 sections with 3 trains each would require—

$$1,107 \times 4 = 4,428\text{kw.}$$

To allow for the maximum loss, let it be assumed that the centre 10-mile section, which, as previously indicated, might be supplied direct at 600 volts, is so deal with, and that it is the section that has two trains only.

The kilowatts required would equal—

$$\frac{1,390 \times 600}{1,000} \times \frac{2}{3} = 556\text{kw.}$$

Therefore the total kilowatts to be generated would be—

$$(4,428 + 556) = 4,984, \text{ say } 5,000,$$

and the combined efficiency $(2,905/4,984)$ would be 58·3 per cent.

This 5,000kw. is the power required to be generated to work the 14 trains, travelling 479 miles during the hour, as shown in Table V., and upon it all comparative calculations and deductions have to be based. The demand may, of course, go beyond this, or it may be less, but so long as the generating power, and that of the corresponding parts, is there to meet it, that branch of the question may be disregarded. As I have previously stated, the comparison is made between the ascertained quantities travelling a stated mileage at a stated speed. If the mileage were greater, or the number of trains greater, the comparison would be equally applicable. It is, in respect of the mileage result, immaterial, so long as we apply it to a fairly representative condition. The speed and the train load indicated in Table IV. will, I believe, bearing in mind that the number of trains are regarded as all carrying the full load indicated, be found to conform to this.

*(To be concluded.)*

## ELECTRICITY WORKS ACCOUNTS.

### Bolton Municipal Electric Supply Works.

In discussing the accounts of this undertaking for 1898-9 we had occasion to remark on the low fuel and repairs items. These charges were abnormally low, while the two remaining items of generating costs were distinctly above the normal. It is a good indication to find all these several items changing towards the average even if some of them have to take an upward course.

The high coal rates in force might fairly be held accountable for the amount by which the fuel item at Bolton for 1899-1900 is above the average, and for the slight rise exhibited by the generating costs. Taken as a whole, the costs figures in our table are excellent results, since not only have the works and total costs dropped but they compare most favourably with the average under similar conditions of output and load factor.

Owing, largely, to the addition of the Corporation tramways as a customer the output has advanced by no less than 98 per cent. Of this increase of 98 per cent., 61·2 per cent. is due to the tramways, and 36·8 per cent. to the increase in the supply for private and public lighting.

Since the tramways have only been running during a part of the period covered by the present accounts we shall have to wait until the accounts of the current year's working are available to know the full effect the traction load will have upon the station. It is but natural, therefore, that the average load factor for 1899-1900 at Bolton differs inappreciably from that of 1898-9, the respective values in the two years being 9·89 per cent. and 9·92 per cent.

Owing to the large increase in the expended capital the working profit, in relation to the average capital over the year, has fallen from 7·3 per cent. to 6·89 per cent.

### Burnley Municipal Electric Supply Works.

While there has occurred a decided increase in the aggregate generating, works, and total costs at Burnley, it is satisfactory to find that even the present higher figures are still much below what they might fairly have been expected to stand at under the conditions. The increase is chiefly due to a charge of £581 to "general stores" under generating charges, but not otherwise allocated in the official accounts. This charge represents about 0·4d. per unit sold. A most commendable reduction has been effected in the management and property charges, and now, like the other costs, they present most satisfactory figures.

Less encouraging is the rate at which the business advances. During the year covered by our table the lamp connections increased by only 11·8 per cent. The increase of the output is better, but even the advance of 27·4 per cent. is slow, while the load factor has dropped from 10·8 per cent., at which it stood in 1898-9, to 10·2 per cent. last year.

| | BOLTON. | | | | BURNLEY. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Bolton Corporation. | | | | Burnley Corporation. | | | |
| *Date of Commencement of Supply* | October 31, 1894. | | | | 1893. | | | |
| *System of Supply* | Alt. curr. transformer sub-stations, also house transformers. | | | | 3-wire continuous-current with batteries. | | | |
| *Chief Engineer* | Arthur Ellis. | | | | R. Birkett. | | | |
| **YEAR ENDED** | MAR. 31, **1899.** | | MAR. 31, **1900.** | | MAR. 31, **1899.** | | MAR. 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 560,375 | | 1,174,478 | | 355,735 | | 441,093 | |
| " SOLD (TOTAL) | 416,635 | | 824,792[c] | | 271,650 | | 345,199 | |
| " sold to consumers | 406,306 | | 814,406[c] | | 259,778 | | 332,970 | |
| " sold for public lighting, &c. | 10,329 | | 10,386 | | 11,872 | | 13,229 | |
| " used on works | 11,240 | | 89,883 | | 15,497 | | 24,152 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 13·3 | | 8·80 | | 28·6 | | 12·1 | |
| Maximum supply demanded | 481 kilowatts | | 950 kilowatts | | 288 kilowatts | | 387 kilowatts | |
| Number of public lamps | 5 arc, 5 (32 c.p.) glow | | 10 arc | | 3 arc, 12 (8 c.p.) glow | | 3 arc, 12 (16 c.p.) glow | |
| Number of consumers | 559 | | 751 | | 290 | | 317 | |
| Connections to mains in 8-c.p. lamps | 43,740 | | 56,705 | | 19,049 | | 21,195 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 31,300 | | 93,800 | | 9,500 | | 28,700 | |
| CAPACITY OF PLANT IN KILOWATTS | 1,000 | | 3,000 | | 304 | | 920 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | — | — | — | — | £63,570 | £209 | £63,570 | £69·1 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | — | — | — | — | 63,570 | 209 | 63,570 | 69·1 |
| RECEIVED (TOTAL) | £68,222 | £68·2 | £68,222 | £22·7 | 39,750 | 131 | 51,250 | 55·7 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 68,222 | 68·2 | 68,222 | 22·7 | 39,750 | 131 | 51,250 | 55·7 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | 23,820 | 78·4 | 12,320 | 13·4 |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | 23,820 | 78·4 | 12,320 | 13·4 |
| REPAID (TOTAL) | 5,660 | 5·66 | 7,672 | 2·55 | 3,318 | 10·9 | 4,317 | 4·69 |
| RESERVE OR SINKING FUND | — | — | — | — | — | — | 999 | 1·09 |
| DEPRECIATION FUND | — | — | — | — | 2,166 | 7·12 | 2,150[d] | 2·34 |
| EXPENDED (TOTAL) | 67,253 | 67·3 | 117,590 | 39·2 | 40,620 | 134 | 51,057 | 55·5 |
| Lands and buildings | 45,353 | 45·4 | 25,267 | 8·42 | 13,676 | 45 | 14,366 | 15·6 |
| Plant | | | 65,869 | 21·9 | 15,544 | 51·1 | 19,942 | 21·7 |
| Mains | 21,894 | 21·9 | 26,453 | 8·8 | 10,194 | 33·5 | 15,543 | 16·9 |
| Miscellaneous | — | — | — | — | 1,206 | 3·97 | 1,206 | 1·31 |
| BALANCE OF CAPITAL ACCOUNT | + 969 | 0·97 | − 49,368[f] | − 16·5 | − 87[a] | − 2·86 | + 193 | 0·21 |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
| TOTAL | £7,928 | 4·568d. | £12,088 | 3·520d. | £4,580 | 4·048d. | £5,906 | 4·094d. |
| Revenue from supply | 6,973 | 4·016d. | 11,081[g] | 3·225d. | 4,384 | 3·876d. | 5,156 | 3·573d. |
| " meters, &c. | 219 | 0·126d. | 296 | 0·086d. | 124 | 0·110d. | 146 | 0·101d. |
| " public lighting | — | — | — | — | — | — | 95 | 0·066d. |
| " sale of lamps, &c. | 736 | 0·424d. | 710 | 0·207d. | — | — | 509 | 0·353d. |
| " miscellaneous sources | — | | — | | 72 | 0·064d. | — | — |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £3,393 | 1·954d. | £6,185 | 1·800d. | £1,973 | 1·744d. | £2,990 | 2·073d. |
| WORKS COSTS | 2,461 | 1·418d. | 4,852 | 1·411d. | 1,140 | 1·008d. | 2,067 | 1·426d. |
| *Generation of electricity* | [illegible] | *1·377d.* | *4,845* | *1·410d.* | *988* | *0·873d.* | *2,011[e]* | *1·395d.* |
| Fuel (including cartage, &c.) | 838 | 0·483d. | 2,695 | 0·785d. | 340 | 0·301d. | 510 | 0·354d. |
| Oil, waste, water, stores | 348 | 0·201d. | 400 | 0·116d. | 129 | 0·114d. | 146 | 0·101d. |
| Wages at station | 1,086 | 0·626d. | 1,377 | 0·401d. | 458 | 0·405d. | 541 | 0·375d. |
| Repairs and maintenance at station | 118 | 0·068d. | 373 | 0·109d. | 61 | 0·054d. | 231 | 0·162d. |
| *Distribution of electricity* | *71* | *0·041d.* | *7* | *0·002d.* | *144* | *0·127d.* | *37* | *0·026d.* |
| Wages, &c. | nil | | 7 | 0·002d. | 144 | 0·127d. | 37 | 0·026d. |
| Repairs, renewals of mains, &c. | 71 | 0·041d. | | | | | | |
| *Public lighting* | — | — | — | — | *8* | *0·007d.* | *9* | *0·006d.* |
| Attendance | — | — | — | — | 8 | 0·007d. | 9 | 0·006d. |
| Renewals | — | — | — | — | | | | |
| MANAGEMENT AND PROPERTY CHARGES | 932 | 0·537d. | 1,332 | 0·388d. | 832 | 0·733 | 934 | 0·648d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | *0·143d.* | *417* | *0·121d.* | *353* | *0·312d.* | *377* | *0·261d.* |
| *Management* | *682* | *0·393d.* | *915* | *0·266d.* | *479* | *0·423d.* | *557* | *0·386d.* |
| Salaries | 400 | 0·230d. | 610 | 0·178d. | 347 | 0·307d. | 415 | 0·288d. |
| Stationery, &c. | 83 | 0·048d. | 106 | 0·031d. | 38 | 0·034d. | 40 | 0·028d. |
| Establishment charges | 119 | 0·069d. | 57 | 0·017d. | 94 | 0·083d. | 102 | 0·071d. |
| Law charges, &c. | 80[a] | 0·046d. | 142[h] | 0·041d. | — | — | | |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £4,536 | 7·3% | £5,903 | 6·39% | £2,607 | 7·51% | £2,916 | 6·36 |
| Sum carried to Depreciation Fund | — | — | — | — | 1,238 | 3·56 | 779 | 1·70 |
| Sum carried to Reserve or Sinking Fund | 1,732 | 2·79% | 2,012 | 2·18% | 603 | 1·74% | 999 | 2·18% |
| Net interest on loans (incl. Debenture charges) | 1,599 | 2·57% | 2,440 | 2·64% | 765 | 2·21% | 1,138 | 2·48 |
| BALANCE FROM LAST ACCOUNT | 307 | 0·494% | 512 | 0·554% | — | — | — | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 1,512 | 2·43% | 1,963 | 2·12% | — | — | — | — |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | — | — | — | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 42·8% | | 51·1% | | 43·1% | | 50·7% | |
| Expenditure per kilowatt capacity | £3. 7s. 10d. | | £2. 1s. 3d. | | £6. 9s. 10d. | | £3. 5s. 0d. | |
| REVENUE PER KILOWATT CAPACITY | £7. 18s. 7d. | | £4. 0s. 7d. | | £15. 1s. 2d. | | £6. 8s. 5d. | |
| Expenditure per 8-c.p. lamp capacity | 2s. 2d. | | 1s. 2½d. | | 4s. 1½d. | | 2s. 1d. | |
| REVENUE PER 8 C.P. LAMP CAPACITY | 5s. 0½d. | | 2s. 7d. | | 9s. 7½d. | | 4s. 1½d. | |
| REVENUE PER 8 C.P. LAMP CONNECTED | 3s. 7½d. | | 4s. 3½d. | | 4s. 9½d. | | 5s. 6½d. | |
| Price charged for lighting, per unit | 6d. to 3d.[b] | | 6d. to 3d.[d] | | 6d.[b] | | 6d.[b] | |
| Price charged for power, per unit | | | 5d. to 1d.[e] | | 6d.[b] | | 2d. and 3d. | |
| Price charged for public lighting | | | 6d. to 3d.[d] | | 3d. per unit | | 3d. per unit | |

BOLTON.—REMARKS.—a Includes deputation expenses £[illegible] and insurance £28. b On maximum demand system with one-hour scale, less 10 per cent. discount. c Inclusive of [illegible] units to tramways. d On maximum demand system with one-hour scale, or at a flat [illegible] price of [illegible]; charges under both systems subject to 10 per cent. discount. e On maximum demand system, being [illegible] per unit for the equivalent of 80 hours' consumption at the rate of the maximum demand during the quarter. This charge applies only to motors of [illegible] and over; for motors [illegible] and not less than [illegible] the charge is [illegible] per unit; for motors of [illegible] and under the charge is the same as for lighting. All the above charges are subject to 10 per cent. discount. f Over expended. g Includes revenue for public lighting and £[illegible] for current supplied to tramways. h Includes insurance £[illegible] and Provisional Order charges, £[illegible].

BURNLEY.—REMARKS.—a Over expended. b Or a charge of 2d. per unit, plus [illegible] per kilowatt of maximum demand. [illegible] Includes £[illegible] to General Stores. d £[illegible] has been taken from this fund for defraying cost of change of pressure.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861–1878).

Published every Friday, Price Sixpence; Post Free, Sixpence Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## TELEGRAPHIC AND TELEPHONIC PROGRESS.

MR. GAVEY's review of the telegraphic and telephonic features of the Paris Exhibition, in the Paper he read last week at the Institution of Electrical Engineers, has awakened considerable interest, and constitutes more or less a summary of recent progress in telegraphy and telephony and of the present position of these two branches of electrical engineering. So far as telegraphy is concerned, the actual position is somewhat disappointing. The science of telegraphy may now be deemed fairly old, but there is no reason to think that our knowledge of means of communicating messages over distances is approaching finality. In fact, few other applications of science are so pregnant of possibilities for future development. Assuming the etymological and not the judicial meaning of the word telegraph, the majority of telegraphic messages are still transmitted in the Morse code. Although it is many years since HUGHES perfected his ingenious type-printing instrument, and although this has been adopted to a greater or less extent by some of the Continental governments, practically all the inland messages in Great Britain and all the messages transmitted to great distances through submarine cables still depend on the Morse code. The problem of devising a cheap type-printing instrument which can be worked at rapid speeds and whose action is hindered as little as possible by the inductance and capacity of the line has been before telegraph engineers almost since the birth of electric telegraphy, but we are only approaching very slowly a partial solution of it. Type-printing telegraphs working faster than the Hughes have always been still more complicated, and simpler instruments than the Hughes have not attained its speed. The principle of the Rowland system, which affords the equivalent of very high speeds by being a multiplex system, was most lucidly explained by Mr. GAVEY, although he was deprived of the assistance of a diagram; but the actual instrument is a thing of awe-inspiring complexity. We believe we are not far from the mark in saying that each Mercardier set is equipped with 50 or 60 relays. The new Pollák-Virág writing telegraph is perhaps more promising, combining as it does the principle of the Wheatstone automatic system with that of a writing

telegraph, but it labours under the disadvantage at present of a photographic recording process, and so far it is also fairly complicated and requires delicate adjustment. Mr. GAVEY's prophecy that we are within measurable distance of seeing an instrument that will produce a written or printed record, ready for sending out without even the assistance of paste, is encouraging, however, especially as in the tone he gave effect to it, one could almost discern a promise. Assuming that a column-printing telegraph of a practical form is soon to be made suitable for ordinary land-line and short submarine work, let us hope that telegraph engineers will not forget to seek a solution of the same problem applied to long cables. First, however, a faster speed of Morse signalling through cables will have to be attained. Another problem is the better utilisation of capital spent on conductors, as it does not appear probable that we shall be able, for many years at all events, to dispense with these adjuncts to telegraphy. Multiplex telegraphy can, perhaps, be carried a little further than it is now, although here again improvement means a greater elaboration of delicate appliances, but possibly there is room for a well worked out system of duplexing or multiplexing ordinary lines for a sudden emergency or unexpected rush of traffic. No doubt relays could be made more delicate than those at present in use, but especially in view of the spread of electric traction it is doubtful whether this aid to diminishing the size of conductors would be advantageous.

Sir WILLIAM PREECE's remarks about wireless telegraphy were all too true. So long ago as September 22, 1896, at the Liverpool meeting of the British Association, Sir WILLIAM himself made the first public announcement of Mr. MARCONI's invention, and yet now, more than four years later, he feels compelled to ask: "Where is there at present a single circuit worked commercially on a practical system of wireles telegraphy?" It must be remembered however that, even if not a commercial success, wireless telegraphy has been developed usefully for naval purposes, and there is little doubt that it has a future before it in naval and military signalling, for coast communications, and similar applications, even though the wholesale displacement of telegraph wires and submarine cables is little more than a dream.

We now come to telephony. Here there has been undoubted progress, and progress at a rapid rate. Had Mr. GAVEY seen fit to comply with Mr. ROBERTS' request, and described the progress made since 1878, he would have had to give almost the whole history of telephony, for BELL's invention only dates from 1876. During the last few years, also, improvement has been following improvement, not so much in the telephone instruments themselves, which are still wonderfully similar to the original Bell and Edison patterns, as in the methods of inter-communication. The old "Umschalter" board was displaced by the multiple board, and almost as quickly the "branching multiple" has followed the "series multiple," and the branching board, with its self-restoring indicators, is now being improved out of recognition by the employment of luminous signals and the adoption (whether permanently or tentatively we leave Mr. GAVEY, Mr. SINCLAIR and Mr. KINGSBURY to settle between them) of the central-battery system. One thing gives occasion for thought in view of the undoubted progress in our methods of telephonic communication. Telephony, although no longer in its infancy, has only just passed its majority, and yet for years we have been troubled with complaints as to the insufficiency and even the inefficiency of the service. Twenty-five years ago a man who predicted that, by means of an instrument on his writing table, he would be able to converse with a friend several miles distant, in his own voice, would have been set down as a madman. Six or eight years later subscribers to telephone exchanges were already complaining that at times speech through their instruments was not always clear, that "cross talk" sometimes occurred, as well as occasional delays in effecting communication, and that the service was too costly. The rapid improvements in exchange equipment and the introduction of underground cables of wires, with low capacity and negligible mutual induction, have mitigated these evils from year to year, but the telephone still remains as it always has been the most abused and the most significant emblem of our modern civilisation.

Mr. GAVEY and other members of the Institution who spoke at the meeting last week were greatly impressed with the scientific beauty and practical possibilities of the Poulsen recording telephone—termed by different speakers microphonograph, telephonograph, and telegraphone—and Mr. SINCLAIR referred to the absence of enthusiasm with which its advent was greeted in our columns. The days at which this instrument was at work at the exhibition were unfortunately not many, and the form of the instrument was decidedly a laboratory one. As a scientific experiment the Poulsen recording telephone (a detailed description of which, from Herr POULSEN's own pen, is published in this issue) is as conclusive as it is brilliant, and we are gratified to hear the accounts of its perfect articulation and freedom from intrusive noises. But up to the present it is still an undeveloped scientific experiment, and great modifications will have to be made in it before it can become a practical instrument to replace the office boy in connection with subscribers' telephone instruments. It is significant, moreover, that both Mr. GAVEY and Mr. SINCLAIR, the engineers representing the two great competing telephone interests in this country, should have been more impressed with the possibilities of Herr POULSEN's invention as a forerunner of the much-desired telephone relay than as a practical recording telephone, into which it is primarily intended to develop it. Mr. GAVEY indicated in a few words and a sketch on the blackboard the means in which the Poulsen principle might possibly be developed in the relay, and Herr POULSEN himself refers to this application. Here, however, they are more or less in the realms of speculation, and we almost expected at the meeting that Prof. PERRY would have risen from his presidential chair and dissipated Mr. GAVEY's hopes with a simple application of the calculus.

One more side of the question may be alluded to in considering progress in telephony, and that is the question of administration. In Great Britain we have instruments and examples of exchange equipments and underground work second to none. The German telephone administration has only recently commenced introducing transmitters and receivers of most modern types, and is still cursed with the single-wire, earth-return system in nearly all its telephone districts. The French department, although it has from the start enjoyed underground cables and metallic returns, has a switchboard at its central exchange of by no means up-to-date design; and even in the call offices at the exhibition itself carbon-pencil transmitters were in use. But Great Britain, in spite of its technical superiority, is still behind. The cause is not far to seek: it is the "triangular duel" between the Post Office, the Local Authorities, and the National Telephone Co. referred to by Sir WILLIAM PREECE. We have consistently advocated one policy, and we say, with Sir WILLIAM PREECE: "If there is a business in this world that ought to be manipulated and managed by one administration and by one concern, and conducted on one principle, it is the business of telephony."

## ELECTROMAGNETIC THEORY.—CXX.*

BY OLIVER HEAVISIDE.

(*Continued from page 44*).

§ 479. The motion of electrified hyperboloids comes under the theory of a moving electron merely because the equipotential surfaces inside the conical wave are hyperboloids of revolution. As the essential mathematics has been given, only some special points need be noticed here. Fig. 26 will serve to illustrate, only changing its meaning. The electron is now to be at the apex. The outer cone is the wave front. The two internal cones are sheets of electric force. The two hyperboloids are equipotential. The equations are, by § 468,

$$V = \frac{Q \tan\theta}{2\pi c l}, \qquad \mathbf{E} = -\frac{\mathbf{r} Q \tan\theta}{2\pi c l^3}, \qquad \mathbf{H} = \mathrm{V}\mathbf{u}\mathbf{D}, \tag{1}$$

where $l$ is given by

$$l^2 = z^2 \tan^2\theta - y^2. \tag{2}$$

The apex is the origin, $z$ being measured to the right, and $y$ upwards on the paper, whilst $\mathbf{r}$ is the vector from the origin.

Consider the inner hyperboloid. Abolish **E** and **H** outside it. It then becomes an electrified hyperboloid moving parallel to its axis. Its field of force is internal, and is given by the

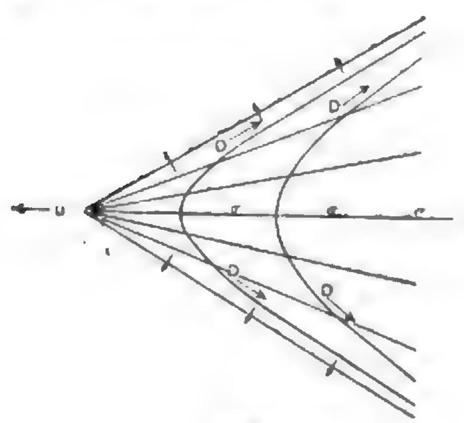


FIG. 26.

above formulæ. **E** is directed everywhere towards a certain external point, the apex of the asymptotic cone. The electrification is negative, surface density **ND**, if **N** is the inward normal. By differentiating (2), remembering that $l$ is constant for the hyperboloid, we find

$$\mathbf{N} = \frac{z \tan^2\theta - y}{(y^2 + z^2 \tan^4\theta)^{\frac{1}{2}}}; \tag{3}$$

therefore, by the formula for **E**, we get

$$\mathbf{ND} = -\frac{Q \tan\theta}{2\pi l (y^2 + z^2 \tan^4\theta)^{\frac{1}{2}}}. \tag{4}$$

The total electrification on the hyperboloid is infinite, because if $ds$ is an element of the curve in the plane of the paper,

$$2\pi y \frac{ds}{dz} = 2\pi y \frac{(y^2 + z^2 \tan^4\theta)^{\frac{1}{2}}}{y}, \tag{5}$$

which makes

$$\iint \mathbf{ND}\, dS = \frac{Q \tan\theta}{l} \int dz, \tag{6}$$

so that the total electrification on the hyperboloid is proportional to the distance from its vertex.

The moving force per unit of electrification is $\mathbf{E} + \mathrm{V}\mathbf{u}\mathbf{B}$, or

$$\mathbf{E} + \frac{\mathrm{V}\mathbf{u}\mathrm{V}\mathbf{u}\mathbf{E}}{v^2} = \left(1 - \frac{u^2}{v^2}\right)\mathbf{E}_2 + \mathbf{E}_3,$$

$$= -\mathbf{E}_2 \cot^2\theta + \mathbf{E}_3 = -\frac{Q \cot\theta}{2\pi c l^3}(\mathbf{z} \tan^2\theta - \mathbf{y}); \tag{7}$$

of which the tensor is

$$\frac{Q \cot\theta}{2\pi c l^3}(y^2 + z^2 \tan^4\theta)^{\frac{1}{2}}. \tag{8}$$

So, by (4) and (8),

$$\mathbf{ND}(\mathbf{E} + \mathrm{V}\mathbf{u}\mathbf{B}) = \frac{1}{c}\left(\frac{Q}{2\pi l^2}\right)^2. \tag{9}$$

This is constant all over the hyperboloid. It is somewhat remarkable that the normal pull of the electromagnetic field upon the electrification should be everywhere of the same intensity. As in previous cases, applied force in the direction of motion is required to maintain it. The question arises whether the force may be of finite total in this case. It is unlikely to be so, on account of the association of the theory with that of a point charge, but as there are no places of infinite **E** and **H** now, it is worth looking to see. We have

$$\cos \widehat{\mathbf{z}\mathbf{N}} = \frac{z \tan^2\theta}{(y^2 + z^2 \tan^4\theta)^{\frac{1}{2}}}, \qquad \cos \widehat{\mathbf{z}\, ds} = -\frac{y}{(y^2 + z^2 \tan^4\theta)^{\frac{1}{2}}}, \tag{10}$$

and therefore

$$2\pi y \cos \widehat{\mathbf{z}\mathbf{N}} \frac{ds}{dz} = 2\pi y \frac{\cos \widehat{\mathbf{z}\mathbf{N}}}{\cos \widehat{\mathbf{z}\, ds}} = 2\pi z \tan^2\theta; \tag{11}$$

consequently the total moving force in the direction of motion is

$$\frac{1}{c}\left(\frac{Q}{2\pi l^2}\right)^2 \int 2\pi z \tan^2\theta \,.\, dz, \tag{12}$$

where the lower limit is finite, and the upper infinity. The total for the complete hyperboloid is therefore infinite.

Now look at Fig. 26 again. If we extend the electric field until it reaches the outer hyperboloid, we shift the electrification to it, and the same theory applies, with a different value given to $l$. Next, abolish the **E** and **H** inside the inner hyperboloid. We then have two charged hyperboloids moving along together, the inner one being positively, and the outer one negatively electrified. The electromagnetic field exerts the normal traction given by (9) on both hyperboloids. The outer surface is pulled back, the inner one forward. The necessary applied forces required to maintain the motion are with the motion on the outer surface and against it on the inner.

If the direction of motion is reversed, without changing **E**, the effect is merely to reverse **H**. The moving forces remain the same.

§ 480. In considering (§ 468) the waves sent out from a growing plane source of induction, two distinct cases arose, according as the speed of growth was less or greater than that of light. The question of the transition from the one case to the other presents itself: whether there is any difficulty in the intermediate case of equal speeds, and what is the state of affairs in the cylindrical cap which completes the diverging plane waves generated when the speed of growth exceeds that of light.

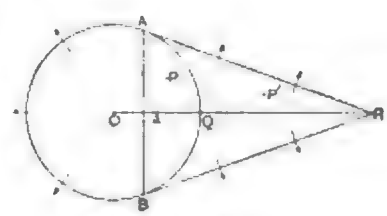


FIG. 34.

One figure will serve for both cases in connecting the two solutions. The circle is of radius $vt$. Its centre is the place where the f source began, say at the moment $t = 0$. When $u < v$, the circle (section of cylinder) is the wave front, and the region occupied by the source extends from the centre to some distance less than $vt$, say to $a$, when $u = \frac{1}{2}v$. Then any point P within the circle receives induction not from the existent source between O and $a$, but between O and some point not so far as $a$, except at $a$ itself. If P is on the circle itself it is only just beginning to receive induction, namely, from O. The intensity of **H** is greater in the right than in the left semicircle, because of the source being to the right of O. The formula for **H** is (29), § 468. Put $t_2 = 0$, and

give $\tau_2$ the value there determined. The result may be written in the form

$$H = \frac{f}{2\pi\mu v(v^2-u^2)^{\frac{1}{2}}} \log\left(\frac{1+\lambda}{1-\lambda}\right)^{\frac{1}{2}}, \tag{1}$$

where $\lambda$ is given by

$$\lambda = \frac{(v^2-u^2)^{\frac{1}{2}}(v^2t^2-z^2-y^2)^{\frac{1}{2}}}{v^2t-uz}. \tag{2}$$

Here $z$ is measured from O to the right, and $y$ upward on the paper. Note that the denominator in $\lambda$ cannot vanish, provided we keep inside the circle of disturbance, so that $\lambda$ is real positive and $< 1$.

In the limiting case $u = v$, the solution reduces to

$$H = \frac{f}{2\pi\mu v}\frac{(v^2t^2-z^2-y^2)^{\frac{1}{2}}}{vt-z}. \tag{3}$$

The $f$ source now extends from O to Q. The magnetic force is still zero on the circle, save at the point Q, where it is $f/2\pi\mu v$.

Increasing $u$ above $v$, the wedge begins at Q, with sides tangential to the cylinder. In the case shown, $u = 3v$, so that R is the extreme limit of the source at time $t$. We cannot expect the formula (1) to be valid outside the circle when taken literally. But it may be suitably interpreted. It is equivalent to

$$H = \frac{fu}{2\pi\mu v}\frac{1}{(u^2-v^2)^{\frac{1}{2}}}\tan^{-1}\frac{(u^2-v^2)^{\frac{1}{2}}(v^2t^2-y^2-z^2)^{\frac{1}{2}}}{v^2t-uz}, \tag{4}$$

and when $u > v$, the vanishing of the denominator separates the circle into two regions, to right and left of the chord AB. On the left side, the angle $\tan^{-1}$... increases from O on the circular boundary to $\frac{1}{2}\pi$ on the chord. On the right side it increases from $\frac{1}{2}\pi$ on the chord to $\pi$ on the remainder of the circle. That is

$$H = \frac{fu}{2\mu v(u^2-v^2)^{\frac{1}{2}}}, \tag{5}$$

on the cylindrical boundary on the right side, one-half this value on the plane AB, and zero on the remainder of the cylindrical boundary.

Now the last formula shows the constant value of H inside the wedge as found by a different kind of integration, §468, suitable for the case $u > v$. See Fig. 30, §468, indicating the limits of integration when the point P is shifted outside the circle, say to P′. So, by using the formula appropriate to the $u < v$ case, the extension to $u > v$ requires us to keep H at the circular boundary value, and continue it up to the plane wave fronts.

We must next show that the complete integral in the $u > v$ case passes properly into the above form when we leave the region of constant H and enter the circle. This can be done. Thus, by (31), §468,

$$H = \frac{fu}{2\pi\mu v}\frac{1}{(u^2-v^2)^{\frac{1}{2}}}\int\frac{-d\tau}{(\beta^2-\tau^2)^{\frac{1}{2}}}$$

$$= \frac{fu}{2\pi\mu v}\frac{1}{(u^2-v^2)^{\frac{1}{2}}}\left[-\sin^{-1}\frac{\tau}{\beta}\right]; \tag{6}$$

where
$$\beta = \left\{\left(\frac{v^2t-uz}{u^2-v^2}\right)^2 + \frac{v^2t^2-y^2-z^2}{u^2-v^2}\right\}^{\frac{1}{2}}, \tag{7}$$

and
$$\tau = \frac{v^2t-uz}{v^2-u^2} - t_0. \tag{8}$$

At the limits, when complete,

$$t_0 = \frac{v^2t-uz}{v^2-u^2} \pm \beta, \tag{9}$$

using the + sign with the larger value of $t_0$, which indicates two values of the time variable. So the $\tau$ limits are $\mp\beta$, which used in (6), produce the preceding result (5). But this is only true provided the lower $t_0$ limit does not pass the centre of the circle, because the source does not exist on the left of O. But when P is shifted to the circle, the lower $t_0$ limit is sent down to zero. After that, when P′ is shifted inside the circle, the lower limit for $t_0$ must remain zero. Therefore, applying this to (6), by (8) we get

$$H = \frac{fu}{2\pi\mu v(u^2-v^2)^{\frac{1}{2}}}\left[-\sin^{-1}\frac{\tau}{\beta}\right]_{\frac{v^2t-uz}{v^2-u^2}}^{-\beta} \tag{10}$$

That is,

$$H = \frac{fu}{2\pi\mu v(u^2-v^2)^{\frac{1}{2}}}\left\{\frac{\pi}{2} - \sin^{-1}\frac{v^2t-uz}{(u^2-v^2)\beta}\right\}. \tag{11}$$

This gives the full value (5) on the right portion of the circular boundary, half this value on the line AB, and zero on the left circular boundary. Just as before, in fact. So formula (11) should mean the same as (4). This is the case, for they are mutually transformable. But pay proper attention to the sign of $v^2t - uz$. Otherwise these inverse circular functions are treacherous. The radical must be kept to its + value always.

We have therefore a complete harmony. We can pass only suggestively from the $u < v$ to the $u > v$ case. But the latter is more comprehensive, and we can include in it both cases. We have then two forms of solution, one outside, the other inside the circle; and if $v$ is made less than $u$, the outside solution disappears and leaves the inside one alone.

Now go on further. When the source has reached R, stop its further extension, and see what happens. The former state of things will continue, but with an exactly similar negative state superposed, with origin at R instead of at O. After a little while therefore, we shall have things as in Fig. 35.

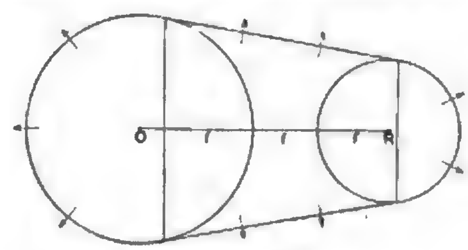


FIG. 35.

The plane source extends from O to R, beginning at O at time $t = 0$. Inside the left circle the value of H is given by (11). Between the two circles and between the tangent lines it has the constant value (5), this being the region of the plane waves. In the right circle, the formula for H is like (11), with suitable change of origin, and time reckoning. H falls from the full value to half value in passing to the vertical chord, and then to zero on the right circular boundary. As time goes on the circles overlap, and the region of constant H and E disappears.

If we increase $u$ to infinity, we obtain the result due to the immediate starting (all over at the same moment) of the plane strip of $f$ extending from O to R. Fig. 32 suits this case excellently.

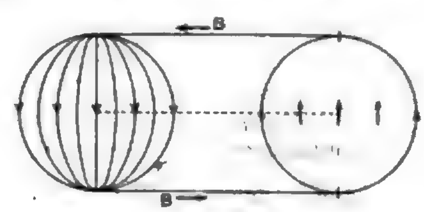


FIG. 32.

We have $H = f/2\mu v$ between the two circles, and in the left circle it is given by

$$H = \frac{f}{2\pi\mu v}\left\{\frac{\pi}{2} + \sin^{-1}\frac{z}{(v^2t^2-y^2)^{\frac{1}{2}}}\right\}. \tag{12}$$

This is derived from (11) by making $u = \infty$. But it may, of course, be obtained from the reduced form of the integral leading to (11). H falls to half the constant value on the vertical diameter, and then to zero on the left semicircle. Similarly in the right circle.

It may be asked what the semi-elliptic lines now represent. In a previous problem, §478, they were the lines of the induction entering at the top and leaving at the bottom, their continuations being plane sheets of induction. But in the present case the plane sheets are sheets of electric current. Does the current divide over the circles in the same way in

the present problem? Yes, just the same. The $y$ and $z$ components of the current, say $C_2$ and $C_3$, are

$$C_2 = \frac{dH}{dz}, \qquad C_3 = -\frac{dH}{dy} \tag{13}$$

that is, the rate of increase of H along any line in the plane measures the transverse current density from right to left across the line. To fix ideas, x is downward through the paper, y upward on the paper, and z to the right. Origin at centre of left circle. So, if f is down through the paper, so is H all over, whilst E is from left to right above f, and from right to left below it, between the circles. The electric current, therefore, enters at the bottom and leaves at the top of the left circle. Using (13), applied to (12), we have

$$C_2 = \frac{f}{2\pi\mu v}\frac{1}{(v^2t^2 - r^2)^{\frac{1}{2}}}, \qquad C_3 = \frac{f}{2\pi\mu v}\frac{-yz}{(v^2t^2 - y^2)(v^2t^2 - r^2)^{\frac{1}{2}}}, \tag{14}$$

where $r^2 = y^2 + z^2$.

Now the displacement $c$E is the time integral of the current. Outside the circles this means simply first $E_3 = 0$, until $vt = y$, and then $E_3 = \pm\frac{1}{2}f$, from $vt = y$ until $vt = r$. At this moment the circle $vt$ reaches the point, and later still the time integrals of (14) must be added on. Thus,

$$E_2 = \frac{1}{c}\int C_2 dt = \frac{f}{2\pi}\Big[\log\{vt + (v^2t^2 - r^2)^{\frac{1}{2}}\}\Big]^{vt}_{r}$$
$$= \frac{f}{2\pi}\log\frac{vt + (v^2t^2 - r^2)^{\frac{1}{2}}}{r}. \tag{15}$$

This is the complete formula for the upward component of the electric force in the circle.

As regards the other, we have by differentiation,

$$\frac{d}{d(vt)}\sin^{-1}\frac{vtz}{r(v^2t^2 - y^2)^{\frac{1}{2}}} = -\frac{z\sqrt{y^2}}{(v^2t^2 - y^2)(v^2t^2 - r^2)^{\frac{1}{2}}}. \tag{16}$$

Particularly attend to the $\sqrt{y^2}$. If it is written $y$, everything will go wrong in the subsequent work, and the displacement will not be continuous in the circle. Having found this out by troublesome experience, it follows that in integrating (14), which has the numerator $-yz$, we, of course, use the left member of (16) when $y$ is +, but must change its sign when $y$ is −.

The final results are

$$E_3 = \pm\frac{f}{2\pi}\left(\frac{\pi}{2} + \sin^{-1}\frac{vtz}{r(v^2t^2 - y^2)^{\frac{1}{2}}}\right) \tag{17}$$

inside the left circle, using the + or − sign according as $y$ is + or −, that is above or below the plane of the source of induction. The initial displacement due to the plane waves, already referred to, is included in (17). The two equations (15) and (17) give a complete account of how the two oppositely directed uniform horizontal displacements above and below the plane of f are joined together through the terminal circles. The nature of a line of E differs according to whether it strikes the f plane in the cylinder or goes round its extremity in the outer part of the cylinder. If it goes round it does so in a continuous curve which is naturally vertical across the continuation of the f plane. This applies to the outer lines of force. But the inner ones strike the f plane sideways above and below it, in the right part of the left circle and in the left part of the right circle, so as to produce closed lines of displacement possessing a pair of convex cusps.

*(To be continued.)*

**Heavy Motor Traffic in France.**—A meeting of the Liverpool Self-Propelled Traffic Association has been arranged for the evening of December 3rd, when an address on "Heavy Motor Traffic in France" will be delivered by M. G. Forestier, Inspector of Roads and Bridges in France. The address, which will be delivered at the Royal Institution, Liverpool, will be illustrated by lantern and cinematograph views. In connection with the visit of M. Forestier, the Lord Mayor of Liverpool will give a luncheon at the Town Hall on the 4th prox.

## THE TELEGRAPHONE: A MAGNETIC SPEECH-RECORDER.

BY VALDEMAR POULSEN.

The following is a description of the principles and the arrangement of my invention, which I have called the telegraphone. A steel wire (piano wire) AB, about 1·5m. (5ft.) long and 0·5mm. ($\frac{1}{50}$in.) in diameter is stretched on a board (Fig. 1). Along it can slide the electromagnet E, which embraces it with one of the poles (Fig. 2). The core of the electromagnet is a piece of soft iron wire about 8mm. ($\frac{1}{3}$in.) long and 0·75mm. ($\frac{1}{34}$in.) in diameter, and the electromagnet itself is in series with a battery and a microphone, or is connected to a transformer in the microphone circuit. At the beginning of an experiment the wire should be completely unmagnetised.

If, while the electromagnet is sliding along the wire with a velocity of about 1m. per second, the microphone is spoken into, the current fluctuations produced register themselves by means of the electromagnet on the steel wire. If now the electromagnet is connected up with a telephone and made to travel over the wire again, the telephone repeats what was spoken into the microphone. Thus, owing to the great coercive strength of steel, there has been impressed on the wire in undulations, so to speak, of magnetisation, a kind of writing which is permanent, and faithfully records the articulations of the voice. When E is put, now, in direct connection with a moderately strong battery and is made to pass once more over the wire the magnetic writing is obliterated under the influence of the constant magnetising force, which is great compared with the intensity of the writing magnetic forces.

FIG. 1.

The wire AB is too short to contain many words. In order to obtain a larger capacity a very long piano wire is wound very firmly round a drum having a fine spiral groove on its surface, and the piano wire follows this spiral groove. Parallel with the axis of the drum there is a rod upon which a kind of sleeve can slide. The electromagnet is fastened to this sleeve. When the apparatus is in operation, the electromagnet embraces with one of its poles, or with both, the steel wire (Fig. 3), and during the rotation this steel wire itself pushes the electromagnet and the sleeve along the rod. It is very easy to handle a drum of this kind, and the whole arrangement is very convenient for experiments. Of course, it must be borne in mind that in the various telephonic and telegraphic applications of the telegraphonic principle there are certain conditions which must be fulfilled. The nature, dimensions, and cost of the writing basis, and the velocity, the construction of the electromagnet and the magnitude of the current must all be considered. Without going into details here I only beg to direct the attention upon some essential points concerning the three proceedings—viz., the inscription, the reproduction, and the obliteration.

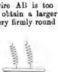


FIG. 2.

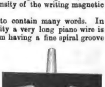


FIG. 3.

Most frequently the inscription is effected by means of a polarised electromagnet; but the polarisation and the degree of the polarisation must not be arbitrary. Let, for instance, the electromagnet, by means of which the writing is to be performed, obliterate a prior magnetic record and also simultaneously magnetise the writing basis. Then, during the inscription the electromagnet is given the polarisation opposed to that which it had during the obliteration. In this way a lively movement of the molecular magnets is obtained at the very moment of forming the writing. The susceptibility seems to increase very much in that magnetic *status nascendi*, and every shade of the writing becomes extremely perceptible. Ordinarily the polarisation of the writing magnet is only a very small fraction of that of the

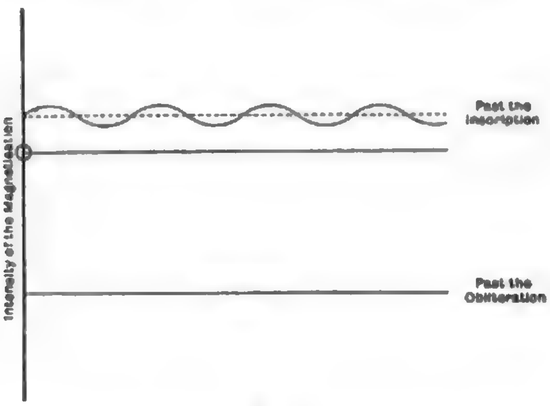


FIG. 4.

obliterating one. The nearer its polarisation approaches to the neutralisation of that of the writing basis, however, the feebler may be, of course, the polarisation of the obliterating magnet. The coercive force determines the degree of polarisation which exactly neutralises the magnetisation of the writing basis. It is found that the writing is somewhat weak when the polarisation of the electromagnet during the process of inscription is just equal to that used in the preceding obliteration. In order to polarise the electromagnet a constant current or a permanent magnet may be used.

If the positive and negative curves of an alternating current differ, their faculty of producing the writing may equally differ. This explains the peculiarity that the direction of the primary current with a certain polarisation of

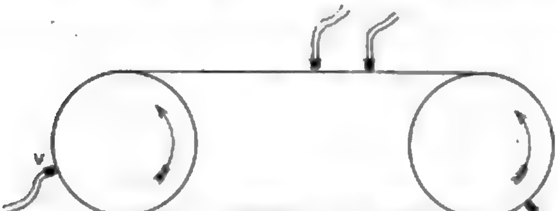


FIG. 5.

the writing basis may sometimes influence the writing which, in the secondary circuit, is performed by an unpolarised electromagnet. This is owing to the lack of uniformity in the manner in which the resistance of the microphone is increasing and diminishing. The inequality here spoken of is perhaps the more considerable the more the mobility of the carbon granules is considerable.

It seems that a speech (or a song) inscribed on the wire may be reproduced indefinitely without any perceptible diminution in clearness, the tone of the voice remaining perfectly distinct. Even when the apparatus is as primitive as that of Fig. 1, the reproduced voice is distinguished by the highest clearness and purity, and free from disturbing accompanying noises. The telegraphones of more recent date are able to reproduce with the greatest exactitude not only words spoken or sung into the microphone, but also whispers and even the feeble sounds of respiration.

The writing is completely obliterated by passage through a magnetic field of sufficient strength. Ordinarily it is sufficient to let the writing basis pass the writing magnet or another small electromagnet energised by a current from two or three cells. If a speech, however, be inscribed by means of an unpolarised magnet on a writing basis already written upon, there results, as a rule, not an obliteration, but an interference.

Besides common piano wires, steel ribbons and nickel wires have been used as writing bases. The dimensions of the steel ribbons were 3mm. × 0·105mm. ($\frac{1}{8}$in. × $\frac{1}{250}$in.). The steel ribbon passes from a roll to a second receiving roll, where the layers of the ribbon may cover each other without the writing being destroyed. As to this last point, it has been proved by experience that the magnetism does traverse the ribbon, though, as a rule, there is sufficient air space between consecutive layers to afford nearly complete protection. With a speed of about 1m. (3ft.) per second, 0·154 litre ($\frac{1}{25}$ cub. ft.) of steel is needed for a speech lasting an hour. Instead of ribbon, a fine piano wire unrolling from one place to another may be used. In some cases nickel may with perfectly good effect be used as a writing basis, which fact is in accordance with the known properties of this metal as regards permanence for weak magnetisations, and demonstrated by A. Abt. The great dependence on mechanical influences which is characteristic of the magnetic state of nickel demands, however, careful handling of the nickel wire. It is not likely that the common steel used hitherto is exactly the most suitable for telegraphonic purposes; most probably other and better kinds are to be found.

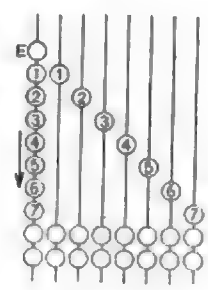


FIG. 6.

I have no intention of speaking of all the various specifically phonographic applications of the telegraphonic principle, nor of the constructive differences in connection with such applications. Nevertheless, I think that the following arrangement ought to be sketched: A long steel ribbon is stretched between two rolls which can rotate at a rather considerable speed. The ribbon passes a series of electromagnets at a speed regulated according to the circumstances. The electromagnet E inscribes words, music, &c.; the other electromagnets—"the reading magnets"—reproduce the communications in the telephone of each hearer; and, finally, the obliterating magnet, V, equalises the magnetic variations of the ribbon ("telephonic newspaper," Fig. 5.). As using does not weaken the writing, we are able to intercalate any number of reading magnets.

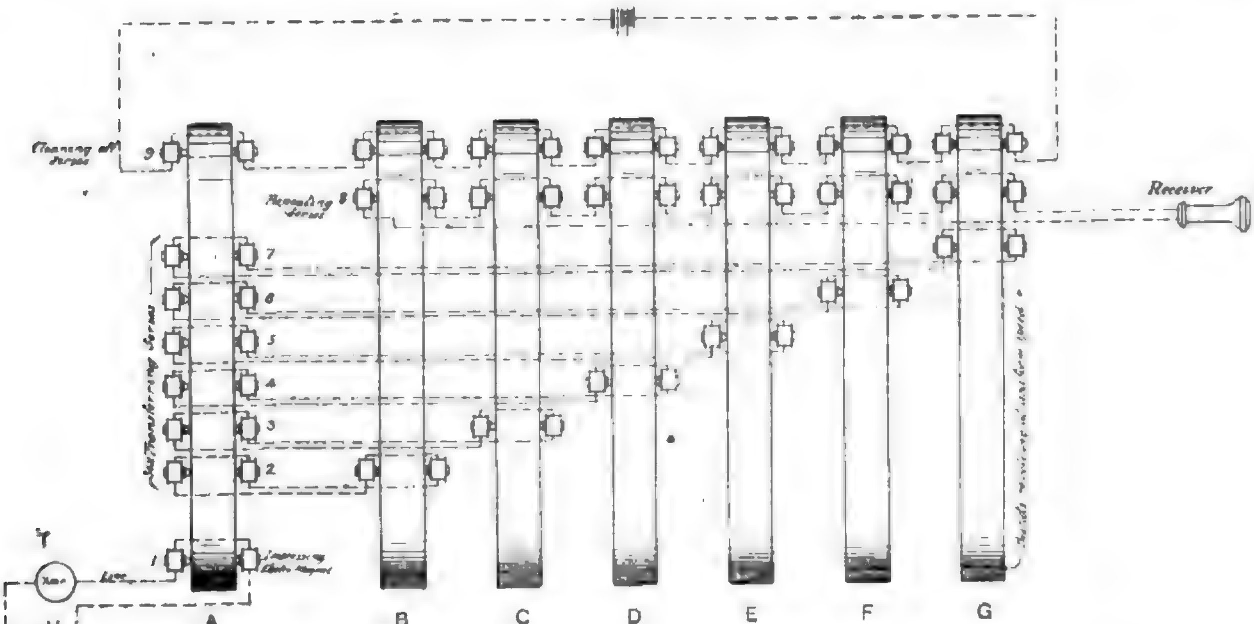
Again, it is possible to use the telegraphone to increase the telephonic current (telephonic relay). The engineer E. S. Hagemann has proposed an arrangement which, theoretically at least, is very simple; and which I here describe. A drum is provided with a series of circular steel rings having their centres in the axis of the drum, their planes perpendicular to the axis. As the drum rotates, whatever is spoken into the microphone is inscribed on the first ring by means of a writing magnet. By means of a series of reading magnets placed on the first ring, the words are transmitted to the other rings, which synchronically carry their equally formed writings past their reading magnets, duly connected together, and afterwards past obliterating magnets (Fig. 6).

An elegant method of compensation has been invented by the engineer P. O. Pedersen and allows several speeches to be intermingled, so that they can afterwards be reproduced separately. As it is not feasible to describe this method satisfactorily in a few words, I shall not speak further of it here. Later, perhaps, Mr. Pedersen himself will make a communication about it.

In my endeavours to develop the telegraphone I have received the greatest assistance—first from Mr. P. D. Pedersen, and also from Mr. E. S. Hagemann. I owe them both my best thanks. I have, besides, to thank the Institution and experts abroad, as well as those of my own country, for the interest they have shown in the telegraphone.

## TELEGRAPHS AND TELEPHONES AT THE PARIS EXHIBITION.

In reading his Paper on "Telegraphs and Telephones, at the Paris Exhibition," last week, Mr. Gavey sketched the figure below on the blackboard, and added the following explanation with regard to the possibility of applying the principle of the Poulsen microphone to the development of a telephonic repeater :—



As illustrating a method which it is thought might be developed into a satisfactory telephone repeater, the following was suggested as a groundwork to be built upon. Assuming, as illustrated in the figure, that there are six or more endless steel bands, A, B, C, D, &c., revolving at an absolutely uniform rate round suitable pulley wheels, and that, approaching closely to the band A are the poles of an electromagnet 1 connected to a telephone T; that a little further on an electromagnet 2 is mounted in a similar manner, but connected to a corresponding magnet on band B, and beyond this an electromagnet 3 establishes a relation between bands A and C, and so on, next that bands B, C, D, E, F are fitted with a number of electromagnets, 8, joined up in series and connected to the line over which it is desired to transmit, and finally a series of electromagnets through which a permanent current circulates are fixed at point 9.

Then, on starting the apparatus, and speaking into the telephone T band A is energised by the series of transverse magnetic polarities due to the variable currents in the electromagnet. As the band in its revolution passed under magnet 2 it generates currents which are transmitted to its corresponding electromagnet on band B, there to repeat the magnetic effect. The same action takes place between electromagnet 3 and band C, and so on until the whole of the independent bands are each impressed with the same magnetic alphabet. On completing half of the revolution the bands B, C, D, E, F pass under and energise the series of electromagnets which are joined up in such a manner as to combine the electromotive forces due to each separate band, and lastly the series of electromagnets 9 wipes out the whole record, and leaves the bands free to be acted on by fresh impressions

The following is an abstract of the discussion on Mr. Gavey's Paper :—

Sir WILLIAM PREECE, K.C.B., who opened the discussion, said it did his heart good to see such a crowded assembly to listen to an address which had telegraphy principally for its text. His mind could not help going back to the early stages of the history of the Institution, when sensation after sensation was brought before them ; when the room itself was filled to overflowing, and applauses, ringing as cheerfully as that which had just been given to Mr. Gavey, were the order of the day. If young members of the Institution took the trouble to read the earlier volumes of the *Proceedings* they would find there a great deal that was interesting ; they would find there a good deal to learn and a great many facts which would save them from a good many troubles. This was not the first time that a Paper had been read in that room detailing the exhibits at different exhibitions. He had had the gratification himself, on more than one occasion, of bringing before the Institution things shown in Paris, Chicago, Philadelphia, Munich, and Vienna, and he hoped and trusted that the practice originating with the very early days of the Institution would be continued, and that every possible advantage would be taken to find out how progress was going on in other countries. He would not say that we were behindhand, but if we did not look out we should be getting behind. Twenty-three years had elapsed since the telephone had first been introduced into England (at Plymouth and at the Institution), and where were we now ? Was the telephone industry in this country in a flourishing or in a proper position ? A kind of triangular duel was going on. On the one hand there was a company striving hard and doing its best to maintain a very difficult position. There were municipalities springing up and trying to emulate their would-be competitor, and there was in the background a small department called the Post Office doing its very utmost to meet the wants of the public, and this latter had the very great advantage over every one of its competitors—viz., that its back was broad enough to bear the greatest possible abuse that could be brought against it. He envied the position of Mexico. Mr. Gavey had mentioned that there everybody might start his own exchange and be placed in communication where he liked and with whom he pleased on condition that there was complete intercommunication. But how was free intercommunication possible if every competitor had his own switch and transmitter and instrument? The difficulty was bad enough with three competitors, but what would it be in these circumstances? If there was a business in this world that ought to be manipulated and managed by one administration and by one concern, and conducted on one principle, it was the business of telephony. He had hoped that he would see the day when every house in this country should have its own telephone, and that there would be a practicable and easy mode of placing every house in communication with every other house in the United Kingdom. Well, this was thrown to the winds with a great many other wild illusions and wild imaginations. It might come in the distant future, but he was afraid, with grey hairs coming so rapidly, that he would never see his ideal telephone system carried out. Mr. Gavey had mentioned something about the exhibits of wireless telegraphy. Well, we were getting tired of wireless telegraphy. The papers were still advertising strange experiments in different places, but we wanted to see practical wireless telegraphy. Where was there at present a single circuit worked commercially on a practical system of wireless telegraphy ? If there was, let somebody come forward and read a Paper on it before the Institution. The most beautiful thing and greatest novelty in the Paper was the microphonograh of Mr. Poulsen. Unfortunately, there

was very great difficulty in showing this in operation. He had tried to see it in Paris but the instrument had been sent to Berlin. Nevertheless, it was one of those things that was going to open the eyes of all our physicists and scientists and theoretical men on the question of the molecular character of all magnetic and electric operations. This continual exchange of energy through electrical connections, through diaphragms and steel and circuits performed by this beautiful instrument of Mr. Poulsen's was marvellous. Mr. Gavey had referred to the decision of the Electrical Congress to recommend the adoption of the two units, one the C.G.S. unit of magnetic field and the other the C.G.S. unit of magnetic flux; but he had not mentioned that these units were to be called "gauss" and "maxwell" respectively. He personally had serious doubts whether the name of Maxwell would come into practical use. Probably the abbreviation into the word "max" might come into use; and he had little doubt that writers would take up the unit of field and call it "gauss," and thus this would rapidly come into general use. He was proud to see his successor in the technical chair at the Post Office bring this subject before the meeting with the clearness with which he had.

Mr. W. J. HAMMER called attention to the fact that the inventor of what Mr. Gavey called the "microphonograph" strongly objected to this title, and desired it to be known as the "telephonograph." He had seen this instrument in Berlin, and some interesting modifications of it, and he could certainly endorse what Sir William Preece and Mr. Gavey had said about its useful simplicity and perfection. He had had considerable experience in connection with similar instruments, and had certainly never come across anything in the shape of speaking instruments to approach this one. With other instruments, in which the sound waves are recorded by something in the way of a style, there was bound to be a scratching noise that could not be eliminated, but the way the magnetic lines of force were stored up in Mr. Poulsen's invention enabled the sounds to be reproduced in the most perfect manner. He himself had made experiments with it by using words which were very difficult for the best of phonographs to give out, and whispering, and things of that kind, and the results made him very certain in his statement that it was superior to anything that had ever been made in the way of a talking machine. He concluded by adding a tribute to the beautiful and satisfactory working of the Pollák-Virág wireless telegraphy in its present form. He had seen the working of the system, and had some samples of the writing obtained from it.

Mr. M. F. ROBERTS said that reticence on the part of exhibitors at the exhibition to give full information with regard to their exhibits was one of the many difficulties he, as well as Mr. Gavey, had met with in Paris. He found in many cases that the attendants in charge of the stands either had not the necessary knowledge to explain the exhibits or else had been definitely instructed not to explain them. This difficulty was added to by the want of a suitable catalogue. He had been told by different gentlemen who had sent men specially over to Paris that in many cases the visits were practically useless simply because they could not obtain the information they wanted. With one or two exceptions, he thought they might say that the improvements pointed out by Mr. Gavey were improvements in points of detail, and he would have been particularly interested had Mr. Gavey extended his remarks and made reference to the progress made between different exhibitions, briefly referring to what had been the most marked improvements since 1878. To his mind it appeared that the improvements in the case of telegraphs very largely consisted of a higher finish and improvement in the apparatus exhibited, whereas in telephony the improvements appeared to be very largely in the simplification of parts and the design of parts which could be readily produced at cheap rates. Of course, it was possible to extend the development in the case of telephony taking this line, because there was such an enormous multiplication of the reproduction of the same parts, whereas in telegraphy the problem that had to be dealt with varied very considerably in almost every case. Not only, too, did it vary in the case of a given line but it varied for different times of the day. The standardisation, or successful design of parts for telephone working, appeared to be largely due to specialisation by certain firms. For example, in the case of one of the exhibits Mr. Gavey had described, this firm had one gentleman at the exhibition who had made a special study of switchboards, another who had made a special study of instruments, and a third whose department was to give information with respect to dynamos. Now they could easily understand where a powerful firm had representatives and employés who devoted their attention specially to one part, that we did get the improvements which Mr. Gavey called attention to in the case of the central battery system of working, and he thought it was this specialising in America which had resulted in the very great progress to be noticed in the American exhibits at the exhibition. Mr. Gavey had also called attention to the Rowland telegraph apparatus, and at every other Paris Exhibition he believed there was a typewriting instrument, but it was an astonishing fact that typewriting machines had made such little headway in this country. He hoped that the very successful exhibit by the Rowland's Company would have one effect—viz., to popularise the use of the typewriting telegraph in this country.

Mr. A. W. HEAVISIDE, in a communication which was read by the secretary, asked for more, his motive being that a subjects so deeply interesting as electrical applications in any form needed much detail to be of any practical utility. So far as he knew, though much experience had been gained in the use of the Delaney multiplex system, the valuable electrical data relating thereto had not been published to the world. For instance, it would be extremely useful if the profession were fully acquainted with actual time lag under practical conditions, with given conductors of both copper and iron and with an impressed E.M.F. of a given value, the effect of leakage at the insulators, and the practical difficulties experienced in a variable climate like ours. Similarly, in the case of Rowland's multiplex, he asked, did abrupt omission of two half-waves produce any deleterious reaction from the electrostatic discharge? The operator's control of the receiving roll by means of a transverse mark appeared to be weak. The receiving roll, if feasible, should be automatically controlled. The advantage that the receiving messages were delivered from the receiving instrument in a condition to be sent out for delivery was no mean one if it really saved a corresponding number of operators. Mercadier's system of superimposed vibrations at the sending end and selective apparatus at the receiving end he thought most suggestive. If 24 superimposed vibrations could be sent simultaneously, and each receiving apparatus could be tuned to respond only to that which belonged to it, then why not have a main pair of conductors of considerable cross section with 24 loops of variable lengths at 24 different stations? Of course, metallic loops must be used, and this revived a 19 years' old suggestion of his for working the Wheatstone bridge, which was probably worth trial. Anything that had for its object the reduction in the number of wires and stability of signalling was worthy of much thought. He thought Pollák and Virág's photo-autographic telegraph apparatus marvellously clever, but apparently wanting in simplicity at present. That it might become commercially applicable everyone desired, and to throw cold water upon it would be as bad as calling a telephone a philosophical toy. He suggested that in this, as in all the systems described in the Paper, it would be useful to append a theoretical diagram illustrating the principle of each case. It must be remembered that there were many student members of the Institution, and life was too short for every individual member to look up all the authorities. It was a case of *Science Abstracts* over again. Central battery telephone switches were on their trial, and if the extensions from the simple subscriber's circuit—from the telephone to the central exchange—could be adapted to the many diverse needs the telephone had to meet, it had probably come to stay. It was to be hoped that the new decade would see such a development of the telephone in Great Britain and Ireland as would remove the reproach we suffered from of being behindhand as compared with other countries. One feature of the central battery system, if he rightly understood it, was that it secured privacy of communication between the users, a feature that had distinguished the Newcastle-on-Tyne exchange for many years, and which commended itself to all. In the matter of microphones, he said the question of how to get loud speaking without jarring had been a problem since the days of Hughes, and still remained a problem. An ideal microphone should respond in identically the same manner from day to day, give every vibration with great delicacy, and invariably recover itself without lag or jar. If carbon filaments for microphones could be manufactured with similar qualities as those possessed by horsehair when used for domestic furniture, an ideal microphone might result. He had experimented with carbon filaments, and had obtained the most beautiful speech, but their brittleness occasioned short life. Perhaps makers of incandescent lamps could solve the problem. In regard to Poulsen's microphonograph, one could only admire and wonder what next!

Mr. DANE SINCLAIR was inclined to think Mr. Gavey was too enthusiastic on the common battery or central energy system of telephone exchange. With regard to the invention in connection with the phonograph that Mr. Gavey had called the "microphonograph," and another gentleman preferred to call the "telephonograph," he thought the latter was the more accurate description, but in justice to Mr. Gavey the name he had given to it was the one by which it was known generally. In this connection, too, he was glad to say that for once he had been ahead of his good friend Sir William Preece. When he was in the exhibition he got the instrument set to work for him under all the conditions he could possibly ask for, and it seemed marvellously pretty and marvellously wonderful. There was no doubt, as both Mr. Gavey and others had said, that it gave a distinct record of speech not to be compared with any hitherto. If, in addition, this invention gave, as Mr. Gavey had suggested it might, a telephone relay, then it passed at once out of the beautiful scientific interest into the happy interest of something that was going to be of commercial value and of commercial importance to users of the telephone. Under Sir William Preece's directions very heavy copper wire had been erected from one end of this island to the other, but if we were going to have a telephonic relay this heavy copper wire, weighing 800lb. to the mile, became no longer necessary, and, of course, as the price of the conductor went down the user would reap the advantage. He believed there were large possibilities indeed in the future from this instrument, and he had been rather disappointed at the time he was examining it to find that the electrical Press in London were not speaking of it in a way that it quite deserved.

Mr. J. E. KINGSBURY, speaking of Mr. Poulsen's instrument, said that while credit was given to Prof. Bell for a very bold idea in expecting to put on an electrical wire electrical undulations to represent sound waves, this invention was hardly less bold. As a scientific instrument we were bound to give it first place, and to regard it as a grand application of a very clever idea, but it was, of course, a little too soon to remark upon the practical uses which might lie in store for it. He, personally, thought that there were no conditions of the telephone service known to practical telephonists which the common battery system, described that evening, and shown at the Paris Exhibition, did not meet. Mr. Sinclair ought to have expressed his views to the contrary a little more strongly, and given reasons for them. Coming to the question of a telephone repeater, he reminded Mr. Gavey that, whilst, perhaps, the question might have been raised more specifically 12 years ago, still it was of very early origin. The first patent was taken out in 1879, when there was no million dollars reward, and it was a curious thing that when there was no such inducement there was a prolific supply, but now there was a big reward offered there was nothing good to be found. The idea was to take a telephone diaphragm as a receiving instrument and make it a combination instrument, attaching to it a microphone transmitter. This seemed to have the germ of a good and satisfactory telephone relay or repeater, but although it had been before the public for 20 years, it did not seem to have been developed to any practical stage.

Prof. SILVANUS P. THOMPSON, referring to the new magnetic units

F

with which the Paris Congress had endowed us, was not quite sure that the name "Maxwell" was destined to receive the same immediate use as "Gauss," because it was a synonym of a name we had before, viz., one magnetic line, and it was just as easy to say one million lines as one million maxwells. Indeed it was rather easier to say "megaline" than "megamaxwell," and he did not think it would displace the word "line." He had had an opportunity of inspecting the system of wireless telegraph devised by Mr. Slaby and Count Arco, not only in the Paris Exhibition, but also in Berlin, where he had witnessed its working between Berlin and Oberweide, a distance of 7 miles or 8 miles, and he did not think that Mr. Gavey's diagram quite conveyed exactly what the arrangement of the invention was. The vertical thing, that reminded one of a German sausage, really represented a wire cage, if it could be called a cage, made of either six or eight wires about 100ft. or 150ft. long, joined to a ring about 6ft. across at the top, and another ring 6ft. across at the bottom, hung from a tall chimney, or something of that kind. It was a remarkable thing that it was possible to send wireless messages from one of these cages to the other when the tops of the cages as well as the bottom, were earthed. That which seemed to be the one thing on which emphasis had hitherto been laid in wireless telegraphy—viz., that there should be an elevated and insulated conductor—did not follow in this case. This conductor might be elevated—it certainly was not insulated—yet, nevertheless, the signals were transmitted with absolute certainty. Lastly, he also bore testimony to that extraordinary perfection of regulation of the recording and speaking phonograph and telephone of Mr. Poulsen's, which he had had an opportunity of seeing in Paris. It was not then called the "microphonograph," it was not called the "microtelephone," and it was not called the "telephonograph"; it was then called the "telegraphone."

Mr. J. GAVEY, who then replied, dealt first of all with Mr. Roberts's request for more definite particulars of the improvements which have taken place in telegraphy and telephony between 1878 and the present day. He had, he said, rather inclined to make the Paper suggestive than to state too definitely what he thought the improvements were, but in answer to this request he would just say that although between 1878 and the present time the improvements in telegraphy had not been so marked, he certainly thought that what had been seen at the Paris Exhibition pointed to very marked improvements in our methods of telegraphy in the immediate future. At the present time we had in England and America our good old servant the Morse system, which had rendered invaluable service throughout the whole world, but which he could not help thinking was not quite up to modern requirements. He was rather looking for improvement in the direction of transmitting messages by some simple method such as the typewriting key which would either transmit direct as in the Rowland's, or which would perforate slips—as had been designed by a couple of other inventors—that would be passed through an automatic transmitter at a high rate of speed and that would admit either of the typing or the writing out of the messages in ordinary characters, thus putting an end to the old necessity of transcribing, and not entail the messy operation of sticking down each slip on a sheet of paper. In making this remark he said he wished it to be understood that he did not in the slightest degree belittle the lovely instrument devised by Prof. Hughes, but he thought everyone would admit that an instrument which would either print or write—he did not care which—a message in such a form that it could be immediately sent out, would be far away in advance of anything we had yet met, and he ventured to prophecy that we were within measurable distance of seeing an instrument of this type introduced. Mr. Roberts's remark that improvements in telephony had been mostly in detail was quite true, and when they came to think of it there was nothing else possible. They must have an instrument into which they could speak and hear by, and there must be lines and such apparatus by which one subscriber could be readily switched through to another. Given these, all other improvements must be improvements in detail, and he ventured to think that all the improvements which had been made in telephonic work within the last four or five years had almost amounted to a revolution. With reference to the suggestion that a more extended description might have been given in the Paper, he was afraid it would have been no gratification to them had he extended the Paper to the length which would have been necessary to do this. Prof. Thompson had referred to the sausage-like poles in the Slaby-d'Arco diagram. This was copied almost exactly from a pamphlet which was given to him by the exhibitors in the exhibition, and which was supposed to describe the system accurately.

A hearty vote of thanks to Mr. Gavey concluded the discussion.

---

An exhibition of the Steljes type-printing telegraph was then given. A detailed description of this instrument appeared in *The Electrician*, Vol. XLV., p. 359.

---

**A Record Title.**—The titles of the Royal Society Papers of certain leaders of physical science are generally considered to be unsurpassed in the matter of length, but we do not remember to have seen one to equal the following title of an article in an esteemed German contemporary:—"Entspricht der elektrische Betrieb auf den Linien der Grossen Berliner Strassenbahn durchweg den Anforderungen, die nach dem gegenwärtigen Stande der Elektrotechnik an eine ordnungsmassige und sichere Betriebsführung gestellt werden konnen?"

# CORRESPONDENCE.

## ELECTRIC TRACTION AND MAGNETIC RECORDS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The theory of magnetic storms put forward by Mr. Evershed is familiar to all those acquainted with the subject, and few things are more certain than that it is not by itself adequate to the explanation of the phenomena. That the stimulus comes from the sun, and that it travels in the form of an electromagnetic vibration is probable, but, beyond this, all is doubtful. Lord Kelvin some years ago pointed out the difficulty of supposing that the immense amount of energy liberated during a magnetic storm is supplied by the sun.

Dr. A. Schmidt has recently studied a magnetic storm from minute to minute, by the aid of the registers of observatories, situated in the area roughly outlined by joining Kew, Kiel, Vienna, Pola and Paris. M. Mascart describes the results in his recent "Traité de Magnetisme Terrestre" (1900), p. 292. It is sufficient to say that the proximate cause of the disturbance appeared to be circular currents existing in the atmosphere, "and displaying characteristics similar to those of the direction of the wind in cyclones and areas of high pressure. Two systems of currents, rotating in opposite directions, follow each other at a short distance, hence the magnetic disturbances have their maximum value in the intermediate region." It is difficult to believe that phenomena which can be described in these terms are the direct effects of solar radiation.

Again, the well-known connection between magnetic storms and auroras points to a common cause, and if the views of Elster and Geitel are correct it is probable that it is to be found in the ultra-violet rays, and not in waves of the type which would be required to give rise to magnetic disturbances producing deviations which, in some cases, last for many hours (*cf.* Mascart, pp. 385-386). It is further known that earth currents are closely connected with magnetic storms, but Neumayer (Berghaus' "Physikal Atlas," Erdmagnetismus (1891), p. 15) says that the relations between the two are very uncertain.

I quote these opinions to show that a cursory study of well-known sources of information proves that men who are not likely to have overlooked the work of Maxwell or of Langley do not share Mr. Evershed's view that we know all that is good for us to know about the cause of magnetic storms.

As to the magnetic disturbance supposed to be connected with a flash of light seen in the sun, the late Mr. Whipple years ago expressed the opinion that the connection was very doubtful. I have myself seen the curve on which the disturbance was registered and agree that the deviation was of a kind which is so often observed that its occurrence on this occasion is just as likely to be due to accident as to a connection between the solar and terrestrial phenomena. If any argument is to be based on a single coincidence, the coincidence must be of a much more striking character than was actually the case.

The future usefulness of observatories is assured in many ways.

Both England and Germany are about to send out Antartic expeditions to add to our knowledge of the magnetic conditions of the southern hemisphere. Efforts are continually being made to establish observatories in regions for which magnetic data are scanty. The object of these is to enable us to get a simultaneous view of magnetic phenomena all over the earth, and this object would be frustrated if observatories in civilised countries were shut up.

If it is necessary to give a specific example of a problem which can only be solved by a full knowledge of the magnetic state of the globe, I may cite the question as to whether electric currents are continually flowing from air to earth and vice versa. The evidence is at present conflicting, and must be so till the magnetic state of the earth is better known. Of discoveries recently made in observatories I may cite the rapid oscillations made known to us by Eschenhagen, and the non-periodicity of the diurnal variation on days of magnetic calm, discovered at Kew by Dr. Chree.

Finally, the physicist who commits himself to the statement, with regard to any branch of physics, that "we may safely infer that no facts of a novel character will be forthcoming" ignores history and tempts fate. In Mr. Evershed's case the refutation which the future was almost sure to bring has not been delayed. On the very day before his letter was published in your columns Sir Norman Lockyer read a Paper before the Royal Society, in which he stated that the spectra of sun spots had exhibited certain well-defined variations for the greater part of 21 years, but at the end of that period had behaved abnormally. If magnetic observatories had been shut four years ago it would have been impossible to answer the question whether the magnetic cycle is affected by this change in the behaviour of the sun, which was first remarked three years ago, and which most people heard about for the first time last Thursday.—Yours, &c. ARTHUR W. RÜCKER.

Nov. 26, 1900.

## THE AUTOMOBILE CLUB TRIALS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although the electrical vehicle trials recently undertaken on the initiative of the Automobile Club of Great Britain were the means of bringing together a good many competitors, there are very many points in connection with them which are open to criticism and the serious consideration of everyone really interested in the electrical vehicle industry—not only interested in a transitory way, but especially those who, whilst thoroughly believing in the practicability and ultimate general use of such vehicles, desire that they should only be put to such uses as they are really suited.

That such a district as Chislehurst should have been chosen is alone a matter of great surprise, as no engineer who is thoroughly conversant with the electrical accumulator or secondary battery could conscientiously recommend a person residing in this or any similar district to use an electrical carriage without pointing out the very heavy expense entailed in the upkeep of the batteries resulting from the very heavy discharges necessary to propel the vehicles on account of the conditions of the roads and the steepness of the hills. Of course, in summer time and dry weather the deterioration of the plates would not be so serious, but one wants a carriage in winter time as well as in summer.

Although many of the vehicles entered got through the trials in a very satisfactory manner, no useful purpose can possibly be served by forcing a car over the hills at Green Street Green and Knockholt, and what would be the condition of the batteries if these tests were continued daily for, say, only 20 days? To give an illustration of the difference in the demand upon the cells when used as they should be used at somewhere about their normal discharge rate, and under such conditions that the up-keep of a set of cells should not reach a prohibitive sum, but should be within, say, £20 per annum, a small electrical carriage seating two was taken over the same roads a few days ago. That the roads were in a worse condition than on the days of the trials may be admitted, as there had been continuous wet weather for some five or six days since that time.

The weight of the carriage complete is 19cwt., of which the cells weigh 7½cwt. The two passengers weighed 2¾cwt. This carriage takes 28 amperes at 80 volts, when run on a level hard road, and travels at 13 miles an hour. But when run on Route F of flat (*sic*) or nearly flat road the average consumption of current was 45 amperes, the maximum being 70. That there was one continuous half-mile of flat road is open to doubt, and to those who may be unacquainted with Chislehurst, but who know London it may be pointed out that on the following day the same car was driven up Pentonville Hill, Islington, and the maximum current taken was 58 amperes, the average being 45 amperes, and the speed 8 miles an hour. This will give a fair idea of what some of the flat (*sic*) roads were like which were chosen for these trials. No alterations or adjustments of any description were made to the car or the battery, which was charged at Chislehurst, and during the run over the route the car was in perfect order. The car was driven from London, via Camberwell, Denmark Hill, Half Moon Lane, College Hill, Crystal Palace, Penge, Bromley, Swan Hill, Bickley, and Old Chislehurst Hill, to the "Bull's Head." On this last hill the current taken was 95 amperes.

Many thanks are due to the Club and to those gentlemen who at very great personal inconvenience and discomfort undertook the varied duties in connection with the trials, but why the probable competitors were kept in the dark as to the routes and district chosen until the eleventh hour and were not consulted, as was the case when the 1,000 miles run for the oil motor vehicles was arranged, is a matter which, perhaps, may be explained at a later date—although it has been suggested by a cynic that the absence of the public from the trials was a matter for congratulation, in view of the rumours one hears of the friendly aid of the horse, required by some of the competitors.

If there are to be trials in the future (and it is earnestly hoped that this one is only the first of many), let them be arranged so as to be carried out under those conditions which the true friends of this growing industry can safely advise—under such conditions as can be carried out day after day without ruining the batteries. For town use alone the field is large enough, to recommend their use for long country drives is a mistake; there are too many difficulties in the way, such as the charging of the cells and consequent loss of time whilst this is being done, and the fewness of charging stations, although this latter difficulty will be removed as time goes on, and when, as on the Continent, nearly every little village has its own electric lighting station.—Yours, &c.,

London, Nov. 27. CARL OPPERMANN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the illustrations you give in *The Electrician* for the 16th inst. of the controllers used on the Electric Motive Power Co.'s cars which took part in the recent trials of electrically-propelled vehicles, I think a few particulars respecting them may be of interest to your readers, as the diagrams by themselves are somewhat difficult to understand.

The controller is an invention of mine to overcome the destructive sparking which usually occurs on breaking the main circuit when changing from one cell combination to another, and, as far as I know, it differs from all others inasmuch as, instead of trying to minimise the effects of the spark by means of quick-break devices, spark catchers and so forth, it goes to the root of the matter and eliminates the spark altogether by never breaking the main circuit at all. This is accomplished by introducing a number of intermediate combinations through which the changes are effected, and so arranging the contact pieces that circuit is always made on one before another is broken. Three intermediate stages or "pass-over" combinations are provided between each working combination. In passing from one of the latter to another the first stage cuts out some of the parallels composing it but leaves one or more of them in circuit to maintain the current. The second stage puts back into circuit in parallel with those still there, part or all of the cells cut out, but grouped in a different series according to the new E.M.F. it is desired to obtain. The third stage cuts out the remainder of the cells of the old grouping, and the contacts then pass on to the next working combination, where all the cells out of circuit are put back in parallel with those introduced at the second stage, and in a similar series grouping.

The arrangement of connections and contacts shown in the diagrams is for coupling 12 cells or sets of cells in six parallels of two each, four parallels of three each, three parallels of four each, and two parallels of six each, together with the necessary "pass-over" combinations between each of these. Numbering each set of cells from 1 to 12 consecutively, the connections giving the four working combinations may be expressed as follows:—

| Six parallels. | Four parallels. | Three parallels. | Two parallels. |
|---|---|---|---|
| 1·2 | 1·2·3 | 1·2·3·4 | 1·2·3·4·5·6 |
| 3·4 | 4·5·6 | 5·6·7·8 | 7·8·9·10·11·12 |
| 5·6 | 7·8·9 | 9·10·11·12 | |
| 7·8 | 10·11·12 | | |
| 9·10 | | | |
| 11·12 | | | |

Then the pass-over combinations between six parallels of two each, and four parallels of three each will be

| 1. | 2. | 3. |
|---|---|---|
| 1·2<br>3·4<br>5·6 | 1·2<br>3·4<br>5·6<br>7·8·9<br>10·11·12 | 7·8·9<br>10·11·12 |

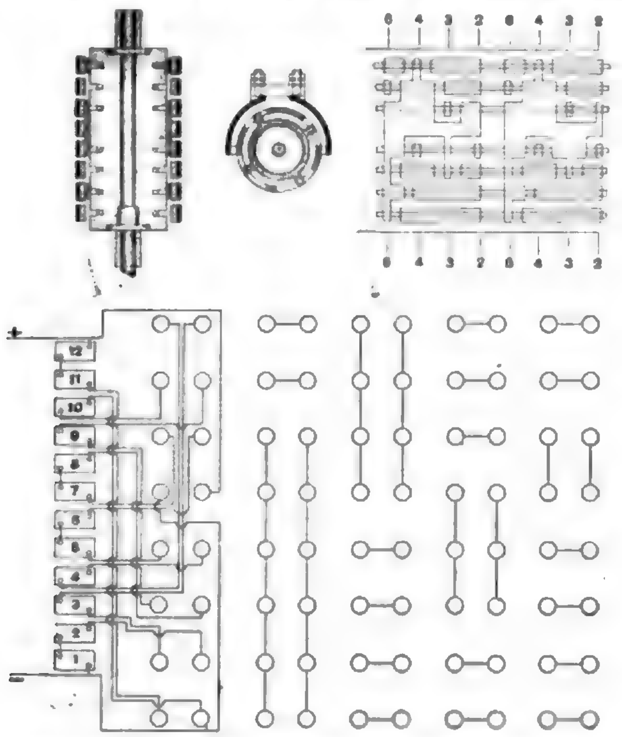
And between four parallels of three each and three parallels of four each

| 1. | 2. | 3. |
|---|---|---|
| 1·2·3<br>4·5·6 | 1·2·3<br>4·5·6<br>9·10·11·12 | 9·10·11·12 |

And between three parallels of four each and two parallels of six each

| 1. | 2. | 3. |
|---|---|---|
| 1·2·3·4 | 1·2·3·4<br>7·8·9·10·11·12 | 7·8·9·10·11·12 |

Throughout the whole of this series of combinations, any two of them directly adjacent to each other may be in circuit at the same time, so the motor circuit need never be broken. In each case, however, the second of the intermediate combinations consists of unequal series of cells joined in parallel



with each other, and there will be a local current through the switch from the greater to the lesser series. For this reason the E.M.F. in circuit must not be varied too abruptly, but provided the two E.M.F.s involved in any one change are not in a greater ratio than 3 to 2 it is found in practice that these local currents are not excessive. Moreover, the local circuits are almost entirely free from self-induction, and the spark on breaking them is practically negligible.

The controller itself is of the drum-type, with two rows of contact springs bearing on opposite sides of the drum. The bottom left-hand diagram shows the connections from the cells to the two rows of terminals respectively connected to the contact springs; the other diagrams at the bottom give the connections effected inside the controller to obtain the four working combinations. The top right hand diagram is a developed plan of the drum, showing the arrangement of the contact pieces on its surface for connecting together the requisite contact springs. These contact pieces are of two kinds—rings passing round the drum for connecting opposite terminals in pairs, and two longitudinal pieces for connecting any number of terminals in the same row. These two pieces are insulated from each other and from the rings, and the rings are also insulated from one another. The general arrangement of the contact pieces and springs is shown in the two left-hand figures, which are longitudinal and transverse sections through the drum.

Controllers built on this principle, with quite slight contact pieces, have worked very successfully on cars, frequently taking up to and above 150 amperes at 60 volts to 80 volts E.M.F. without showing any depreciation from sparking. It is of course necessary to provide some simple device to ensure the controller not remaining at one of the pass-over positions, otherwise the battery would be worked unequally and too much current taken from certain sections of it.

On motor cars an incidental advantage of never breaking the motor circuit while running, is that it avoids the jerk usually felt while changing from one speed to another, and which may be very marked when climbing a hill, or otherwise heavily loaded, no matter how quickly the break and re-make may be effected.—Yours, &c., E. J. WADE.

Streatham, Nov. 22, 1900.

## X-RAY BURNS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue you refer to the finding of the coroner's jury at Hastings with respect to the alleged fatal effect of the Röntgen rays. You state that "great care—perhaps much greater care than is usual—should be taken when exposing a patient specially predisposed." Will you allow me to point out that the most essential factor—*time*—has not been mentioned as influencing the result of such exposures.

The evidence disclosed the remarkable fact that the exposures were continued for something like two hours! Now, to obtain a fair radiogram of a hip joint, even with moderately-sized apparatus, is a matter of a few minutes only nowadays, and as the tubes generally employed for the radiography of such thick parts of the body are what is known as "hard" tubes, which barely ever show any effect upon the skin, the danger of any dermatitis even in its mild stages is practically nil.

I have, since October, 1898, employed the rays (under medical direction) for the very purpose of producing slight dermatitis on all sorts of patients with greatly varying predispositions, but never have I been able to produce any effects upon the skin whatsoever under conditions such as are present when a radiogram of a hip joint—even for the purpose of localisation—is to be taken.

This fact cannot be given too much publicity, as the sensational statements published in certain sections of the Press are calculated to prevent the public from availing themselves of the immense benefits of this last method of diagnosis.—Yours, &c., A. W. ISENTHAL.

London, Nov. 23.

## RECORDING TELEPHONES: A PRIOR CLAIMANT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to Mr. Gavey's excellent lecture at the Institution of Electrical Engineers last Thursday week on the magnetic-record phonograph, it may be interesting (as showing how very close indeed one may approach a valuable invention without quite attaining it, and how long such may then lie dormant without being re-invented) to point out that in the year 1879, while experimenting *re* the photo-electric phonograph in conjunction with Prof. Alexander Graham Bell, the inventor of the telephone, it did occur to me that possibly magnetic variations would remain permanent on a strip or band of steel; and I actually tried the experiment of drawing such a band along over the poles of an electromagnet, while the coils thereof were joined up in circuit with a microphone which was being spoken to, and then again drawing the strip along while the said coils were joined up with a telephone receiver identically as is done now.

By the light of subsequent experience, it is easy to see where I made a mistake. I had a permanent magnet connected to the electromagnet and which was too powerful for the combination (it was, in fact, the magnet and coils of a telephone), and which permanent magnet was, of course,

wiping the magnetic variations out as fast as they were formed. Had I taken this permanent magnet away while trying this experiment, the magneto-phonograph would have been an accomplished fact over 20 years ago.—Yours, &c.,

London, Nov. 29. A. C. BROWN.

A DISCLAIMER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In one of the London evening papers of the 27th inst. there are remarks in an article relating to the prospectus issued by the British Electric Street Tramways Co. (Ltd.) coupling the name of Thomas Parker (Ltd.) with that company. We beg to say Thomas Parker (Ltd.) has nothing whatever to do with the British Electric Street Tramways Co. (Ltd.), and has no interest whatever in its promotion. We should be glad if you would publish this letter to avoid any misapprehension.—Yours, &c.,

H. AND J. E. UNDERHILL AND THORNEYCROFT.
(Solicitors to Thomas Parker, Ltd.)

Wolverhampton, Nov. 28.

## LEGAL INTELLIGENCE.

### Hawkes v. the Leyton Urban District Council.

In the Court of Appeal on Tuesday, before the Lord Chief Justice and Lords Justices Rigby and Vaughan Williams, the case of Hawkes v. the Leyton Urban District Council came on for hearing on appeal by defendants from an order of Mr. Justice Buckley, who had granted plaintiff an injunction restraining defendants from carrying on their electric supply works at Leytonstone so as to cause a nuisance by vibration and noise to the plaintiff as owner and occupier of premises in Cathall-road, Leytonstone. Defendants admitted there had been noise and vibration, but pleaded that since alterations at the works the nuisance no longer existed. Plaintiff, however, alleged that the noise and vibration caused by the engines was still sufficient to establish a case of nuisance, and Mr. Justice Buckley granted an injunction which the defendants now sought to have discharged.

Mr. H. TERRELL, Q.C., in support of the appeal, said defendants had established very considerable electric light works at Leyton, the whole of the streets being now lighted by electricity. At first defendants worked their machinery by means of gas engines. Commencing with two engines, increasing to four, and ultimately had eight gas engines at work. With all these engines, however, they were not able to cope effectively with the great demand for current, and they accordingly put in a steam engine as a stand-by. In the working of gas engines something occasionally goes wrong, and there ensued what was called "back-firing."

Lord Justice RIGBY: What is back-firing?

Mr. TERRELL said it was an explosion at the wrong side of the piston. At times, especially on Saturday nights, when the electric light requirements were very great, this back firing took place, and they were unable to take off the engine at once or the supply would have been insufficient.

The LORD CHIEF JUSTICE: Is it your case that back-firing must take place?

Mr. TERRELL: No. In the case of all gas engines regularly worked there would be instances from time to time of back-firing, but the moment it occurred it was usual to take off the engine. In this case he admitted that until 1899 the engines were at times overworked, and they were not able to take off the engine in which back-firing occurred.

The LORD CHIEF JUSTICE: I suppose the decision against you was both on the ground of noise and vibration.

Mr. TERRELL: Yes. The plaintiff's premises were some 200 ft. away from the electricity works. His (Mr. Terrell's) case, shortly, was that it was only occasionally there was an explosion, and that there are no injunction ought to have been granted; and, further, that under all the circumstances the injunction was far too wide, and that it ought to have been limited to the use of particular gas engines, so as to obviate the nuisance caused by back-firing. It was also part of his case that alterations had now been effected which would do away with the noise and vibration. The defendants were erecting steam plant, which to a great extent would obviate noise and vibration. In the Court below he pointed out that, as the explosions were only intermittent and not continuous, the case was not one for an injunction in the very wide terms in which it was granted. The injunction, as it now stood, would apply to any machinery employed by the defendants—steam or otherwise—and whatever they did hereafter plaintiff might attack them on a motion to commit.

The LORD CHIEF JUSTICE: Are the new steam engines only to be stand-byes?

Mr. TERRELL said it was proposed to work the steam engines as the main plant and the gas engines would be worked as a sort of auxiliary plant. In the event of back-firing occurring they would now be able to take off an engine.

LORD JUSTICE RIGBY: As to the terms of the injunction, you apparently suggest that the case as to the gas engines should be determined first, and that, in the event of any complaint as to the steam engines, there should be a separate trial.

Mr. TERRELL: Yes. The matters were entirely separate and would necessitate the calling of distinct expert evidence. He was perfectly willing to let the injunction go if it was limited to the noise and vibration caused by the back-firing of the gas engines, but in no case ought the injunction to be continued in the present very wide terms. His main point, however, was that where there was merely temporary and not a continuing noise, it was not the practice of the Court to grant an injunction.

The LORD CHIEF JUSTICE: You cannot contend that electric lighting stations must be a nuisance. They are all over the place, and no doubt have cured their nuisances. You must make out that there is not a nuisance to justify us interfering.

Mr. TERRELL: I say it was only temporary and occasional, and due to extraordinary circumstances. That is my whole point.

Yesterday Mr. DIBDIN, following on the same side, said defendants had done everything they could to minimise the vibration. They had substituted steam for gas engines at a cost of something like £100,000. In these circumstances he submitted it was most unreasonable for defendants to be liable to be attacked at any moment by plaintiff moving to commit for breach of the injunction.

Mr. ASTBURY, Q.C., for the respondent, contended that the order made in the court below should not be disturbed. The plaintiff complained of two nuisances—windows shaking and explosions, which could only be caused by gas engines.

The LORD CHIEF JUSTICE asked what would be the position if defendants put up steam engines and took away all the gas engines, and the shaking of the plaintiff's windows still continued? Could plaintiff, having regard to the injunction which had been granted, move to commit defendants?

Mr. ASTBURY: If what they were doing was still a nuisance, and it was so proved to the Court, we could. If a nuisance was proved in fact, the plaintiff was entitled to an injunction *ex debito justitiæ*.

Lord Justice RIGBY: Look at the order. It says defendants are restrained from committing a nuisance, and it does not describe the nuisance. I think the order should be more definite—nuisance by gas engines—or words pointing out what the nuisance was. I do not see how it could hurt you.

Mr. ASTBURY said if that had been asked for by defendants in the Court below he would have acceded to it in a moment. In these circumstances he contended that defendants were not entitled to the costs of the appeal.

The LORD CHIEF JUSTICE, in giving judgment, said that the Court was of opinion that the terms of Mr. Justice Buckley's order were too wide, and that the order should be limited to an order restraining defendants from carrying on their business so as to cause a nuisance to plaintiff by the use of gas engines. If defendants had asked Mr. Justice Buckley to limit the order in this form he would no doubt have acceded to the application, but they had not done this and they ought not, therefore, to have the costs of the appeal.

Order accordingly.

### Corporation of Wolverhampton v. the British Electric Traction Co.

Mr. Justice Joyce in the Chancery Division yesterday delivered his reserved judgment in this case. (Fully reported in *The Electrician* for Nov. 16, p. 138.)

Mr. Justice JOYCE, in the course of his judgment, said the action was brought by the Corporation of Wolverhampton against the British Electric Traction Co. for specific performance of a parliamentary contract contained in the Act of 1899 authorising the Corporation to purchase within the borough certain tramways to which the defendant company had since succeeded. There was no real defence to the action, but there was a counterclaim by defendants for a declaration that they had running powers over the tramways, and it was agreed by counsel before his lordship that the only question in the case was whether the claim to such running powers could be maintained or not. His lordship went exhaustively through the material sections of the Dudley Sedgley and Wolverhampton Tramways Order of 1880, the Sedgley and Wolverhampton Tramways Act of 1893, and the Act of 1899, by which the Corporation obtained powers to acquire the tramways from defendants. He did not think sec. 17 of the Act of 1880 bore the construction attempted to be put upon it by defendants, and that their counterclaim was not well founded, and must be dismissed. There would accordingly be judgment for plaintiffs on the claim with costs.

Mr. FREEMAN, Q.C., for defendants, said as there was no hostility between the parties, he thought plaintiffs ought to undertake not to pull up the rails at the junctions until his clients had considered whether they would appeal. That would take a month.

His LORDSHIP held the request a reasonable one, and said the best thing would be that the order should not be passed for a fortnight.

Mr. FREEMAN agreed, and assumed that if defendants decided to appeal, the rails would not be disturbed pending the appeal.

His LORDSHIP said he did not know whether he had any power as to that, except by arrangement. Ultimately he gave a decree for specific performance, and the counterclaim was dismissed with costs, defendants to pay the costs of the action.

### National Telephone Co. v. Bloomfield.

At Banbury County Court last week Mr. Pitt-Lewis (deputy-judge) heard an action brought by the National Telephone Co. against Mr. J. W. Bloomfield, of the "Red Lion" Hotel, Banbury, and the Parade, Leamington, and Mrs. Page, of the "White Lion" Hotel, Banbury, for £8 each, being the rent of telephones held under an agreement. The defence was that the defendants did not get a proper service. Mr. Bloomfield

said that at his Leamington establishment he had waited 33 minutes, and was then told that he could not be connected with his house at Banbury. Neither he nor his customers had ever been able to get any reply from Leamington, and only once had he been able to get through to Wolverhampton. One customer had paid 1s. 6d. in call fees, and then failed to call Halifax. He had offered the company £5 to take the instrument away. Mr. T. A. Page gave similar evidence.

For the plaintiffs Mr. Collinge, solicitor, said the company had carried out their agreement, which was to give defendants the use of the trunk lines when they were available.

The DEPUTY JUDGE said he did not think the plaintiff company had carried out their contract, and had not fulfilled its conditions with regard to the use of the trunk lines, which was an inducement held out to subscribers. Judgment must be for the defendants, with costs.

### Crompton & Co. v. Killarney Electric Lighting Co. (Ltd.).

In the Queen's Bench Division, Dublin, on Wednesday, Mr. Drury, on behalf of the plaintiffs, moved for final judgment for £36, for the hire of a dynamo and other electrical plant supplied to defendants.

Mr. Bernard, for defendants, opposed the motion, submitting that they had a counterclaim against plaintiffs for repairs done to the machinery, and other causes of action.

The motion was granted, the plaintiffs' solicitors undertaking to accept service of any writ served on behalf of defendants in support of their counterclaim.

### Teague v. Russell.

In the Court of Session, Edinburgh, on Tuesday, issues were approved for the trial of an action in which Mr. Francis Teague, burgh electrical engineer at Paisley, sues Dr. William Russell, 52, High-street, Paisley, for £1,000 damages for alleged slander. The defender is a member of Paisley Town Council and one of the members of the Electric Lighting committee. Pursuer alleges that at a meeting of the committee, on Sept. 24, 1899, defender used language which represented that the pursuer was an agent for the sale of electric lamps, and obtained a royalty thereon, and that, with a view to earning the royalty, he refused to discharge his duty as a servant of the Town Council, and declined to furnish to an intending consumer an electric lighting installation unless the consumer agreed to purchase the lamps in which pursuer was interested. The statement was indignantly denied by pursuer. Defender denies slander, and pleads privilege. He avers that all that was said was uttered in the course of the business of the committee, and was entirely pertinent to the matter under consideration. He had no ill will to the pursuer, nor had he any intention of slandering him.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Battersea Borough Council require an electrical engineer to take charge of their electric supply department. Further particulars are given in an advertisement, and applications (on official forms, to be obtained at the Municipal Buildings, Lavender Hill, S.W.) must be delivered to the town clerk (Mr. W. Marcus Wilkins) by noon, Jan. 1.

Ilford District Council require a resident electrical engineer. Applications must be sent to the clerk (Mr. John W. Benton), Council Offices, Ilford, by Dec. 10. An advertisement contains further particulars.

The National Boiler and General Insurance Co. (Ltd.), 22, St. Ann's-square, Manchester, require additional surveyors of electrical plant. Applications to the chief engineer (Mr. Edward G. Hiller). See advertisement.

The Commissioners of National Education (Ireland) require an assistant organiser in elementary science. Salary £250 per annum. Applications to secretary (Mr. A. Hamilton), Dublin, by Dec. 12.

An experienced superintendent of stores is required for a large electrical company. See advertisement.

Mr. Neville Appelbee has been appointed borough electrical engineer at Ashton-under-Lyne. Mr. Appelbee served his apprenticeship to the Anglo-American Brush Electric Light Corporation, and afterwards was engaged as an assistant engineer by the Corporation. In 1889 he joined the staff of the St. James' and Pall Mall Electric Light Co.; in 1891 he entered the service of Messrs. W. T. Goolden & Co.; and in 1892 he was engaged as shift engineer at the Bankside station of the City of London Co. In 1895 he was appointed borough electrical engineer at Cardiff, a position which he held until his present appointment to Ashton-under-Lyne.

The Scarborough Electric Supply Co. has appointed Mr. J. Moseley Williams as mains superintendent.

Mr. W. T. Kerr, of Greenock, has been appointed assistant engineer at the Crewe Corporation electricity works.

Mr. C. A. Frost, of Lancaster, has been appointed assistant engineer at the Darlington Corporation electricity works.

Mr. A. T. Smith, chief assistant at Morecambe, has been appointed to the Bury (Lancs.) electricity works in a similar capacity.

**Argentina.** An extensive calcium carbide factory has been established near Cordoba, trading under the name of the Fabrica Nacional de Carburo de Calcio, the general agency of the factory for the Argentine Republic being in the hands of Messrs. Mudd & Co., of Buenos Ayres. The machinery for these extensive works came chiefly from the United Kingdom. The necessary electric power (about 3,000 H.P.) is obtained from the large artificial waterworks recently constructed on the Rio Primero in the Sierra de Cordoba. The Fabrica Nacional is under British control. It is reported that a French company is being formed to utilise the same water power for a second carbide factory about to be established.

**Barry (Glam.)** An inquiry was held last week into the application of the Council to borrow, among other sums, £550 for electric lighting and refuse destructor works and abattoir. There was no opposition.

**Beckenham.**—The new electricity works were formally opened on Thursday last by Mrs. Cole, wife of the chairman of the District Council. Mr. Lendon, chairman of the Electric Lighting committee, announced that the capital expenditure amounted to £37,000, and that 48 miles of cable had been laid in the district. The British Insulated Wire Co. had contracted to maintain and work the undertaking for five years without expense to the Council. Refuse destructor works would also be erected, and consumers' premises would be wired on the "free" wiring system at a charge of ½d. per unit extra. Already there is an equivalent of over 6,000 8 c.p. lamps connected.

**Brighouse.**—The Corporation have decided to erect new electricity works in conjunction with a refuse destructor at an estimated cost of over £25,000. Two years ago the Corporation acquired a small station from a local company, but this has proved inadequate to meet the demand for current. Messrs. Lacey, Clirehugh and Sillar are consulting engineers to the new scheme.

**Brighton.**—The Council have adopted the scheme for lighting the electric tramway routes by 107 arc lamps.

**Cardiff.**—The engineer and manager of the electric lighting department (Mr. N. Appelbee) tendered his resignation to the Electrical committee on Wednesday on his appointment to the position of borough electrical engineer at Ashton-under-Lyne. The resignation was accepted, and it was agreed to liberate Mr. Appelbee at the end of the year. Afterwards the question of the appointment of a mains superintendent was considered. There were 30 applications, and among the candidates was Mr. Henry Pengelly, who for 6½ years had occupied the position, but who resigned some months ago. This led to a protest from some of the members, but the chairman (Ald. P. Carey) pointed out that now Mr. Appelbee was leaving it was desirable that the town should secure the services of someone with a knowledge of the network of mains. He moved that Mr. Pengelly be one of the selected candidates. The resolution was lost, only the proposer and seconder (Councillor Thomas) voting for it. It was then agreed to invite the following three applicants to appear before the committee at the next meeting: Messrs. E. Jones (Cardiff), at present acting as mains superintendent; B. Croft (British Electric Traction Co.); and J. Anderson (Walton-on-Naze).

**Cathedral Lighting.**—The choir and Ladye Chapel of York Minster have been supplied with an electric lighting installation by a local contractor, Mr. Pepper. There are in all 170 32 c.p. lamps.

**Chester-le-Street.**—The Council have approved the scheme of the United Kingdom Tramways and Light Railway Syndicate to construct an electric railway to connect the Hettons by Houghton-le-Spring, Newbottle, Painshaw, and Washington with Gateshead and Tyneside.

**Colwyn Bay.**—Electric current is being supplied for public lighting.

**Court of Common Council (London).**—At yesterday's meeting Ald. KNIGHT asked the Chairman of the Streets committee how much longer the public were to be inconvenienced by the laying of the telephone cables of the Post Office? Mr. HUDSON said it was a matter for the Post Office, not for the Streets committee. Mr. BROOKE-HITCHING asked what steps the committee had taken with a view to inducing the National Telephone Co. and the Charing Cross and City Electric Co. to lay their wires and mains at the same time as the Post Office? Mr. HUDSON: A telephone company has no power to open the streets. We cannot force the Electric Lighting Co. to proceed with any greater speed.

The Streets committee presented a report relative to the opening of the public ways of the City by companies and persons having statutory rights, and recommending that an order be passed that all works which entail interference with the public ways of the City be in future carried on continuously day and night until completed. The report was agreed to, and referred back to the committee, so that notice of the decision might be given to the parties concerned, including the Post Office.

The Streets committee submitted, and the Court approved, the amended duties of the electric inspector under the City of London

Electric Lighting Orders 1890, 1891, and 1899; also those of the electrical engineer to the Corporation.

The Streets committee also presented a report relative to the present system of dealing with dust and refuse from the City. Mr. BROOKE-HITCHING asked that the consideration of the matter be adjourned. A MEMBER suggested that the City of London Electric Lighting Co. should be approached with a view to their taking the whole of the City refuse of a combustible nature. The consideration of the report was postponed.

**The Accident on the City and South London Railway.**—Major Pringle has issued his report on the accident which occurred between London Bridge and Bank stations on the City and South London Railway on Sept. 26. Owing to the failure of an armature a train, consisting of a locomotive and three passenger coaches, came to a standstill. The following-up train came on to the same block section and collided with the rear of the train temporarily incapacitated. The inspector reports that the following-up train driver and his assistant were responsible for the collision, for, though the tail lights of the stationary train were visible 67 yards, neither the driver nor his assistant observed them. The inspector therefore concludes that no proper look-out was kept.

**Edinburgh.**—The Electric Lighting committee decided on Tuesday to recommend the Council to apply for sanction to borrow £76,000 further for electric lighting extensions. With this sum the total expenditure on electricity supply will amount to £700,000.

**Electric Lighting Notices.**—Notice of intention to apply for provisional orders has been given by the following:—

*Local Authorities.*—Dorchester, Todmorden, Pudsey, Waterford and Workington Corporations, and Barry, Benwell and Fenham, Blackrock (Co. Dublin), Cannock, Crompton, Dungannon (Ireland), Frome, Goole, Hampton, Hoddesdon, Honley (Yorks.), Llandaff and Dinas Powis, Croydon (for Mitcham), Neath, Pontypridd, Tredegar, Trowbridge, Ware, Wellingborough and Worsley District Councils; Marylebone Borough Council (for Marylebone, London); Bromley Rural DistrictCouncil (for Foot's Cray and part of Chislehurst), and Croydon, for the rural district of Croydon in Mitcham.

*Companies, &c.*—Aberdare Electric Lighting Co. (Ltd.) for Aberdare; Messrs. G. G. Brodie, C. Steer, and W. Whitehouse for Bromsgrove; Mr. E. W. J. Peterson for Carnarvon; County of Surrey Electrical Power Distribution Co. for Dorking; County of London and Brush Co. for Deptford; Isle of Wight Electric Light and Power Co. for East Cowes; Isle of Thanet Electric Railways and Lighting Co. for Isle of Thanet Rural District and Garlinge, Northdown and St. Peter Extra (Kent); Marylebone Electric Supply Co. for Marylebone (London); Electrical Power Distribution Co. for Neath, Briton Ferry and Aberavon, and for Macclesfield; Urban Electric Supply Co. for Newbury; Midland Electric Corporation for Power Distribution to extend area of supply under the company's 1898, 1899 and 1900 orders by adding Perry Barr, Tettenhall and Great Barr (Staffs.) and Lye and Wollescote and Stourbridge (Worcs.); Mr. C. Chadwell for Rishton, Great Harwood and Newton-le-Moors (Lancs.); St. Austell and District Electric Light and Power Co. for St. Austell; Messrs. J. D. Milburn, A. Scholefield, C. W. Fairweather and C. S. Vesey Brown (carrying on business as the Northern Counties Electricity Supply Co.) for Shildon, Handsworth (Yorks.), Benfieldside (Durham), Consett, Annfield Plain, Norton, Thornhill, Alnwick and Pickering; County of Kent Electrical Power Distribution Co. for Sittingbourne; North Metropolitan Electrical Power Distribution Co. for Stoke Newington (London) and Rickmansworth; Richmond (Surrey) Electric Light and Power Co. for Teddington, Hampton, Hampton Wick and Ham, and for Heston and Isleworth; and the British Electric Traction Co. for Warwick.

In the following cases procedure by bill has been decided upon:—

*Barrow-in-Furness* Corporation seek powers in their omnibus bill to prohibit or regulate the erection of overhead electric wires to provide for the lighting of private streets, &c.; *Blackburn* Corporation to supply electric current within the gas and water limits; *Dover* Corporation to acquire undertakings of Dover Electricity Supply Co. and Dover Gas Co., and to supply electricity, gas, &c., for all purposes; *Lowestoft* Corporation to sell or let on hire electrical fittings, motors, &c., to supply electricity, and to alter date of filing electricity accounts; *Mansfield* Corporation to erect electricity generating station, to supply current for public and private lighting in district and to neighbouring authorities, to let fittings and motors on hire, to alter date of rendering accounts, &c.; *Smethwick* Corporation to supply electrical fittings and motors on hire, to supply electricity outside borough, and to alter date of making up accounts, &c.; *Southend* Corporation to borrow money for electric lighting and tramway undertakings, to enlarge powers under provisional order (1891), and Light Railway Order (1899), to suspend repayment of capital for electric lighting, light railway and other purposes until completion of work; *Wigan* Corporation to sell or let on hire electrical fittings or motors, to supply electricity within and beyond borough, to alter date of filing accounts, &c.; *Rugby* District Council to amend Rugby Electric Lighting Order (1899), to authorise supply of electrical fittings, and to supply electrical energy to adjacent local authorities or companies; *Dover Gas Co.* to alter name of company, to acquire undertaking of the Dover Electricity Supply Co., and to exercise powers, &c., of that company.

Bills are being promoted to incorporate company to establish generating works and to supply electricity in bulk or otherwise in the county of Durham and the North Riding of Yorkshire; to incorporate a company to establish works for the supply of electricity in bulk in the counties of Nottingham and parts of the county of Derby, to acquire land in Colwick (Basford), Sookholme (Skegley), and Newbold and Denton (Derby), and Trowell (Basford) for generating stations, &c.; to incorporate a company to establish generating stations and to supply electricity for all purposes in parts of the West Riding of Yorkshire, to acquire lands in Mothley, Adwick-upon-Dearne, Thornhill and Bingley for generating stations, and to supply electricity in bulk to companies and local authorities, &c. (This project partly covers the area set out in the bill of the South Yorkshire Co., some particulars of which appeared in our last issue.)

**Electric Traction Notices.**—The following notices of intention to apply for electric traction powers are issued:—

*Provisional Orders.*

Folkestone, Liverpool (additional tramways) and Swindon Corporations, and Birkdale, Cheriton, Crompton, Littleborough, Pontypridd and Royton District Councils seek authority to construct and electrically equip tramways, &c. The Middleton Corporation and Chaderton District Council are also applying for an order to construct and work electric tramways, to attach wires, &c., to houses, to enter into agreements with local authorities, companies, &c.

The United Tramway, Light Railway and Electrical Syndicate for Normanton, Whitwood, Castleford, Pontefract, &c., in West Yorks.; Leamington and Warwick Tramways and Omnibus Co. to re-construct and electrically equip existing tramways, alter gauge, &c.; British Electric Traction Co. to alter and equip existing tramways in Pontypridd and Rhondda Valley, and vary purchase provisions of Tramways Act (1870), &c.; Weston-super-Mare and District Electric Supply Co. to construct electric tramways and to abandon certain authorised lines, &c.

In the following cases it has been decided to proceed by bill:—

London County Council to construct additional tramways, to reconstruct and adapt existing tramways for electric traction, to enter into agreements with companies, local authorities, &c., and to acquire land for generating station at Camberwell.

Blackburn Corporation to construct new and reconstruct existing tramways, to obtain running powers over light railways in adjacent districts, &c.

Blackpool Corporation to construct new electric tramways, &c.

Bolton Corporation to construct new electric tramways, to attach poles, wires, &c., to houses, to purchase, work, or lease tramways outside borough, to run omnibuses and motor cars, &c.

Bradford Corporation to construct new tramways in Bradford and Drighlington, to apply mechanical traction, to enter into agreements with adjacent authorities, to work or lease tramways in adjacent districts, &c.

Derby Corporation to construct tramways in Derby and adjacent districts, to run motor cars and omnibuses within and beyond borough, to attach wires and posts to houses, &c.

Dover Corporation to construct additional tramways, to run omnibuses within and beyond borough, &c.

Eccles Corporation to construct new and reconstruct existing tramways, to employ electric traction, to enter into agreements with local authorities, &c.

Folkestone Corporation to construct tramways in Folkestone and Folkestone-next-Sandgate, to adopt electrical or other mechanical traction, to acquire, sell and lease tramways within and without the borough, &c. (The Corporation has also given notice of application for a provisional order.)

Hull Corporation (in an omnibus bill) to construct and work additional electric tramways, to run omnibuses within and beyond city, &c.

Kingston-on-Thames Corporation to construct, work, or lease tramways, to adopt electric traction, to enter into agreements with local authorities, light railway and tramway companies, &c.

Leeds Corporation to construct additional tramways, &c.

Lowestoft Corporation to construct electric tramways in district, to enter into contracts with the National Electric Traction Co., the East Anglian Light Railways Co., &c.

Manchester Corporation to construct and work additional tramways, &c.

Smethwick Corporation to construct and work electric tramways within and beyond borough, to acquire running powers over tramways of adjacent authorities and companies, &c.

Wigan Corporation to construct and work tramways in Wigan and Standish-with-Langtree, &c.

King's Norton and Northfield District Council to construct electric tramways, to sell or lease tramways, to enter into working agreements, &c.

City of Birmingham Tramways Co. to construct tramways in Birmingham, King's Norton, and Northfield, to adopt electric traction, to reconstruct existing lines, to extend time for completion of tramways authorised by the Company's Act, 1897, to enter into agreements with local authorities, &c.

British Westinghouse and Manufacturing Co. are promoting a bill for power to enter into agreements and arrangements with respect to the adaptation of the railways of the Metropolitan and Metropolitan District Railway Companies, and a portion of the railway of the London and South Western Railway Co. for working by electric traction, to acquire lands for generating stations, to enable the Metropolitan and Metropolitan District Companies to raise additional capital and apply funds, to authorise the temporary suspension of running powers of other railway companies, to revive and extend time for acquiring lands and construction of works authorised by the Metropolitan and District Railway Acts, 1897 and 1900, and the Metropolitan Railway Act of 1898, &c.

City and Brixton Railway Co. to extend time for purchase of lands and further capital powers, to enter into agreement with City and South London Railway Co., &c.

City and South London Railway Co. to construct a subway for foot passengers from the Angel station to Agricultural Hall, Islington; to extend time for completion of works, &c.

London United Tramways Co. to construct electric tramways in the counties of London, Middlesex and Surrey, to acquire lands for generating stations, &c. The new lines include one from the London county boundary at Roehampton, across Barnes Common, over Hammersmith Bridge to the Broadway, a connection from the same point with the existing tramway in Kew-road; a line commencing by Hampton Court Palace, and including Kingston in its route; and other lines which will connect the system with Hampton, Hampton Wick, Teddington, Twickenham, Surbiton, Isleworth, Brentford, Old Brentford, Ealing, Heston, and Hounslow. There are in all 20 separate tramways.

Metropolitan District Railway Co. seek powers to convert their lines into electric railways, to construct and equip generating stations, to purchase and adapt rolling stock, plant and motors for electric traction, &c., to provide that all companies using the railways of the company shall use electric traction on a system to be prescribed by the company, and to adapt their rolling stock for haulage by electric traction, &c. Also to enable the company to enter into agreements with local authorities or companies for the supply of electrical energy.

Portsmouth Street Tramways Co. ask powers to construct additional tramways in Gosport and Alverstoke, to adopt electric traction, to postpone date of purchase under Tramway Act (1870), &c.

South Lancashire Tramways Co. seek powers to extend the electric tramway system authorised last year. The lines already sanctioned commence at Eccles and terminate at the borough boundary of St. Helens. The line then passes over the 22 miles of track belonging to the Corporation of St. Helens, and of the Prescot and Liverpool Light Railway, proceeds to Knotty Ash, at the boundary of Liverpool, where it joins the Corporation system. The aggregate length of the lines is 107 miles, and will establish unbroken tramway communication between Liverpool and Manchester. It is now proposed to extend the system northwards to Darwen and thence to Blackburn, and southwards to Warrington. These extensions will add another 24 miles to the system already authorised, and establish a continuous network of electric tramways to a total length of over 130 miles. The generating station will be erected at Leigh, and the resident engineer will be Mr. A. H. Gibbings, late borough electrical engineer of Bradford. A company has been formed to take over the privileges conferred by the several acts for tramways and light railways, and to combine the whole into one undertaking to be known as the South Lancashire Electric Traction and Power Co. (Ltd.). The capital will be £850,000 in shares and £750,000 in mortgage debentures.

Worcester Tramways Co. to construct new and reconstruct existing tramways, to employ electric traction, &c.

Powers are sought to incorporate a company to construct electric tramways in Finchley and Hendon, to enter into agreements with the Charing Cross, Euston, and Hampstead Railway Co., &c.; also to incorporate a company to construct an electric (express) railway between Liverpool and Manchester; to incorporate a company to construct an underground electric railway from the terminus of the City and South London Railway at the Angel, Islington, to Drummond-street, St. Pancras; to incorporate a company to construct electric tramways in the Tyneside district, including Newcastle, Tynemouth, Walker, Wallsend, &c.; and to incorporate a company to construct and work electric tramways in Scarborough and district.

The following are bills for joint powers for tramway and lighting:—

Bexley District Council to construct electric tramways in Bexley, East Wickham, Crayford, Dartford, Woolwich, &c., to supply electricity in bulk outside the district, to supply electric fittings, motors, &c., on hire, &c.

Shipley District Council to construct new and reconstruct existing tramways, to adopt electric traction and to supply electricity for public and private lighting, electric fittings, &c.

Stalybridge, Hyde, Mossley and Dukinfield Councils are promoting a bill to incorporate a joint board consisting of representatives of the four Corporations to construct and work electric tramways, to supply electricity for all purposes, electric fittings, &c., on hire, to vest the Hyde and Dukinfield electric lighting orders in the board, to acquire lands for generating stations, &c.

Willesden District Council to construct and work electric tramways, to enter into agreements with Paddington Tramways Co., to obtain running powers over proposed light railways of the Middlesex County Council, &c., to supply electricity to neighbouring districts for traction, and also supply electrical fittings, &c., on hire, electric current to neighbouring districts for lighting and traction, to alter date of filing accounts, &c.

Wimbledon District Council seek powers to supply electricity within and beyond the district, electric fittings and motors on hire, to construct and work electric tramways in Wimbledon, Merton and Mitcham, to work or lease tramways, to run omnibuses, &c.

By another bill power is sought to acquire the undertaking of Portmadoc, Croesor and Beddgelert Tram Railway Co., to construct new railways to Beddgelert and Llyn Gwynant and to Trefiys, to adopt electric or other mechanical power, to generate and supply electricity for all purposes in Ynyscynhiaiarn, Criccieth and Beddgelert (Carnarvon), Llanfrothen (Merioneth), &c.

Other bills seek to incorporate a company to construct electric tramways in Watford and district, to supply electricity in bulk to other companies or local authorities, to acquire lands compulsorily, &c., and to incorporate a company to construct electric tramways in West Cumberland, including Cleator Moor, Whitehaven, Cockermouth, Maryport, Workington, &c., and to acquire lands for erecting works for supplying electric current in Hensingham, Moresby, Distington, Workington, Stamburn, &c.

The following are bills for miscellaneous purposes:—

To incorporate a company to construct works for the supply of gas and electricity for all purposes in Arlesley and other districts in Bedfordshire.

Harpenden Gas Light and Coke Co. seek powers (*inter alia*) to apply for a licence or provisional order under the Electric Lighting Acts (1882 and 1888), to acquire works and machinery for generation and supply of electric current.

Another bill seeks to incorporate a company to construct an electrically-operated bridge across the river Tyne, some particulars of which appeared in our last issue.

The District Messengers and Theatre Ticket Co. seek powers to establish offices in London within 6 miles of the General Post Office, and to connect such offices telegraphically or telephonically with each other, to erect and maintain between such offices wires, call boxes, &c., to enable subscribers to transmit certain messages, &c.

**Electric Omnibuses.**—It is stated that arrangements are in progress for starting a service of electric omnibuses between Beauvais and Breteuil and between Claremont and Crèvecœur (Oise), France.

**Electric Railways in Spain.**—A project has been brought forward by a Barcelona engineer for the construction of an electric railway from Lerida (Spain) to the French frontier, water power being utilised to generate current. It is stated that a German company has offered to finance and construct the line if the necessary concessions can be secured.

**Electrolytic Treatment of Ores.**—An interesting report on the mining and metallurgical industries of Montana, U.S.A., has been issued, and, among other questions, deals with the application of electrolytic processes to the separation of the precious metals and their refining by electrolysis. In the first place, reference is made to the great advance of the Butte district of Montana during the past 20 years. The total area of this district is only 2 sq. miles in extent, but is covered with a perfect network of mineral veins. The famous Anaconda mine was discovered in 1882, and was purchased as a silver mine. On reaching a depth of 200ft. copper in considerable quantity made its appearance, and thousands of tons of copper ore containing over 50 per cent. of the metal have been won since that time. At first the matte or regulus was sent to Baltimore and the United Kingdom for smelting and refining. Later, a large plant was installed at Anaconda, probably the most extensive smelting city in the world at the present time. These old smelting methods have given place to one which converts the matte direct to metallic copper in Bessemer converters, and the product is then treated electrolytically for the separation of the precious metals. In 1899 the whole of the gold and silver credited to the Silver Bow County was obtained by electrolytic treatment, from 2oz. to 4oz. of silver and small quantities of gold being obtained from each ton of ore treated. The quantity of gold found previous to the introduction of the electrolytic process was considered of no practical value. The electrolytic branch of the mining industry in the United States dates back only a few years, yet at Dec. 31, 1899, there was established in the country 11 electrolytic copper refineries of a total annual capacity of 198,600 tons of copper, 170,273oz. of gold, and 21,190,200oz. of silver, having an approximate value of £16,000,000.

**Essex Manufacturers' Exhibition.**—There is to be an installation of Marconi's system of wireless telegraphy at the Essex Manufacturers' Exhibition, to be held in the Shire Hall, Chelmsford, on Dec. 12, 13, and 14. The exhibition is in aid of the Essex Disabled Soldiers' Fund.

**Eston (Middlesbrough).**—The Council have decided to approach Messrs. Bolckow, Vaughan & Co. in order to obtain a supply of electric current for public lighting. It is probable that the South Bank Council will also make a similar application. Messrs. Bolckow, Vaughan & Co. possess an electricity generating station which cost over £40,000.

**Gibraltar.**—In 1899 the revenue from the electric light works established here in 1898 realised approximately £4,300, maintenance charges being about £4,649, with an additional £714 for interest on capital expenditure. For the street lighting, for economy's sake, the old gas fittings were at first adapted for the electric light, but the result was voted unsatisfactory, and a delay in the service occurred in consequence until proper electric fittings were substituted, which has now been done. The demand for electric current has already necessitated a considerable increase in the generating plant at the King's Bastion station.

**Heywood (Lancs.).**—An inquiry has been held into the application of the Council to borrow £17,000 for electric lighting and £5,438 for refuse destructor works.

**Inquest.**—An inquest concerning the death of Albert Edward Shirley, who was killed in a boiler explosion which occurred on Nov. 21 at the Metropolitan Electric Supply Co.'s Sardinia street station, was held on Wednesday:—

Mr. R. R. Todd, engineer-in-chief, said it was difficult to form a decided opinion as to the cause of the explosion, but he thought there was an original defect in the weld of the tube, which had become weak to bursting point by natural deterioration. As to the question of what was a proper test of a boiler he did not think any harm could be done to a boiler by a

periodical test up to about one and a half to one and three-quarter times the working pressure. The jury returned a verdict of accidental death, and exonerated the makers of the boiler from all blame. They added a rider to the effect that they thought there should be a proper inspection of all boilers by the Government.

**Kingston-on-Thames.**—At a ratepayers' meeting a resolution was passed in opposition to the proposed municipal tramway scheme, but the Corporation were at the same time requested to oppose the bill of the London United Tramways in order to insert protective clauses.

**Lancaster.**—An inquiry was held here on Tuesday into the application of the Corporation to borrow £14,700 for refuse destructor works. Property close to the electricity works had been purchased for £5,750, and the contract for "Meldrum" destructors amounted to £5,275, the balance being for buildings and future contingencies. The steam generated at the destructor works is to be utilised at the electricity station.

**Leeds.**—The Lighting committee recommend the Council to accept tenders amounting to £72,572 for extending their electricity works. The existing station is to be extended by including the site of the Britannia Mills, which have been demolished and the site cleared. Tenders are to be invited for machinery for the new buildings. The committee also recommend the provision of a third 600kw. two-phase set, and the laying of a main across Monk Bridge to supply current for light and power to the district south of the river.

**Leyton.**—Sanction has been obtained for the borrowing of £14,467 for various improvements, including the adaptation of the gas lamps for electric lighting.

**Light Railways.**—The following local authorities and companies are applying for powers to construct and work light railways:—Barton-upon-Irwell; Croydon (for Croydon and Mitcham); Dartford (for Dartford and Crayford) and Halesowen Councils; British Electric Traction Co. (for Glamorgan, and to extend to the Rhondda Valley Light Railways Order, 1900); Brunner, Mond & Co., J. H. Holden and J. Hesketh (for Warrington and Northwich and district); Isle of Thanet Electric Tramways and Lighting Co. (to amend and extend the Isle of Thanet Light Railway Order, 1898); Lizard Light Railway Co. (asking for extension of time); Mid-Suffolk Light Railway Co. (to amend the Mid-Suffolk Light Railway Order, 1900); North Wales and District Light Railway and Electric Power Syndicate (for Pwllheli, Nevin and Porthdinlleyn); Potteries Electric Traction Co. (extensions); Sandgate and Hythe Electric Co. (for Sandgate, Cheriton and Folkestone); Worcester Tramways, (Ltd.) (for Worcester and district).

The Brackenhill Light Railway Order has been submitted to the Board of Trade for confirmation. Objections by Dec. 17.

The West Hartlepool Light Railways (Deviations, &c.) Order has also been submitted for confirmation. Objections by Dec. 17.

**Limerick.**—The Corporation have been successful in inducing the Local Government Board to sanction the loan for electric lighting. The Board now state that, in consequence of the representations of the recent deputation, the merits of the scheme, and the margin of borrowing powers available, they have decided to sanction the loan, to be raised in instalments of £7,000, £5,000, £5,000, and £5,000. Application is to be made to the Commissioners of Public Works for the loan.

**London County Council.**—At Tuesday's meeting the Highways committee reported that Dr. A. B. W. Kennedy had submitted a description and drawings of the system of electric traction which he had devised and recommended should be adopted for the three lines of tramway authorised under the Council's act. After full consideration the committee had approved Dr. Kennedy's proposals, and recommended that the Council approve the scheme for use on the tramways between (*a*) Westminster Bridge-road and Upper Tooting-road, (*b*) Kennington Park-road (at its junction with Kennington-road) and the terminus in Blackfriar's-road, and (*c*) St. George's-circus and the terminus in Waterloo-road. Mr. BENN moved to insert the words "underground conduit" before the words "system of electrical traction," and this was agreed to. Mr. BOULNOIS, M.P., asked what would be the cost of the experimental line. Mr. BENN said it would be £15,000 per mile for single line. Recommendations were approved.

Mr. LEON asked whether the Highways committee were considering the many bills likely to be introduced into Parliament in the next few years with regard to underground electric railways. He thought the Council should consider whether they could not be made more useful by having them introduced on some system which would make them co-operate more than was likely to be done by private venture. Mr. BENN said the Council had little control over these underground electric railways. They could oppose the bills on the ground of applying some general system in the interests of London. That was an important matter. He did not know whether the Highways committee would take the initiative, but he would make inquiries and report to the Council.

**Manchester.**—The Manchester Tramways committee have appointed Mr. H. F. Parshall to report upon the present condition of the electricity undertaking, and especially in regard to the supply of electric current for traction. Mr. Parshall will supervise the work on the three tram routes now being relaid, the planning of the Stuart-street station, and a general control of the stations in Dickinson-street and Bloom-street.

**Newark.**—The Council have acquired a site for electricity works at £1,900, and have instructed Mr. C. S. Vesey Brown to prepare plans and estimates for two schemes, one not to exceed £20,000 and the other £30,000.

**Newspaper Enterprise.**—As time goes on the number of leading journals which are able to issue jubilee and centenary numbers naturally increases. The latest to enter the lists of the latter category is the *Dundee Advertiser*, which in January will issue its centenary number. This will contain a history of the paper, of the people who have made it the important publication it has now become, and of the town in which it is published. The centenary number will detail the mechanical processes by means of which the paper has been produced for the past 100 years, and will show how slow was the rate of progress in this branch of industrial work prior to the advent of the rotary machine. So far as the *Dundee Advertiser* is concerned, this important advance dates from 1874, when a steam-driven Victory machine was introduced. The Victory was superseded by Hoe's machine in 1897. In 1896 commenced the introduction of electric driving, and now the steam and gas engines formally in use have been practically superseded by electric motors, which are used not only for driving the big machines, but are also installed in the stereotyping departments and for driving the linotype composing machines. There are still several Crossley gas engines remaining in use for some of the other branches of work carried on, and so the offices have three kinds of motive power in use—electric, steam and gas. The *Advertiser* buildings are a notable feature of Dundee.

**Nova Scotia.**—The Nova Scotian towns of Yarmouth, New Glasgow, Amherst, Picton, and Windsor have (a correspondent informs us) electric lighting plants installed. There is an abundance of water power all over the province, although of no large volume at any one place.

The Nova Scotia Telephone Co. has now 14 exchanges with 2,500 subscribers (not including private lines). The subscription to private subscribers is $10 per annum, and for the complete public service $25 per annum for private houses and $40 for business premises, with extra charges for trunk or long distance communications.

**Pacific Cable.**—We commented last week upon the general inaccuracy of the half-penny London press in connection with matters electrical, and gave the percentage of accuracy in such statements as one-fifth. We were too liberal, for this week the most enterprising of these journals publishes the information that a contract has been entered into with the Telegraph Construction and Maintenance Co. to manufacture and lay the Pacific cable for £17,950,000. The error here was a mere trifle of, say, £16,000,000.

**Paignton.**—A canvass of ratepayers is to be made to ascertain the support likely to be accorded the proposed electric lighting scheme of Mr. Paris Singer. Notice of intention to apply for a provisional order cannot be given for the next Session, but Mr. Singer proposes to apply later for parliamentary powers.

**Penny Postage.**—The Orange River and Transvaal colonies have been added to the British possessions which have adopted penny postage with the mother country and vice versa.

**Rhyl.**—The Council on Wednesday agreed to supply electric current to the Rhyl and Prestatyn Light Railway at 1½d. per unit up to 150,000 units per annum, and at 1¼d. per unit above that quantity. April 1, 1902, was fixed for the completion of the line.

**San Paulo (Brazil).**—As soon as the dam at the Tietê, 250m. in length and 17m. in depth, is completed, there will be a reservoir 8km. in length by 200 in breadth, situated 33km. from the city of San Paulo, available for supplying motive power for the use of this city. The whole of the hydraulic and electric plant has been installed, and Dr. Cooper, the engineer-in-chief, anticipates that the inauguration will take place early in February. San Paulo will then be supplied from this source with motive power for the street cars, lighting, and general industrial uses, the estimated power available being 16,000 H.P. per day of 10 hours. Col. Page Bryan, the American Minister to Brazil, together with the Admiral in command of the United States squadron in these waters, have just returned from a visit to the waterfalls of Tieté, and are expected shortly to make public their impression of the value of these falls for industrial purposes. The San Paulo Light and Power Co., with a capital of £1,000,000 sterling, is financed by Canadian capitalists. It is unfortunate that the English syndicate, which, we understand, was offered the concession now worked by the company, could not be induced to take the matter up. However, Brazil is a country of great natural resources with a great future. Up to the present its

extensive available water power remains practically undeveloped. An Englishman, residing in the country and well acquainted with the State of San Paulo, Brazil, asks us to notify that he is willing to give particulars. Communications addressed to "J. S.," care of the publisher of *The Electrician*, will be forwarded.

**Sheffield**.—The Brightside electric tramway route was opened on Monday.

Ald. Styring has been re-elected chairman of the Electric Light committee.

**Swansea**.—Electric current was supplied from the Corporation electricity works for the first time on Thursday evening last. The Lighting committee have decided to give a supply to the Swansea Harbour Trust Estate, but terms have not yet been settled.

The Electric Lighting committee recently had under discussion the revised terms of the National Electric Wiring Co. for the wiring of premises on the "easy" payment system. Originally the company asked 1s. 4d. per lamp per annum, while the Corporation offered 1s., and as the company were now willing to accept the Corporation's offer, the chairman thought it desirable that the agreement should be carried out. It was decided to ask for more favourable terms.

**Swinton and Pendlebury**. The Lancashire Electric Power Co. have offered to supply the Council with electricity in bulk at a maximum rate of 2d. per unit, and an electrical engineer has been called in to report upon the offer.

**Switzerland**.—According to a report on British trade with Switzerland for 1899, the imports of electric generating machinery and apparatus into that country amounted to £100,000, of which Great Britain supplied only £2,000. The exports of electrical machinery from Switzerland show a great increase during 1899 over 1898, the machines being on order mainly for France, Russia, and Spain.

**Telegraph Extension in German East Africa**.—The estimate of the German Imperial Government for 1901 contain an item of £10,000 towards the expense connected with the beginning of the telegraph line which will connect Dar Es Salam, German East Africa, with Lake Tanganyika. This line will eventually form a connecting link in the Cape to Cairo telegraph system. At present it is only intended to construct the line to Mpapua, a distance of about 270 miles from the coast.

**Willesden (Middlesex)**. At the Council meeting, on Tuesday, it was reported that the engineer had received the bills of quantities in connection with the main and sub-electricity stations. The Council decided to apply for sanction to a loan of £52,550, for use as follows: Buildings, walls, sites, works, chimney shaft (main station), £36,104; tenants' compensation, £121; cost of road, £325; coal sidings, £12,500; offices and sub-station, £13,500. The surveyor's estimate was within £1,500 of the total amount.

**Workhouse Lighting**.—The Kensington (London) Guardians have adopted an electric lighting scheme for the workhouse, prepared by Prof. H. Robinson, at an estimated cost of £12,500. Prof. Robinson is to submit a complete plan and specification for the buildings, plant and machinery required. The estimated annual maintenance charge for the installation is put at £1,470.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Ayr* Tramways committee require tenders for the supply, delivery and erection of (Sec. 2) poles, centre and side brackets, section boxes, &c., and the complete overhead electrical equipment of the tramways; (Sec. 3), supply of feeders, distributors, telephone cables, conduits, trenching, &c., for underground work. Specifications, &c., can be obtained at the office of the Burgh electrical engineer, Electricity Works, Ayr, on and after Nov. 24, and tenders must be sent to Mr. A. G. Young, town clerk, Council Chambers, Ayr, N.B., not later than Friday, Dec. 7. An advertisement gives further particulars.

*Aberdeen* Electric Lighting committee invite tenders for the supply and erection of storage batteries. Specifications, &c., can be obtained of Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen, on and after Dec. 3, and tenders have to be delivered to Mr. Bell not later than noon of Dec. 22. An advertisement gives further particulars.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Further particulars are given in an advertisement, and specifications may be obtained from the town clerk (Mr. W. Marcus Wilkins), Municipal-buildings, Lavender-hill, S.W. Specification, &c., can also be seen at (but not obtained from) the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, and tenders, addressed to Mr. Wilkins, must be delivered before noon Feb. 1 next.

*Bristol* electrical committee require tenders for induced-draught plant, steam, electric, feed and general service pumps and water-softening plant. Further particulars are given in an advertisement, and tenders (addressed chairman of committee) must be delivered by noon of Dec. 20. Mr. H. Faraday Proctor is city electrical engineer.

*Swindon* Corporation invite tenders for the supply and erection of three steam dynamos, balancer, and motor generator. Specifications can be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's Gate, Westminster. An advertisement gives further particulars, and tenders must be delivered to the acting town clerk (Mr. Henry Kinneir), Town Hall, Swindon, Wilts., by Dec. 24.

The directors of the *Caledonian Railway Co.* invite tenders for the supply of various stores for six or 12 months from Feb. 1, 1901, including telegraph and electrical appliances, galvanised wire, india-rubber and asbestos goods, hardware, bolts and nuts, screws, &c. Further particulars are set out in an advertisement, and specifications may be obtained after Dec. 3 from the stores superintendent (Mr. Jas. Lorimer), Charles-street, St. Rollox, Glasgow. Tenders must be lodged with the secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by Dec. 17.

The directors of the *North Eastern Railway Co.* invite tenders for telegraph apparatus, telegraph wire and line stores for the six months ending June 30, 1901. Further particulars are set out in an advertisement, and forms of tender may be obtained from Mr. A. Graves, Telegraph Department, York. Tenders must be sent to the secretary (Mr. C. N. Wilkinson), by noon of Dec. 10.

The directors of the *Highland Railway* require tenders for various stores for six months from Jan. 1, 1901, including brass and copper plates, sheets, bars, copper and brass tubes, steel and iron castings, galvanised iron and steel wire, lead, oil, &c. Forms of tender may be obtained from the stores superintendent (Mr. C. Kennedy), Inverness. Further particulars are set out in an advertisement, and tenders must be lodged with the secretary (Mr. Wm. Gowenlock) by Dec. 12.

*Bexhill* District Council invite tenders for the supply and erection of water-tube boiler and pipework and a 150kw. steam dynamo. An advertisement gives further particulars, and specifications may be obtained after 26th inst. at the office of the consulting engineer (Mr. A. H. Preece), 13, Queen Anne's-gate, Westminster, S.W. Tenders, addressed to the clerk (Mr. E. Sholto Douglas), must be delivered at the Council offices, Bexhill, before noon of Dec. 10.

*Portsmouth* Corporation invite tenders for the permanent way construction and underground feeders in connection with the electrical equipment of their tramways. Specifications may be obtained from the tramways engineer (Mr. E. Rotter), and tenders must be delivered to the town clerk (Mr. Alexander Hellard), Town Hall, Portsmouth, by 10 a.m. of Dec. 7. An advertisement gives further particulars.

*Portsmouth* Corporation also require tenders for the overhead electrical equipment of the tramways in the borough and Cosham extension. Specifications may be obtained from the tramways engineer (Mr. E. Rotter), and tenders may be delivered to the town clerk (Mr. Alex. Hellard) by 10 a.m. Dec. 7. An advertisement gives further particulars.

The Visitors' committee for the County Asylum, *Winwick*, near Warrington, require tenders for wiring and fittings, &c. Specification may be obtained at the offices of the architects, Messrs. Crisp and Oatley and Mr. W. S. Skinner, Edinburgh Chambers, Baldwin-street, Bristol; and also from the clerk to the committee (Mr. J. P. Muspratt), County Offices, Preston, where tenders must be lodged by noon of Dec. 29. An advertisement gives further particulars.

As announced in an advertisement, the *Rathmines* District Council require tenders for boiler-house and engine-house plant, condensing apparatus and pipework, switchboard extension, mains, and public incandescent lighting. Specification may be obtained (by manufacturers) at the offices of the consulting engineer (Mr. Robt. Hammond), 64, Victoria-street, Westminster, London, S.W., after Dec. 6. Tenders, addressed to the clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, Co. Dublin, must be delivered by 4 p.m., Jan. 11.

*Oldham* Electricity committee require tenders for an ejector-condenser and two motor-driven circulating pumps. Specification, &c., can be obtained from the superintendent (Mr. A. Andrew), Gas and Water Offices, Oldham, and specifications and drawings can also be seen at (but not obtained from) the office of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W. An advertisement gives further particulars, and tenders must be sent to Mr. Andrew by Dec. 18.

*Wakefield* Corporation require tenders for a 550 H.P. high-speed triple-expansion enclosed engine and a 400kw. direct-driven alternator. Specifications may be obtained from the electrical engineer (Mr. R. Blackmore), Corporation Electricity Works, Calder Vale, Wakefield, and tenders must be addressed to the town clerk (Mr. Chas. Jas. Hudson) before Dec. 14. An advertisement contains further particulars.

*Ilford* School Board invite tenders for wiring and fitting (for about 200 16 c.p. lamps) their Melbourne-road Higher Grade School for the electric light. Specification may be obtained of the architect (Mr. C. J. Dawson, F.R.I.B.A.), 7, Bank-buildings, Ilford, and tenders must be sent to the clerk (Mr. W. J. Rendall Moore), solicitor, School Board Offices, Cleveland-road, Ilford, by 4 p.m., Dec. 17. An advertisement gives further particulars.

*Fulham* (London) Guardians require tenders for wiring the Children's Home. Forms of tender may be obtained from the architect (Mr. A. Saxon Snell), 22, Southampton-buildings, Chancery-lane, W.C., and tenders must be delivered to the clerk (Mr. E. J. Mott) by 10 a.m. Dec. 20. An advertisement gives further particulars.

*Trimdon Grange* Colliery Co. (co. Durham) require tenders for various stores, including electric light fittings for 12 months. Tenders to Messrs. Walter Scott (Ltd.), Trimdon Grange Colliery by Dec. 14.

*Dublin* Electric Lighting committee invite tenders for erecting electricity station buildings and chimney shaft at the Pigeon House. Tenders by Dec. 13.

The *Metropolitan Asylums Board* require tenders for wiring the new asylum at Tooting Bec. Tenders by Jan. 2.

*Reigate* Corporation require electricity meters. Tenders by Dec. 19.

*Leigh* Corporation require tenders for mains, motors and starting switches, and about 1,000 220-volt incandescent lamps. Tenders by Dec. 17.

*Hendon* Urban District Council invite tenders for the supply and erection of electricity generating plant and apparatus. Tenders to Clerk to Council, Public Offices, The Burroughs, Hendon, by 4 p.m. Dec. 31.

Borough of *Southwark* (London) require tenders for certain back E.M.F. cells. Tenders to Mr. L. J. Dunham, acting town clerk, Town Hall, Walworth-road, S.E., before noon Dec. 3.

*Blackpool* Corporation require tenders for arc lamp carbons and oils for one year. Tenders to Borough Electrical and Tramways Engineer by Dec. 17.

*Manchester* Tramways committee invite tenders for 12 workmen's electric tramcar bodies. Tenders to Chairman by Dec. 1.

*Birkenhead* Corporation invite tenders for a switchboard and instruments for the Craven-street generating station. Tenders to town clerk (Mr. Alfred Gill), Town Hall, Birkenhead, by 4 p.m. Dec. 4.

The directors of the *Great Northern Railway Co.* invite tenders for supply of new, and purchase of old, stores for 12 months from Jan. 1. A list of the contracts and forms of tender may be obtained from the stores superintendent (Mr. Weeks), Doncaster. Tenders to Stores committee, King's Cross, London, N., by Dec. 4.

*Partick* Burgh Commissioners require tenders for electricity meters, demand indicators, and fuses. Tenders to Town Clerk, 97, West Regent-street, Glasgow, before noon Dec. 4.

Trustees of Hightown Wesleyan Church (*Crewe*) require tenders for electric lighting of church. Tenders to Town Clerk by Dec. 10.

*Brighton* Corporation invite tenders for points and crossings, sole plates, manhole covers, tie bars, fish bolts, &c. Tenders by Dec. 6.

*Brighton* Corporation also require tenders for the construction of the permanent way of their electric tramways. Tenders by Dec 13.

*Kendal* Corporation invite tenders for electricity generating plant, &c. Tenders to town clerk's office by Dec. 8.

*Copenhagen* Corporation require tenders for three 530kw. dynamos, switchboard, &c. Tenders by noon of Jan. 3.

Tenders are invited until Dec. 20 by the *Chinchilla* (Spain) municipal authorities for the concession for electric lighting for 20 years. Tenders to El Secretario del Ayuntamiento.

*Kertsch* (Russia) Municipal Council require tenders for electric tramway concession. Tenders to Banque de Commerce de l'Azoff Don, Kertsch.

## TENDERS RECEIVED AND ACCEPTED.

In our issue for Oct. 26, we gave a list of successful tenderers for the plant, apparatus and material required for the Durban Corporation electric tramways. These tenders were advertised in *The Electrician* for June 8, and on June 15 an extension of time for sending in tenders was notified. *Industries* (published at Durban) of Oct. 18 publishes the complete list of tenders sent in. Parts A and B of the contract, which have been secured by Messrs. Macartney, McElroy & Co. for a total sum of £35,594. 10s. 10d., consist of (A) poles and overhead equipment, (B) electric motor cars; and Part C, which has been secured by Messrs. Dick, Kerr & Co., for £26,240. 10s. 10d., is for steam and electric generating plant. Babcock and Wilcox boilers and Yates and Thom engines are to be used. There are to be 22 double-deck cars, having each accommodation for 50 passengers. These cars are specially designed for a semi-tropical climate. Our South African contemporary regards the number of tenders received as evidence that the terms of the contract and the conditions of the specification met with generally favourable consideration from British contractors. Prior to the preparation of the specifications (which were drawn up by the Durban borough engineers) Mr. J. Roberts, borough electrical engineer, personally inspected the principal power stations in England and America.

The following firms tendered for Part C only :—

| | |
|---|---|
| Mather and Platt, Manchester | £23,176 0 0 |
| Davey, Paxman & Co., Colchester | 23,452 15 0 |
| Ditto ditto (alternative) | 27,001 10 0 |
| Clayton Engineering Co., Manchester | 24,313 1 6 |
| D. Stewart & Co., Glasgow | 27,568 10 0 |

| *Durban.* Tenderers. | Time of completion in months. | No. | Part A. | Part B. | Total A and B. | Part C. | Total contract. |
|---|---|---|---|---|---|---|---|
| Lowdon Bros. & Co., Dundee | ... | 1 | £17,287 0 6 | £15,905 0 0 | £33,192 0 6 | £21,337 0 0 | £54,400 0 0 |
| Ditto ditto | ... | 2 | " | 16,015 0 0 | 33,302 0 6 | ... | ... |
| Reunert and Lenz, Durban and Johannesburg | 10 to 12 | 1 | 16,427 13 3 | 18,300 0 0 | 34,727 14 3 | 22,850 0 0 | 56,577 0 0 |
| Ditto ditto | ... | 2 | " | 22,150 0 0 | 38,577 14 3 | 23,600 0 0 | 61,177 0 0 |
| J. G. White & Co., New York and London | 9 to 11 | 1 | 19,883 1 2 | 18,296 0 0 | 38,179 1 2 | 22,209 0 0 | 58,000 0 0 |
| Ditto ditto | ... | 2 | " | 18,120 0 0 | 38,003 1 2 | 22,209 0 0 | 57,824 0 0 |
| R. W. Blackwell & Co., London | 10 to 12 | 1 | 19,241 6 3 | 21,702 6 8 | 40,943 13 4 | 20,417 10 0 | 59,862 17 9 |
| Ditto ditto | " | 2 | " | 23,447 5 2 | 42,688 11 10 | 20,417 10 0 | 61,777 16 3 |
| Ditto ditto | " | 3 | " | 21,702 6 8 | 40,943 13 4 | 24,017 10 0 | 63,362 17 9 |
| Ditto ditto | " | 4 | " | 23,447 5 2 | 42,688 11 10 | 24,017 10 0 | 65,107 16 3 |
| Macartney, McElroy & Co., London | 12 to 14 | 1 | 16,994 10 10 | 18,600 0 0 | *35,594 10 10 | 25,255 0 0 | 60,849 10 10 |
| Ditto ditto | " | 2 | " | 18,820 0 0 | 36,814 10 10 | 25,2[illegible]5 0 0 | 61,069 10 0 |
| Brush Electrical Engineering Co., London | 12 f.o.b. | 1 | 18,947 12 0 | 23,498 0 0 | 42,445 12 0 | 24,175 0 0 | 66,620 12 0 |
| Ditto ditto | London | 2 | " | 22,376 0 0 | 41,323 0 0 | | ... |
| Crompton & Co. (Ltd.), London | 16 to 19 | 1 | 21,332 13 3 | 20,397 0 0 | 41,729 13 3 | 25,798 0 0 | 67,527 0 0 |
| Siemens and Halske, Durban | 11 to 18 | 1 | 25,379 0 0 | 19,534 12 0 | 44,913 12 0 | 23,742 0 0 | 68,600 0 0 |
| Ditto ditto | " | 2 | 23,008 0 0 | 19,534 12 0 | 42,542 12 0 | 23,742 0 0 | 66,129 0 0 |
| Dick, Kerr & Co., London | 8 to 11 | 1 | 22,096 0 0 | 22,424 0 0 | 44,520 0 0 | †26,240 10 0 | 70,598 0 0 |
| Ditto ditto | " | 2 | " | 23,165 0 0 | 45,261 0 0 | ... | ... |
| Ditto ditto | " | 3 | ... | ... | ... | 21,379 10 0 | 65,598 0 0 |
| ‡Hubert Davies and Spain, Durban | 10 to 12 | 1 | 18,457 6 9 | 24,226 0 0 | 42,683 6 9 | 26,628 0 0 | 69,311 0 0 |
| Ditto ditto | " | 2 | " | 22,730 0 0 | 47,187 6 9 | ... | |
| Reiners, Von Laer & Co., Port Elizabeth | 15 | 1 | 25,446 2 10 | 24,972 0 0 | 50,238 2 10 | 21,600 0 0 | 71,838 0 0 |
| British Schuckert Electric Co., London | ... | 1 | 26,839 17 10 | 21,950 0 0 | 48,789 17 10 | 28,725 0 0 | 76,500 0 0 |
| Ditto ditto | ... | 2 | " | 21,620 0 0 | 48,550 17 10 | ... | ... |
| Hamilton & Co., Port Elizabeth | ... | ... | 25,446 0 0 | 24,792 0 0 | 50,238 0 0 | 28,650 0 0 | 78,100 0 0 |
| Witting Bros., London (Electricité and Hydraulique) | ... | ... | 125,368 0 0 | 26,300 0 0 | 151,668 0 0 | 26,350 0 0 | 178,018 0 0 |
| George Hill & Co., Manchester | ... | ... | 26,625 14 0 | 23,050 0 0 | 49,676 14 0 | ... | ... |

* Accepted for A and B. † Accepted for C.

‡ Messrs. Hubert Davies and Spain also sent in eight alternative tenders for part C ranging from £24,010 to £30,723. 10s.

Devonport Corporation have accepted the following tenders in connection with their electricity supply undertaking :—

| | |
|---|---|
| A. H. Coles (buildings, exclusive of chimney and flues) | £5,433 |
| S. Z. de Ferranti, Ltd. (two vertical steam engines) | 3,200 |
| Electric Construction Co. (two generators, balancer, battery booster and motor) | 3,659 |
| Ditto (switchboard) | 2,922 |
| Ashmore, Benson, Pease & Co. (storage battery) | 2,600 |
| Higginbottom and Mannock (overhead 10-ton crane) | 326 |

Nine tenders were received for the buildings, 22 for the steam engines, generators, &c., 11 for the switchboard, and seven for the storage battery and crane respectively.

The following tenders were also recommended for acceptance :—

| | |
|---|---|
| Babcock and Wilcox (two boilers and mountings) | £1,950 |
| E. Bennis & Co. (stokers and automatic steam damper) | 535 |
| E. Green & Son (economiser) | 440 |
| Glenfield and Kennedy Co. (tanks and meter) | 274 |
| Carruthers & Co. (valve chest) | 60 |
| Mather and Platt (grease filter) | 70 |

The following tenders have been received by the London County Council for the supply of arc lamps for the Victoria Embankment and Westminster Bridge :—

| | £ | s. | d. |
|---|---|---|---|
| Gilbert Arc Lamp Co. | £2,209 | 18 | 6 |
| Ditto (alternative) (accepted) | 2,515 | 0 | 0 |
| General Electric Co. | 3,320 | 0 | 0 |
| Verity's Limited | 2,959 | 12 | 0 |
| Oliver & Co. | £2,910 | 11 | 6 |
| Ditto alternative) | 2,676 | 2 | 0 |
| Crompton & Co. | 2,598 | 0 | 0 |
| New Century Arc Light Co. | 2,330 | 0 | 0 |

The following tenders have been received for wiring the Glasgow Exhibition buildings :—

| | £ | s. | d. |
|---|---|---|---|
| Claud Hamilton, Ltd. (industrial hall) | £694 | 9 | 6 |
| Lowdon Bros. (machinery hall) | 327 | 0 | 0 |
| Ditto (grand avenue) | 214 | 17 | 0 |

Ayr Town Council have accepted the tender of Messrs. Siemens Bros. & Co. for the supply of a 200kw. steam dynamo (Belliss engine) at £2,505.

Aberdeen Gas and Electric Light committee have accepted the tender of the Johnson-Lundell Electric Motor Co. for a 420kw. set for the Dee Village electricity station at £3,990.

Wigan Corporation have accepted the tender of Messrs. A. Haacke & Co. for boiler and pipe covering.

Rhyl District Council have accepted the tender of Messrs. Thornton & Sons for erecting refuse destructor and electricity station buildings at £6,225.

Bristol Electrical committee have accepted the tender of the Electrical Power Storage Co. for a battery of E.P.S. cells at the Temple Back station, and that of Messrs. Higginbottom and Mannock for a travelling crane.

Messrs. H. M. Salmony & Co. (Ltd.), of 118 and 120, Charing Cross road, London, W.C., British representatives of the Elektricitats Aktien Gesellschaft vormals W. Lahmeyer & Co., report that a contract for generators and motor-dynamos for the Charing Cross and City Co.'s electricity supply station has been given to Messrs. Lahmeyer. The switchboard will be provided with Lahmeyer's patent switching gears, which are arranged in such manner that no high-tension current is on the main board itself. Even the instruments recording the high-tension current are so connected that they can be handled with perfect safety, as no high tension current reaches them.

## BUSINESS NOTICES.

The British Griffin Chilled Iron and Steel Co. (Ltd.) have removed their London offices from 18, St. Swithin's-lane to Cannon-street-buildings, 139, Cannon-street, E.C. Mr. W. Glenny Keagey, secretary of the company, has resigned, but continues his connection with the London offices of the New York Car Wheel Works at St. Swithin's-lane.

Messrs. A. G. Adamson and G. C. K. MacLennan (trading as Adamson Bros.), electrical engineers, 22, Christopher-street, Finsbury, London, E.C., have dissolved partnership. Debts by Mr. Adamson, who continues.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against W. Haines, electrician, &c., Bury New-road, Whitefield, Lancs., must be in by 11th inst. Mr. T. H. Winder, O.R., Exchange-street, Bolton, is trustee.

Claims against Geo. Bentley, electrical engineer, 63, Cross-lane, and 8, Grafton-street, Earlestown, Lancs. (formerly trading at 8, Market-street, Earlestown), must be in by Dec. 11. Mr. G. F. Clarke, 71, Cross-lane, Earlestown, is trustee.

Wm. Clapham Priestley, electrical engineer (trading as Priestley and Taylor), 35, Grove-street, and Birstal, Leeds, has executed a deed of arrangement. Liabilities £276. 9s., assets £27. Mr. S. R. Fuller, 36, Park-row, Leeds, is trustee.

A deed of arrangement has been executed by Geo. Margetts, electrical engineer, 53, Brown-street and 621, Rochdale-road, Harpurhey, Manchester. Liabilities £1,358. 18s., assets £1,406. 10s. 4d. The trustee is Mr. R. V. Critchley, 6, St. James-square, Manchester. The principal creditors are :—

| | |
|---|---|
| Moores, Farrell & Co. | £570 |
| Telegraph Manufacturing Co. | 227 |
| Dorman and Smith | 187 |
| Alley and McLellan | 142 |
| Veritys Limited | 52 |
| Johnson and Phillips | 51 |
| McClure and Whitfield | 27 |
| Crossley Bros. | £22 |
| Clayton, Turner & Co. | 18 |
| Penistone Electric Co. | 13 |
| British Thomson-Houston Co. | 12 |
| Chloride Elec. Storage Synd. | 11 |

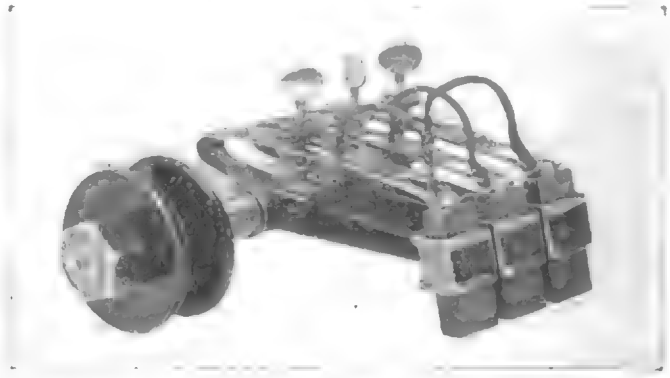
**Sale by Auction.**—Catalogues are now ready of the important sale by public auction, by Messrs. Wheatley Kirk, Price & Co., at Oldbury, near Birmingham, of the freehold land and works lately in the occupation of the Aluminium Co. (Ltd.), whose business has been removed to Weston Point, near Runcorn. The works are situate 5½ miles from Birmingham, and adjoin the Great Western Railway. The position is in the midst of an important industrial district, and the centre of the Staffordshire coal and iron industry. A long canal frontage, with private basin, is also available. The catalogue contains general views of the buildings and a coloured plan.

At the conclusion of the sale of the land and works, the auctioneers will dispose of the valuable and modern electric lighting and power plant, engines, boilers, pumps, dynamos, combined light and power shafting and miscellaneous stock and stores, &c., at present installed. The 250 lots which this part of the catalogue describes, include Willans, Robey and other engines; Danks, Babcock and Wilcox, and other boilers; Crompton, "Castle," "Manchester" and other dynamos and accessories. A number of photographs of the machinery are given in the catalogue, and indicator diagrams of the engines are also shown, making the publication a useful guide to intending buyers. This is one of the most important sales of high-class machinery in excellent condition that has been held for some years, and it is anticipated that an influential class of buyers will be attracted to Oldbury. The sale takes place on Wednesday, Dec. 5, at 10 for 11 o'clock prompt. Catalogues (price 6d.) can be obtained of the Auctioneers, 46, Watling-street, Queen Victoria street, London, E.C., and Albert Chambers, Albert-square, Manchester; or of the Solicitors, Messrs. Baker, Blaker and Hawes, 117, Cannon-street, London, E.C.

**Plant for Sale.**—Messrs. A. Verey & Co., Dover, advertise in another column some direct-current electric motors for sale.

**To Let.**—A suitable site for electricity works adjoining Shepperton station is advertised in another column.

**B.T.H. Plant.**—Illustrations accompany a description of slow and moderate-speed motors (type M P) in pamphlet No. 80 issued by the British Thomson-Houston Co. The solid-shank brush holder designed for use with carbon brushes is shown in the illustration.



The brushes are provided with a flexible conductor made in one with the brush, assuring perfect connection. Adjustment of brush pressure on the commutator is made by thumb nuts and springs, as shown.

**Electric Power Transmission Co.**—A preliminary list of electric power and traction plant and accessories has been issued by the Electric Power Transmission Co., Birmingham, and can be obtained on application. Standard continuous-current steel-clad motors, automatic starting switches and rheostats, &c., are illustrated.

**Fire.**—We are informed that the recent fire at the works of Messrs. Joseph Sankey & Sons does not in any way affect their output of stampings, as the stamping works are situate some distance from the scene of the fire.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or

machines, which are not separately specified) from Nov. 21 to Nov. 26, with the ports of destination :—

*Africa*—Alexandria, £78 ; Beira £150 (telegraph material) ; Cape Town, £198 ; Durban, £122 ; East London, £259 (telegraph poles) ; Port Elizabeth, £153 ; Port Said, £125. *Argentina*—Buenos Ayres, £165 (including £81 telegraph material) ; Rosario, £510. *Australasia*—Adelaide, £500 ; Auckland, £54 ; Fremantle, £411 ; Melbourne, £205 (including £16 telegraph material) ; Newcastle, £32 ; Sydney, £1,234 ; Wellington, £25. *Austria*—Trieste, £23. *Belgium*—Ostend, £546. *Brazil*—Rio Grande, £60 (telegraph material) ; Rio Janeiro, £832 (including £801 telegraph material). *Canada*—Montreal, £150. *Ceylon*—Colombo, £46. *Chili*—Antofagasta, £157 (telegraph material) ; Santiago, £213 ; Valparaiso, £55. *China*—Shanghai, £149. *Colombia*—Santos, £34 (telegraph material). *Germany*—Hamburg, £300 (telegraph material) ; Nordenham, £1,000 (telegraph cable). *Gibraltar*, £16. *Holland*—Amsterdam, £61 ; Rotterdam, £80 (telegraph wire). *India*—Bombay, £75 ; Calcutta, £607. *Japan*—Nagasaki, £60. *Malta*, £219. *Russia*—St. Petersburg, £30. *Straits Settlements*—Penang, £155 (telegraph material) ; Singapore, £36. *Sweden*—Karlskrona, £107 (telegraph wire) ; Stockholm, £16 (telegraph wire). Total, £9,252, against £147,520 in the corresponding week last year (Nov. 22 to Nov. 28).

# COMPANIES' MEETINGS AND REPORTS.

## British Westinghouse Electric and Manufacturing Co. (Ltd.).

The first annual general meeting of this company was held on Friday last, under the presidency of the Hon. R. CLERE PARSONS, M.I.C.E., A.I.E.E.

The ASSISTANT-SECRETARY (Mr. Bannister) read the notice calling the meeting, and the report of the directors was taken as read.

The CHAIRMAN explained that he was occupying the chair owing to the absence, through ill-health, of Mr. Benson. He congratulated them on the company's sales during the past year, which had amounted to £550,000, as against £256,528 in the previous year, as stated in the prospectus. The sales last month were £32,550, and for the present month they had been so far £31,890. These results, too, were from their trading with machinery procured from the American company, and they naturally expected that it would be much larger when the works of the company at Manchester were completed. Within the next few days they hoped to secure orders amounting to £40,000 ; and they were also preparing tenders for sales, which they had every reason to expect they would obtain, amounting to £104,000. No doubt many would have wondered how it was that with the large turnover of last year a net profit of only £10,777 was shown ; but the company's position was peculiar. Although the American company had been trading here for some years and had made a considerable position for themselves, the concern which this company were now engaged in was a very different one. They were expending at a very rapid rate. They were putting together a manufacturing company which would have a staff soon of from 3,000 men to 5,000 men. Highly-paid officials had to be engaged, and when the works at Manchester were completed they looked forward to having them furnished not only with machinery but also with a most efficient staff. This could not be done for nothing. The consequence was that the scheme by which their undertaking was started—namely, that the American company should guarantee the interest upon the preference shares for two years, was arranged specially to meet the position of the company, and it had done so admirably. As, however, the works would not be finished in the time anticipated, they had approached the American company and had asked them whether they would make up any deficiency in the dividend of 6 per cent. on the preference shares, continuing their guarantee until the works were completed. He had just received a telegram from America from Mr. Westinghouse stating that the matter was receiving their careful consideration. Various reports had reached the directors' ears to the effect that the company had abandoned the construction of their works at Manchester. This he denied, and, pointing to a map and plans, he indicated the extensive properties which had been purchased by the company on the Trafford Park Estate, and explained the magnitude of the works in course of construction, as well as their admirable position for the company's purposes. The equipment of the works and of the company in regard to their staff, which was one of the most important points in a manufacturing concern, had had the directors' most careful attention, and they had selected in this country a number of young engineers who had received the highest possible training in their technical colleges throughout the country. These young men had gone to America to the works at Pittsburg, where they were undergoing a careful training in every branch of electrical engineering. The directors wished—and this was also the desire of their American friends—that this company should as far as possible be made an English company, and employ as far as possible English engineers ; but it was necessary—at all events at the outset—to obtain a certain number of American engineers, who had been carefully trained for years, in order to start the business properly in this country, and to run it until the company had obtained properly educated English engineers, knowing the newest processes in the American shops. Upwards of two thirds of the capital in their company was English, and the trade done by them would eventually be carried out not by foreigners but by Englishmen, and on the most advanced principles. During the past year many of them might possibly have seen the company's exhibit at the Agricultural Hall, where they showed a complete system of electric tramways such as would be suitable for the streets of London—not in the centre of London, but streets especially on the south side of the Thames, where there were over 100 miles of tramway now being worked by horses. They expected before long to be in a position to submit a complete proposal for the electrification of the tramlines on the south side of the river, and they also hoped that ere long a complete tramway system would be adopted in London which would compare favourably with the great system of electric traction worked in the United States. A most important point had arisen in the last few days—namely, the electrification of the underground railways of London. For many months the board had been busily engaged on this most important matter. Within the last two months the Metropolitan and the District Railway companies had issued an invitation to the leading manufacturers of electric machinery asking for schemes to be submitted to them for carrying out this great work. The directors had given the matter most careful attention, and, in order to submit as complete a proposal as possible to the railway companies, it was found that it would be absolutely necessary to apply to Parliament for powers for doing certain things in connection with the running of the railways. The powers which they had asked for had reference to this—that they would present a proposal to supply the entire outfit of electrical machinery, rolling stock, &c., to the Metropolitan and District Companies at a given figure. Payment for the work might be in the shape of Lloyd's bonds, which would be issued to the contracting parties on the certificate of the railway engineers, and the bonds would be negotiated by this company in any way they might think fit. Another proposal which they intended to submit, and for which they had asked Parliament to sanction powers, was to lease the sites for the generating stations for which the railway companies had secured Parliamentary powers, to erect on those sites the necessary generating stations, to lay the necessary conductors, and to supply the rolling stock, and all that was necessary for carrying on the traffic, and that they should receive from the railway companies a guarantee upon their receipts. This would be practically in the form of a contract with the railway companies, and would not interfere in any way with the debenture, preference, or any other proprietors, of which there were a large number. Before presenting this application to Parliament the directors took the opportunity, as he thought was only right, to mention the matter to the chairman of the District Railway and also to the chairman of the Metropolitan Railway, but unfortunately the latter was ill, and was not able to receive them. Their sole object in presenting this application to Parliament was with this view—that they might be in a position to carry out the contract without hindrance or delay if the railway companies should think fit to entrust this company with the work. He wished the shareholders clearly to understand that their proposal had been entirely straightforward, and not with any view of hampering the railway companies in any way. It was merely that they might have the powers which they thought necessary, supposing their proposal for carrying out the work should be the one that was thought to be the most advantageous. Possibly it might not be so considered, and then their application to Parliament would naturally be inoperative. With regard to the expenditure which was necessary upon the works at Trafford Park, an issue would shortly be made of 25,000 shares of £5 each. Although these shares were fully underwritten the directors would have much pleasure in doing their utmost to secure the applications of any preference shareholders for the issue. He concluded by proposing a resolution for the adoption of the report and accounts and the payment of the balance dividend on the preference shares.

Mr. Sheriff JOSEPH LAWRENCE seconded the motion. Referring subsequently to the proposed change from steam to electric traction on the Metropolitan and District Railways, he remarked that it was a great problem, and he maintained that no electrical manufacturing company in Great Britain, or even in Europe, could fairly claim to be better able to handle the problem than this company. It should be remembered that theirs was not a financing company, but a purely manufacturing company, and it was from this standpoint chiefly that the problem would be solved. If any finance were brought into the matter it would be a secondary feature. Fortunately, they had been able hitherto (and he hoped they would continue) to keep clear of entanglements in the way of finance, but at the same time the board and the shareholders would have to keep their minds alive to the possible development on a large scale of electrical work in this country. We were so much behind in this matter that the chances were now that the swing of the pendulum might go violently in the opposite direction, and we might be overwhelmed in the course of the next two or three years with great schemes for dealing with the traffic of London.

Mr. J. ALLEN asked whether the shareholders could be given an idea when the erection of the plant would be completed, so as to enable the company to manufacture their own machinery.

Mr. FERGUSON said he supposed that until the works were completed they would not be able even to attempt to deal with the work referred to on the Metropolitan and District Railways.

The CHAIRMAN, in reply, stated that they were certainly behind in the completion of the works, but he explained that this was owing to the fact that it had been deemed advisable to place the contract in the hands of English firms. Possibly by the end of next year they would be in a fair way to commence operations at Manchester, but he did not think that they could do so much before that. This, however, would not prevent them from carrying on their trade as rapidly as they had done in the past, and even more rapidly, the American company having recently practically doubled their works. If they got the contract for the work on the underground railways, they would certainly be able to carry it out, because all the machinery which they would require would be manufactured in America.

The resolution was carried unanimously.

On the motion of Mr. ANNAN BRYCE, seconded by Mr. LAWRENCE, a vote of thanks was passed to the Executive committee and the staff.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., having been re-elected a vote of thanks to the chairman brought the meeting to a close.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)**—Registered Nov. 20, with a capital of £750,000 in £5 shares, to carry on the business of tramway and light railway proprietors and contractors, electricians, electrical and general engineers, motor, cable, wire and accumulator manufacturers, makers of rolling stock, &c.

**ISIDOR FRANKENBURG & CO. (LTD.)**—Registered Nov. 22, with a capital of £250,000 in £10 shares, to acquire the business carried on by Mr. Isidor Frankenburg, at Greengate, Salford, Manchester, and to carry on the business of and dealers in electric cables, waterproof rubber and leather goods, &c. The first directors are Isidor Frankenburg (permanent governing director), Merton F. Frankenburg, and Ralph Frankenburg.

**LYNDHURST ELECTRIC LIGHTING AND TRACTION CO. (LTD.)**—Registered Nov. 20, with a capital of £500 in £1 shares (250 founders'), to carry on the business of tramway and railway constructors and proprietors, suppliers of electricity for light, heat, motive power, &c., electricians, electrical and mechanical engineers, promoters, &c. The subscribers include Mr. C. J. Wharton, consulting engineer, Palace Chambers, Westminster.

**NEW CENTURY ARC LIGHT CO. (LTD.)**—Registered Nov. 19, with a capital of £30,000 in £1 shares (5,000 preference), to carry on the business of suppliers of electric light, heat and power, electrical and general engineers, electricians, electrical apparatus manufacturers, &c., and to enter into an agreement with Mr. W. G. Davis. The first directors are M. Bush and A. C. Schonberg.

**RAWLINGS BROS. (LTD.)**—This company was registered on Nov. 24, with a capital of £100,000 in £1 shares, to carry on the business of electrical, hydraulic, and general engineers, manufacturers of and dealers in accumulators, cables, wires, lamps, and all electrical instruments and accessories, suppliers of electricity, &c. The subscribers are J. J. Rawlings, engineer, W. R. Rawlings, electrical engineer, R. T. Smith, H. S. Rawlings, electrical engineer, F. Rawlings, engineer, G. W. Rogers, and C. Rawlings, electrical engineer. The first directors are Messrs. J. J. and W. R. Rawlings, and R. T. Smith.

**UNITED RAILWAY AND TRADING CO. (LTD.)**—Registered Nov. 22, with a capital of £500,000 in £5 shares, to carry on in America the business of constructors and proprietors of railways, tramways, and telegraph and telephone lines, and to carry on the business of electrical and mechanical engineers, contractors, merchants, &c.

**WHITTAKER BROS. (LTD.)**—Registered Nov. 20, with a capital of £7,000 in £1 shares, to carry on at Dudley, Kidderminster, and elsewhere the business of electrical and general engineers, telephone and telegraph constructors and owners, suppliers of electric light and power, electricians, manufacturers of electric and other motor cars and launches, cable, wire, and electrical apparatus manufacturers, &c. The first directors are W. W. Henkins (chairman), J. H. Whittaker, B. W. F. Whittaker, and T. G. Marsh.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29⅜d. per oz. (Nov. 29). Consols (2¾ per cent.) 98¼—98⅜ for money, 98¼—98⅜ for account; 2½ per cent. 97¾—98 (Nov. 29). Stocks and Shares Continuation Days, Dec. 11 and 24; Ticket Days, Dec. 12 and 27; Pay Day, Dec. 13; Mining Share Carry-over Days, Dec. 10 and 21.

**ALLGEMEINE ELEKTRICITATS GESELLSCHAFT (BERLIN).**—The report of the directors of this company for the year ended June 30, which will be presented at the general meeting on Dec. 6, recommends the payment of a dividend of 15 per cent. on 47,000,000 marks and 7½ per cent. on 13,000,000 marks recently issued. The company does an extensive foreign business, the agents in this country being the Electrical Co. (Ltd.), 122 and 124, Charing Cross-road, London, W.C., and the report states that all departments were busily engaged, and that the outlook is extremely satisfactory. Reference is made to the 3,000kw. machine exhibited in Paris, and which has been described in *The Electrician*. Altogether 16,418 machines, representing 153,241kw. were turned out last year, against 11,438 machines and 145,499kw. in the previous year. Some interesting particulars regarding the progress of the Oberspree Cable Works are next given, and once more the output of the incandescent lamp factory amounted to 1,000,000 lamps. As soon as the necessary staff arrangements are made the manufacture of the Nernst lamp for the market will (the report states) be undertaken. In the electric traction department similar activity and progress is reported, and tramways representing nearly 110 miles of track and 400 tramcars have been constructed or are in progress. Omitting the German Empire, work is being executed in such distant places as Santiago (Chili), Buenos Ayres, Seville, Jassy, Sofia, Aarhus, Malmo, Baku, &c., and in some cases concessions for lighting and traction have been obtained. Up to the present the company has erected 243 electricity generating stations and equipped them with plant equivalent to 210,010 H.P. The report refers with pride to the fact that for each of the six exhibits at the Paris Exhibition a Grand Prix was awarded. After giving some information about the Bitterfeld and Rheinfelden Electro Chemical Works, the new Riedler quick speed pump, &c., particulars of the parent company's financial relations with the subsidiary companies are given.

**BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)**—This company, which has a share capital of £750,000, made an issue during the week of £400,000 4½ per cent. first debenture stock at par.

**BRITISH ELECTRIC STREET TRAMWAYS (LTD.) Construction and Maintenance Co. (Parent).**—Particulars will be found on another page of a company which has been established "to acquire electric running powers in populous districts where none now exist, to construct underground electric railways, take over and equip old tramways with modern electric systems," and generally to act as a construction and maintenance company for electric traction enterprises. The nominal capital of the company is £300,000 in £10 shares. The present issue is for the whole 30,000 shares at par, payable £1 on application, £4 on allotment, and the balance in two equal monthly instalments after allotment. There is an arrangement by which subscribers for shares in the British Electric Street Tramways (Ltd.) participate in the founders shares of the Founders' Syndicate (Ltd.). The prospectus states that the company "will have its own extensive factories plant and machinery" while it is to acquire "important systems of electric tramway construction, with a series of letters patent by eminent electricians connected with railway traction," and that these "will secure to the company many advantages in obtaining valuable contracts from municipalities and local bodies where the safety and convenience of the public are the first consideration." It is further hinted that the company have an improved overhead system. The full prospectus is a lengthy document, and intending subscribers to this issue are advised to carefully study it in their own interests. There is an absence of technical details, but the statements in the prospectus are obviously prepared for popular and not for professional consumption. The subscription list opened on Wednesday and closes at 4 p.m. on Saturday, Dec. 1. Prospectuses and forms of application may be obtained from the bankers, solicitors, or auditors, and at the offices of the company, 34, Victoria-street, Westminster, S.W. Mr. Reginald Goodman, A.C.A., is secretary *pro tem.*

**ENGINEERING AMALGAMATION.**—The undertakings of the Leeds Steel Works (Ltd.) and Walter Scott (Ltd.) are about to be amalgamated. The capital of the new company will, it is stated, be close upon £1,000,000.

**R. HOOD HAGGIE & SON (LTD.)**—Subscriptions are invited for an issue of 53,334 preference and 53,334 ordinary shares of £1 each in a company formed to acquire and extend the well-known business carried on by Messrs. R. Hood Haggie & Co. at Newcastle-upon-Tyne and elsewhere. The share capital of the company is £160,000 in preference and ordinary shares in equal amounts, of which the founders take 26,666 of each denomination. The list opens this day (Friday), and closes on Thursday, Dec. 6.

**ISIDOR FRANKENBURG (LTD.)**—It has been decided to convert the old-established business of Mr. Isidor Frankenburg, Greengate Rubber and Cable Works, Salford, Manchester, into a joint-stock undertaking, and the company was registered on Nov. 22, with a capital of £250,000 in £10 shares, 12,500 of which are 5 per cent. cumulative preference and 12,500 ordinary shares. The new company acquires an extensive indiarubber and waterproofing business, established in 1866, as well as the progressive electric cable manufacturing business which was added in 1896, and which is at the present time (according to a private prospectus we have seen), earning substantial profits. The whole of the goods sent out by the firm are made at Manchester. The conversion to a limited liability company has been effected with a view of considerably extending the works and of interesting Mr. Frankenburg's employés in the business. To these employés a large proportion of the preference shares will be offered, Mr. Frankenburg taking the whole of his purchase money (£195,000) in shares—£125,000 in ordinary and £70,000 in preference shares. There are no debentures, and no public issue is to be made, as it is the intention of the vendor that the business shall remain in the hands of his family and employés. The first directors are Mr. Isidor Frankenburg and his sons, Mr. Merton and Mr. Ralph Frankenburg, and it is intended that the remainder of the directorate shall be selected from the firm's chief employés.

**LEAMINGTON AND WARWICK TRAMWAYS AND OMNIBUS CO. (LTD.)**—This company has entered into an agreement with the British Electric

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation | Nov. 24 | 595 | − 121 | 25 | 13,105 | + 2,551 |
| *Birmingham Tramways | „ 24 | 4,246 | + 164 | 20 | 91,097 | + 4,389 |
| Blackpool Corporation... | „ 22 | 200 | + 61 | 34 | 27,187 | + 7,165 |
| Blackpool and Fleetwood | „ 24 | 162 | + 3 | 21 | 19,575 | ... |
| Bolton Corporation ...... | ... | ... | ... | .. | ... | ... |
| Bradford Corporation... | „ 26 | 714 | − 345 | 34 | 18,404 | + 4,940 |
| Brisbane Trams ......... | Oct. 10 | 2,004 | − 394 | 14 | 26,112 | + 5,180 |
| *Bristol Trams & Carriage | Nov. 23 | 2,704 | + 54 | 21 | 70,274 | − 1,540 |
| *Buenos Ayres & Belgrano | Oct. 28 | 3,421 | +1,208 | 17 | 40,452 | + 2,719 |
| Central London Railway | Nov. 24 | 5,755 | ... | 17 | 87,922 | ... |
| City & South London Ry. | „ 25 | 1,849 | + 814 | 21 | 33,957 | +13,448 |
| Cork Elec. Trams ......... | „ 22 | 325 | − 31 | 47 | 19,320 | + 1,452 |
| Dover Corporation ...... | „ 24 | 162 | + 4 | 34 | 7,893 | + 431 |
| Dublin & Lucan Rly. | „ 24 | 61 | + 4 | 21 | 2,097 | + 365 |
| Dublin United ............ | „ 23 | 3,151 | + 254 | 21 | 88,385 | +10,305 |
| Dublin Southern Dist.... | „ 23 | 685 | + 10 | 21 | 21,592 | |
| *Dundee Corporation ... | ... | | ... | ... | ... | ... |
| *Glasgow Corporation ... | „ 24 | 8,841 | − 296 | ... | ... | ... |
| Hull Corporation......... | „ 24 | 1,306 | + 655 | 21 | 28,976 | +15,378 |
| *Liverpool Corporation... | „ 17 | 8,157 | +1,193 | 46 | 364,534 | +47,321 |
| Liverpool Overhead Rly. | „ 25 | 1,525 | + 48 | 21 | 35,074 | + 798 |
| *Sheffield Tramways ...... | „ 25 | 2,591 | + 633 | 47 | 106,710 | +36,982 |

* Partly electrical

Traction Co. for the sale of the tramway in Leamington and Warwick, which is to be converted to the electric overhead trolley system. The existing tramway is a horse-worked line 3 miles in length. The capital of the company is £15,850, with 4 per cent. debentures amounting to £4,600. The last dividend, paid in June, was at the rate of 5 per cent. The British Electric Traction Co. has agreed to purchase the existing shares at par, payable either in cash or shares. The payment to the existing share and debenture holders will be about £21,000. The re-laying of the track, electrical equipment, and power station will represent an additional expenditure of about £29,000.

**PEARSON FIRE ALARMS.**—In a circular to the shareholders of this company it is announced that certain negotiations, particulars of which have recently been placed before the shareholders, have been completed, and that a contract has been made for the supply of 4,000,000 (four million) Pearson instruments. In connection with this large contract a deposit of no less than £1,000 (one thousand) has been lodged with the company! The communication under review notifies that the general meeting of the company will be held in December when, doubtless, the names of the parties concerned in the purchase (or perhaps it is the hire) of these 4,000,000 instruments will be made known.

**SOUTHERN ELECTRICAL INSTALLATION AND WIRING CO. (LTD.)**—The annual meeting was held at Hastings last week. The report covered a period of 14 months, and stated that the profit on the installation business of the company, as distinct from the "free" wiring department, might be considered satisfactory, in view of the increased cost of labour and material. With regard to "free" wiring, the directors found that it was difficult to transact business during the first nine months' working of the company, but definite progress was now being made in this department as the public were beginning to appreciate the advantages offered. A fresh issue of capital would shortly be made to provide for the development of the business. The balance profit was £390. 7s. 1d., and after paying interest on preference shares (£126. 4s. 2d.) there remained a balance of £264. 2s. 11d., out of which the payment of a dividend of 5 per cent. to Sept. 30 was recommended and approved.

**STOCK EXCHANGE NOTICE.**—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to the 5 per cent. cumulative preference £1 shares and £150,000 4 per cent. first mortgage debenture stock of the *General Electric Co. (1900) Ltd.*

**WESTERN TELEGRAPH CO. (LTD.)**—An extraordinary meeting of this company was held on Monday, under the presidency of Mr. W. Andrews, chairman of the company, to confirm the resolution passed at the meeting held on Oct. 30 last, amending Art. 110 of the Articles of Association. The confirmatory resolution was passed unanimously.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 21. | | Price Wednesday, Nov. 28. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Nov. 28. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'okh'th & Gr'nw'ch D'st'ct Elec.Lt.Ord.(fully pd. | ⅝ | ⅞ | ⅝ | ⅞ | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13¼ | 13¾ | 12¾ | 13¾ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 19/3 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,561 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | 9 | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | 6 1/16 | ... |
| 60,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 5 1 | February and August | 10 | 9¾ |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | | |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 6¾ | 6½ | 7 | 4 5 9 | March | 6¾ | 6 1/16 |
| £180,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December | ... | .. |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort.5% 30 yrs.Gold Bonds(red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | .. |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 | 10 | 9 | 10 | 4 0 0 | February and August | 9¾ | 9¾ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 13½ | 13 | 14 | 4 5 8 | January and July | 13 7/16 | 13⅜ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | 127 | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | 9 | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 5 0 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. allotted (red.) | 104 | 111 | 104 | 111 | 4 1 10 | ... | ... | ... |
| 10,[illegible] | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | 5½ | 4½ |
| 11,[illegible] | 5 | | [illegible] Ordinary | 8 | 9 | 7½ | 8½ | | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 1 6 | .. | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2½ | ... | ... | . | ... |
| 12,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | . | ... |
| 45,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 13 | 14 | 13½ | 13½ | 4 1 6 | April and October | 13½ | 13 |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 19 7 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 7 | ... | 98½ | ... |
| 6,452 | 10 | 8/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | 14½ | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/5 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 12 16 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor.Deb. | 75 | 85 | 75 | 85 | 6 18 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 180 | 200 | 180 | 200 | 4 0 0 | April and October | ... | ... |
| £115,[illegible] | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 4[illegible] | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15½ | .. |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | " " | ... | ... |
| £[illegible] | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | .. | ... | ... | .. |
| 14,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | .. | ... | ... | ... |
| £5[illegible] | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | — | ... | ... |
| 60,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 13¼ | 12¾ |
| 29,437 | 5 | ... | Do. [illegible] | 11½ | 12½ | 11½ | 12½ | ... | ... | 12¼ | 12 |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 2 15 0 | ... | ... | ... |
| £167,905 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 103 | 105 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 23 | 24 | 23 | 24 | 3 8 11 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully paid) | 10½ | 11½ | 10½ | 11½ | 3 13 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | .. | ... |
| 12,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10 1/16 | ... |
| 45,000 | 10 | 11/0 | British Elec. Trac. Ord. | 15½ | 16½ | 15½ | 16½ | 6 17 11 | ... | 14 1/16 | 14½ |
| 50,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 5 9 | February and August | 12⅞ | 12 1/16 |
| £500,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 121½ | . |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | .. | ... |
| 27,500 | 5 | ... | Do. "B" | 4 | 4½ | 4 | 4½ | ... | ... | 4⅛ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 101 | 107 | 101 | 107 | 4 15 5 | ... | .. | ... |
| £121,000 | Stock | 18/9 | Do. 5% 2nd Deb. Stock Prov. Certs (all p.d.) | 96 | 99 | 96 | 99 | 5 2 0 | .. | 98 | ... |
| 2[illegible],297 | 10 | 3/6 | Central London Ordinary | 10½ | 10¾ | 10 | 10½ | 2 17 2 | June and December | 10½ | 10½ |
| £455,[illegible] | Stock | 1½% | City and South London Railway Con. Ordinary | 51 | 53 | 52 | 54 | 2 9 7 | February and August | .. | 52 |
| 52,[illegible] | 10 | 1/3 | Do. Ordinary (Nos. 22,501 to 60,000) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | 5½ | ... |
| £1[illegible],000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 139 | 143 | 139 | 143 | 3 9 11 | " " | ... | ... |
| £2[illegible] | Stock | 5% | Do. (18[illegible]) | 133 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £244,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 119 | 123 | 118 | 123 | 3 5 1 | May and November | 121½ | ... |
| [illegible] | 10 | .. | Dublin United Tramways (1896) Ltd., Ordinary | 17 | 18 | 17 | 18 | .. | .. | 17½ | ... |
| [illegible] | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | . | . | — | ... |
| £[illegible] | 100 | ... | Do. 3½ per Cent. Mort. Debentures (red.) | 102 | 105 | 102 | 105 | . | | . | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 21 | 22 | 21½ | 22½ | 3 12 8 | March and September | . | ... |
| 10,[illegible] | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 9 | " " | ... | ... |
| £2[illegible] | Stock | 4½% | Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 3[illegible] | 10 | 1/3 | Kidderminster & District El. L. & Tr'ct'n 6% Pref. | .. | | .. | | 4 17 7 | May and November | ... | ... |
| 37,[illegible] | 10 | 3% | Liverpool Overhead Railway Ordinary | 8 7/16 | 9 | 8 9/16 | 9¼ | 4 9 6 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13½ | 13½ | 3 11 1 | " " | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture | 104 | 107 | 104 | 108 | 3 17 0 | January and July | ... | ... |
| [illegible] | 100 | 5% | Montreal Street Railway 5 per Cent. Mort. Bonds (1908) | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| £160,000 | 100 | 4½ | Do. Series 2 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 4 | ... | .. | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | .. | ... |
| 50,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4½ | 5½ | 5 14 3 | May | 5 | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | | .. | | .. | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | ... | | . | | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11 | 12 | 10½ | 11½ | ... | ... | ... | ... |
| 10,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | .. |
| £1[illegible] | Stock | 37/0 | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | ... | ... |
| 840,000 | Stock | 3% | Waterloo and City Ordinary | 92 | 95 | 92 | 95 | 3 3 2 | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 21. | | Price Wednesday, Nov. 28. | | Rate per Cent. Yields. | Dividends Due. | Business Done During Week Ending Nov. 28. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 100 | 99 | 100 | 3 17 6 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,100 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 85 | 90 | 5 11 1 | ... | ... | ... |
| £933,720 | Stock | 15/0 | Anglo-American | 53 | 54 | 53 | 56 | 6 11 2 | Feb., May, Aug., Nov. | ... | ... |
| £3,044,640 | Stock | 30/0 | Do. Preferred | 98 | 100 | 98 | 100 | 6 0 3 | " " | 100 | 99 |
| £3,044,640 | Stock | 27/0 | Do. Deferred | 10½ | 11½ | 10½ | 11 | 12 5 6 | " " | 11 | 10¾ |
| 13,333,300 | $100 | $1¾ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 11 5 | Jan., Apr., July, Oct. | ... | ... |
| £1,[illegible] | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 17 4 | " " | 103 | ... |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ | 7½ | 6½ | 7½ | 7 17 0 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 14½ | 15½ | 6 9 0 | " " | ... | ... |
| 11,981 | 8 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £9[illegible],000 | [illegible] | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | [illegible] | 3/0 | Direct United States Cable | 10½ | 10¾ | 10½ | 10¾ | 5 10 0 | Jan., Apr., July, Oct. | 10½ | 10½ |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 101 | 99 | 101 | 4 8 0 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 143 | 145 | 143 | 145 | 4 16 11 | Jan., Apr., July, Oct. | 146 | 143 |
| £1,828,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 97 | 100 | 97 | 100 | 3 10 1 | " " | 98 | 97 |
| £1,432,368 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 112 | 116 | 112 | 116 | 3 9 2 | May and November | 114 | 113 |
| 350,000 | 10 | 2/6 | Eastern Extension | 14½ | 14¾ | 14½ | 14¾ | 4 16 7 | Jan., Apr., July, Oct. | 14½ | 14 |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) iss'd at 25pm, all pd. | 6½ | 7 | 6½ | 6¾ | ... | ... | 6½ | ... |
| £300,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 115 | 118 | 115 | 118 | 3 8 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 100 | 103 | 3 17 9 | February and August | ... | ... |
| £3[illegible],000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 102% | 99% | 102% | 3 18 5 | May and November | ... | ... |
| 1[illegible],227 | 10 | 1/[illegible] | Globe Telegraph and Trust | 10½ | 10¾ | 10½ | 10¾ | 4 17 5 | Jan., Apr., July, Oct. | 10½ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | " " | 15½ | 15½ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 32 | 31 | 33 | 3 15 7 | January and July | 31½ | ... |
| £91,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 4 10 0 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 60 | 61 | 60 | 61 | 4 14 4 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 101 | 104 | 101 | 104 | 3 14 3 | June and December | ... | ... |
| 11,439 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | 7½ | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 126 | 130 | 4 11 5 | " " | ... | ... |
| 15,609 | 10 | ... | West African Telegraph | 3½ | 3¾ | 3½ | 3¾ | 4 9 2 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 101 | 99 | 102 | 4 19 3 | March and September | ... | 99½ |
| 30,306 | 3½ | ... | West Coast of America | ½ | ¾ | ½ | ¾ | ... | ... | ½ | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 14 4 | January and July | ... | ... |
| 88,321 | 10 | 1/0 | West India and Panama | ¾ | 1 | ¾ | 1 | ... | May and November | ¾ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ | 7½ | 6½ | 7½ | 5 0 0 | " " | 6½ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £90,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 13 6 | January and July | ... | ... |
| 307,500 | 10 | 5/0 | Western Telegraph (late Brazil'n S'bm'rine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Sept., Dec. | 14½ | 14 |
| £76,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 | 106 | 103 | 106 | 4 14 4 | June and December | ... | ... |
| £3[illegible],777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | 3½ | ... |
| 224,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | [illegible] | [illegible] | [illegible] | [illegible] | ... | July | ... | ... |
| 72,500 | 1 | 3½% | Monte Video Telephone Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | 5 0 0 | November | ... | ... |
| 96,493 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 590,000 | 5 | 3/0 | National | 4½ | 4¾ | 4½ | 4¾ | 6 3 3 | February and August | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 15 | 13 | 14 | 4 5 9 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 13 | 15 | 13 | 15 | 4 5 9 | " " | 13½ | ... |
| 250,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | " " | 5 | ... |
| £1,[illegible],000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 93 | 95 | 93 | 95 | 3 11 5 | June and December | 95 | 93 |
| £[illegible] | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | ... | ... | 103 | 101½ |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1½ | ¾ | 1½ | ... | April and October | ... | ... |
| 58,000 | 5 | 4/6 | United River Plate | 4½ | 5 | 4½ | 5 | ... | July | ... | ... |
| 16,089 | 5 | 2/6 | Do. 5% Cumulative Preference (fully paid) | 5 | 5½ | 5 | 5½ | 4 10 11 | June and December | ... | ... |
| 23,351 | 5 | ... | Do. do. (£1 10s. paid) | 3½ | 3¾ | 3½ | 3¾ | ... | ... | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | June and December | 105 | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 8d. | [illegible] Pref. | 1 | 1½ | ¾ | 1½ | 4 8 11 | ... | ... | ... |
| 145,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ¾ | ⅞ | ¾ | ⅞ | 7 7 8 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £40,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 99 | 97 | 99 | 4 6 2 | ... | ... | ... |
| 75,000 | 5 | 8/0 | British Insulated Wire Ordinary | 10½ | 11½ | 10½ | 11 | 4 10 11 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6½ | 6¾ | 6½ | 6¾ | 4 10 0 | January and July | ... | ... |
| 1[illegible],000 | 5 | 1/6½ | British [illegible] Preference | 4½ | 5½ | 4½ | 5½ | ... | ... | ... | ... |
| 90,[illegible]60 | 3 | 1/1½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 6 8 4 | September | 1½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 6 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 [illegible] 3 | " | 2⅛ | 2⅛ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 108 | 111 | 108 | 111 | 4 0 11 | March and September | ... | ... |
| £1[illegible],000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 105 | 103 | 105 | 4 7 3 | January and July | ... | ... |
| 3[illegible],000 | 5 | 5/0 | Callender's Cable & Construction Ord. | 12½ | 13½ | 12½ | 13½ | 5 11 1 | " " | ... | ... |
| 4[illegible] | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 | 5½ | 5½ | 5½ | 4 4 11 | " " | 5¼ | 5½ |
| £[illegible],000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 19 11 | November and May | ... | ... |
| 1[illegible],000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 5 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | 99½ | 99½ |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 8 10 0 | March | ... | ... |
| 6[illegible],000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | 1 | 1½ | 1 | 1½ | 5 6 8 | ... | ... | ... |
| 61,000 | 3 | 2/[illegible] | Crompton and Co. Nos. 1 to 32,144 | 3½ | 4 | 3½ | 4 | 5 12 6 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 103 | 99 | 102 | 4 18 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | 1 | 1½ | 1 | 1½ | 5 6 8 | ... | ... | ... |
| 99,[illegible]50 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 [illegible] 3 | February and August | 2 | ... |
| 17,189 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,02[illegible] | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 8 | June and December | ... | ... |
| £1[illegible],000 | Stock | 23/4½ | Do. 5½ [illegible] Profits [illegible] | 98 | 100 | 98 | 100 | ... | ... | ... | ... |
| 35,000 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 [illegible] | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 104 | 101 | 104 | 4 7 [illegible] | ... | ... | ... |
| 14[illegible],100 | 2 | 1/2½ | Electric Construction Co. Limited | 2 | 2½ | 2 | 2½ | 5 [illegible] | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3½ | 2½ | 3½ | 4 6 [illegible] | July | ... | ... |
| £[illegible],500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 16 [illegible] | January and July | 103½ | ... |
| 11[illegible] | 1 | ... | [illegible] | ... | | ½ | | ... | ... | ... | ... |
| 50,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ | 13¾ | 13½ | 14 | 6 11 [illegible] | February and August | 14 | 13½ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5½ | 5¾ | 3 18 3 | " " | 5½ | 5½ |
| £5[illegible],000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 | 112 | 108 | 112 | 4 0 6 | " " | ... | ... |
| 5[illegible],000 | 10 | 5/0 | India Rubber, Gutta Percha and Tel. Works | 21½ | 22½ | 21 | 22 | 3 9 2 | " " | 21½ | ... |
| £3[illegible],000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 3 | March and September | [illegible] | ... |
| 37,1[illegible] | 12 | 12/0 | Telegraph Construction and Maintenance | 37 | 41 | 37 | 41 | 4 5 9 | March and July | 40 | 37½ |
| £1[illegible],000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1906 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| [illegible],000 | 5 | 9/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 10½ | 11½ | 3 4 4 | ... | 10¾ | ... |
| 2[illegible],000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5¾ | 5½ | 5¾ | 4 6 11 | ... | 5½ | 5½ |
| 3[illegible],000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 5 1 9 | April and October | ... | ... |
| 4[illegible],000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 [illegible] | " " | 7½ | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 4 | May and November | 106½ | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,177. [No. 7. Vol. XLVI.] FRIDAY, DECEMBER 7, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

A LETTER from Dr. OLIVER J. LODGE in our correspondence columns this week is a valuable contribution to the discussion on terrestrial and other cosmic electrical phenomena which has arisen lately out of the controversy between the supporters of magnetic observatories and the advocates of electric traction. Not alone because of the complaint with which the letter is introduced by its author, but chiefly to call attention to a timely contribution to this controversy, do we mention it on this page. "The whole subject of electricity," writes Dr. LODGE, "demands reconsideration in the light of the facts now known concerning the existence of electrons." The old facts remain, and the theories about them serve as stepping stones to higher and more advanced theories, but in the near future it seems probable that "a glorified electrostatics" will dominate the field of thought and theory. Incidentally, Dr. LODGE expresses fear that too much may be forced upon the electron theory, just as in the past it has been customary to saddle each theory popular at the moment with the duty of explaining everything electrical and magnetic, or even everything physical. "A little time hence . . . . electrons or charged corpuscles will be the central feature of physical science,"—so writes Dr. LODGE, doubtful nevertheless of the adequacy of that hypothesis.

THE moral of all this is not altogether clear from Dr. LODGE's letter, as to the lesson to be drawn by the workers in magnetic observatories. If we are to accept the view that the "glorified electrostatics" and the electron theory will afford a new and progressive key to this class of research work, we must place Dr. LODGE beside Mr. SIDNEY EVERSHED as an advocate of reformed methods; and we must infer that, in Dr. LODGE's view, the present alarm at disturbance from traction currents is quite unnecessary. But, on the other hand, Dr. LODGE's implied scepticism as to the adequacy of the electron theory, or any single-handed hypothesis, to explain *all* the facts, may be taken as affording some justification for the magnetic observatory workers in electing not to be off with their old love until they can feel perfectly safe in being on with the new. Moreover, the old love is by no means dead nor yet quite grown cold; for was not Prof. RÜCKER, as the spokesman of the magnetic observers, in his letter in our last issue, able to point with pride to a brand new and unexpected discovery which can be watched along the time-honoured lines of research in magnetic observatories? So long as novelties are occasionally evolved from the persistent grinding out of records, year after year, it is permissible to claim that there is vitality yet remaining in the old methods. But it may be the vitality of aged life flickering itself out; and a more vigorous and youthful successor may, perhaps, be found in the lines of research suggested by Mr. EVERSHED, and now forecast with greater precision and detail by Dr. LODGE.

RECENT reports from Central Africa speak most encouragingly of the progress of pioneer telegraph construction in that region. Not only has the direct trans-continental line, which owes its inception to Mr. CECIL RHODES, been making remarkable headway, but the cross-country section between Uganda and Lake Victoria, as we have already announced, is now within measurable distance of completion. Messrs. GROGAN and SHARP, in their now famous book, "From the Cape to Cairo," give a graphic description of the first-named undertaking as they saw it advancing near Karonga, Lake Tanganyika, where "the telegraph clearing sweeps on its relentless line . . . . . stretching away over the far hills till the trees at the sides merge together, and it is lost in the distant horizon." A well-deserved tribute of praise is paid by these travellers to Mr. MOHUN and his undaunted assistants, who had overcome the greatest possible difficulties "arising from the precipitious and densely-wooded nature of the country, and its pestilential climate." Another formid-

able trouble is, of course, the transport of stores. Iron poles and sockets are being used throughout on this line. For the Uganda lines, part of the way at least, a friendly tree has been utilised—the local "bark-cloth"—which lends itself to transplantation, seemingly, with as much readiness as the proverbial mulberry bush at home. Anyone in doubt as to the civilising and administrative value of these tremendous enterprises, to say nothing of their commercial possibilities, should read Mr. GROGAN's reflections on the subject in the concluding chapters of the book from which we have been quoting.

**Obituary.**—We regret to announce the death of M. Camille Blanchard, Vice-President of the Société Belge d'Electriciens, who was killed in the railway accident which occurred near Dax (France) on November 15th.

**Institution of Mechanical Engineers.**—We are informed that Papers dealing with "Combined Trolley and Conduit Tramway Systems," and "Small Lathes and Screw Machines," will be read early in 1901 before this Institution.

**Cable Interruptions.**

| | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Tangier—Tarifa | Jan. 3, 1900 |
| Pará—Maranham | Mar. 2, 1900 |
| Zanzibar—Mombasa | Sept. 20, 1900 |
| Falmouth—Bilbao | Nov. 19, 1900 |
| Cayenne—Pinheiro | Nov. 26, 1900 |
| Pernambuco—Ceara | Nov. 29, 1900 |

**Welcome-Home Dinner to the Electrical Engineer Volunteers.**—We learn that at the dinner, of which Mr. Edmunds is hon. treasurer, to be given at the Prince's Restaurant, on Monday, December 17th, the chair will be taken by Prof. Perry, the President of the Institution of Electrical Engineers, as Lord Kelvin, who presided at the send-off dinner, given by the same group of hosts, is unavoidably prevented from attending.

**Smelting by Electricity.**—The *Tribuna* (Rome) of Nov. 29th states that, after repeated trials at Brescia with a furnace of 150 H.P. for smelting iron by electricity, a furnace of 500 H.P. has been installed for the production of iron, steel, and other metals direct from the ores. The process is the invention of Capt. Stassano, of Rome, and the experiments were conducted before a commission composed of Profs. Arno, of the Polytechnic of Milan, Del Lungo, of the Institute of Spezzia, and Engineer Siracusa, Director-General of the Italian Electric Co. of Turin.

**Institution of Electrical Engineers.**—It has been arranged to hold a reception, partly by the members of the Institution of Electrical Engineers and partly by the corps of Electrical Engineer (R.E.) Volunteers, to welcome home the active service contingent of the latter body, at the Covent Garden Opera House, on Tuesday, December 18th. In making this announcement at the meeting of the Institution on the 29th ult., Prof. Perry mentioned that, although the South African contingent was expected home about the 8th or 9th inst., they had fixed the date of the reception for the 18th, because "there are delays in ships," and it was best to have a safe date. Ladies will be invited, and invitations for this reception would be sent out to the members in the ordinary course.

**Personal.**—The *Liverpool Daily Post* says that Mr. C. J. Allen has just completed the plaster study for a bust in marble of Principal Oliver Lodge, which is to be placed in the hall or library at University College, Birmingham, as a memorial of Dr. Lodge's association with that institution, the work having been commissioned by a number of Dr. Lodge's friends and admirers. It is, says our contemporary, a striking and admirable likeness, executed with the freedom and boldness which have made Mr. Allen's work distinctive. The sculptor has also completed, for the library of University College, a bust in bronze of Mr. William Rathbone, LL.D. This is a gift to the college by Dr. Lodge, as a mark of personal friendship and of appreciation for Mr. Rathbone's work in the interests of the University.

**Pacific Cable.**—On Monday the British Colonial Office announced officially that the Pacific Cable Committee had considered and accepted, on behalf of Her Majesty's Government and of the Governments of Canada, New South Wales, Victoria, Queensland, and New Zealand, the tender submitted by the Telegraph Construction and Maintenance Co. (Ltd.), 38, Old Broad-street, London, E.C., for the manufacture and laying of the projected Pacific cable, the amount of the tender being £1,795,000. The work comprised in the tender has to be completed by December 31, 1902. The total length of the cable must be over 8,000 miles, the longest section being from Vancouver to Fanning Island—over 3,500 miles—and much the longest submarine telegraph cable ever submerged. The cable will be laid from Vancouver to Fanning Island, on to Fiji and Norfolk Island, thence to Queensland and New Zealand.

**Owens College.**—On Monday last Prof. Oliver Lodge delivered a lecture on "Heat" at the new physical laboratory at Owens College. Referring to the great physicists who had advanced our knowledge of the theory of heat and of the steam engine, Prof. Lodge said that he was glad to have spoken on this subject in Manchester. In speaking of Liverpool one thought perhaps of the Mersey, or perhaps of St. George's Hall; when one mentioned Birmingham he was not sure what rose to mind, but perhaps generally it was the Colonial Secretary. But when he thought of Manchester he thought of the Town Hall, and especially of the entrance hall, where there was a statue of John Dalton on the one side and another of James Prescott Joule on the other. He could imagine nothing more stimulating to the youth of Manchester than to stand before that statue of Joule and realise the magnificent vista which was open to human intelligence.

**Royal Society.**—Last Friday being St. Andrew's Day the anniversary meeting of the Royal Society was held in their apartments at Burlington House. The usual medals were presented as follows: The Copley Medal to Prof. Marcellin Berthelot, For. Mem. R.S., for his brilliant services to chemical science; the Rumford Medal to Prof. Antoine Henri Becquerel, for his discoveries in radiation proceeding from uranium; a Royal Medal to Major Alexander Percy MacMahon, F.R.S., for the number and range of his contributions to mathematical science; a Royal Medal to Prof. Alfred Newton, F.R.S., for his eminent contributions to the science of ornithology and geographical distribution of animals; the Davy Medal to Prof. Guglielmo Koerner, for his brilliant investigations on the position theory of the aromatic compounds; and the Darwin Medal to Prof. Ernst Haeckel, for his long-continued and highly-important work in zoology, all of which has been inspired by the spirit of Darwinism. The Society next proceeded to elect the officers and Council for the ensuing year, the names being the same as those published in the list which appeared in our issue of November 2nd, page 59. In the evening the Fellows and their friends dined together at the Whitehall Rooms.

**Electrical Oscillations and Electric Waves.**—In his second Cantor Lecture on this subject at the Society of Arts on Tuesday, Prof. Fleming dealt with the phenomena of resonance, explaining first the distinction between free and forced oscillations. Numerous experiments were performed, and they were uniformly successful, in spite of the delicacy of adjustment necessitated by some of them which rendered them difficult for the purpose of lecture demonstration. One neat experiment, illustrating the $\sqrt{LC}$ law, consisted in adjusting two condenser and coil circuits to resonance, then destroying the effect by adding a condenser to one of them, and again compensating this and reproducing resonance by adding inductance to the other. For this latter purpose Dr. Fleming utilised a simple and convenient form of adjustable inductance which he termed an "accordion coil." This consisted simply of turns of insulated wire wound loosely on a drum, so that the inductance could be varied without

varying the ohmic resistance by pressing the turns closer together and drawing them apart. In one of the pauses between two of the experiments Prof. Fleming became humorously prophetic, and said that, in the course of time, the tuning of circuits would become a regular business just as the tuning of pianos, and that it might solve the difficult problem of "What to do with our boys." Experiments with Lecher wires were also repeated with success. At the conclusion of the lecture, Prof. Fleming could not refrain from a reference to Sir William Preece's recent utterance that he was "tired of wireless telegraphy." Sir William, he said, would have to possess himself in patience, as wireless telegraphy was only just beginning, and after this would doubtless follow wireless transmission of power. Mr. Marconi, he went on to say, had now entirely solved the problem of independent transmission of signals by an ingenious application of the principle of resonance, but the time was not yet ripe for the publication of the means he had adopted. Between Niton (Isle of Wight) and Poole it was possible to transmit and receive on instruments next to one another two entirely different sets of signals, the messages being clearly reproduced and in no way interfering with one another. At the same time the Admiralty were testing their wireless telegraph apparatus between Portsmouth and Portland, the line crossing the Niton-Poole line at an angle of about 15deg., but the two lines did not affect each other in the slightest. The latest thing Mr. Marconi had accomplished, Prof. Fleming said, was both to transmit and receive simultaneously two entirely different messages, utilising the same air wire.

Annual Dinner of the Institution of Electrical Engineers.—The members of the Institution of Electrical Engineers, together with a distinguished number of guests, celebrated the annual dinner of the Institution at the Hotel Cecil on Monday last, with Prof. John Perry, F.R.S., in the chair. Among the company were Mrs. Hertha Ayrton (the only lady member of the Institution), Lord Morris, Lord Kelvin, Lord Alverstone, Sir Courtenay Boyle, Sir William McCormack, Sir James Kitson, Sir John Wolfe Barry, Sir Richard Harrison, Admiral Holland, and a number of other distinguished scientists and members of the associated professions. After the loyal toasts, Mr. S. Z. de Ferranti proposed "The Navy, the Army, and the Auxiliary Forces, including the Corps of Electrical Engineers (R.E.) Volunteers." The first to reply was Admiral S. Holland, Superintendent of H.M. Dockyard, Chatham, who recounted some amusing experiences in the use of electric plant on men-o'-war. The next to reply to this toast was Gen. Sir Richard Harrison, Inspector-General of Fortifications, who said that in his inspection of the Corps of Electrical Engineers' Volunteers he had always found them a highly efficient and well-trained body of men. The last to reply was Lieut.-Col. R. E. Crompton, who spoke in terms of the highest praise of the detachment which he had commanded in South Africa. He believed that electricity would come more and more into use in war, not only for the transmission of intelligence but for heavier work, both in life-saving and in actual fighting. The next toast, "Science and Engineering," was proposed by Lord Alverstone (Lord Chief Justice), who briefly sketched the progress of science and of applied science during the nineteenth century. Lord Kelvin was the first to reply, and in his speech he took up the thread of Lord Alverstone's remarks, and gave his audience a characteristic survey of the progress of science during the century, calling attention more particularly to the unique nature of the rapid strides made by electrical science which had been developed in the latter half of the century. Sir John Wolfe Barry, in replying to the same toast, emphasised the need for a greater attention to art in engineering. The toast of "The Institution of Electrical Engineers" was proposed first by Sir James Kitson and afterwards by Sir Courtenay Boyle, the former commenting on the utilitarian aspect of electric supply in bulk and the latter pointing out the economic and practical necessity for a Government department to act as an intermediary between the discoveries of science and the commercial applications thereof, which department was found in the Board of Trade. In reply to this, the President (Prof. Perry) likened electrical engineering to a baby, of which he said the Institution was the nurse, and was just as ignorant of what the baby was going to develop into as nurses usually are. The final toast "Our Guests," was proposed by Mr. James Swinburne in a humorous speech, in which he caricatured the relations between expert witnesses and the legal fraternity. This toast was replied to first by Lord Morris (Lord of Appeal) and afterwards by Prof. A. W. Rücker (President of the British Association), and Baillie A. D. Mackenzie (Chairman of the Edinburgh Electric Lighting Committee). The proceedings terminated at a late hour.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY,) December 7th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*4 p.m.* Special Students' visit to the Electrical Standards Laboratory of the Board of Trade, 8, Richmond-terrace, Whitehall.

THE FARADIAN CLUB.

*8 p.m.* Meeting at 8 and 10, Charing Cross-road, when Mr. J. S. Raworth will give a lecture on "The Modern Steam Engine."

**SATURDAY, December 8th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*11.30 a.m.* Students' Visit to the Manchester-square station of the Metropolitan Electric Supply Co.

INSTITUTION OF JUNIOR ENGINEERS.

*3 p.m.* Visit to the electric generating station of the London United Tramways Co., 88, High-road, Chiswick.

**MONDAY, December 10th.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture III. on "Electric Oscillations and Electric Waves," by Prof. J. A. Fleming, F.R.S.

**TUESDAY, December 11th.**

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

*7.30 p.m.* Meeting at Owens College. Paper to be read: "Proposed Manchester and Liverpool Express Railway," by F. B. Behr.

INSTITUTION OF CIVIL ENGINEERS.

*8 p.m.* Ordinary Meeting, when the following Papers will be read and discussed: (1) "The Signalling on the Waterloo and City Railway," and (2) "Note on the Signalling of Outlying Siding Connections," by A. W. Szlumper. (3) "Signalling on the Liverpool Overhead Railway," by S. B. Cottrell.

**WEDNESDAY, December 12th.**

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

*8 p.m.* Ordinary General Meeting at the Institution of Engineers and Shipbuilders in Scotland, 207, Bath-street. A discussion will take place upon Mr. Langdon's Paper "On the Supersession of the Steam by the Electric Locomotive," read in London on November 29th.

ELECTRO-HARMONIC SOCIETY.

*8 p.m.* Smoking Concert at the St. James's Hall Restaurant, Regent-street, W.

**THURSDAY, December 13th.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Paper to be read: "Rapid Variations in the Current through the Direct-Current Arc" (illustrated by experiments), by W. Duddell. Previously to this, if necessary, the discussion on Mr. Langdon's Paper will be concluded.

**FRIDAY, December 14th.**

PHYSICAL SOCIETY.

*5 p.m.* This meeting will be held in the Physical Laboratory of the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Electric Inertia," and (2) "The Effect of Inertia on Electric Currents in a Rotating Sphere," by Prof. A. Schuster, F.R.S. (3) Exhibition and description of a Quartz-Thread Gravity-Balance, by Prof. R. Threlfall, F.R.S. (4) "On the Theory of Magnetic Disturbances by Earth Currents," by Prof. A. W. Rücker, F.R.S. (5) "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents," by Dr. R. T. Glazebrook, F.R.S. (6) "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rücker, F.R.S. (7) Exhibition of a set of Half-second Pendulums, by W. Watson.

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting at Storey's Gate. The following Paper will be read and discussed: "Power Gas, and Large Gas Engines for Central Stations," by H. A. Humphrey.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Electro-Capillarity of Mixtures.*—M. Gouy has studied the effect of adding a small quantity of an "active" salt (in the capillary sense) to a solution of a comparatively inactive salt. Such active salts are chiefly iodides, bromides, platino-cyanides, sulpho-cyanates, and sulpho-carbonates. They produce, even in very dilute solutions, a considerable depression of the maximum deviation. If 0·01 gramme-equivalent of such a salt is added to a litre of a normal solution of an inactive salt, the mixed solution behaves practically as if it contained only the former salt. In spite of the great difference of concentration, the active salt practically supplants the inactive. The effect of adding the active body, say an iodide, to a less active one, say a bromide, is always to reduce the surface tension. Bromide added in small quantities to iodide produces no effect, but in some cases the depression of the maximum is increased by the presence of an inactive body. The author supposes that there exists an elective action at the mercury surface which produces an accumulation of the anions of the active body rather than of the others. If the active anions are few the state of equilibrium takes some time to establish itself, and we then have a case of electro-capillary viscosity.

[Gouy, *Comptes Rendus*, November 19, 1900.]

*Electric Dispersion in Confined Air.*—Elster and Geitel showed some time ago that the dissipation of an electric charge in air is probably due to the action of ions, as in all other known cases. H. Geitel has studied this question by observing the dispersion in an hermetically-sealed vessel. The first result obtained was that the dissipation gradually increases in the course of several days. This goes to disprove the assumption that a given volume of air is only capable of discharging a limited quantity of electricity. The author attributes the increase to the gradual laying of the dust, which, as we know now, hinders the dissipation instead of promoting it. Allowing for that disturbing factor, it appears that the rate of discharge is constant in time, and not only that, but the quantity dispersed in a given time is independent of the value and the sign of the potential, as long as that value is comprised between 240 volts and 80 volts, at all events. This is just as if in an ordinary circuit the current depended upon the resistance only, and not upon the E.M.F., and resembles the case of a clock, which goes at a certain rate whatever the tension of the spring. The nearest allied phenomenon is that described by J. J. Thomson and E. Rutherford, who found that in artificial anomalously conducting air the current intensity tends towards a maximum with increasing potential. The author supposes that a definite number of ions is regenerated in unit of time in the confined air-space.

[H. Geitel, *Physikal Zeitschr.*, November 24, 1900.]

*Geographical Elements of Electric Dispersion.*—In the course of a protracted cruise, J. Elster has taken the opportunity of studying the dispersion of an electric charge under a great variety of circumstances, and has arrived at some important conclusions. Out of 890 measurements 102 were made on Capri, 49 at Lugano, 58 on Spitzbergen, 14 in Algiers, and 28 at Tromsø. In every case it was noticed that an increase in the humidity of the air brought about a decided decrease in the rate of dissipation. Such a decrease is also observed in ascending above sea-level. Thus at Lugano, which is 900ft. above sea-level, the positive dispersion coefficient was 3·83 and the negative coefficient 2·17. At Maloja (5,700ft.), three days later, the coefficients were 8·33 and 9·44 respectively, showing in this case a greater negative dispersion. At the *Casa Inglese* on Etna, the positive coefficient was 3·19, and the negative 7·58. The unipolar character of the discharge becomes very marked at some high altitudes. Thus the ratio between the two coefficients was found to be 14·8 on the summit of Monte Solaro (Capri) and 16·0 on the Piz Languard, near Pontresina. At the same level the difference in the polarity becomes the stronger the higher the latitude. As a rule, the rate of discharge of negative electricity is double that of the positive electricity. A few cases of unipolar discharge were noticed on the Mediterranean stations, but these were probably due to the ionisation of the air by the breakers on the beach.

[J. Elster, *Physikal Zeitschr*, November 24, 1900.]

## THE NERNST LAMP.

We have had an opportunity of examining the type of Nernst lamp manufactured by the Nernst Electric Light (Ltd.), a company owning the patent rights of the lamp for the colonies (excluding Canada) and some more or less remote parts of the world. When the Nernst lamp patents were disposed of, it will be remembered that the Westinghouse Company acquired the patents for the United States and Canada, Messrs. Ganz & Co. the rights for Austro-Hungary and Italy, and the Allgemeine Elektricitats Gesellschaft the patents in Great Britain, Germany, and other European countries. Unless, therefore the last-mentioned company sells its patent rights for Great Britain to a British manufacturing firm, it appears more than probable that the Nernst lamps used in this country will be made in Germany. Each company that has acquired Nernst patents has been left to work out a practical form of lamp on its own lines, and the samples shown us differ in several respects from the model adopted so far by the German company. Neither of the two types are yet on the market, but that of the Nernst Electric Light (Ltd.) was shown us as the pattern that will soon be made in quantities, —although we were informed that orders for shipment would not yet be accepted, and that prices could not be quoted at present.

The efficiency adopted by the company is somewhat lower than what has hitherto been associated with the idea of the Nernst lamp. Although the incandescent rod of refractory material, which for convenience we will still call the "filament," may furnish light at an efficiency of little more than 1 watt per candle, a resistance absorbing a certain amount of power has to be placed in series with the filament in order to steady the current. As is well-known, the filament of the Nernst lamp is made of a material which does not conduct at low temperatures, but becomes a conductor at higher temperatures, and at these higher temperatures its temperature coefficient for resistance has still a fairly high negative value. It is, therefore, necessary to add a resistance coil with a positive temperature coefficient in series with the filament to prevent instability, and this coil has a resistance equal to 10 per cent. of the resistance of the lamp. This does not account for the whole decrease of efficiency below what was originally attributed to the Nernst lamp, for the lamps made by the company are made to a standard of 1·7 watts per candle-power; so it may be reasonably concluded that a lower temperature is employed than in the original experimental lamps, and that this may account to some extent for the much longer lives, of 500 to 1,000 hours, and even more, which are now obtained.

Our illustrations show the form the Nernst lamp has taken under the hands of the company, through the work of Mr. Drake, Mr. Sheppard, and the consulting engineer, Mr. James Swinburne. Fig. 1 is an external view of the simple lamp, which requires a spirit lamp as lighter, Fig. 2 shows the same lamp without its cover, Figs. 3 and 4 illustrate a self-lighting lamp, and Fig. 5 is a pattern for high-candle powers. The simple lamp for lighting with a spirit lamp has a globe open at the bottom, as shown in Fig. 1. The filament, which is of about the thickness of a pin, is held between platinum wires, the junction between the platinum and the filament being covered with a blob of a similar material as that of which the filament itself is composed. This junction gave a good deal of trouble at first, especially the one at the anode or + pole in the continuous-current lamp. It was found that considerable heating took place here, and that, at a spot near the anode, the filament itself diminished in thickness. To overcome

this, the platinum wire wound round the end of the filament is brought to the surface of the covering material, and in the case of larger lamps projecting pieces of platinum, to assist in the dissipation of the heat, have been tried with success. The thicker wires seen in Fig. 2 leading to the platinum wires are of nickel. The steadying resistance is of fine platinum wire, wound on a piece of unglazed biscuit porcelain, the latter material being employed for all the non-metallic parts of the renewable portion of the lamp.

Air is necessary for the burning of the lamp, at all events with continuous currents. This is probably because a supply of oxygen is necessary to prevent electrolysis of the magnesia which is the basis of the filament, or perhaps rather to effect the reoxidisation of the magnesium which is the product of the electrolysis. The top of the cap which fits over the globe is therefore perforated with a few large holes, the self-lighting lamps being in globes closed at the bottom. In the self-lighting lamps, the platinum spiral which acts as the heater forms part of the renewable portion of the lamp. This is clearly seen in Fig. 3.

It is proposed to supply these renewals at a low cost, receiving in part payment the old ones in which the filament is burnt out. The white spiral seen in the figure is of porcelain,—the platinum spiral is formed of a long piece of fine wire wound on the small porcelain rod before the latter is bent into a spiral shape. This bending is done in the blowpipe after the platinum coil has been wound on it. The self-lighting lamp has a resistance coil of platinum wire similar to the simple lamp, but the renewable part has three contacts to allow of the heating coil being switched off as soon as current passes through the lamp. This coil always remains in position round the filament, however. Two of the contacts are made by hooks in the base-plate fitting into the two eyes seen in the figure. These are placed at different centres so that the right connections must be made in putting in the filament block. In some later lamps the still simpler expedient has been adopted of having one hook shorter than the other. The third connection is an ordinary plunger and spring, as in an ordinary centre-contact incandescent lampholder. Above this base-plate, and in what may be called the hood of the lomp, is the electromagnet for cutting out the heating coil as soon as current passes through the filament, the actual cap which fits into the ordinary lampholder being above this again. Since this base-plate and the cap and hood fitting over it is to all intents and purposes a lampholder, it is difficult to see why the company adapt all their lamps to fit into an ordinary holder as well, thus introducing an unnecessary intermediate contact and retaining the plaster of Paris cap which is the weakest part of the carbon filament lamp. Moreover, by dispensing with the old lamp-holder, the price of the Nernst lamp complete would have to be compared with that of the carbon filament lamp *plus* its lampholder, and this would tend to overcome the initial cost difficulty.

FIG. 1.—SIMPLE LAMP WITH SPIRIT LIGHTER.

FIG. 2. SIMPLE LAMP WITHOUT GLOBE. FILAMENT AND RESISTANCE WITHDRAWN.

FIG. 3.—SELF-LIGHTING LAMP WITHOUT GLOBE. FILAMENT AND ATTACHMENTS WITHDRAWN.

Lamps with B C. terminals should only be required, one would think, when it is indispensable to utilise existing fittings.

As there is no vacuum space between the filament and the lamp cap, the latter would get very hot in the case of lamps of large candle-power, and damage the insulation on the electromagnet. To meet this Mr. Drake has devised the form of lamp shown in Fig. 5. The connections CCC between the two parts of the lamp pass through a sort of cage, A, and an air space is thus interposed. It is to be hoped, however, that the bare connections CCC will be insulated, when the lamp is put on the market, as at present they afford too great a temptation for making short-circuits. The contacts between the renewable part and the permanent part of the lamp are in this case formed by ordinary block terminals TTT, and the correct connections are ensured by cutting a hole H, of trapezoidal section, in the part of the base in the

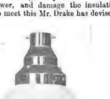
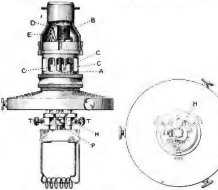


FIG. 4 - SELF LIGHTING LAMP COMPLETE.

centre of these, into which fits a similarly-shaped projection P from the base of the removable part. The steadying resistance is not seen in the figure; it is similar to that employed in other lamps.

The electromagnetic device, shown in Fig. 5, for switching out the heating coil is the same as in employed in the other self-lighting lamps made by the company. The small coil B is in series with the filament, and, as soon as current passes through it, the armature D is attracted, breaking the contact E, which is in series with the heating coil. Although very simple, this device gave considerable trouble to design so as to avoid humming in the case of alternating-current lamps. A still more compact form is now being made experimentally, in which the axis of the coil is parallel to the base, and the contact is in the base itself. This modification, together with the device of making the contact hooks long and short, instead of at different centres (already alluded to), reduces considerably the size of the lamp.

The company's offices are lighted with Nernst lamps of various sizes, and their appearance compares not unfavourably with carbon filament lamps and fittings. Comparing them with the cumbrous self-lighting lamps exhibited by Mr. Swinburne at the Society of Arts about two years ago, it is evident that great progress has been made Whether, however, the shareholders of the Nernst Electric Light (Ltd.) were well advised in investing £270,000 (out of a total capital of £320,000) for the patent rights in distant lands of an invention which it has taken two years of experiment to prepare for the market, is another matter. No doubt we shall learn the present opinion of the shareholders on the question at the annual meeting of the company which will be held shortly. In the meantime we congratulate Mr. Swinburne, and the technical staff of the company, on the good work they have done in developing Nernst's invention into what promises to be a thoroughly practical and useful piece of apparatus, calculated more than ever to cheapen and popularise electric lighting.

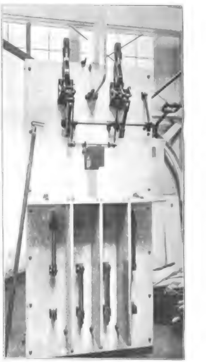


Part Section. Plan.

Fig. 5.—50-c.p. 100-volt Lamp. Half-size

## THE WESTINGHOUSE TIME-ELEMENT CIRCUIT-BREAKER.

This ingenious piece of apparatus is designed to prevent a short circuit in a long transmission line from opening any other circuit-breaker than the one nearest to the fault. The ordinary brush type of Westinghouse circuit-breaker is controlled by a time-element attachment, which additional mechanism is contained in a small box placed just beneath the two circuit-breakers, as shown in the illustration. The box contains a spring motor mechanism tending to drive a disc between the poles of permanent magnets. The action of the spring mechanism is restrained by a pawl, which is connected by levers to the ordinary tripping gear armatures of the circuit-breakers, as shown. The action of the time-element circuit-breaker is as follows:—On an overload occurring the armature is caused to move a short distance, but not sufficient to operate the trip-gear and open the circuit, though just sufficient to release the restraining pawl of the spring mechanism. When the disc of the time-element attachment has travelled a certain distance the armature of the tripping magnet is given its full motion, and the circuit is automatically opened. Should the fault be removed before the disc has completed the travel necessary to allow the circuit-breaker to act, the armature returns to its original position. The length of time which must elapse between the occurrence of the overload and the breaking of the circuit is adjusted by varying the position of the permanent magnets with regard to the disc, as is done in the regulation of supply meters in which Foucault currents in a disc are used as the retarding force.


The Westinghouse Time Element Circuit-Breaker.

These special Westinghouse circuit-breakers are in general use on the Niagara power transmission circuits, in the transmission from the power-house to the Union Carbide Co., where current is stepped up from 2,200 volts two-phase to 11,000 volts three-phase for the line; at the receiving end it is again reduced to 2,200 volts, and eventually to 110 volts. Time element circuit-breakers are placed in the 2,200-volt circuits at the generating end. Our illustration shows a pair of these 2,200-volt circuit-breakers provided with contact breaks of sufficient length for this pressure, and actuated through a time-element attachment.

## CREWE CORPORATION ELECTRICITY WORKS.

General.—The electricity works at Crewe, which will shortly be opened, have been built by the Corporation under their provisional order of 1898. The consulting engineers were Messrs. Hopkinson and Talbot, to whom we are indebted for a great part of the information contained in the following description. Crewe being a small town, with a population of only 48,000, the supply area is a small one. The London and North-Western Railway Engine Works has its own electric light and power plant, and there is also another large independent installation in the district. The three-wire system has been adopted, with 460 volts between the outers. Mr. L. C. Harvey acted as resident engineer during the erection of the works, and was then succeeded by Mr. H. H. Denton.

Site.—The station has been built on land purchased by the Corporation for this purpose, the piece of land directly enclosed for the electric light station being about $1\frac{1}{2}$ acres. It is bounded on one side by Edleston-road, a brook used for condensing purposes forms the second side, while the other two sides will be enclosed by iron railings.

The boilers are built up of seven parallel belts of Siemens-Martin steel plating $\frac{11}{16}$in. thick. Each plate is in one seamless length. All joints are arranged so as to come above the level of the side flues, and are butt jointed with straps on each side, secured by four rows of rivets. The end plate is flanged and rivetted into the shell. The front plate is secured to the shell by an angle ring and caulked inside and out after rivetting. Four gusset stays are used at each end of the boilers. The fire tubes are made up of solid-welded mild steel rings $\frac{5}{8}$in. thick, with $2\frac{1}{2}$in. flanged seams. The internal diameter of these tubes is 2ft. $9\frac{1}{2}$in., tapering down to 2ft. $8\frac{1}{2}$in. at the last ring. The first and last rings are made slightly thicker. Four conical water tubes are welded into each fire tube.

Each boiler is fitted with a dead-weight safety valve, a high steam and low water valve, a 16in. manhole and a standpipe and stop valve, which terminates inside the boiler in an anti-priming pipe. The dead-weight, high steam and low water and stop valves are of Yates and Thom's make. The front of the boilers are fitted with two Hopkinson water-gauge glasses, two feed-water check valves and a 14in. steam gauge. Hopkinson blow-off cocks are fixed, with locking keys, preventing their removal till the cocks are closed.

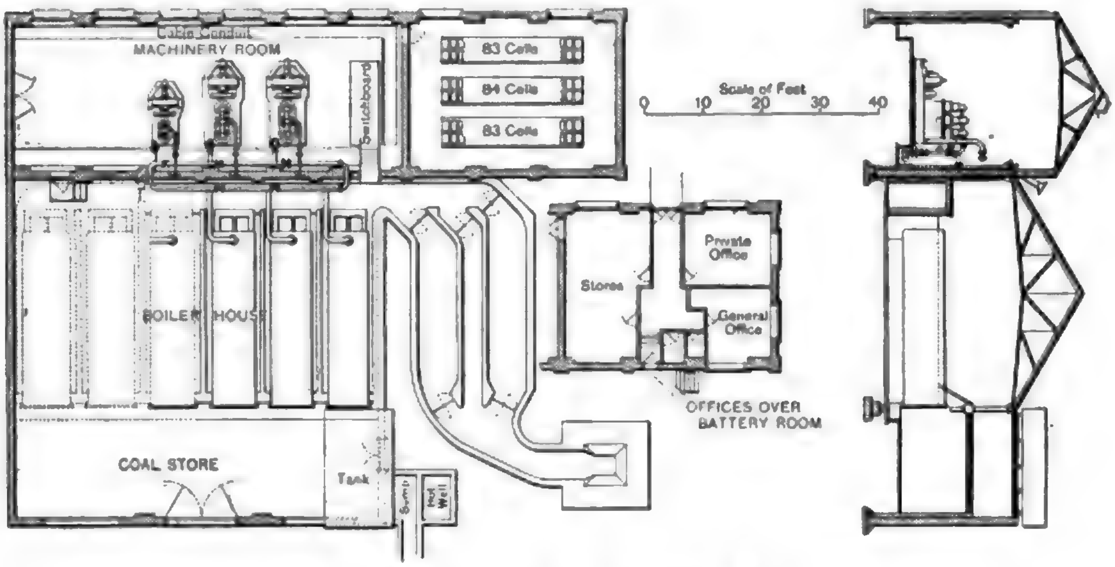


Fig. 1.—Plan and Section of Crewe Electricity Works.

Buildings.—Running parallel with and within 15yd. of the brook is built the boiler-house, at the end of which is the pump room and economiser shed. Parallel with the boiler-house is the engine room, which is faced to the height of the eaves with white glazed bricks. At the end of the engine room is situated the accumulator room, over which are the engineer's and general offices and stores, lavatories, telephone room, &c. A plan and section of the station are given in Fig. 1. The whole of the buildings, including the chimney, have been built of brindled Staffordshire bricks faced with Ruabon bricks.

The foundations of the buildings are 7ft. 6in. deep, built on 12in. of concrete. The foundations of the chimney are $4\frac{1}{2}$ft. deep and are built on a 4ft. bed of concrete 25ft. square. The boiler-house is situated $4\frac{1}{2}$ft. above the high-water level of the brook, the bank of which on the station side is strengthened by an 18in. retaining wall. All the roofs are gable-slated, supported by iron principals, and the buildings are lit by skylights running the full length of the roofs as well as by windows.

Boiler-house.—The boiler-house is 64ft. 8in. by 58ft. 8in. wide. At present, three Lancashire boilers have been installed, each 30ft. long by 7ft. internal diameter, made by Yates and Thom. Space has been provided for doubling this number.

Proctor mechanical shovel stokers have been fitted, and 12 sq. ft. of grate area is provided in each of the two-fire tubes of the boiler. The boilers can, of course, be stoked by hand.

For feeding the boilers a Green steam pump has been erected, capable of supplying the three boilers against the working pressure of 150lb. per square inch. In addition, there are two injectors placed at the opposite end of a 3in. cast-iron feed-water ring. The feed water can be drawn either from the hot-well or from the tank overhead, and can be either forced straight into the boilers or circulated through a Green economiser, consisting of 256 tubes. These tubes are arranged in three groups, two of 96 tubes and one of 64 tubes, coupled together with expansion elbows. The heating surface of the economiser is about 2,560 sq. ft. It is provided with a weighted lever relief valve to each section. It is also fitted with a 7in. pressure gauge, and thermometers are placed at the inlet and outlet. The blow-off from the economiser is taken into the common blow-off pipe from the three boilers, which discharges straight into the brook.

The exhaust steam from the feed pump is utilised for a water heater placed in the feed ring. A $2\frac{1}{2}$in. wrought-iron auxiliary steam ring has been erected for the supply of steam to the feed pump and injectors.

In front of the boilers is a space of 19ft. 3in., with a head room of 11ft. 6in. to the underside of some 12in. × 6in. girders

supporting 7in. × 4in. girders, which carry ¾in. chequered iron plates, forming a coal-storage floor. This floor is 19ft. 3in. wide, by 64ft. 8in. long, and is capable of storing from 80 tons to 100 tons of slack coal. From this floor the coal can be shovelled straight into the hoppers of the mechanical stokers, which hoppers are brought flush with the coal-floor level. Coal has to be carted from the railway company's yards to the generating station, the cart being backed on to the platform of a shoot which runs up to Edleston-road. It is then tipped down the shoot into a bunker at the bottom. The bunker is provided with a sliding door, by which a truck is filled, the truck running the full length of the coal floor.

Above the coal floor is a cast-iron water tank 66ft. 6in. long by 22ft. 6in. wide and 4ft. deep, capable of holding 35,000 gallons of water. The tank is carried by 7in. × 4in. girders, resting on 12in. × 6in. girders. The 12in. × 6in. girders, and those of the same size carrying the coal floor, fit into shoes on some 10in. columns, which also carry the principals for the boiler-house roof.

A complete 8in. diameter steam ring has been provided with Glenfield valves between each engine and each boiler, so that any portion can be shut down for repairs. The pipes used are of mild steel, with welded flanges. Cast-iron tees have been inserted where branches are taken off to the engines, and also for the spring pipes to the stop valves on the boilers. The main steam ring is supported by cast-iron pillars resting on the top of the flues, and in the engine room by hangers, with ⅞in. rods and 2in. by ¼in. clips.

The main flue is 10ft. high by 4ft. 6in. wide, and runs direct to the shaft, a distance of 116ft. A side flue has been built, in which is erected the economiser, the necessary shape having been given to the outside wall of the main flue to provide for another economiser chamber being built on the opposite side. The main dampers in the flues are single-swing door of the full section of the flues.

The chimney is built of the same kind of bricks as used for the buildings, and has a Ruabon brick string course with a blue brick capping. It is 130ft. in height, and has a cylindrical bore of 7ft. the whole way up, and is lined with fire-brick to a height of 26ft. 6in. The base of the chimney is square to a height of 27ft. 10in., where it changes to an octagon shape.

**Engine Room.**—The engine room is 67ft. 6in. by 26ft. and is 25ft. to the underside of the eaves. To the gable is 33ft. The principals and all ironwork connected with the crane is painted a very light blue, which looks well against the white glazed bricks and varnished matchboarded roof; 3ft. 9in. pilasters are built on each side of the room surmounted by padstones, upon which rest 12½in. by 5in. gantry joists for a hand-power 10-ton overhead travelling crane. This crane, made by Messrs. J. Spencer, has a span of 24ft. 4in. to the centre of the bridge rails, which are rivetted to the gantry joists. The transverse gantry is of rolled steel girders 2ft. 2in. deep at the centre, and 1ft. 3in. deep at the ends, with T stiffeners 5ft. apart. The end bogie carriages are of H section connected to the main girders by gusset plates. The crab is fitted with a friction brake and spur-wheel gear, with a change of gear to give two different speeds, and travels on 3in. bridge rails by double flanged cast-iron wheels.

Three engines have been erected at present. The two largest are 275 B.H.P. compound three-crank Willans engines directly coupled to 480-volt 190kw. Mather and Platt four-pole dynamos. Their cylinder diameters are 14in. and 20in., and the engines run at a speed of 330 revs. per min.

There is also a two-crank compound Willans engine of 137 B.H.P. direct coupled to a 95kw. 480-volt Mather and Platt four-pole dynamo, which is capable of running up to 560 volts for the purpose of charging the battery. The cranks of this smaller engine are set at 180deg., the cylinders are 12in. and 17in., and the speed is 360 revs. per min.

The dynamos are shunt-wound continuous current machines and can be used for supplying power to the trams when this scheme, which is in hand, is carried out. The armatures are drum wound, and built up of insulated iron plates, slotted, and wound with copper strip placed in insulated troughs. The poles are cast in one with the yoke ring of special soft steel of high permeability, and the magnet coils are wound on separate spools, which slip over the poles. Pole-pieces of special design are subsequently attached. The yoke ring is split across in a horizontal plane so that the upper half may be readily removed to afford access to the armature. The armature is ventilated to meet the prescribed temperature test—viz., that after 10 hours' continuous run the rise of temperature must not be more than 70°F. above the surrounding atmosphere. The combined efficiency of the sets is to be such that the steam consumption does not exceed 26lb. per kilowatt hour on full load.

Each engine is fitted with a Ledward ejector condenser, discharging into a trench running the length of the engine-room, the water from which is carried off by a 12in. pipe to the hot well. The engines can either be run condensing or to atmosphere, the exhaust pipes being run up chases in the wall directly behind each engine, and running out through the wall under the eaves. In the condensers the usual Ledward system is followed (Fig. 2). A column of water enters the ejector tube through a contracted orifice under a pressure of about 7lb. per square inch, and, passing through a series of specially-shaped nozzles, produces a high vacuum in the surrounding chamber communicating with the exhaust steam, which is, therefore, drawn into the ejector tube, the mixed steam and water issuing from the discharge pipe.

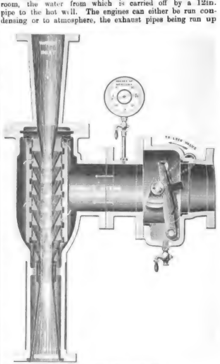


Fig. 2.—Ledward Ejector Condenser.

Condensing water is circulated through an 8in. pipe by an Ernest Scott and Mountain centrifugal motor-driven pump. The motor is rated at 5·5 H.P. and the pump is capable either of circulating water for condensing purposes or of delivering water at the rate of 12,000 gallons per hour into the tank above, a height of 28ft. The pump is fixed directly over a sump which is connected to the brook by a culvert.

Battery.—A battery has been provided consisting of 250 31-plate Hart cells having a capacity of 400 ampere-hours with a maximum rate of discharge of 180 amperes for two hours. There are 42 regulating cells on each side, and they are connected to the cell switch by bare copper rods. The cells are in glass boxes, and are erected on wooden stands. The switchboard being in the engine-room, on the wall which separates the engine-room from the accumulator room, a steel spindle passes from the handwheels to the cell switches themselves, which are circular and of the concentric pattern, and are placed in the accumulator room parallel to the handwheels. The regulating cells are placed at the outer ends of the battery, the middle point of the battery being fixed.

Switchboard.—The switchboard is 16ft. by 7ft. 8in., and is divided into three sections, fitted with Kelvin instruments throughout. It is of the usual three-wire type, with positive dynamo and feeder panels to right, negative to left, and between them a middle-wire panel. The switchboard has been made by Messrs. James White to Messrs. Hopkinson and Talbot's specification. On the front of the board, on the positive and negative sides, are six dynamo bars, four of which it is intended for use at present, leaving two spares. On the negative side a dynamo switch is fitted, and on the positive side a dynamo ampere-gauge takes its place. On the back of the board, on the positive and negative sides, are six vertical feeders bars and one spare bar. Substantial copper plugs are provided, by which any of the six dynamo bars can be plugged on to any of the six feeder bars or to the spare bar. The feeder switches are of the laminated "S" type, and the feeder ampere-gauges of the Kelvin edgewise pattern. Kelvin multicellular electrostatic feeder voltmeters are fitted on the positive and negative sides, while on the middle panel a Kelvin illuminated dial dynamo voltmeter with multiple contact switch is provided. In the space on the middle panel are the field regulating slides and, below these, hand wheels for the charge and discharge battery regulators. Lord Kelvin's earth current recorder with automatic circuit switch is employed, and at the bottom of the middle panel a Kelvin undertype edgewise ampere-gauge is fitted, which indicates the middle wire current.

The machine leads run through circuit meters and single pole fuses before reaching the switchboard.

Mains.—The feeders and mains are brought into the station at the opposite end of the engine room to the switchboard, and run up one side in a culvert passing to the back of the switchboard, where the cables are fixed to the wall and brought overhead to their respective terminals. A clear passage is thus afforded for examining connections behind the board.

The cables have been manufactured and laid by W. T. Henley's Telegraph Works Co., and, with the exception of lamp connections, are single conductors insulated with impregnated paper and lead-covered. They are laid "solid" in wooden troughing. In Edlestone-road, in which the works are situated, the cables are armoured, but elsewhere merely lead-covered. The network is fed at two points by two single feeders, no feeder running to the third wire. Each of these cables is 0·2 sq. in. in sectional area. The feeders are connected to the private and public lighting distributor in special feeder boxes in which all the disconnecting links are arranged with conical fittings to ensure good contact with the 'bus bars. Five distributors are laid together in one trough, two 0·2 sq. in. for private and two 0·1 sq. in. for public lighting, and a 0·2 sq. in. middle wire common to both. All these five cables are brought in to the generating station. At present 20 miles of cable have already been laid as follows:—

| | | |
|---|---|---|
| 0·2 sq. in. feeders | 1·7 | miles. |
| 0·2 sq. in. private | 12·6 | " |
| 0·1 sq. in. public | 5·7 | " |

Eight network boxes have been put in various parts of the town. They are of cast-iron with screw-down lids, and the cables are brought through glands filled with compound, and terminate with couplings which connect them to 'bus bars. Brick pits, with manhole covers, are built round these boxes.

Street Lighting.—The present gas lamp-posts have been adapted to receive two 16 c.p. or 25 c.p. incandescent lamps, mounted in Reason fittings (Fig. 3), which are connected to the mains by 3-core 7/19 vulcanised rubber lead-covered cable. These circuits are switched from the generating station. On each post is a double-pole fuse in a brass watertight case. Large street lighting extensions are at present being carried out, and when finished another 400 street lamps will be connected to a network of 3-core and twin cable. There are only three arc lamps at present on the street-lighting mains, and these are in the centre of the market square, the existing gas standard having been adapted.

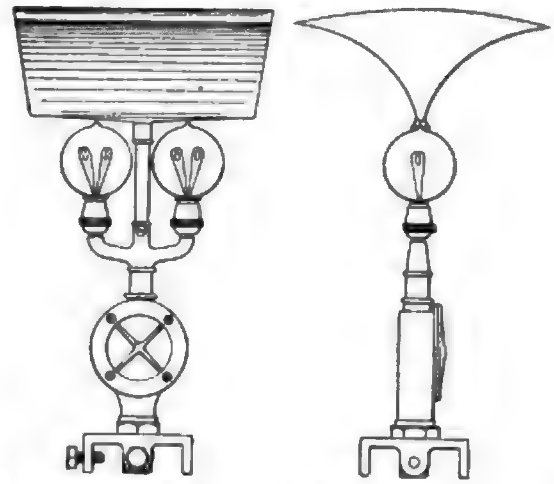


FIG. 3.—Incandescent Street Lighting Fittings. Scale: 1/4th full size.

The station lighting has been carried out by Messrs. W. O. Rooper and Robins. The engine-room is lit by four enclosed arc lamps, and by brackets down each side of the room. The other buildings, offices, &c., are equally well lit.

Miscellaneous.—There are about 70 consumers at present connected to the mains. The price charged for current for lighting will be 6d. and 3d., on the maximum demand system, and 3d. for power. The station will start with a maximum load of 100kw. and about 2,000 8-c.p. lamps connected to the mains, with 18 arcs on the private lighting mains.

## ON THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.*

BY W. LANGDON.

(*Concluded from page 203.*)

A generating plant capable of an output of 10,000kw. is, of course, ample to provide for a calculated demand of just half that amount. I adopt the following estimate as applicable to the prime cost:—

| | | |
|---|---|---|
| *Generating Station.* | | |
| Buildings, foundations, chimney stacks, &c. | £50,000 | |
| Equipment, including steam units, boilers, coal conveyers, steam mains, condensers, pumps, &c. | 200,000 | |
| | | £250,000 |
| *Sub-stations.* | | |
| Buildings—five stations | 10,000 | |
| Equipment of ditto with transformers, converters, &c., delivering at 600 volts, and all necessary fittings | 70,000 | |
| | | 80,000 |
| Cables, including laying | 70,000 | |
| Contact rail—200 miles (i.e., 4 roads of 50 miles each) | 70,000 | |
| | | 140,000 |
| Total capital outlay for generation and distribution of current | | £470,000 |

The figures comprised within the two first items are practically those given by Mr. Parshall with reference to a somewhat similar plant, with the exception that the amounts have been increased to the extent of £15,000 for the generating station equipment, con-

* Paper read last night before the Institution of Electrical Engineers.

sequent upon the adoption of a higher voltage; and £10,000 for generating station buildings to meet any advance of prices. £10,000 has also been added for independent transformer buildings. The cost of cables, including laying in position, is based upon the current demand and mileage. The hourly demand has been shown to be 5,000kw. The annual output for the section of line under consideration will therefore be this amount multiplied by the 24 hours per day, and 365 days to the year, viz., 43,800,000 kilowatt hours. On this basis I estimate the annual cost for generation and distribution of current as shown in the annual column of the following table, from which, by dividing the sums there shown by the annual kilowatt output, I obtain the per kilowatt-hour charge. To the foregoing we have to add the cost for drivers and assistants in attendance upon the electric locomotives—performing practically the same duties as the driver and firemen in attendance upon the steam locomotive; together with that for repair and renewal of all machinery, including the locomotives.

In his presidential address to the members of the Institute of Mechanical Engineers in 1898, Mr. S. W. Johnson, the locomotive engineer for the Midland Railway, furnished valuable data in relation to the cost of moving railway trains. From this data, I, by his courtesy, am enabled to furnish the details shown on Table VI.

**Table VI.**—*Steam Locomotive Charges.*

| Average Midland Railway total locomotive expenditure, &c., during 24 years, 1873-96. | | Cost per train mile. |
|---|---|---|
| *Running Expenditure.* | £ | Pence. |
| Wages: Drivers and firemen | 358,635 | 2·650 |
| Cleaners, coalmen, &c. | 94,422 | 0·698 |
| Water | 28,575 | 0·211 |
| Oil and stores | 44,842 | 0·331 |
| Coal and coke | 289,595 | 2·139 |
| Total running expenditure | £816,069 | 6·029 |
| *Repairs and Renewals.* | | |
| Wages | 178,718 | 1·320 |
| Materials | 178,742 | 1·321 |
| Total repairs and renewals | £357,460 | 2·641 |
| Salaries | 24 187 | 0·179 |
| Turntables and buildings | 2,861 | 0·021 |
| Gas | 9,868 | 0·073 |
| Gross expenditure | £1,222,899 | 8·943 |

| | |
|---|---|
| Tons of coal and coke consumed | 727,889 |
| Cost per ton | 7s. 11½d. |
| Train mileage | 32,485,530 |

This table shows that the average cost for 24 years for drivers and firemen was £358,635, or 2·650d. per train mile; and that for repairs and renewals £357,460, or 2·641d. per train mile.

To arrive at the cost for drivers and attendants for the electrical locomotive, I might revert to Table IV., and deduce from it, at a given rate of wage per hour, for the number of trains occupying the line for that period, the kilowatt hour cost, but this it appears to me, would not be quite right. There can be no question that the cost incurred by the locomotive department is extremely heavy,* but it is a charge incumbent upon the working of the traffic, and whatever are the conditions which militate against a reduction in this charge with the locomotive department, presumably they would hold good against the electric unless the traffic could, under the latter, be so facilitated as to enable it to be got through with greater speed and less shunting. It is not clear this could be done. I am, therefore, very reluctantly I must admit, obliged to adopt the extremely heavy cost incurred by the steam locomotive, for there would be very little, if any, difference in the rate of pay to the respective class of men.

The repair and renewal of electrical machinery, whether in relation to the generating or the locomotive plant, should be considerably less than that of the steam locomotive plant, for the reason that there will be extremely few moving parts, while many small units, used for pumping and other like purposes, would be provided for from the central generating station at a less cost, or entirely abolished.

The train mileage (Table IV.) run by the 14 trains during one hour is 479. Assuming that the cost attending the repair and renewal of the electrical machinery will be 2d. per train mile, as against that for the steam locomotive power and works, viz., 2·641, we shall have a result of 0·1916d. per kilowatt hour.

There is yet one more addition to make. The cables and contact-rail are peculiar to the electrical system. I do not include them in the above 2d. per train mile for repair and renewal of machinery.

* Assuming the weekly wage of driver and firemen to amount to 90s., probably an excessive sum, it would seem that the weekly mileage travelled would be but 407. If the wages were 70s., the mileage would be but 317.

Having regard to the value of the recovered material, I assume 2½ per cent. on the primary outlay will meet the renewal of cables, and 4 per cent. that of the contact-rail. This means 0·0249d. per kilowatt hour.

Table VII. furnishes all these items, against each of which is also shown the cost per train mile—*i.e.*, the cost per kilowatt hour multiplied by the total output, viz., 5,000kw. for the hour's work, divided by the train mileage worked during the hour, viz., 479.

**Table VII.**—*Electrical Charges.—Cost in pence per kilowatt hour and per train mile.*

| — | Per kw. hour. | Per train mile. |
|---|---|---|
| Generating charges | 0·1574 | 1·643 |
| Sub-stations charges | 0·0299 | 0·312 |
| Outdoor attendance | 0·0041 | 0·043 |
| Oil, waste, and sundries | 0·0109 | 0·114 |
| Locomotive drivers and assistants. [This item is shown at the cost incurred under present mode of working] | 0·2538 | 2·650 |
| Repair and renewal of machinery, motors, &c. | 0·1916 | 2·000 |
| Renewal of cables and contact-rail | 0·0249 | 0·259 |
| Total cost for power and haulage | 0·6726 | 7·021 |
| Interest at 3½% on primary outlay—viz., £470,000 | 0·6901 | 0·941 |

Therefore, if my deductions are correct, it would appear that the cost of working by electricity as against that for the steam locomotive is, per train mile, so far as the Midland is concerned, as 7·021d. to 8·943d., being an apparent saving of 1·922d. per train mile, or £260,155 on the average yearly cost for the 24 years indicated.

A closer comparison of the chief items may help us to learn where and how so large a saving is effected. Coal stands in Mr. Johnson's data at 727,889 tons, at a cost of £289,595. Based upon the figure adopted by me—viz., 3·0lb. per kilowatt hour, the tonnage required is 454,145,* and the money £180,712.† The steam locomotive consumes on the average 50·191lb. of coal per train mile. My figures place the quantity required for electrical energy at $\frac{(5,000 \times 3 \cdot 0)}{479}$ 31·315lb. The saving under this head is therefore 273,744 tons, which at 7s. 11½d. will account for £108,927. We have to bear in mind that the calculation on which the cost of electricity is based makes no provision for shunting operations. It is based entirely upon the train mileage run. Shunting work is, of course, included in Mr. Johnson's figures, and will account, to some extent, for the difference. The main gain, however, is to be found in the economy of a stationary, as against an itinerant generator, as well as in the fact that much coal is consumed by goods and mineral trains when shunted, and by all trains when standing at stations, the whole of which would be saved if worked by electricity.

With stationary engines a less expensive coal than that used for locomotives would be available, thereby effecting a reduction probably more than sufficient to meet the cost for shunting, previously alluded to. It may be pointed out that coal is more costly at present. Such is the case, and were my calculations based upon the present rate of coal, the result would largely enhance the advantage of electricity. Say, for instance, that coal stood at 10s. instead of 7s. 11½d. the locomotive cost would be 727,889 tons at 10s. = £363,944 instead of £289,595. That for electricity would be 454,145 tons at 10s. = £227,072, instead of £180,701. The result would be that electricity would show, under coal at 10s. a ton, a saving of £136,872 instead of £108,927, on precisely the same mileage, with a proportionate increased saving at prices ranging above that figure. The fact that dear coal enhances the comparative value of an electrical system—especially with the possibility of coal at a higher rate than 7s. 11½d.—cannot be too strongly emphasised.

*Water.*—The steam locomotive calls for £28,573, or 0·211d. per train mile; electricity, £7,066, or 0·0522d. per train mile—a difference in favour of the latter of £11,507. It is difficult to attempt a comparison between the cost of a largely-scattered supply—water pillars at numerous stations—and a concentrated one—one to every 50 miles or so of line. The site for such a generating station would naturally be selected with a view to cheap water supply, and, as a rule, no great difficulty would attend its selection. A further point to be borne in mind is that, naturally, all machinery would be of the most modern and economical type, and that the working would reach the highest ideal for an electrical plant, viz., an actually constant and perpetual demand.

*Drivers.*—It is quite clear that whatever may be the cause of the existing heavy charges, it will apply equally to electric as to steam

* $\frac{5,000\text{kw.} \times 3 \cdot 0}{479} = 31 \cdot 315$ $\frac{32,485,530 \times 31 \cdot 315}{2,240}$ 454,145 tons.

† $\frac{0 \cdot 1279\text{d.} \times 5,000\text{kw.}}{479} = 1 \cdot 335073$d. per T.M. 32,485,530 T.M. × 1·335d. = £180,711.

locomotives. The engine must stand by its train, and the men along with it. Any reduction that may be effected will be in the mode of dealing with the traffic. The present condition, viz., that of a mixed traffic travelling at various rates of speed—one class of train being required to make room for another of a more important character—is not destined to effect economy in this branch of expense.

*Repair and Renewal.*—I have assumed that the cost of repair and renewal would be practically one-fifth less with electricity than steam. I think I am more than justified in this. The wear and tear of stationary engines, or motors, cannot possibly be so great as that of the steam locomotive. The number of electric locomotives would necessarily be as great, but their wearing parts would be immensely less, than those of the latter. Many local units would be entirely dispensed with.

*Oil and stores* forms a somewhat large item in the running expenses of the steam locomotive. Much of this is for the lubrication of moving parts which would be non-existent in electric engines. Moreover, with stationary engines it is possible to recover, and again use, a great portion of the lubricator employed. It would appear that considerable economies in oil should accompany the employment of electricity.

We may now perhaps glance at possible economies on that which is indispensable for the steam locomotive, but which is unnecessary, or not so largely necessary, with electricity. Water pillars, turntables, engine sheds, coal stages—all these are expensive items which with electricity are either not required, or capable of considerable modification.

Water pillars, supplemented in many instances by fixed engine-power for pumping the water into reserve tanks, involving power-houses, sheds, and other structures, form part of all large stations and many other points at which the locomotive requires to take water. With electricity, water to any extent would be required only at that point at which the central generating station is placed. If this station served 50 miles of railway, then it would take the place of all the pumping plants, water pillars, &c., otherwise required throughout that section for the steam locomotive. Every pumping station involves the provision of labour, fuel, &c. All water pillars require special attention during hard weather. Economies in first outlay and annual charges on this account should accompany the use of electricity. Turntables would be unnecessary. The annual outlay for repairs in this respect is not great, but the cost of laying down the large turntables now required is very heavy.

As the number of locomotives increases, so increases the demand for engine sheds. Electric locomotives would of course need housing as well as the steam locomotive, but the space which they would occupy would probably be about half that now required. Wherever we find an engine shed there we see an area of land covered with coal, lines of rails applicable thereto, coal stages to which the coal has to be carried, and from which it has to be distributed to the locomotives. First, the coal has to be stacked, then loaded into trucks and carried to the coal stage, and thence weighed and placed on the engine's tender. This is the course of procedure at each engine depot. If we compare it with the work of a large central station, such as that sketched out in this Paper, I think it will come home to us that, although the work would be large, it could not be nearly so large as at present. If stacking were at all necessary there would be the less quantity to stack, and it would all be dealt with in a more concrete form and at comparatively few centres. Again, in this respect there is reason to look for economies in land, in buildings, and labour.

All these are assets directly due to the employment of electricity. Others, not considered in the figures which I have advanced, would, with its presence, be available; the lighting of the trains, stations, goods warehouses and yards, marshalling grounds, &c.; signalling, to some extent, might become automatic; while at large centres where signal boxes have become both numerous and cumbrous, it would appear but reasonable that, with the aid of such a power, points and signals might not only be actuated, but the means for operating them might be so condensed as to admit of the entire duties being embraced within such a space as would enable one man to deal with them. Labour and space would be economised, and less time would be occupied in giving effect to the various operations than is possible with the existing means. To this we may add that obviously it would also provide for the operation of lifts, and other local demands for power which at present have to be met by isolated plants.

Let us now turn to what may perhaps be regarded as difficulties to be encountered. The first question that will arise will be: are we safe in placing so many of our eggs in one basket? With the steam locomotive we have a travelling unit which has to manipulate its own load, and is in no way responsible for the duties of others. If it breaks down the inconvenience is chiefly confined to the vehicles it is hauling, and in due course they are extricated from their difficulty by the aid of another engine.

With electricity we are locating our power at one spot in so many miles of line, and if that breaks down that section of line is practically dead. But with the usual spare parts—the duplication, if necessary, of the generating units—there should be no reason to anticipate such a failure. The same argument in a measure applies to the power at the distributing stations. Here, however, the case may be met not only by duplication, but by, in emergency, connecting one section through to its neighbour. For the time being inconvenience would be felt; speed would be reduced, but traffic would not be stopped. Of all this we have evidence in that which has already been done. We see railways being worked, tramways operated, and other large undertakings all dependent upon one large and central source for their life and being. Electric railways have become an accomplished fact, and we may turn to those that are in use as exponents of success or of difficulties to be encountered. Does the magnitude of the question we are considering—the eventual supersession of the steam by the electric locomotive—remove it from the category of that which has so far been done? I think not. The basis is there. It is to-day in useful operation. Improvements will come. The mode of working which we see to-day may, and probably will, be simplified, but this will only strengthen that which has already been accomplished.

Still, there are points of great interest for consideration. As a rule, that which has been done has, with one or two exceptions, been confined to underground lines, and these exceptions have not as a rule dealt with such heavy work as the large overland railways require to compass. Overground railways have to work through all kinds of weather—rain, snow, fog—and at times to pass over rails submerged in water. Winter floods are not unusual in certain localities of nearly all overland railways. These are conditions which will affect the construction of the locomotive, the arrangement of the current collector, and the contact-rail, and are subjects for thought not only in themselves but in relation to the mass of under-gear which now appertains to all passenger railway stock, as also to the relative position and construction of roads, their repair and renewal.

A question may here intervene whether a similar economy would attend the operation of small branch lines of railway where the trains are few and far between. Consider! Why are the trains so few and far between? The traffic is, we will say, a fixed quantity. There are only so many tons of goods and so many passengers passing over it daily. The steam locomotive is available only at certain times, and to attain economy it is necessary that so many trips only should be made. The accommodation is limited to this. But if the power for working the trains were constant, although reduced, any number of trips might be made. The additional cost would be that only of the driver, for the rest the branch would be no more costly, while the frequency of the communicaiton would tend towards the development of the district and the consequent increase of trade.

I have now, I believe, fairly set forth the salient features of this question. The data which I have produced speaks greatly in favour of electrical energy as a motive power for the movement of railway trains. The economies which it would apparently effect are, indeed, so large as to raise a doubt whether my deductions—whether the figures I have adopted—are fair and reasonable. It must not be forgotten that my calculations are based upon a mileage run clear of stoppages or other contingencies. Stoppages are unavoidable. They *will* arise, and provision must be made to meet them. But I find it difficult to identify them further than I have already done. Stoppages will not affect the coal bill. I have taken the present cost of drivers and firemen to apply to that for drivers and assistants for electric locomotives. My allowance for repair and renewal of machinery will, I think, be generally supported. Necessarily the subject has to some extent had to be dealt with more in the abstract than in detail, but I venture to hope my figures will not be found illiberal. We must not lose sight of the fact that the conditions are a constant load and continuous output for every hour of the year. I believe the cost of shunting at stations and in goods yards may be met by the economy attending the use of a cheaper coal than that which is necessary for the steam locomotive; but assuming that some provision should be made for this, for administration and contingencies, I conclude that 20 per cent. (say £50,000) of the accredited saving will cover it.

We thus bring the net annual advantage to approximately £208,124, and if we deduct interest on the primary outlay it will further reduce it to £191,674. Whether it is, in face of the savings to be affected in engine sheds, coal stages, water cranes, &c., fair to make a debit in full of this amount, I must leave those who are interested in the question to determine. Broadly, it appears to me to mean this: that were a new company to start with electricity as their motive power, they would not need to take into consideration the interest on the entire additional outlay, because they would save a great portion of it in other directions.

But were an established company to adopt it, they would already have incurred the cost for the lands, buildings, &c., and the expense for establishing electric working would unavoidably prove to them, for some years, an addition to their capital charges.

Although I feel that my reason for pursuing such a course will be

obvious, it may be desirable that I should emphasise the fact that my sole object in availing myself of the data afforded by Mr. Johnson's presidential address to the members of the Institution of Mechanical Engineers is that I might deal with data extending over a long period of years, rather than draw a comparison with a period which might be regarded as possessing some abnormal feature. It must, however, be noted that recent figures tend to greatly magnify the result. I have shown that, with electrical working, certain economies are to be anticipated. The annual amount of these economies is based upon the ascertained saving *per train mile*, multiplied by the average annual mileage for the 24 years—viz., 32,485,580. The mileage for 1899 is 45,453,438, and the expenditure £2,006,069, as against the 24 years' average £1,122,899; and the train-mile cost has risen to 10·59d. as against 8·943d. Assuming that the saving per train mile remained the same—it would probably be larger, consequent upon the increased cost of coal—the resultant saving would be, independent of any deductions for interest or contingencies, £364,006. Large as is the apparent economy thus presented, it would, were it possible to employ a gas plant for so large an output, be increased by the use of the "Mond" gas system. Such a system would appear to invite consideration, at all events, for smaller installation, as, for instance, for the operation of branch lines.

Here it may perhaps be asked: What good can attend the production of these figures, or the results they advocate, seeing that the railway system generally is wedded to the steam locomotive? Is it probable that any railway company will cast on one side their present equipment for the purpose of taking up that, which, although holding out fair hopes of a large economy, is yet, in a measure, or in the large measure to which it would have to be applied, mainly an untried agent? To this I reply: Railway companies are under the direction of business men—men who know the value of money. Satisfy them that economies are to be effected—and do not let us forget that the economies are not confined solely to those with which this Paper has dealt, but probably to many others indirectly associated therewith—and that the economy embraces a reliable means of working, and they will not be found undesirous of testing its worth. The life of a steam locomotive is not an indefinite quantity. Its replacement by one of more modern construction or of greater power, quite apart from its ultimate destruction by wear and tear, is an appreciable fact. As traffic increases, so additions have to be made. We see so many new engines ordered year by year. What is to prevent a railway company, instead of thus perpetrating its annual costs, setting apart portion by portion of their system for operation by electrical energy, and, instead of ordering for, say, that portion of their system, steam, to order electric locomotives; and thus to bring, piece by piece, their entire system under electrical operation? No sane railway management would do otherwise; and I assume that, should my figures stand unrefuted, no railway company would desire to follow any other course. Prove its economy, prove its reliabity, and there is nothing in the fact that railways are, for the time being, the slave of the steam locomotive, to militate against their supersession by electrical energy.

That this Paper deals with a problem which, sooner or later, will force itself upon the attention of all who are interested in railway progress, few will be disposed to dispute. So far it has been considered solely in the realm of economical working—in the interest of the railway shareholder. But are we justified in looking at it only from this standpoint? Does it not embrace a question of still greater magnitude? Is it not one of even national interest? If, by the aid of electricity, we can save no less than 18·876lb. of coal per train mile, it is clear we could save *no less than three million tons* a year* if all our railways were worked by that agency. View it again from still another standpoint. Twenty thousand locomotives moving about throughout the land cannot fail to leave their mark behind them. Our railway stations, the telegraphs which traverse the railway routes, the trees which grow on its borders, all bear evidence of their presence. The supersession of the steam locomotive by the electric locomotive will bring with it a purer and a more cleanly atmosphere—cleanly railway stations—cleanly railway carriages—a higher and a purer sanitary condition of life.

---

The following is an abstract of the discussion which took place on Nov. 30 in connection with Mr. Langdon's Paper:—

DISCUSSION.

Mr. MARK ROBINSON said this was a very important communication, dealing with a matter of the utmost importance to the country and to its industries, and the conclusions arrived at by the author were welcome to a great many present. Mr. Langdon had not spoken as an enthusiast—scarcely as an advocate—but had treated the subject with great impartiality and moderation. In fact, Mr. Langdon's moderation was his only excuse for criticising the Paper. The case for electricity had been put under some disadvantages. The author took five sub-stations, each feeding 10 miles of line with continuous current at 600 volts. No doubt he had reason for this number of stations, and for the number of miles which each station should feed; likewise for the number of kilowatts required. He questioned the need for the big central station which supplied these five sub-stations. This had been laid out for 10,000kw., but he personally believed that 2,000kw. in each of the five sub-stations supplying 10 miles of line could be worked as economically, or nearly so; in which case there would be great advantages in working the system on this plan. With 10,000kw. (corresponding to 16,000 H.P.) it would mean four engines of 4,000 H.P. each. The idea was that as engines got to very large sizes they became much more economical, that there were going to be very notable savings in coal and other things to justify the cost of the cables leading to the substations and to the line in transformation; but, in his opinion, there were no such economies in increasing the size of engines. Probably Mr. Langdon had turned to the country where this had been carried to its great development—*viz.*, America, where they believed very much in large stations. In America the economy of slow-running engines was thought much about, and it was, no doubt, true that slow running engines increased their economy as their size increased. Fast-running engines stood upon quite a different footing. In them a new factor tending to economy came into play, which had practically no existence in slow-speed engines—viz., the great shortening of the period during which the surfaces were exposed first to hot steam and then to comparatively cool steam. This was certainly one of the great reasons why fast-running engine were economical. He had consulted several electrical engineers of large experience, and they had all supported the idea that a station of from 2,000 H.P. to 3,000 H.P. could be run with almost the same cost per kilowatt as a large station, and if they raised this to 3,000 H.P. or 4,000 H.P. it would be true again. These five sub-stations were a little smaller than he might wish for, but taking them as 2,000kw. stations it would mean three 800 H.P. engines or four 700 H.P. engines, and these would use as little steam per kilowatt as engines of any larger size, they would cost less for engine attendance and their office management expenses would be comparatively little more. Five such stations as those connected by telephone on the same line would be practically one unit, and each station really a foreman's job. Assuming that in each 10 miles section a site was found for water facilities, &c., and that a fifth of this total power (10,000kw.) was installed in each of these five stations, and assuming that the five stations cost as much to build as the one large one, say £60,000 (which was safe because these very large stations increased rapidly in cost on account of the great span of the buildings, &c.): assuming also that the £200,000 provided for in the Paper for generating plant was available and sufficient for the five smaller stations a saving of at least £70,000 would be effected on the equipment, besides the cost of stationary transformers, &c., and the £70,000 estimated for cables, making a total saving of £140,000 and a total capital outlay of only £330,000 as against £470,000. In addition, the 17 per cent. estimated by Mr. Langdon as the loss in the rotatory converters and static transformers would also be saved, to say nothing of the 10 per cent. lost in high tension transmission. By this means each section containing three trains instead of requiring 1,107kw. as estimated would only require 834kw., and the total was reduced from 4,984kw. to 3,892kw.—viz., a reduction of 22 per cent. Again, 22 per cent. off the £260,000 allowed for buildings and plant was a further reduction of over £57,000, so that the capital charge would be brought down to £273,000 as against £470,000. At the same time there was also the 22 per cent. which one might hope to save upon the engine room costs. He was quite prepared to learn that there might be difficulties in finding five convenient sites for these five stations with good water facilities, &c., so that in the event of a reduction in the number of stations something would have to go back on to these costs, but the saving was so great as it stood at present that he could afford to return a good deal in this way and still get an advantage. For railways with very light traffic separated over long distances, or on metropolitan lines, high tension transmission with transformation at the end might be perfectly right, but he could not help thinking that for railways in general this ought to be the exception rather than the rule. There was still another good economy not taken into account in the Paper—viz., that when a line became wholly electrical the passenger trains could be run upon the better system of having the motors on the axles of the carriages, which gave good advantages for such trains and was less hard on the railway.

Mr. H. H. CUNYNGHAME, of the Central London Railway, thought the question of the application of electricity to locomotion largely depended upon the question of the pounds of coal per ton-mile. Some years ago he read a short Paper, which was published in the *Proceedings* of the Institution of Civil Engineers, upon the subject of the consumption of fuel by locomotive engines. At that time he was chief engineer of the Canada Southern Railway. This was an extremely level line, no gradient being more than 15ft. to the mile. It was also entirely free from curves, there being one long straight of 53 miles joined to another of 54 miles. Nevertheless, for this reason this line was, perhaps, the very best possible for doing work with a very small consumption of fuel. The goods trains were necessarily very long, and were drawn by one engine, and the consumption of fuel with these trains worked out at 0·15lb. of coal per ton mile; and on the passenger trains, where a much higher speed was maintained, the consumption of coal was 0·8lb. per ton-mile. When dealing with electric railways it was precisely the same problem. The gradients of the line affected the amount of power used, or, in other words, the quantity of power was dependent upon the resistance of the line, which was mainly the gradients. On the Liverpool Overhead Railway, which was practically a level line, the quantity of coal burned per ton-mile, as stated in a Paper read before the Institution of Civil Engineers, was 0·4lb. On the Central London Railway, although only having a brief experience, the figure, irrespective of the amount consumed for station lighting, lifts, &c., was

---

* 396,341,265 train miles × 18·876lb. = 3,339,040 tons.

0·5lb. per ton-mile, which covered all losses in transmission, tranformation, &c. In the Paper the question of power seemed to have been assumed at some standard amount, irrespective of the gradients. The quantity of power used on such a line as the Central London Railway, not taking into account lighting and lifts, was something like 70 watt-hours per ton-mile, but as showing how very much this power varied with the gradients he mentioned that on the Montreal electric street railway the quantity used was something like 300 watt-hours per ton-mile. Of course on that line the gradients were very severe, in some cases as steep as 1 in 10; it was therefore difficult, *à priori*, to say how much power would be used on a railway until one got to know the character of it. The cost of producing the power, again, depended upon the character of the power-house. The lowest consumption of coal that he knew of in producing a kilowatt-hour is 3·6lb., and the lowest cost something like ½d., irrespective of depreciation, interest on capital, &c., and he did not know of any case in which this has been bettered. The question of the application of electricity to railways was extremely interesting to all interested in electricity, but his opinion was that the whole problem depended almost entirely upon the construction of economical power-houses and the economical distribution of the current.

The Hon. C. A. PARSONS also inclined to the view that the case for electrical propulsion might have been made out more favourably than Mr. Langdon had done. The question of generating from one large central station rather than from a number of small stations he considered was a side issue. The particular question was whether, in general, trains could be propelled electrically on a large scale at anything like the cost of steam locomotion, and it seemed to him that when the electric system was worked out in practice many economies would manifest themselves which could not at the present time be considered or realised. The one great advantage of a central station utilising high pressure over long distances was the opportunity afforded to the designer of placing his station where there was practically free water for condensing and easy access in other respects for coal.

Mr. H. A. HOY said that a little study of the question of electric traction on railways had led him to fall in with the views expressed by Mr. Robinson. With regard to Mr. Parsons' suggestion that it was absolutely necessary to have a good water supply, he thought they might look further into what Mr. Robinson had suggested and work something on the lines practised in America without going quite so far—viz., have moving stations. By having such moving stations with suitable high-speed engines these could be placed at suitable points down the line and moved from one point to another and by this means the loss in the electrical pressure which took place over long distances would not be entailed.

Mr. J. S. RAWORTH said that Mr. Langdon was not stimulated by the expectation of selling high-speed engines, and he had not got the inventor's fever which made him come forward to enlighten the world as to the advantages of his inventions. Neither was he troubled with that peculiar disease of a professor viz., intellectual indigestion, which rose the pressure inside him to such a point that he must read Papers or burst. The present Paper should call forth the highest thanks because it was an effort on Mr. Langdon's part to tap the pockets of financiers on behalf of electrical engineers. If he (Mr. Langdon) could only induce the railway shareholders to encourage electrical engineers and come to their assistance, then there was a mine of wealth before everyone of them. He asked them not to be led away into any side issues in this discussion. The main point was a financial point, and the railway managers or shareholders would not bother their heads about electrical methods so long as they were convinced that they could make money by making a change from steam to electricity. He had followed Mr. Langdon's figures very closely, and did not quite come out the same as he did, but it would be all the better if any criticism that had to come came from the electrical engineers' side rather than from the other side. He had hoped to see some locomotive superintendent come forward and say to Mr. Langdon that he was all wrong. In looking through Mr. Langdon's figures he had noticed that in Table II. the maximum number of trains per hour passing through Luton was given as 16, but in the last column of that table 19 trains were mentioned as passing through that station between the hours of 2 p.m. and 3 p.m. In Table III. (Harpenden) there were 10 trains more per day than at Luton, and curiously enough they were all light engines. Coming to the calculation of the power required to drag trains from London to Bedford he had not been able to follow Mr. Langdon. Mr. Langdon had used a nomenclature of his own, and though he (Mr. Raworth) had succeeded in mastering it to some extent, he had thought it better to recalculate the whole thing from the bottom. He had calculated the total foot pounds required to drag 287 trains over the whole 50 miles during the 24 hours, and by this means, with an average of 12 trains per hour, had arrived at the figure of 7,382kw. as the necessary electrical power. Providing for a possible maximum of 16 trains per hour, and allowing 600kw. for acceleration and for stops, the total amount of power required would be 9,850kw., so that Mr. Langdon was a happy guesser in fixing the amount at 10,000kw. The formula given in the Paper as representing the tractive effort per ton he thought contained some little error, because if a speed of only 1 mile per hour were used they would only need 3lb. per ton to push the train.

Mr. LANGDON: The formula is not applicable under 15 miles per hour.

Mr. RAWORTH, continuing, said that as Mr. Langdon had taken the expenses for the last 24 years of steam locomotion and only the expenses for the last 12 months in connection with electric traction it would readily be seen how favourably the case for steam locomotion had been put. Until a few years ago the steam locomotive took 29lb. to 30lb. of coal per train mile. Now it took 50lb. to 51lb. Again, a few years ago wages were very much lower than they were now. They had to pay upon the higher scale, whereas the calculation in the Paper had been made upon the lower scale. Further, 3½ per cent. had been allowed as interest on the capital outlay, which amounted to £16,000 per annum. He thought that, for the purpose of comparison, it would not be necessary to allow anything for interest on the money, because a locomotive department did not allow anything for interest upon its capital. It would only be necessary to allow for interest on the money in case they had to go to the directors and say, "If you will scrap all your present locomotives and put in electrical apparatus, I will show you a profit even upon the capital that you have to spend."

Mr. HENRY MAVOR asked that the discussion might be kept open until after December 12, so that a full discussion of the Paper by the Glasgow section might take place and be embodied in the *Proceedings* of the Institution. They had in the North a large number of very highly skilled locomotive engineers who were able to discuss the question, and he believed that their contributions were worth recording.

Lieut.-Col. CROMPTON did not think many in that room had had the advantage that he had had of having designed a long electric railway. He had been employed about a year ago by the Indian Government to design a line to cross the Himalayas. He had had to prepare data after the style of Mr. Langdon's Table IV., and wished he could have had that very excellent model before him at the time. He really had followed these lines, although not so neatly, and had since checked them by using a length of Indian railway for which data was available. One of the first things that struck him was the extraordinary discrepancy between the actual calculated horse-power taken by the trains in the fourth column from the end of Table IV. and the actual full horse-power of the corresponding locomotives. To electrical engineers, who were accustomed to talk about the load-factor of machinery, the subject was very interesting. They at once saw why the performance of a locomotive on a railway was such a poor one from the economy point of view, although when working under its best conditions and its best load-factor, it ought to be a highly economical machine. It also explained why there should be any doubt in the minds of locomotive engineers as to whether compound locomotives were a success or not. In the habit, as electrical engineers were, of comparing compound with single engines in electric lighting stations, they could not understand why there should be any debate on such a question. To them it was long ago a foregone conclusion. The extraordinarily poor load-factors of the locomotives themselves disappeared when they applied power to the line from a number of fixed stations, and it was quite certain that an economy in the fuel used would follow therefrom corresponding with the increased load-factor in working from a number of fixed stations. Another item on which there would be a very great economy and which had not been claimed to its full extent by Mr. Langdon was that of wages. Probably Mr. Langdon felt justified in saying they would have to employ men for drivers and pay them the high wages paid to steam locomotive drivers; but when he was preparing his financial statement for the Cashmere Railway already mentioned, he had had some discussion with locomotive superintendents and others in India, and had come to the conclusion that they would not have to pay the same high rate of wages that was paid to steam locomotive drivers. The reason for this higher rate was that a locomotive engine on a difficult line of railway was worked under difficult conditions and they could not have anyone but a highly-trained man to get a full duty out of the engine. A man not having years of experience would not be able to keep time. Consequently, a special standard rate of wages had to be paid to such men. Electric locomotives, however, were confined to one engine in front of the train or separated into various motors under the carriages. The driving of these motors would be a very different business. The driver would have to observe the signals and have some knowledge of the line. But this knowledge of the line was nothing like the same thing required of the man who was not only responsible for the same work with a steam locomotive, but who also had to coax his engine to give out its power to the best advantage and with the smallest possible coal consumption. For that reason there would be a very large saving in wages, and in his report to the Indian Government—which had been accepted—he had taken advantage of this fact. He was fully of the belief that native drivers of the same calibre as the natives only allowed to work small unimportant steam lines would be amply sufficient for his electric locomotives on the mountain railway. Another question of great interest was that of repairs. He was under the impression they would find that the electric locomotive or the motor on the carriages would not cost anything like the percentage value of its cost for repairs that the steam locomotive did, for the reason that nearly all the wearing surfaces were capable of being easily boxed in. They were in the nature of spindles revolving in journals, and there were not any of those most expensive surfaces to maintain, such as sliding surfaces, which anyone who had had experience of locomotive work would admit were the most expensive part of the machinery to keep up. He could not impress too much upon those who had to urge the claims of electric locomotives the fact that they would cost very little to maintain, from that one cause—viz., that their wearing surfaces were only revolving surfaces. One of the chief reasons why electric locomotives would be adopted in the future—and Mr. Langdon had not urged this sufficiently—was that the present steam locomotives were overloaded. They could not be made big enough and powerful enough for the traffic on the lines. The height of the driving wheels was being reduced in order to get big overhanging boilers, and the result was boilers of nearly 5ft. in diameter overhanging comparatively small driving wheels, and all this because enough power could not be got into them. Once it was admitted that electric motors could be distributed on the various carriages there was no limit to the power which could be put into an electric train. Here was an argument which should influence financial men to encourage and support electric locomotion. He would add some more figures to the discussion in the *Journal*.

The discussion was then adjourned until December 6.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.

"Contents Subject Index to General and Periodical Literature." By A. Cotgreave, F.R. Hist.S. (London: The Author, Public Library, West Ham, E.) By subscription, cloth 7s. 6d., unbound 6s.

"Science Abstracts" for November, 1900. (London: E. and F. N. Spon). 2s.

"A Century of Copper." Part II. By Nicol Brown and C. C. Turnbull. (London: Effingham Wilson.) 5s.

"A School Chemistry." By J. Waddell. (London: Macmillan & Co.) 4s.

"Lawyers and their Clients: A Practical Guide for the Latter." (London: Effingham Wilson). 2s.

"Cash: How to Invest It." By "Experience." (London: Dawbarn and Ward.) 1s.

Report by the Chief Labour Correspondent of the Board of Trade on the Strikes and Lock-Outs of 1899, with statistical Tables. (London: Eyre and Spottiswoode.) 11d.

"The Practical Engineer" Electrical Pocket Book for 1901. (Manchester: Technical Publishing Co. London: John Heywood.) 1s.

Annual Report of the United States Commissioner of Patents for 1899. (Washington: Government Printing Office.)

## ELECTRICITY WORKS ACCOUNTS.

### Edinburgh Municipal Electric Supply Works.

Another year's accounts of the Edinburgh undertaking indicates a maintenance of the splendid rate of progress which has characterised it since operations were started in 1895. Concerns with large outputs, and consistently exhibiting low cost figures, are always interesting in that they are also consistently sensitive to altered conditions. The Edinburgh undertaking is one of these concerns, and in the accounts now before us clearly reflects the influence of higher coal rates, the fuel charge having risen from 0·424d. to 0·522d. per unit. It is an achievement to have kept, and even perceptibly diminished the total costs in the circumstances, for although the output was higher by 33 per cent. than in the preceding year, yet the load-factor was materially lower, being 13·8 per cent. in 1899-1900, as compared with 15·3 per cent. in 1898-9.

Owing to a further reduction in the average price per unit, the working profit, relatively to the mean expended capital, has slightly fallen. The balance of £5,886 from the working of 1898-9 was placed aside for depreciation, and out of the past year's working profit £14,119 was placed into the sinking fund and £13,179 paid in interest on loans, leaving a balance of £3,674. The table given below shows the progress made since the station was opened.

### Leeds Municipal Electric Supply Works.

Excellent indeed are the results shown in our analysis of the accounts of the Leeds undertaking for the year ended at March 25, 1900. It is evident from the costs figures that the splendid record already attaching to these works was only earnest of still greater achievements. It is true that among the undertakings the accounts of which we have considered up to the present the total costs at Bradford are very slightly under those given in our last column for Leeds, yet the very different conditions under which supply was effected invest the Leeds results with particular interest and merit. At Bradford the slightly higher output of 2,416,180 units sold contained the large proportion of 25·6 per cent. for traction, besides an ordinary motor load of 19·2 per cent. and a public lighting output of 2·44 per cent. The output thus constituted resulted in a load factor of 13·7 per cent. At Leeds, with no traction, and a negligible public lighting load, the output was 2,005,840 units sold, and the load factor only 6·69 per cent. It will be seen that, judged in relation to the conditions of output and load factor, the Leeds results are certainly the greater achievement.

Consistent with its old character, the Leeds undertaking is specially strong in economy of works costs, in this department surpassing Bradford by 0·082d. per unit. The total works costs of 0·738d. per unit at Leeds is quite 1d. below the mean works costs of municipal undertakings of similar output and load factor in 1898-9. All the several items of generating costs share the credit of this result without distinction. The management and property charges, while less striking are, at 0·45d., beyond criticism, as being well under the average.

Compared with the total costs the revenue shows rather a high average price, the ratio of costs to revenue being only 27·4 per cent. On the other hand the high tariff appears necessary in view of the rather heavy interest and sinking fund charges.

The Leeds undertaking stands as a typical example of a single-phase alternate-current system of supply. It betrays the shortcomings as well as the good qualities of the single-phase system. The records and accounts of the undertaking show that while in consequence of the system employed the load most favourable to economy has been lost to the business, yet apparently the same economy has been attained by reason of the efficiency possible with that system, at least in the circumstances existing at Leeds.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)......Oct. 12, 1900
Ayr (Municipal)..............Nov. 2, 1900
Bath (Municipal) ............April 20, 1900
Bedford (Municipal) .......Aug. 3, 1900
Belfast (Municipal) ......... July 6, 1900
Birmingham (Company)....Sept. 15, 1899
Blackburn (Municipal) .....Jan. 19, 1900
Blackpool (Municipal) .....Oct. 5, 1900
Bournemouth (Company) ..Sept. 7, 1900
Bolton (Municipal) ..........Nov. 30, 1900
Bradford (Municipal) .......June 22, 1900
Brighton (Municipal) .......May 4, 1900
Bristol (Municipal) ..........Aug. 24, 1900
Bromley (Kent) (Co.) .......June 15, 1900
Brompton & Kensington (Co.) Mar. 23, 1900
Burnley (Municipal) .......Nov. 30, 1900
Burton-upon-Trent (Mun.) April 21, 1899
Bury (Municipal) ............Sept. 28, 1900
Cambridge (Company).......April 13, 1900
Canterbury (Municipal) ....Oct. 26, 1900
Cardiff (Municipal) .........Dec. 15, [illegible]
Charing Cross (Company) ..Mar. 9, 1900
Chelsea (London) (Co.).......Mar. 23, 1900
Cheltenham (Municipal).....Nov. 10, 1899
Chester (Municipal)..........Aug. 3, 1900
City of London (Company)..June 15, 1900
Clerkenwell (Company) .....May 18, 1900
Coventry (Municipal) .......Feb. 23, 1900
Croydon (Municipal).........July 20, 1900
Derby (Municipal) ...........Jan. 26, 1900
Dewsbury (Municipal).......Nov. 24, 1899
Dover (Company) ............April 27, 1900
Dundee (Municipal)..........Nov. 2, 1900
Eastbourne (Company) .....May 4, 1900
Edinburgh (Municipal) .....Nov. 17, 1899
Exeter (Municipal) ...........Aug. 6, [illegible]
Folkestone (Company) .....April 27, 1900
Glasgow (Municipal) .......Sept. 14, 1900
Guildford (Company) .......Oct. 19, 1900
Halifax (Municipal)...........Sept. 21, 1900
Hammersmith (Vestry) .....June 29, 1900
Hampstead (Vestry) .........Oct. 19, 1900
Hanley (Municipal) ..........July 27, 1900
Harrogate (Municipal) ......Oct. 20, 1899
Harrow (Company) ..........June 16, 1899
Hast'gs & St. Leonards (Mun.) Sept. 7, 1900
Hove (Company) ..............July 6, 1900
Huddersfield (Municipal) ..Aug. 17, 1900
Islington (Vestry) ............Nov. 23, 1900
Kens'gton & Knightsbr' (Co.) Mar. 16, 1900
Kingston-upon-Hull (Mun.) July 13, 1900
Kingston-on-Thames (Mun.) July 20, 1900
Lancaster (Municipal).......Jan. 19, 1900
Leeds (Municipal).............Dec. 1, 1900
Leicester (Municipal) .......Jan. 26, 1900
Leyton (Municipal) ..........Sept. 8, 1899
Liverpool (Municipal)........June 22, 1900
London (Company) ...........June 8, 1900
Londonderry (Municipal) ..Feb. 16, 1900
Manchester (Municipal).....Sept. 14, 1900
Newcastle and District (Co.) Oct. 6, 1899
Newcastle-upon-Tyne (Co.) Oct. 12, 1900
Newport (Mon.) (Municipal) Dec. 15, 1899
Northampton (Company) ..Oct. 20, 1899
Norwich (Company)..........Nov. 17, 1899
Notting Hill (Company) ....Mar. 16, 1900
Nottingham (Municipal) ..Sept. 21, 1900
Oldham (Municipal) ........Dec. 1, 1899
Oxford (Company) ...........April 13, 1900
Pontypool (Company).......Sept. 28, 1900
Portsmouth (Municipal).....Aug. 24, 1900
Prescot (Company) ..........Dec. 8, 1899
Preston (Company) ..........Sept. 28, 1900
Reading (Company) ..........Oct. 13, 1899
Richmond (Company) .......June 29, 1900
Salford (Municipal) ..........Feb. 23, 1900
Scarborough (Company).....July 13, 1900
St. Helens (Municipal) ......Dec. 8, 1899
St. James' & Pall Mall (Co.)..Feb. 16, 1900
St. Pancras (Vestry)..........June 8, 1900
Sheffield (Municipal) ........Dec. 29, 1899
Shoreditch (Vestry)...........Nov. 23, 1900
Southampton (Municipal) ..Nov. 10, 1899
Southport (Municipal).......July 7, 1899
South Shields (Municipal)..Nov. 9, 1900
Stafford (Municipal)..........Aug. 17, 1900
Sunderland (Municipal).....Nov. 9, 1900
Taunton (Municipal) .......June 16, 1899
Tunbridge Wells (Mun.) ...Sept. 1, 1899
Wakefield (Municipal) .....Dec. 1, 1899
Walsall (Municipal)...........June 22, 1900
Wandsworth (Company) ...May 19, 1900
Westminster (Company) ....Mar. 9, 1900
Whitehaven (Municipal) ...July 26, 1899
Winchester (Company) .....Oct. 26, 1900
Windsor (Company)..........Dec. 22, 1899
Woking (Company) ...........Dec. 22, 1899
Wolverhampton (Municipal) July 27, 1900
Woolwich (Company) ........Jan. 12, 1900
Worcester (Municipal) ......April 20, 1900
Yarmouth (Municipal) ......Nov. 3, 1899

| Year ended May 15 | No. of consumers. | Equivalent 8 c.p. lamp connections. | Output. Total. | Units sold. Public lighting. | Plant capacity. kw. | Max. supply demanded. kw. | Load factor. | Total costs per unit. | Total revenue per unit. | Working profit. Total. | Working profit. to mean cap. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1896 | 452 | 57,690 | 888,335 | ... | 1,160 | 1,016 | 9·98 | ... | ... | ... | ... |
| 1897 | 900 | 99,970 | 1,721,557 | 621,260 | 2,700 | 1,621 | 12·1 | 1·40d. | 3·74d. | £16,815 | 8·97 |
| 1898 | 1,630 | 158,900 | 2,894,437 | 834,660 | 3,300 | 2,388 | 13·8 | 1·41d. | 3·16d. | 20,648 | 7·97 |
| 1899 | 2,514 | 226,737 | 4,174,541 | 1,044,733 | 4,705 | 3,116 | 15·3 | 1·41d. | 2·77d. | 23,730 | 6·95 |
| 1900 | 3,507 | 256,585 | 5,551,728 | 1,191,775 | 8,137 | 4,587 | 13·8 | 1·41d. | 2·75d. | 30,972 | 6·25 |

| | EDINBURGH. | LEEDS. |
|---|---|---|
| *Undertaking Worked by* | Edinburgh Corporation. | Leeds Corporation. |
| *Date of Commencement of Supply* | April, 1895. | May, 1893. |
| *System of Supply* | Three-wire cont. and H.T. alternate current. | Alternate-current transformers. |
| *Chief Engineer* | Frank A. Newington. | Harold Dickinson. |

| YEAR ENDED | MAY 15, **1899.** | | MAY 15, **1900.** | | MAR. 25, **1899.**[a] | | MAR. 25, **1900.** | |
|---|---|---|---|---|---|---|---|---|
| **QUANTITIES—** | | | | | | | | |
| Units generated | 4,625,397 | | 6,273,397 | | — | | — | |
| ,, SOLD (TOTAL) | 4,174,541[a] | | 5,551,728 | | 1,001,540[a] | | 2,005,840 | |
| ,, sold to consumers | 3,129,808 | | 4,359,955 | | 1,001,290[a] | | 2,004,840 | |
| ,, sold for public lighting, &c. | 1,044,733 | | 1,191,773 | | 250[a] | | 1,000 | |
| ,, used on works | 231,152 | | 339,903 | | 20,985[a] | | 47,239 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 28·4 | | 21·8 | | — | | 21·1 | |
| Maximum supply demanded | 3,116 kilowatts | | 4,587 kilowatts | | 2,539 kilowatts | | 3,426 kilowatts | |
| Number of public lamps | 702 arc | | 747 arc | | 1 arc | | 1 arc | |
| Number of consumers | 2,514 | | 3,507 | | 1,000 | | 1,394 | |
| Connections to mains in 8-c.p. lamps | 226,737 | | 296,585 | | 78,350 | | 105,263 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 147,000 | | 254,000 | | 75,000 | | 95,000 | |
| CAPACITY OF PLANT IN KILOWATTS | 4,705 | | 8,137 | | 2,400 | | 3,040 | |
| **CAPITAL—** | Total. | Per kilowatt capacity | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity |
| AUTHORISED (TOTAL) | — | — | — | — | — | — | — | — |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | — | — | — | — | — | — | — | — |
| RECEIVED (TOTAL) | £390,000 | £83 | £587,058 | £72·1 | £4,241 | £1·77 | £226,521 | £74·6 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 390,000 | 83 | 587,058 | 72·1 | — | — | 226,521 | 74·6 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | — | — | — | — |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | — | — | — | — |
| REPAID (TOTAL) | — | — | — | — | 4,241 | 1·77 | 9,101 | 2·99 |
| RESERVE OR SINKING FUND | 28,353 | 6·03 | 42,472 | 5·22 | — | — | — | — |
| DEPRECIATION FUND | 8,352 | 1·78 | 14,596 | 1·79 | — | — | — | — |
| EXPENDED (TOTAL) | 395,357 | 84·0 | 595,655 | 73·2 | 232,516 | 96·8 | 307,522 | 101 |
| Lands and buildings | 51,928 | 11·0 | 105,264 | 12·9 | 74,174 | 30·9 | 70,357 | 23·1 |
| Plant | 138,611[b] | 29·5 | 211,197[b] | 25·9 | 89,048 | 37·1 | 129,267 | 42·7 |
| Mains | 202,381 | 43·0 | 276,540 | 34·0 | 65,542 | 27·3 | 95,259[b] | 31·3 |
| Miscellaneous | 2,437 | 0·52 | 2,654 | 0·326 | 3,752 | 1·56 | 12,665 | 4·17 |
| BALANCE OF CAPITAL ACCOUNT | -5,357[c] | 1·14 | 8,597[c] | 1·06 | 228,275[b] | 95·1 | -81,001[b] | -26·6 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £48,238 | 2·773d. | £63,525 | 2·746d. | £18,281 | 4·384d. | £36,221 | 4·335d. |
| Revenue from supply | 38,985[d] | 2·240d. | 52,631[d] | 2·275d. | 17,182 | 4·120d. | 34,066 | 4·080d. |
| ,, meters, &c. | 10 | 0·001d. | 44 | 0·002d. | 832 | 0·199d. | 2,155 | 0·258d. |
| ,, public lighting | 9,198 | 0·529d. | 10,372 | 0·448d. | — | | — | — |
| ,, sale of lamps, &c. | 28[e] | 0·002d. | 28[e] | 0·001d. | 16 | 0·004d. | — | — |
| ,, miscellaneous sources | 15 | 0·001d. | 451[f] | 0·020d. | 251[c] | 0·060d. | — | — |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £24,508 | 1·409d. | £32,553 | 1·407d. | £4,178 | 1·002d. | £9,930 | 1·189d. |
| WORKS COSTS | 19,015 | 1·094d. | 25,621 | 1·108d. | 2,494 | 0·598d. | 6,165 | 0·738d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 7,366 | 0·424d. | 12,071 | 0·522d. | 780 | 0·187d. | 2,592 | 0·310d. |
| Oil, waste, water, stores | 862 | 0·050d. | 1,121 | 0·048d. | 234 | 0·056d. | 361 | 0·043d. |
| Wages at station | 2,537 | 0·146d. | 3,618 | 0·156d. | 853 | 0·205d. | 1,871 | 0·224d. |
| Repairs and maintenance at station | 2,012 | 0·116d. | 2,632 | 0·114d. | 342 | 0·082d. | 867 | 0·104d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 1,674 | 0·096d. | 1,052 | 0·045d. | 100 | 0·024d. | 224 | 0·027d. |
| Repairs, renewals of mains, &c. | 1,156 | 0·067d. | 1,004 | 0·043d. | 135 | 0·032d. | 246 | 0·029d. |
| *Public lighting* | [illegible] | [illegible] | [illegible] | [illegible] | — | — | — | — |
| Attendance | 2,281 | 0·131d. | 2,235 | 0·097d. | — | | | — |
| Renewals | 1,128 | 0·065d. | 1,928 | 0·083d. | | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 5,493 | 0·316d. | 6,933 | 0·300d. | 1,684 | 0·404d. | 3,764 | 0·451d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | 2,319 | 0·133d. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| *Management* | [illegible] | 0·183d. | [illegible] | [illegible] | 1,362 | [illegible] | [illegible] | [illegible] |
| Salaries | 413 | 0·024d. | 425 | 0·018d. | 1,045[d] | 0·251d. | 2,223 | 0·266d. |
| Stationery, &c. | 170 | 0·010d. | 185 | 0·008d. | 114 | 0·027d. | 137 | 0·016d. |
| Establishment charges | 853 | 0·049d. | 1,040 | 0·045d. | 95 | 0·023d. | 194 | 0·023d. |
| Law charges, &c. | 1,838[f] | 0·106d. | 2,702 | 0·117d. | 110[e] | 0·026d. | 320 | 0·038d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. expended | Total. | % to mean cap. expended | Total. | % to mean cap. expended | Total. | % to mean cap. expended |
| WORKING PROFIT FOR YEAR | £23,730 | 6·95% | £30,972 | 6·25% | £14,103 | 6·14% | £26,291 | 9·73% |
| Sum carried to Depreciation Fund | | — | 5,885 | 1·19% | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 9,566 | 2·80% | 14,119 | 2·85% | 4,241 | | 5,316 | 1·97% |
| Net interest on loans (incl. Debenture charges) | 8,278 | 2·42% | 13,179 | 2·65% | 6,256 | 2·72% | 12,473 | 4·02% |
| BALANCE FROM LAST ACCOUNT | — | — | 5,886 | 1·19 | — | — | — | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 5,883 | 1·72% | 3,674 | 0·74% | 3,606[c] | 3·42% | 8,502 | 3·15% |
| *Deficit* | — | — | — | | — | — | | — |
| ORDINARY DIVIDEND PAID | — | — | | — | — | — | — | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 50·8% | | 51·3% | | 22·9% | | 27·4% | |
| Expenditure per kilowatt capacity | £5. 4s. 3d. | | £4. 0s. 0d. | | £1. 14s. 10d. | | £3. 5s. 3d. | |
| REVENUE PER KILOWATT CAPACITY | £10. 7s. 0d. | | £7. 16s. 0d. | | £7. 12s. 5d. | | £11. 18s. 0d. | |
| Expenditure per 8 c.p. lamp capacity | 3s. 4d. | | 2s. 6½d. | | 1s. 1d. | | 2s. 1d. | |
| REVENUE PER 8 C.P. LAMP CAPACITY | 6s. 6½d. | | 5s. 0d. | | 4s. 10½d. | | 7s. 7½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 4s. 3d. | | 4s. 3½d. | | 4s. 8d. | | 6s. 9½d. | |
| Price charged for lighting, per unit | 3½d.[g] | | 3½d.[g] | | 4½d. to 5d.[f] | | [illegible] | |
| Price charged for power, per unit | 1½d. net | | 1½d. net | | 2d. less 5% | | 2d. less 5% | |
| Price charged for public lighting | £14 per arc per annum[h] | | £14 per arc lamp per ann. | | 4d. per unit | | — | |

EDINBURGH.—[illegible]

LEEDS.—[illegible]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON,
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| are as under:— | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union | 30s. 0d. | 15s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## PRINCIPAL LODGE ON EDUCATION.

On the recent occasion of the reception given by the teaching staff and students of the new University of Birmingham to Dr. OLIVER J. LODGE, as their Principal, that eminent physicist delivered an address which embodies many suggestions affording food for careful thought and consideration by authorities on education. There is an originality about many of these suggestions that would be striking on any occasion; but the particular occasion of the birth of a new University and the installation of a principal whose fame has had its origin more in brilliant scientific research than in the business of controlling education adds additional attractiveness. Yet the originality of thought and method which has characterised all Dr. LODGE's work as a leader of physical science might reasonably have been expected to exhibit itself in his philosophy of education and in his art of University teaching. Briefly stated, Dr. LODGE's educational system consists in the encouragement of true knowledge and right understanding instead of, or even at the expense of, mere learning by rote and evanescent remembrance through cramming. He made the bold suggestion that a student's knowledge should not be tested by an examination immediately following upon the course of teaching, but that there should be a lengthy period of private cogitation and mental assimilation interposed between the last lecture and the examination. On this plan all the merely crammed information would, he asserted, be forgotten, and the knowledge really acquired would have time to become thoroughly absorbed; and thereby the examination itself would become a more rational and effective test. As an illustration of the reason which led to this proposed change, Dr. LODGE likened the merely cram method of teaching to the act of packing a portmanteau; while the method of true education he likened to stocking a pond with fish. Examining the student was likened to fishing, a sport which was much better undertaken after the stock had had time to develop and increase. He therefore urged that the long summer vacation should be allowed to intervene between the period of instruction and the examination, instead of the examination taking place at the end of the term. Another suggestion, strikingly put though embodying an idea that is not

altogether new, was Dr. LODGE's advocacy of "indirection" in study—"the not aiming too straightly at the thing to be accomplished." After all, this "policy of indirection," as he terms it, is but another form of the excellent advice, given to students in all historic ages, not to confine within too restricted limits the foundations of their knowledge—to study not only deeply but broadly also. It is succinctly expressed in the well-known definition of an ideal education as "something of everything and everything of something"—a definition which no truly discriminating mind could confuse with the "little learning" that is "a dangerous thing." Not shallow draughts of merely superficial learning are meant by "something of everything" in real education; it is rather the antithesis of the modern mania for what is termed specialising—as dangerous in its way as dilettantism itself, if commenced at an early stage in the educational career.

Dr. LODGE is by no means the first to criticise the existing examination system, nor is he the only valiant champion of reformation. Others before him have called attention in equally emphatic language to the evils that are fostered by the system now universally in vogue, evils that are as fully recognised by the ignoble army of crammers, who depend on them for their livelihood, as they are—in a more honest way—by all who have to control teaching or to conduct examinations. The evils, we say, are universally recognised; but hitherto no one has been successful in discovering or inventing a panacea. It remains to be seen whether, in the event of Dr. LODGE's remedy being anywhere adopted, any measure of prevention or cure of these evils will be effectively realised. There have been advocates of reform who have endeavoured to abolish examination altogether, both oral and written, and who have placed their faith wholly in the evidence of proficiency afforded during the process of education in the class-room and laboratory. These extremists, however, have overlooked the important fact that, although examination should never be an end in itself, it is an essential means to an end, if immediate rewards and distinctions are to be conferred by the teaching institution. Examinations, in fact, are a necessary evil. There have been others whose favourite remedy has been the arrangement of examination questions in such a manner as to preclude or minimise the advantage to the candidate of merely crammed information. This may be an excellent recommendation, but it is practically impossible to carry it out; for, on whatever system periodical examinations on any definite syllabus of studies may be conducted, the accumulation of yearly papers of questions will soon afford crammers a steadily improving clue to the probable character of questions in the immediate future. Dr. LODGE undoubtedly has recognised this in drawing up the scheme which we have just outlined; but he places confidence in a vacation period as affording means for the evaporation of crammed information, thus placing the mere crammer on his proper low level in the examination room. He has apparently overlooked, however, the vital consideration that the adoption of his scheme is really no safeguard against cramming, because it would be open to any "student" who might so desire to cram information into his portmanteau-like memory-organ all through the convenient vacation and right up to the hour of examination. In fact, we may well despair of any system of examination being devised that shall render cramming completely inoperative; though it would probably be possible to reorganise our educational system in such a manner as to give the really intelligent student a better chance than he has now against the individual merely stuffed temporarily with convenient information. To the genuine student, on the other hand, Dr. LODGE's recommended period of thoughtful reflection, combined with a measure of mental and physical rest, would undoubtedly prove of great assistance during examination, especially if the examiners would do their best to test the intellectual rather than the memory aspect of the students' minds. Nevertheless, it is not in the brief interval of a summer vacation that any very large amount of intellectual assimilation of studies can take place, when compared with the influence of life long experience and practice. It is the steady exercise of education in daily life that transforms information into knowledge. One of the most efficient aids to this transformation that a student can adopt, as regards the knowledge of ordinary educational subjects, is for him to teach those subjects to junior students—to teach them rationally and intellectually, not to cram them. It is when endeavouring to explain things to others that the weak parts of one's own knowledge are revealed to one's self, and the strong parts gain additional strength and coherence. We put it to the Principal of the University of Birmingham, whether he does not agree that for examination candidates to undertake a little genuine teaching work would be an excellent occupation during the vacation period preceding their examination? If they cannot get pupils, let them teach one another.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

**The Inventor's Adviser, or Every Man's Own Patent Agent.** By REGINALD HADDAN. 5th Edition. (Harrison & Sons, 59, Pall Mall.)

This is a small compact treatise on patent law of Great Britain and apparently most other countries. It is a useful and well-digested book, and the fact that it has evidently filled a general want is borne out by its having already reached a fifth edition. On the whole we are rather inclined to think that it belies its title. More than half of its 400 odd pages deal with British patent law, its interpretation before the Courts, the drafting of specifications, oppositions, amendments, and various other matters, dealing with which form the ordinary avocations of a patent agent. If this portion of the work shows anything at all it shows very clearly that the wisest thing an inventor as a rule can do is *not* to be his own patent agent. Of course, if he can make himself thoroughly conversant with a treatise like this, more especially if he supplements his reading by judicious reference to larger and more exhaustive works, he may put himself in a position to draw satisfactorily his own patent specifications and to deal with other questions arising with reference to them. But in that case he has practically qualified himself to act as a patent agent, and most inventors have not got sufficient time for that.

We have not often seen a work which deals in a more lucid and compact manner with all the questions arising in regard to patent law and practice. More especially is this the case in regard to the practice before the Comptroller and the Law Officer. The portions of the book dealing with this part of the subject form the best epitome of its kind that we have seen. As regards the general interpretation of specifications, in reference to such considerations as novelty, subject matter, prior user, and utility, the author's conclusions are very carefully based upon the practice and decisions of the Courts. But we cannot help regretting that he has so persistently neglected nearly all the more recent decisions. With the exception of "Parkinson *v.* Simon" and one or two other cases, most of the decisions quoted refer to cases that were tried long ago—quite a large number, in fact, even before the Act of 1852. Such a case as "Crane *v.* Price," for instance, can certainly no longer be considered a leading or even a ruling case, and is a precedent

which has been overruled to all practical intents and purposes by such recent House of Lords decisions as "Dredge v. Parnell." This kind of thing is very misleading, more particularly when we consider the increasing tendency of the Courts to take a narrower and narrower view of subject matter. Such highly important and interesting cases as the Pneumatic Tyre cases, the Incandescent Gas Light cases, and the Three-Wire case, do not appear to come in for treatment at all. This is a point the more to be regretted in the fifth edition of an otherwise admirable work which, before all things, ought to be up-to-date.

The rest of the work consists of compilation from the patent laws of foreign countries.

**"Up-to-date Domestic and Industrial Applications of Electricity."** By "Alpha." (London: S. Rentell & Co., 1900). 1s.

To those not conversant with the possibilities of electricity this compilation of everyday applications will prove astonishing, while to the electro-technical expert it will introduce many surprising novelties. The author, who mentions that he is himself an electrical engineer and inventor, tells us in his preface that the book is intended mainly for "educative purposes." It is therefore disappointing to find that now and then he speaks of the "generation of the mysterious omnipresent energy called electricity." Still, little slips like this serve at least to relieve the monotony of the vile grammatical blunders which disfigure horribly almost every sentence in the book. A typical example of the "educative" nature of the book is the description of "contacts for fishes":—

I took a live worm out of a small tray, attached it to the string, and immersed it into water; I had not to wait a long time when a fish grabbed at it, with result that a real gun was discharged in the garden.

Most interesting, too, is the clever butter-maker. This consists of two electrodes by means of which an electric current is passed through milk. On one of these electrodes, we are told, butter is deposited, and an electric bell rings "as the electrode covered now with butter, becomes heavy, sinks, and an electric bell circuit is thus closed." Useful, also, no doubt is the shark-catcher, by which a charge of dynamite, buried in the swallowed bait, is exploded electrically. As the author ingenuously points out, "the drawback of this simple and effective method is that the sharks are blown to pieces and their commercial value is reduced." Again, the "Alarm for Comets" should prove invaluable to up-to-date domestic astronomers.

Perhaps the most novel, attractive, pleasing apparatus described in this remarkable series of domestic and industrial applications of electricity is the electric cat. This is a hollow celluloid life-like model of the ordinary household cat, which has inside it a powerful electric lamp. A bait in front of it, if pulled at by a rat or mouse, operates a switch which closes the lamp circuit. The rodent is thereupon so greatly startled that he leaves the neighbourhood in haste. This device is, indeed, one of the most practicable and praiseworthy of the many ingenious inventions discussed.

The unconscious humour of the book will appeal to a wide class of readers, and furnishes a charm which even the vulgar and bad English of the writer cannot destroy. Moreover, the work points us a moral—a moral which one is inevitably guided to by the irritating reiteration of the phrase "as substantially set forth and described above." And this moral is, that the perusal of the archives of the Patent Office is a poor substitute for an education.

**Technical, Industrial, Commercial, English-French-German Vocabulary.** For automobilists, bankers, chemists, commission agents, consuls, commercial travellers, customs, draughtsmen, electricians, engineers, excisemen, experts, exporters, financiers, machine constructors, manufacturers, mechanics, metallurgists, patent agents, physicists, printers' readers, sailors, students, tourists, trading agents, translators, &c. By E. Hospitalier. (Paris: The *Industrie Electrique*, 1900.)

In spite of the variety of techical subjects that should be included to please all the various classes of readers mentioned in the sub-title, this dictionary is only a volume of 816 single-column pages, and is small and slender in shape, like an overgrown book of the "Pseudonym" library. It can, therefore, hardly be expected that the dictionary is complete in all these branches of technics; but, at all events, M. Hospitalier's name is a sufficient guarantee that the electrical part is well edited. To estimate the value of a dictionary it is necessary first to use it for a considerable time; from a cursory inspection, however, it appears that the electrical engineering terms, at any rate, are both numerous and accurately translated in the present volume. We have already noticed slight imperfections in the not purely electrical words. For instance, "Gummi," which is the German equivalent of our (india)rubber, is translated "gum," and a search for the test-word "portable engine," which is commonly translated wrongly in such dictionaries, was fruitless. A feature of the book is the absence of classification even into the three separate languages. In giving the translation, three different kinds of type are employed for the three different languages, but the words are arranged in alphabetical order irrespective of their language. Thus three consecutive items are:—

**Blé.** *Corn. Wheat.* Korn. Getreide.
**Bleaching.** BLANCHIMENT. Bleichung.
**Blech.** FEUILLE. TOLE. *Sheet. Plate.*

This arrangement is a very convenient one. The dictionary will prove most useful, but it would have been still more so had its publication been contemporaneous with the opening instead of with the closing of the Paris Exhibition.

**Electric Wiring Tables.** By W. Perren Maycock. (London: Whittaker & Co., 1900.) 3s. 6d.

The function of a pocket book is to confine the maximum of useful information in the minimum of space. Mr. Maycock's volume of tables is a pocket book in the true sense of the word, measuring only 4[illegible]in. by 2[illegible]in. by [illegible]in., and bound in a good leather cover with rounded edges. The book is evidently intended for the use of those connected with electric wiring work, to whom multiplication and division sums are a source of anxiety and inaccuracy, for the tables in it are calculated to reduce to a minimum the arithmetic required from the designer of an electric wiring installation. In addition, the conductor tables are good and exceedingly well arranged, and it is the omission of both educational and irrelevant matter that has rendered it possible to keep the size of the book down to such small dimensions. We may confidently predict that Mr. Maycock's book will have a large number of users.

**An Elementary Treatise on the Calculus for Engineering Students.** With numerous Examples and Problems worked out. By John Graham, B.A., B.E. 2nd edition. (London: E. & F. N. Spon.) 7s. 6d.

No better time could have been chosen for bringing out a second edition of Mr. Graham's excellent little book. Prof. Perry has been giving the electrical engineering profession a serious reprimand for their neglect of mathematics, and here is an elementary book on the calculus ready to hand for the younger members who wish to repair their error. We praised Mr. Graham's book on the publication of the first edition, and the few alterations that have now been made to it are all in the direction of enlarging its usefulness, being mostly additional examples of the application of the calculus to electrical and engineering problems.

**Case Law of the Workmen's Compensation Act, 1897.** By R. M. Minton-Senhouse, Barrister. (London: Effingham Wilson.) 3s. 6d. net.)

A second edition of this useful record of decisions under the Workmen's Compensation Act has recently been issued, in which Mr. Minton-Senhouse discusses, in simple phraseology, the points of the leading decisions under this Act. The relation of these decisions to former findings of the courts are set out, and a running commentary enables the lay reader to grasp the intricacies of the law, to appreciate the different conditions under which the various actions were brought, and to differentiate one apparently similar action from another. Employers of labour (and especially of such labour as comes within the purview of the law relating to accidents to workmen) can profitably devote a brief time to the study of Mr. Minton-Senhouse's new edition.

**Colliery Engineers' Pocket Book.** By T. A. O'DONAHUE. Second edition. (Wigan: "Mining Engineering" Office.) 1s. 3d.

This little work, both in size and in the selection of matter, almost fulfils the ideal for a pocket book. While there are a few instances of looseness of expression, since the book is intended as a remembrancer rather than as a text book, this defect is hardly of much *practical* consequence. In dealing with the electrical units, the author has slipped somewhat in his explanation of the ampere, defining it as analogous to "gallons in dealing with water."

**Siemens & Halske Aktiengesellschaft: Elektrische Centralanlagen.** (Berlin: Julius Springer, 1900). 10m.

This is a fine and well-illustrated quarto volume, bound in cloth, containing a list of the central stations built by Messrs. Siemens and Halske, with a few tabulated technical details, and in the case of 16 electricity works full descriptions. Among the latter are one of the Vienna and one of the Copenhagen stations, the five-wire system at Rotterdam, the high-voltage Eichdorf-Grunberg transmission, and the Rand Central Electric Works.

**Transformatoren fur Wechselstrom und Drehstrom.** By GISBERT KAPP. 2nd edition. (Berlin: Julius Springer.) 1900.

In this volume, the German electrical engineer has an excellent text-book, sufficiently theoretical and sufficiently practical, on the theory, design and testing of transformers. Mr. Kapp has added considerable matter to the book for its new edition, and has revised such things as the curves of iron losses, &c., to make the whole quite applicable to the improved practice of the present day.

**Manual of Electrical Undertakings, 1900.** Compiled under the direction of Mr. EMILE GARCKE. (London: Donington House, Norfolk-street, W.C. 12s. 6d. net.)

This is the fifth annual issue of a useful manual giving, in very clear arrangement, a mass of information relating to electric lighting, power, and traction. Some idea of the growth of the electrical industry is shown by the increasing bulk of Mr. Garcke's work—from 738 pages in 1898-99 and 1,086 pages in 1899-1900, the new edition has increased to 1,272 pages. The "Manual" contains, in addition to the information given in other similar publications, some useful charts. This is, in fact, a particularly attractive feature, and makes the "Manual" indispensable to the investor who has his money in electric stocks or desires to invest in them. Mr. Garcke deals fully with the manufacturing branch of the electrical industries, and gives some valuable information regarding the new electric railway and tramway lines authorised by Parliament, and also a complete list of the railway and tramway bills and provisional orders submitted to Parliament during the 1900 session. The graphic diagram following page 136 would be improved by being printed on tougher paper, similar to the analysis sheet which follows. Mr. Garcke's book shows great care in compilation, and a peculiar knowledge of the requirements of those likely to consult his "Manual." The book is a credit also to the printers.

**Directory of Electric Lighting and Electric Traction, 1900 1.** Edited by C. S. VESEY-BROWN. (London: Hazell, Watson and Viney. 6s. net.)

Truly, "of making many books there is no end." This is the first issue of a new directory, in which is given a quantity of statistics relating to electric lighting and traction; and its publication accentuates the fact that few industries are so abundantly catered for in the matter of books of reference as the electrical. Mr. Vesey-Brown has attempted, more or less successfully, to combine the information given in other annual publications, notably Mr. Garcke's "Manual of Electrical Undertakings" and "'The Electrician' Electrical Trades' Directory and Handbook." Any review of the new work must of necessity be on the basis of comparison with these much older works. We casually open the "Manual" at the Norwich Electricity Co.'s entry, and compare the particulars given. Except that Mr. Garcke's book, issued within a day or two of that edited by Mr. Vesey-Brown, gives, apparently, some later figures, there seems little or no difference in the class of information to be found in the two publications; but we find considerable variation in the figures. If we wish to know the price of gas per 1,000 cubic ft. at Norwich Mr. Vesey-Brown gives us 3s. and Mr. Garcke 3s. 6d. The population of Norwich, according to Mr. Vesey-Brown, is 100,964, Mr. Garcke 112,000. The equivalent 8 c.p. lamp connections, according to Mr. Vesey-Brown, are 56,000, according to Mr. Garcke 51,184. Somewhat similar discrepancies occur in the Lincoln Corporation entry. Apart from the question of absolute accuracy, however, Mr. Vesey-Brown's book contains a mass of information drawn up in simple form, and if there is a demand for such a collection of data, then those who require it are under an obligation for this conscientious endeavour to provide for their needs. The book is well printed and strongly bound, and will prove useful to those who have not already the information at hand.

## THE MANUFACTURE OF CALCIUM CARBIDE.

BY JOHN B. C. KERSHAW, F.I.C.

(*Continued from page 165.*)

### I.—COMPARATIVE FURNACE EFFICIENCIES.

**III. Experimental and Estimated Yields of Carbide.**—1. At Spray during the experimental trials in March, 1896, Messrs. Houston and Kennelly obtained 8·97lb. 80 per cent. carbide per electrical horse-power day.—*Chem. Tr. Journal*, Vol. XVIII., p. 385.

2. Lewes reports that in his own experimental trials he obtained ·30-·50lb. per electrical horse-power hour.—*Journ. Gas Lighting*, November, 1897.

3. Korda states that in Europe the maximum yield is 9lb. carbide per electrical horse-power day.—*Rev. de Chim. Industrie*, Vol. VII., p. 341.

4. Wolff estimates that the practical yield of carbide is 3kg. to 4kg. per electrical horse-power day.—*Zeits. f. Angew. Chemie.*, 1898, p. 919.

5. Liebetanz, in working out the cost of carbide by steam and water-power, bases his calculations upon a yield of 5kg. carbide per kilowatt day.—*Zeits. f. Angew. Chemie.*, July, 1899.

6. According to the *Engineer*, 1 ton of carbide requires the expenditure of 8,744 electrical horse-power hours in the furnace.

7. Bullier estimates that in practical work 4kg. carbide will be obtained per electrical horse-power day.—*L'Eclairage Electrique*, April 4, 1896.

Taking these various yields and reducing them to a common form, as before, we obtain the figures given in Table II.

Table II.—*Kilowatt Hours necessary to produce 1 Metric ton (2,204lb.) of Calcium Carbide containing 80 per cent. Carbide. Experimental and estimated figures.*

| Authority. | Ref. No. | Kw. hrs. | Authority | Ref. No. | Kw. hrs. |
|---|---|---|---|---|---|
| Lewes | 2 | 4,105 | Liebetanz | 5 | 4,900 |
| Korda | 3 | 4,380 | Wolff | 4 | 5,111 |
| Houston & Kennelly | 1 | 4,393 | ... | 6 | 6,514 |
| Bullier | 7 | 4,470 | | | |

**IV. Actual Yields of Carbide.**—1. At Niagara, in 1896, 500 H.P. was stated to be producing 2½ tons carbide per day.—*The Electrician*, April 17, 1896.

2. Prof. Lewes states that in practice one electrical horse-power year yields 1·25-1·50 tons packed carbide. (The higher figure is used).—*Journ. Acetylene Gas Lighting*, July, 1898.

3. Nikolai states that the average yield of the forms of furnace at present in use is 3kg. per horse-power day.—"Stahl u. Eisen," Vol. XVIII., p. 727.

4. According to Haber, in Germany 8,000 electrical horse-power hours, and in America 6,000 electrical horse-power hours are required to produce 1 ton carbide.—"Elektrochemie," Chap. X, p. 408.

NOTE.—When not specifically stated the carbide has been taken as containing 80 per cent. real carbide of calcium.

5. Patten states that the latest form of multiple arc furnace yields 0·40lb. carbide per electrical horse-power hour.—*Amer. Electrician*, January, 1899.

6. Keller states that at Meran, with the Gin and Leleux furnace, 5·2kg. carbide (testing 86 per cent.) have been obtained per kilowatt day.—*L'Eclairage Electrique*, May 6, 1899.

7. Pierard states that the Memmo furnaces at Ste. Marcel yield 4·88kg. carbide per kilowatt day.—*L'Ind. Electrochimique*, December, 1899.

8. Statement by Borchers that most carbide works consume from 5·1 to 5·76 electrical horse power hours per kilogramme carbide produced.—*Zeits. f. Elektrochemie*, Oct. 5, 1899.

9. Keller states that a yield of 6·2kg. carbide per kilowatt day has been attained with the latest form of the Gin and Leleux furnace. Paper before Páris Congress, *The Electrician*, Sept. 29, 1900.

10. Statement by Carlson of yields obtained by the two types of carbide furnace: Continuous 4·5kg., intermittent 5·8kg. to 6·5kg., 76 per cent. carbide per kilowatt day.—*Zeits. f. Elektrochemie*, February, 1900.

11. Prof. Lewes states that at Foyers the best results obtained have been 3·78kg. pure carbide per electrical horsepower day.—"Acetylene," 1900, p. 302.

Bringing these various figures, as before, to a common form, namely, the kilowatt hours required to produce 2,204lb. of 80 per cent. carbide, we obtain the results presented in Table III.

Table III.—*Kilowatt Hours necessary to produce 1 Metric ton (2,204lb.) of Calcium Carbide, containing 80 per cent. Carbide. Actual figures.*

| Authority. | Ref. No. | Kw. hrs. | Authority. | Ref. No. | Kw. hrs. |
|---|---|---|---|---|---|
| [illegible] | 1 | 3,576 | Lewes ......... | 2 | 4,351 |
| Lewes........... | 11 | 3,788 | Haber ......... | 4 | 4,470 |
| Keller ....... | 9 | 3,871 | Pierard ...... | 7 | 4,920 |
| Carlson ......... | 10 | 4,104 | Nikolai......... | 3 | 5,066 |
| Patton ......... | 5 | 4,105 | Carlson ...... | 10 | 5,616 |
| Borchers ...... | 8 | 4,157 | Haber ......... | 4 | 5,960 |
| Keller ...... | 6 | 4,291 | | | |

The tabulated figures show, as might be expected, wide variation; the two extremes being 5,960 kilowatt hours and 3,576 kilowatt hours per ton of carbide produced. If the figures representing the yield at Niagara in 1896 were reliable, one might be disposed to think that no progress had been made in the efficiency of carbide furnace operations, for the consumption of energy at this place is the lowest recorded, and is slightly below that given by Keller and Lewes in 1900 for the latest forms of furnace.

But figures emanating from the other side of the Atlantic in the early days of the carbide industry were very untrustworthy, and in some cases wholly misleading; and this reported yield of 2½ tons of carbide per day from 500 E.H.P. must be accepted *cum grano salis*.

The three most reliable and striking results are therefore Nos. 9, 10, and 11, and in the concluding portion of this article the furnaces by which these yields are obtained will be described, and the lines along which improvements in design or in working may be expected to occur will be discussed at some length.

(*To be concluded.*)

## REPORT OF THE COUNCIL OF THE ROYAL SOCIETY.*

During the past year the time and attention of the Council have been largely occupied by business connected with matters of national and international scientific interest, in which Her Majesty's Government has either directly sought the advice and assistance of the Society, or has itself given assistance and financial support to undertakings promoted by the Society in the interests of science.

*Disturbance of Magnetic Observatories by Electric Railways.*—The committee appointed by the Board of Trade to investigate this question has made experiments near Stockton and in London with instruments devised by Mr. W. Watson, Assistant-Professor of Physics in the Royal College of Science. No definite decision has, as yet, been arrived at by the Board of Trade, but the matter continues to be a subject of grave anxiety to those interested in the protection of observatories and laboratories from extraneous disturbances.

* Presented to the Society, November 30, 1900. Abstract.

*International Catalogue of Scientific Literature.*—Considerable progress has been made towards the realisation of the project for the publication of an international catalogue of scientific literature. The International Conference of 1900 decided that the catalogue should be issued in 17 volumes, relating to 17 different sciences. At that conference the representatives of six countries officially subscribed for 161 sets of volumes, and representatives of four other countries stated semi-officially that their Governments would probably take 30 sets. The additional results which have since been attained are largely due to the action of a Fellow of the Society, who offered to guarantee the Society against loss if it would subscribe for 45 additional sets on certain conditions, the principal of which were (1) that the United States should subscribe for 45 sets, and (2) that if other countries than those whose representatives at the conference either officially subscribed or made unofficial statements of their probable subscriptions undertook to take a certain number of sets, the supplementary subscription of the Royal Society should be reduced by that amount. The first of these conditions is now fulfilled; in fact, the United States have already subscribed for 65 complete sets or its equivalent, and further subscriptions may be expected. As regards the second condition, the number of additional sets for which the Royal Society is responsible has been reduced to 17 by the promise of subscriptions for 28 sets from countries the intentions of which were not declared at the conference. In view of the above facts, it has been decided to start the catalogue on January 1, 1901, and necessary arrangements have been made to that end. It has from the first been evident that the necessary contracts with a printer and a publisher—if a publisher should be employed—could not be made by an International committee, and as the Central Bureau is to be established in London, the Council has decided that the Society should make these contracts in its own name. Before undertaking this responsibility they laid the facts of the case before Her Majesty's Government, by whom a guarantee of £1,000 a year for five years has been given, "to make good to the Royal Society a part of any loss which may be incurred by the publication of the proposed catalogue." This guarantee was subject to certain conditions, which, in the opinion of the Treasury, have now been fulfilled. It is hoped that it will not be necessary to ask for the sum guaranteed, or, at most, for more than a small part of it. The Council has also decided that the Royal Society shall itself be the publisher of the catalogue, though a contract will be made by which most of the technical duties will be undertaken for the Society by a publisher who will be the Society's agent. It is believed that the chance of the success of the catalogue will be much increased by this method of procedure. Foreign governments would prefer not to enter into direct relations with a publishing firm. Steps are being taken to organise the British Regional Bureau.

*British Academy.*—In connection with the Association of Academies a most important matter has engaged the attention of the Council. At the meeting of the Association held in October, 1899, and referred to in the last report, it was understood that no society devoted to one subject, or to a small range of subjects, would be regarded as an "Academy," and that an academy might be admitted either to the Literary Section alone, or to the Scientific Section alone, but not to both, unless its constitution showed that the sphere of its labours embraced both literary and scientific subjects. So far as the Council is aware, there is no society in existence in England dealing with subjects embraced by the Literary Section in such a manner as to satisfy the first of these conditions. Hence, as matters at present stand, the Royal Society being regarded as a scientific society only, the United Kingdom can only be represented on the Scientific Section of the Association. The Council put themselves in communication with some distinguished men of letters with regard to the formation of a Literary Academy, such as would satisfy the requirements of the Association. These gentlemen were of the opinion that it would not be desirable to attempt to form such an academy by the simple federation of existing societies dealing with the matters in question. Subsequently a number of them submitted to the Royal Society a memorandum in which it was suggested that the Society might give its aid towards the desired result in one of two ways: It might propose to enlarge its scope and include a section corresponding to the "Philosophico-Historical" and "Philological" division of the German Royal Academies and Societies; or it might address a memorial to the Government, pointing out the exceptional position in which England is placed as compared with other European countries through the absence of any academy representing departments of study other than Mathematics and Natural Science, and advocating the formation of such an Academy. A Committee of Fellows of the Society was appointed to consider the above memorandum, with power to confer with such persons as they thought desirable, and to report to the Council on the suggestions made in the memorandum, stating the various reasons which might be urged for and against them but not

advocating any distinct policy. The Committee has devoted much time and trouble to the matter, and has furnished a report of some considerable length which discusses the powers of the Society to deal with the subjects in question, and various ways in which this might be done. As instructed by the Council, it has confined itself to stating the reasons which may be urged for and against the several measures suggested. The present Council had no opportunity of discussing this report until its last sitting; it then agreed to leave the report, without recording any opinion, to the succeeding Council.

*Hughes Bequest.*—Under the will of the late Prof. Hughes a bequest of £4,000 has been made to the Royal Society, with a direction to award the income annually as a prize, either in money or in the form of a medal, or partly one and partly the other, for the reward of original discovery in the physical sciences, particularly electricity and magnetism, or their applications, the prize or medal to be given under conditions to be fixed from time to time by the Society on lines similar to those followed in the bestowal of the Copley, Rumford, and Royal medals.

After full consideration it has been decided to award annually a gold medal to be called the "Hughes Medal," not exceeding in value the sum of £20, together with the balance of the income of the fund to such person as the President and Council may consider the most worthy recipient, without restriction of sex or nationality, as the reward of original discovery in the physical sciences, particularly electricity and magnetism, or their applications, such discovery or applications having been published not less than one year before the award.

*Terms of Bequests.*—A memorandum relating to the terms of bequests to the Society will be printed in the new issue of the Year Book. The object of this memorandum is to make it generally known that, while the Society is willing to receive gifts to be applied to special objects or for the benefit of particular sciences indicated by the donors, nevertheless, in view of the varying necessities of science, the most useful benefactions are those which are given to the society in general terms for the advancement of natural knowledge. The Council have been led by experience to the conclusion that it is neither to the advantage of the Society, nor in the interests of science, that the already long list of medals awarded by the Royal Society should be added to, and consider, therefore, that no further bequests to be awarded as prizes for past achievements should be accepted by the Society. They desire, however, to make known that the funds belonging absolutely to the Society are very few indeed, and they have again and again had the experience that the usefulness of the Society for the Advancement of Natural Knowledge has been greatly hampered by the lack of funds, of which they could freely make use according to their own judgment.

*The Apartments of the Society.*—On several occasions the attention of the Council has been drawn to the inadequacy of the present rooms of the Society, as regards both wall space for the library and accommodation for the meetings of committees. On these grounds Her Majesty's Government was approached with the view of ascertaining whether the Society could be housed in the premises in Burlington-gardens recently vacated by the University of London. The Government, however, have decided to retain the building for their own purposes, and no further action has, therefore, been taken by the Council in the matter. The Council, however, are of opinion that the inadequacy of the accommodation is so great as most seriously to interfere with the proper activity of the Society, and that some measures ought to be taken to remedy what is becoming a serious hindrance to its work.

*Electric Lighting.*—In consequence of an intimation received from Her Majesty's Office of Works, that the system of electric lighting was not considered satisfactory by that department, the Council have, on the recommendation of the House committee, sanctioned the execution of extensive alterations, in order to bring the installation up to the standard of modern requirements. They have also, on the recommendation of the committee, arranged for the permanent supply of alternating current to the building, and for the extension of the direct-current main leads; an arrangement which will, it is hoped, prove both convenient and economical on the occasions of the Society's soirées. The Council desire here to record their sense of the great obligation they are under to Prof. Ayrton for placing his professional skill, and much of his valuable time, at the service of the Society in this matter.

*Publications.*—During the past year 21 Papers have been published in the Mathematical and Physical Section, and 11 in the Biological section of the *Philosophical Transactions.* The two sections together contain, in all, 1,320 pages of letterpress and 20 plates. Eighteen numbers of the *Proceedings* have been issued containing 646 pages and 8 plates. In all, 111 Papers were received between the close of the session in June, 1899, and the corresponding date in 1900. Of these, 48 were submitted for publication in the *Philosophical Transactions*, and 63 for the *Proceedings*; and 36 and 39 have been ordered for publication in the two categories respectively.

*Publication Fund.*—Out of the grant of £1,000 annually placed in the society's hands by Her Majesty's Government "to assist not merely their own publications, but also the adequate publication of scientific matter through other channels and in other ways," the sum of £511. 13s. 4d. has this year been voted to societies and agencies other than the Royal Society. Of the total sum of £5,000 received by the Society in respect of this grant since its initiation the sum of £2,231. 8s. 4d. has been so applied.

*Catalogue of Scientific Papers.*—Progress continues to be made with the "Catalogue of Scientific Papers" and with the classified index thereto. As regards the supplementary portion of the catalogue, the transcription of the copy was completed in the course of 1898, and 45 sheets have now been passed for printing. The committee intend to have the whole of the work completed by the end of July, 1901. Of the classified index to the catalogue about 334,500 slips have been prepared. During the past year 10,500 slips have been prepared. The provisional classification of the prepared slips has been continued, and about 234,000 more slips, bringing the total up to 334,500, have been classified. About 16,000 of these have been finally revised for printing during the past year.

## THE NATIONAL PHYSICAL LABORATORY.*

### 1.—REPORT OF THE EXECUTIVE COMMITTEE FOR THE YEAR, OCTOBER 1, 1899, TO SEPTEMBER 30, 1900.

In presenting their report to the General Board of the Laboratory the Executive committee have to express their regret that, in consequence of the delay in determining on the site, the progress made during the year has not been as great as they had hoped for. The following, however, is a brief record of the main events:—

After a conference with the Commissioners of Woods and Forests, some members of the Executive committee visited various sites suggested by the Commissioners, and reported strongly in favour of the site originally suggested by the Treasury committee, in the Old Deer Park at Richmond. Further interviews were held with the Commissioners, and, subject to the approval of the Treasury, terms were arranged by which an area of about 15 acres was provisionally secured to the Committee for the purposes of the laboratory. The terms of the agreement were laid before the General Board at a meeting, on February 9, 1900, and a resolution was passed approving them. Meanwhile it had been agreed to approach the Office of Works with a view to having the building constructed by them, and a Building committee was appointed to prepare plans.

In the early part of the year the director visited the Reichs-Anstalt in Berlin, and the Bureau International at Sèvres, in order to make himself acquainted with the arrangement of these two institutions before the plans were drawn up. The committee are glad to have this opportunity of recognising the courtesy with which he was received by the authorities of these two institutions. During the autumn of 1899 various sub-committees had reported on the work which might be usefully undertaken by the laboratory, and the Building committee were instructed to have regard to these reports in the preparation of the plans. From the consideration of these it appeared that it would be desirable to erect two buildings at some distance apart. In the one which it was proposed to call the Physics Laboratory, experiments requiring great stability and freedom from disturbance would be carried out; the other, which might conveniently be placed nearer a main road, would be an engineering laboratory. Accordingly, plans for a physics building, at an estimated cost of £6,000, and an engineering laboratory, at an estimated cost of £4,000, were approved by the Executive committee. These were submitted to the general board at their meeting on June 25, 1900.

Meanwhile, questions had been asked in Parliament with regard the site, and Mr. Hanbury received a deputation from persons opposed to placing the laboratory in the Old Deer Park. This was followed by a deputation from the Royal Society, who urged that the scheme proposed by the Treasury committee, and adopted in its general features by the Treasury in a letter to the president, dated October 7, 1898, should be carried out. At their meeting held on October 24 the Executive committee received a semi-official communication from the Treasury stating that the Government, with Her Majesty's approval, had determined to allot the Bushey site. A copy of the communication, which the Executive committee have addressed to the Council of the Royal Society, is appended for the information of the General Board. The exact terms under which Bushey House is to be held have not been settled, but at the request of the Treasury an estimate has been made by the Office of Works of the cost necessary to make it suitable for a laboratory. This estimate, which amounts to £14,296, includes the provision of a new engineering laboratory, and the erection of a boiler-house and engine-room, together with the cost of an engine and dynamo

* Presented to the Royal Society, November 30.

for the supply of light and power. The Committee have been informed that in view of this expenditure the Government intend to ask Parliament to increase their grant for capital outlay from £12,000 to £14,000.

Work, in the meantime, has been going on in the buildings of the Kew Observatory. The control of the work carried on by the Kew committee of the Royal Society, appointed under the provisions of the Gassiot Trust Deed of June 29, 1871, was taken over by the Executive committee from the 1st of January, and the property held by that committee was handed over to the Royal Society for the purposes of the laboratory as from that date. The committee, which was incorporated as a public company, has since been dissolved. The work at Kew Observatory has been continued in all its branches. A detailed account will be published later. It may, however, be stated that the total number of instruments tested up to the end of September is largely in excess of the corresponding number for any previous year.

Among the pieces of work which have increased in importance during the year may be mentioned the testing of telescopic sights for the naval guns. The director has also been in correspondence with the War Office authorities with regard to the testing of aneroids and watches. The magnetic work has grown, and the facilities for it have been greatly improved by the erection of a second house for magnetic observations. Captain Denholm Fraser, R.E., who is in charge of the Indian Magnetic Survey, has been working at the laboratory during a great part of the summer, making himself acquainted with the methods of measurement, and testing the instruments to be used in India. A new workshop and packing-house have been built, and the space thus set free, with the adjacent platinum thermometer room built in 1897, has been utilised as a laboratory for the director. Some of the electrical apparatus of the British Association has been fitted up in this room, and during the summer a series of comparisons of the standard coils was made. Experiments in platinum thermometry have been continued, and valuable results are being accumulated. The air thermometer, given by Sir Andrew Noble, has been erected in this laboratory by Dr. Harker, and is now nearly ready for use. The new workshop has been fitted with certain necessary tools, and a mechanic has been for some little time at work making apparatus for use in the laboratory.

The committee have to thank various donors for gifts. Sir Andrew Noble has contributed £1,000 for the purchase of apparatus. Dr. Isaac Roberts has given a spectroscope and two very valuable induction coils. Dr. Common has provided apparatus for determining the magnifying power and testing the collimation error of the telescopic sights, and has promised a large flat surface for optical work. Mrs. Sworn has given the collection of thermometers used by her late husband. The financial position is for the present satisfactory; the financial year closes on December 31, and the audited accounts will be presented later. During the past year the erection of the workshop and magnetic room, and the fitting of the laboratory have been a cause of exceptional expenditure, amounting to about £475, while about £250 has been spent in apparatus and tools; but the additional staff appointed since the Kew Observatory was taken over consists only of the director and a mechanic. Thus the income for the year will be in excess of the expenditure; there is every prospect, moreover, that the fees for testing will show an increase.

In accordance with the scheme of organisation this report is made up to September 30, 1900. The Executive committee desire to bring before the General Board the suggestion that in future their report should end with the close of the calendar year, being brought down to December 31 in each year. It would then be possible to include audited copies of the accounts, and a complete statement of the results of the year's work.

Copy of Resolution adopted by the Executive committee for transmission to the Council of the Royal Society at their meeting on October 24, 1900:—

"That a copy of Sir F. Mowatt's semi-official communication be forwarded by this committee to the Council of the Royal Society: that the Executive committee report to the Council of the Royal Society that, while they consider that there are several reasons for preferring the site in the Old Deer Park at Richmond—which was recommended by the Treasury committee and approved by the Treasury—the committee are of opinion that a reasonably satisfactory National Physical Laboratory can be provided on the Bushey site, and they do not recommend the Royal Society to further oppose the arrangement which the Treasury, with the approval of Her Majesty, have adopted.

"The Executive commitee note with satisfaction that the Lords Commissioners propose to ask Parliament to grant an additional £2,000, in order to provide for capital outlay in the next financial year.

"They cannot, however, conceal from themselves that it will be very difficult for them to maintain and administer a National Physical Laboratory on the Bushey site for the amount annually allowed by the Treasury, and they fear that it may be necessary for them to press in the near future for an addition to that allowance."

II.—Statement as to Work to be undertaken in the Year, October 1, 1900, to September 30, 1901.

Under this head it may be useful to give a brief summary of the investigations which, in the opinion of the sub-committees appointed to draw up suggestions as to work, might be usefully undertaken. At the same time it must be pointed out that until the new buildings are available, few, if any, of these investigations can be carried out. For the present it seems best to develop the work which has been carried on at Kew for some time past, rather than begin new experimental work. Thus the testing work will go on, and in some respects be extended. The committee have received communications from the Board of Agriculture with regard to the testing of certain apparatus used in the dairy industry, while the director has been in communication with various firms as to the testing of burettes, flasks, &c. It is hoped that it may be possible at once to take up this work. The laboratory has now conveniences for platinum thermometry; as one result of the directors' visit to Berlin, it appeared desirable to have a comparison between the high temperature scale in use here and that employed at the Reichsanstalt. Thanks to the courtesy of President Kohlrausch and the officials of the Reichsanstalt, arrangements for this are now in progress. The work with the gas thermometer will continue, and the committee hope, during the year, to have Sir A. Noble's instrument in order as a standard of temperature. The fact that the B.A. standards have been placed in the laboratory renders possible some necessary work on electrical units, in particular the construction of mercury resistance standards. Preliminary steps have been taken with this object.

---

Sub-committees were appointed, as has been mentioned already, for the purpose of drawing up a series of suggestions as to the work which might most usefully be carried out in connection with the following branches of science or industry: mechanics and engineering, electricity, optics, chemistry, meteorology, terrestrial magnetism, thermometry, legal standards, and the following is an analysis of their principal recommendations:

Three sub-committees—viz., those for mechanics, chemistry, and Electricity—mentioned practically the same investigation as that to which attention ought in the first instance to be devoted. The terms of the recommendation of the Electrical sub-committee are as follows: "The connection between the magnetic quality and the physical, chemical, and electrical properties of iron and its alloys, with a view specially to the determination of the conditions for low hysteresis and non-ageing properties." The other recommendations refer specially to the work of Sir W. Roberts-Austen and the Research committee of the Institute of Mechanical Engineers. It would seem, therefore, to be desirable to provide for this work.

Another important task suggested by the Mechanics committee, which ought, moreover, to prove remunerative, is the testing of various gauges and dynamometers, indicator springs, and the like, and also of gauges of various kinds used in engineering practice. The necessity of further investigation into the methods of measuring wind pressure was also urged. The Electrical sub-committee give the second place to the testing and calibration of electrical and magnetic instruments, as also of samples of iron used for transformers, and other magnetic purposes. This work again ought to be remunerative. The Chemistry sub-committee suggest investigations into the conductivity for heat and coefficient of transmission of radiation of various substances in general, and also as bearing on the question of gaseous fuel. The sub-committee on Thermometry describes the present thermometric work of the laboratory, and expresses the opinion that it ought to be developed—(1) By extending the range of temperature over which thermometers are tested. (2) By providing for (a) gas thermometry, (b) electric thermometry. (3) By arranging for a more exact study of the mercury in glass thermometers. The sub-committee on electricity again calls attention to the necessity of investigation into certain electrical measurements, and Mr. A. P. Trotter, at the request of the committee on legal standards, has submitted a valuable list of measurements, by means of which the work of the electrical laboratory of the Board of Trade would be supplemented and assisted. The sub-committee on optics recommend that the work of testing telescopes, binoculars, photographic lenses and sextants should be extended, and that microscopes and certain other instruments should also be tested. At the request of the sub-committee on legal standards, Mr. Chaney has furnished a statement as to instruments verified by the Standards department of the Board of Trade, with suggestions as to investigations in which the laboratory might assist the department. The sub-committee on Terrestrial Magnetism, in view of the doubt as to whether Kew can be sufficiently protected against magnetic disturbances due to tramways, do not recommend any immediate and expensive changes in this department, but they point out that, if Kew is to continue to rank with stations such as Potsdam and Pawlowsk, the extension of the Observatory will be necessary in the not very distant future, and that this will involve a considerable outlay.

## PHYSICAL SOCIETY.

At an ordinary meeting held November 23, Prof. Everett, F.R.S., vice-president, in the chair, a Paper on

### "A Self-Adjusting Wheatstone's Bridge."

by E. H. Griffiths and W. C. D. Whetham was read by Mr. Whetham. The object of this Paper is to describe a cheap and easy method of getting a self-adjusting bridge to show on a scale the actual resistance of any wire. Contact with the bridge wire is made by means of a light horizontal bar which is suspended by a phosphor bronze strip from the coil of the d'Arsonval galvanometer used with the instrument, a second bar, parallel to, and above the first, is rigidly connected with the coil. A wooden beam worked by clockwork moves up and down between the bars and clamps them alternately. When the beam is down contact is made with the bridge wire. If this contact is not at the zero point a current will flow through the coil, and if the cell is connected up the proper way, it will turn the coil so as to bring the upper bar nearer to the null point. This puts a twist into the phosphor bronze strip, and when the beam rises and clamps the upper bar the torsion comes into play and brings the lower bar under the upper one. The beam then descends and makes contact at this point, and if any current flows through the galvanometer there is further movement until the null point is reached. Any alteration in the resistance of the wire under experiment causes a movement of the zero point on the bridge wire, and this is followed by the lower arm. The position of the lower arm can be directly indicated by means of a scale.

Prof. S. P. THOMPSON asked how the scale was calibrated.

Mr. WHETHAM said the scale was arbitrary, but it could be calibrated by the known resistance of the bridge wire per unit length. Extension of the range can be obtained by shunting the bridge wire with various resistances.

Mr. GLAZEBROOK asked how sensitive the bridge was.

Mr. WHETHAM said that working with a dry cell it could easily indicate one degree on a platinum thermometer.

Mr. BLAKESLEY pointed out that if the cell was connected up the wrong way the zero point would be an unstable one.

A Paper on

### "The Liquefaction of Hydrogen"

was read by Dr. M. W. Travers. These experiments were undertaken in order to provide liquid hydrogen in sufficient quantity for the separation of neon from the helium with which it is usually mixed. The separation is effected by cooling the gases to the temperature of hydrogen boiling at atmospheric pressure. The principles and conclusions do not differ from those of Dewar, but as the production of liquid hydrogen is neither difficult or costly, an account of the experiments is given. In 1884 Wroblewski showed that strongly-cooled and compressed hydrogen on being allowed to expand formed mist or spray in the tube; and later Olozweski repeated these experiments on a larger scale and determined the temperature of the liquid. Other methods of liquefying hydrogen have been suggested by Lord Rayleigh and Kammerlingh Onnes. In the case of many gases, a fall of temperature takes place on free expansion, but in ordinary circumstances the temperature rises in the case of hydrogen and helium. The principle of free expansion was first applied by Hampson and Linde to the liquefaction of air. Within the last two years Dewar has shown that at a temperature close to 200°C. hydrogen behaves as an imperfect gas, and becomes cool when allowed to expand. This principle has been applied by Dewar to the liquefaction of hydrogen in quantity. In the author's experiments hydrogen, under a pressure of 200 atmospheres, passes through a coil which is cooled to 80°C. by a mixture of solid carbonic acid and alcohol. In then enters another coil contained in a chamber which is continually replenished with liquid air. The lower portion of this coil passes into another chamber, which is closed, and communicates through a pipe with an exhaust pump. Liquid air flows continuously from the first chamber into the second through a pin valve controlled by a lever. The liquid air, boiling under a pressure of 100mms. of mercury, lowers the temperature to 200°C. The gas then passes into a regenerator coil, which is enclosed in a vacuum vessel, and, expanding at a valve, passes upwards through the interstices of the coil and the annular space surrounding the chambers through which the gas first passes, to an outlet whence it can return to the main supply pipe. The liquid which separates from the gas is ultimately collected in a vacuum vessel. The apparatus, with the exception of the compressor, motor, and Hampson air liquefier, is, comparatively, inexpensive. About £50 is required for the additional apparatus, and each time liquid hydrogen is made involves a further expenditure of about a sovereign.

Dr. HAMPSON said he would like to offer a correction. Dr. Travers had said that he (Dr. Hampson) was the first to liquefy air by the application of the counter-current process to the Joule-Thomson effect. Although he was the first to make the proposal he was not the first to apply it. He made the proposal to Prof. Dewar's assistant in 1894, and air was liquefied by Prof. Dewar by this method. Dr. Travers had referred at length to a valve which he (Dr. Hampson) had devised, but as it was straightforward common sense he did not wish to accept any credit for the use it had been to the author in his experiments. He would like to call attention to the remarkable features of the work in two respects—the economy of means and the magnitude of results. By means of liquid hydrogen, Prof. Ramsay and Dr. Travers had succeeded in obtaining the physical and other properties of some of the rarer gases.

Prof. S. P. THOMPSON said the author had asserted that the Joule-Thomson effect for hydrogen changes in sign at some temperature, and expressed his interest in the fact that it was possible to get a cooling effect by allowing hydrogen to expand.

Mr. BOYS asked if it was necessary or desirable to allow the hydrogen to expand to atmospheric pressure.

Dr. TRAVERS said the mechanical advantages of this were great.

Dr. LEHFELDT asked if there had been any attempt to determine the temperature of the liquid, and, secondly, if the apparatus could be employed to determine the magnitude of the Joule-Thomson effect.

Dr. HARKER asked if the temperature at which the Joule-Thomson effect changes sign was known.

Dr. DONNAN said that the effect changed sign at the temperature at which "PV" was a minimum.

Dr. TRAVERS, in reply to Dr. Lehfeldt, said he had not determined the temperature of the liquid, and the apparatus was not suitable for measuring the Joule-Thomson effect. He should say that the change of sign occurred about 150°C. It was Daniell Berthelot who first pointed out that the change of sign corresponded with the minimum value of "PV," but the experiments of Amagat on the relation between pressure and volume were not sufficiently accurate to fix the temperature.

## CORRESPONDENCE.

### SUN SPOTS, MAGNETIC STORMS, COMETS TAILS, ATMOSPHERIC ELECTRICITY, AND AURORÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Letters in your Correspondence Column are apt to get overlooked (except when you call attention to them in your "Notes") owing to the fact that their subject matter is not included in your Table of "Contents." I do, however, happen to notice a letter by Prof. Rücker in your recent issue, of date November 30th, and accordingly I attempt a brief contribution.

The whole subject of electricity demands reconsideration in the light of the facts now known concerning the existence of electrons, or at least of negatively charged corpuscles smaller than atoms. The old facts and theories remain true, but a further step can be taken; and a glorified electrostatics, that once despised subject, seems likely to dominate the field. It has long seemed to many persons extremely improbable that magnetic disturbances on the earth are caused by direct magnetic moment at the sun. It has likewise seemed to several persons improbable that such disturbances are caused merely by ethereal or electromagnetic waves emanating from the sun and travelling with the speed of light. Such waves exist no doubt, but there is no reason to postulate for them a magnetic influence. The assumption that every solar influence on the earth (except gravitation) must be due to the agency of Maxwell's and Hertz's waves may turn out to be only another instance of the usual human tendency to overwork any successful theory, and to press a good nag into too great a variety of service. At one time (the reign of chemistry) everything in physics was attributed to some imponderable form of matter; later (under the influence of Tyndall and others) everything was considered to be due to some mode of molecular motion; now everything is popularly supposed to be done by waves. A little time hence (though it is always rash to predict) I suggest that electrons or charged corpuscles will be the central feature of physical science, and that some people (I among others, no doubt) will be engaged in pressing them into all manner of service, and clogging up keyholes by trying to unlock doors with them which they will not really open. Later on still, this will be recognised, and our successors will be attracted by some other real and inspiring novelty; but meanwhile the electron theory will have had its day, and, like that of molecular vibration and of ether waves, each in its own time, will by no means cease to be, but will merely be relegated to its proper place in the cosmos. It is only a few paradoxers who assume that every fresh step means the overthrow and abandonment of former ones.

The attempt thus to explain as many phenomena as possible in terms of the most recently discovered fact is perfectly legitimate and necessary; for the quickest way of finding out what doors can be opened by a particular key is to try it, not too roughly, in their locks.

Very well then: with this caution I would call attention to the facts:—(1) That the observed phenomena of comets tails has long suggested to observers and theorists the existence of a strong repulsive force, probably electric, acting on small particles in the neighbourhood of the (presumably electrified) sun; (2) that the occasional though perhaps fanciful "aiming" of a sunspot disturbance at the earth has suggested to G. F. FitzGerald the notion that magnetic disturbances might be due to something in the nature of a projectile, a torrent or flying cloud of charged atoms or ions projected past or near the earth, and thereby affecting terrestrial compass needles. But on working out the arithmetic of this hypothesis it appeared that the speed and charge necessary were such as to be improbable for atoms of matter to possess, on any reasonable hypothesis of projection.

I have not FitzGerald's ideas clearly in memory, and I may be doing them injustice; but it will be seen that this is not my intention. My intention rather is to call attention to them as containing a possible clue to, or link between, many apparently distinct phenomena, if for ions or charged atoms we substitute the idea of electrons or charged corpuscles (whatever they may be—disembodied charges perhaps), the existence of which is now well known under the name of cathode rays in a Crookes' vacuum tube, and by the name of Lenard rays outside in the atmosphere.

To those who remember the high velocity measured for such particles—not incomparably less than that of light; to those who recognise the truth of J. J. Thomson's proof that their material mass is exceedingly small in proportion to their electric charge; to those who realise the extreme ease with which they are detachable from a negatively-charged body under the action of ultra-violet light and by other methods, it will seem no straining after hypothesis to suggest that such electrons may be flung off the sun; or, if they are scattered like meteors about space, that they are repelled by it, if it be a negatively charged body, as the cathode ray constituents are repelled by a cathode, describing therefore not elliptic but hyperbolic orbits. If so, then in their flight past the earth they must act as an electric current, and therefore, unless they always surround it quite symmetrically, must occasionally deflect its magnetic needles. Furthermore, if they impinge on its atmosphere, they may electrify it.*

And as they graze past the polar regions—for it will be the polar regions they will constantly graze if they come from the sun,—they may in passing through the atmosphere give rise to the appearance not of a shower of meteors but of the boreal and austral auroræ.

The name of Crémieu will here rise to the mind, as that of the experimenter who has thrown doubt on the foundations of electromagnetism, as laid by Maxwell and others, by performing an experiment which appears to contravene the hitherto admitted law that a moving electric charge is a full-blown and perfect electric current. Whereas my own view (*quantum valeat*) is that in all probability no other kind of electric current exists.

If anyone in this country shares in the qualms apparently excited in France by these experiments of Crémieu—which experiments, however, are interesting enough and require explanation (I sincerely hope that he has not found a mare's nest built upon an arithmetical error)—I say if anyone in this country allows himself to doubt the magnetic power of a moving electric charge, let him take a horseshoe magnet and that well-known cylindrical form of Crookes' tube which has a strip of phosphorescent mica along its axis, and refresh himself by employing the magnet to deflect the cathode rays.

* This is not for a moment to be supposed to be the *only* source of atmospheric electricity: there are many *veræ causæ*; but it may be a disturbance of it. And as the earth is constantly sweeping up meteors in its pilgrimage through space, so perhaps it may be sweeping up stray electrons, especially if it be itself positively charged. It may be, however, that no stray electrons can exist near a negatively charged solar system, but are accumulating elsewhere.

To make the experiment more complete, the tube or the magnet should be mounted so as to be capable of bodily motion, and an attempt be made to observe the reaction, which it is to be supposed will be found acting upon the *magnet*, and not as in the case of the radiometer upon the *glass*.—Yours, &c., OLIVER LODGE.

University of Birmingham, Dec. 1, 1900.

## THE AUTOMOBILE CLUB.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Oppermann's letter, which appeared in your last issue, calls for a few remarks. As a body, I think the owners of the cars would repudiate the suggestions that the trials were too severe, or that the constant running under the difficult conditions ruined or tended to ruin the batteries. It appears that such a suggestion is far more calculated to injure the growing industry than the trials themselves. It is well known that one firm ran their car upon the Southsea tour with the same batteries that had been used throughout the trials, and it may be interesting to say that the identical set of batteries has now been sold for lighting purposes. This does not seem to indicate that they were damaged by the severe conditions of the trials.

It is quite true that some dissatisfaction was felt by the manufacturers engaged. These points will no doubt be remedied in future trials of electromobiles which the Automobile Club may conduct.

The matters which chiefly affected the owners were:—

(*a*) The trials being only suitable for certain classes of vehicles. It is well known that light electromobiles are constructed for town use and for light work. On such cars powerful motors are unnecessary, and they are not provided. The trials all took place under the same severe conditions, thus excluding several types of carriage. Manufacturers not being consulted as to the trials were consequently quite in the dark as to what class of car they should enter. It was naturally presumed that the trials would be varied. As a matter of fact, it was a prolonged hill-climbing test.

(*b*) No decent arrangements were made to enable carriages to be attended to: expensive cars were housed in broken-down sheds of the most filthy description—there were inches of liquid mud on the floors, rain came through the roof, the sheds were doorless, and the cars and attendants were nightly exposed to the full force of wind and rain. On the first night two cars had to stand in the open. It rained the whole night! No information being given as to where the trials were to be held, no arrangements could be made for the lodging of the attendants. One company which had entered several cars found that the hotels near the charging station were already occupied. As a result their staff had to be divided between two hotels, each more than a mile of the charging station and over two miles from each other. As all charging of cars took place at night the inconvenience and expense of this arrangement was considerable.

(*c*) Those who had entered cars were treated as competitors, instead of as manufacturers with one object in view—namely, the progress of electromobilism. Most stringent and unprecedented rules were enforced with the utmost severity, and the conditions generally were not calculated to bring out the advantages of electrical self-propelled traction.

It is necessary to add that the officials at the charging station did everything in their power to assist those engaged on the trials, and their courtesy was the redeeming feature of the week. It is, however, to be hoped that much more efficient charging arrangements will be made on any future occasion.—Yours, &c., THEODORE G. CHAMBERS.

London, Dec. 6

## GROUNDING OF LOW-POTENTIAL CIRCUITS AND ELECTRIC WIRING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I, as one amongst probably the majority of your readers, took considerable interest in reading the note in your issue of the 30th ult. *re* the Report of the Special Committee to the United States Underwriters' National Electric Association, under date of August 1. Your readers have recently been

favoured with several extracts and comments relating to electric wiring and electrically-caused fires. I venture, therefore, to take this opportunity of impressing the fact that our American friends (personified in their special Technical Insurance Committee) are at last beginning to feel that it may be to their interest to veer round technically, so as to promote and encourage, rather than condemn, the earthing of the neutral wire for house-wiring work.

As you pointed out in your same issue, the 1899 report of the London Fire Brigade has now become comprehensive enough to include electrical fires, and it states that 18 fires out of a total of 3,630 reported in London are certainly traceable to electrical current. Hence English electrical industry should be congratulated upon its comparatively small percentage. In America, as you are aware, the number of fires attributed to electrical causes probably exceeds 20 to 30 times this number annually, and although the United States may be somewhat larger than England, and electrical fire applications are more generally developed there than here, it is noteworthy that their fire insurance authorities have, after many years of careful and detailed attention to electrical fire risk, now decided to "plump" for earthed return wires.

From the enquiries I have made of prominent electric light engineers in England, I think I am safe in saying that our station engineers at least would be pleased to see a full discussion of this subject. They have many problems—the best means of extending their existing business so as to include the bulk of the light consumers in the town amongst their customers; how, on the other hand, they are to save the lead sheathings of their supply and feeder cables, &c., &c.—facing them at the present time, which are supposed to be more or less directly connected with this earthing question.

Looking at the other interests concerned in this question, namely, the insurance and the public interests—if we are agreed that electric wiring according to present lines is causing no direct electrical fire risk—surely it is time that insurance companies reduced their premiums for electrically-lighted "risks."

The public, we know, eagerly seize to-day, through the Press representatives, every opportunity of enlarging upon any insidious or mysterious fires said to be caused by electrical agency, and as we really know of so few electrical fires, the only reason that could be surmised is the fact that, whilst totally ignorant technically, they see enough of the present construction to feel that the material used is not employed practically and economically, without any question as to its *scientific* disposal. It is true that the public demand low-cost wiring—in fact, electric fitting that shall compete in first cost with gaspipe fitting—and wiring contractors, in their attempt to meet this demand are oftentimes forced to sacrifice even the best material by placing it in the hands of the cheapest possible labour.

You yourself, like many of your readers, probable recognise that I maintain (crankily, perhaps) that electric wiring cannot be put on a commercial and scientific basis so as equally to suit all interests concerned until we are allowed to insulate (properly) *one* rather than *two* wires. Experience is proving that perfect insulation implies perfect protection mechanically, electrically and chemically, whilst the steady growth of armoured conduit systems points to the advantage of employing a metallic protection.

I am therefore forced to the conclusion that some form of concentric system should be adopted in which a vital and inner conductor shall be protected by a suitable surrounding or outer conductor. In other words, we shall have ultimately to adopt "earthing," the broad question being how electric wiring work can be done efficiently and at a price. My object in writing is to suggest that your editorial notes on this subject at the present time would be particularly valuable and interesting, and I would reiterate the last paragraph of your extract: "The permission to ground the neutral point of secondary systems would be welcomed by all those who have the welfare of the electrical industry at heart, and who desire to see the greatest use of electricity accompanied by the minimum risk in its use."—Yours, &c.,

London, Dec. 5. FRED BATHURST.

# LEGAL INTELLIGENCE.

### The British Electric Traction Co. (Ltd.) v. the Commissioners of Inland Revenue.

This action was heard in the Queen's Bench Division on Nov. 28, before Mr. Justice Kennedy and Mr. Justice Phillimore, and was a case stated by the Commissioners of Inland Revenue. On Jan. 24, 1900, an instrument was presented on behalf of the British Electric Traction Co. (Ltd.) to the Commissioners for their opinion as to the stamp duty with which the instrument was chargeable. The instrument was an indenture, dated Jan. 23, 1900, and made between the Corporation of Croydon and the appellants under sec. 19 of the Tramways Act, 1870. It contained a recital that the Corporation was empowered by that act, with the consent of the Board of Trade, to demise the right of user of the tramways referred to in the indenture and the right of demanding and taking tolls in respect of the same. By clause 1 the Corporation granted and demised to the appellants the right of user for the purpose of conveying passengers and small parcels only, of the said tramways, together with the right of demanding and taking tolls, with certain reservations. By clause 2 these rights were granted to the appellants for 21 years from Jan. 1, 1900, for their exclusive use subject to a power reserved to the Corporation to determine such term in certain events. Clause 3 provided for the amount of rent payable, which depended in part on the cost of purchase, reconstruction, electrical equipment, rolling stock, agreed extensions, and other works, and part was ascertainable at the date of the indenture and amounted to £3,250 per annum. By clause 4 there was a provision that the appellants should pay as from the date of a certificate of the Board of Trade authorising electric traction £100 per annum per mile of road along which the tramways were laid in lieu of maintaining roads and repairing tramways, and this amounted altogether to £900 per annum. Under clause 5 a further uncertain sum was reserved as rent in certain contingencies. Clause 6 provided for the determination of the lease at the option of the Corporation, this option being exercisable at the end of five years from the commencement of the term in certain contingencies and thereafter at the end of any subsequent five years. Clause 27 provided that appellants should purchase all electric energy required for the tramways from the Corporation, clause 30 fixing the rate of 2d. per unit during the continuance of the lease, with a provision that so long as the Corporation supplied the energy reasonably required by appellants for working the tramways the minimum sum payable in any one year should be £4,000, with provision for revision of the price charged at the end of the second year. The instrument fixed no time within which the Board of Trade certificate authorising electric traction was to be obtained. Clause 42 provided for the determination by appellants, in certain contingencies, of their obligation to purchase electric energy from the Corporation. Clause 44 gave a special power of distress. It was contended by the appellants that the instrument fell to be charged under the head of "Lease or Tack" in the first schedule of the Stamp Act, 1891, under the sub-heading "of any other kind whatsoever not herein before described," and was liable to a duty of 10s. only. The Commissioners held that in respect of the provisions other than those contained in clauses 5 and 30 the instrument was chargeable under subhead 3 of the above-mentioned head, as a lease "for an indefinite term . . . of heritable subjects where the consideration . . . money to the lessor . . . consisted of money, stock, or security," with an ad valorem duty at the rate of 5s. on every £50 on the rent of £3,250, plus £900—namely, £20. 15s. They also held that it was chargeable with the fixed duty of 10s. in respect of the rent mentioned in clause 5, which was at the date of the indenture unascertainable, and in respect of the minimum sum of £4,000 per annum mentioned in clause 30 was further assessable under the head "Bond, Covenant," &c., No. (1) in the same schedule with £105, being 2s. 6d. per cent. on the minimum sum multiplied by 21, the number of years during which the same might have been payable if the tramways had been electrically equipped and the certificate of the Board of Trade obtained on Jan. 1, 1900, and if the Corporation had made no default in the supply of electric energy during the continuance of the lease. The questions for the Court were, therefore, whether the instrument was chargeable with the several sums of £20. 15s., 10s., and £105, and, if not, with what duty the instrument was chargeable.

Mr. Justice PHILLIMORE said that in his opinion the Crown were right with regard to the £900 per annum and partially with regard to the £4,000 per annum. He was of opinion that both sums represented rent, and that they ought therefore to be taken into consideration in assessing the ad valorem duty with which the instrument was chargeable as a "lease or tack." He came to this conclusion with hesitation, because of the peculiarity of the instrument. The question raised by the appellants under sec. 77 (2) of the Stamp Act did not really arise because the £900 and £4,000 were, in his opinion, part of the principal consideration given for the lease. The word "consideration," as used in the section, included anything sounding in money which the lessee had to pay to the landlord. The question, therefore, whether the covenants contained in clauses 4 and 30 of the lease were covenants relating to the matter of the lease did not arise. As there was no specified time when the supply of electrical energy should commence, the largest possible figure would have to be taken, and the duty must be paid on the assumption that the payments began at once. The fact that these sums were not recoverable by distress did not prevent their being properly described as rent. The rent of a furnished house was none the less rent because it could not be recovered by distress. In his opinion the appellants ought to succeed to the extent only of reducing the £105 to the proper sum payable as in a lease.

Mr. Justice KENNEDY said he felt compelled to differ from Mr. Justice Phillimore. There were two subjects of appeal – the first, as to the accessibility of the sum of £900 per annum, payable under clause 4 of the lease; and the second, as to the accessibility of the £4,000 per annum payable under clause 30. It was not suggested that clauses 4 and 30 were colourable only, and that the sums payable under them were really disguised rent. If that were so he would have agreed with his learned brother. But as both clauses represented an honest business arrangement he was unable to regard either of the sums as rent. Sec. 77 (2), on which appellants relied, did not in terms speak of rent; the word used was "consideration." Within that term was not necessarily, in his opinion, included every covenant in the lease which resulted in the payment of money by the lessee to the lessor. What was intended by consideration in the section were the payments which were usually called rent. Both the clauses in question were contingent and might never come into operation at all. Clause 30 was analogous to the case of brewers' tied houses. The Corporation, who had established works for the supply of electric energy, made a bargain to supply the electric energy required by the appellants. This was a contingent and business arrangement, and in his lordship's opinion clause 30 was a "covenant relating to the matter of the lease" within the second part of sec. 77 (2). Clause 4 was also, in his opinion, a "covenant relating to the matter of the lease," and both the clauses or covenants were under the terms of sec. 77 (2) expressly exempted from the payment of duty in addition to that charged on the lease.

Mr. Justice PHILLIMORE withdrew his judgment, and the judgment of Mr. Justice Kennedy prevailed. The duty chargeable on the instrument was accordingly reduced to £16. 5s., together with the 10s. in respect of clause 5, the liability for which was not disputed.

### National Telephone Co. v. Gulliver.

The facts of this case were fully reported in *The Electrician* of Nov. 23, and on Monday application was made in the Westminster (London) County Court, where it was tried, for leave to appeal, or, in the alternative, for a new trial of the counterclaim.

Mr. MINTON-SENHOUSE counsel for defendants (Messrs. Gulliver & Co. (Ltd.), Argyll-street, W.), made the application on the ground that he was of opinion at the time of the action that he had the right to appeal, but it now appeared he had not, as the amount did not exceed £20. The Telephone Company sued for £17, a year's telephone rent in advance, and defendants counterclaimed £20 damages for not receiving a complete service. The jury found against the defendants. His contention was that plaintiffs were not entitled to be paid for a telephone service which was never a complete one.

Judge LUMLEY SMITH said the jury found the service was properly completed.

Mr. MINTON-SENHOUSE said plaintiff's "Conditions" appeared to stultify each other. They contracted to give a complete service, and stated they would not be responsible for damages provided every endeavour was made to give a complete service. Then they went on to say the company would not be liable for any delay from any cause. Defendants claimed that the company refused to repair or restore the service as they had contracted to do.

The JUDGE: And the jury found against them.

Mr. MINTON-SENHOUSE submitted the jury only found that the telephone was completed, not that the company had repaired or restored it.

Mr. COMPTON SMITH, for plaintiffs, opposed the application, and said the jury found the company did the work and was entitled to payment. The counterclaim was threshed out at great length, and the jury found for plaintiffs.

The JUDGE said he could not set aside the finding of the jury and grant a new trial, but the parties both appeared to be in a position to carry the matter through in a higher court. He granted the application by giving leave to appeal.

### The Chloride Electrical Storage Syndicate (Ltd.) and the Corporation of King's Lynn.

ARBITRATION.

An arbitration was held on Tuesday by Major P. Cardew, R.E., in the matter of a claim by the Chloride Electrical Storage Syndicate (Ltd.) for the payment of the sum of £301. 1s. 7d., which was alleged to be due to them under this contract for the supply of storage batteries for the electric lighting works of the Corporation of King's Lynn.

At the opening of the hearing the Town Clerk stated that the Corporation appeared under protest, and contended that the dispute was not one properly within the arbitration clause of the contract.

For the Chloride Syndicate Mr. FRANK EVANS stated that in August, 1898, the Corporation advertised for tenders for the supply and erection of a battery of 225 storage cells according to specification. The tender of the syndicate, amounting to £846. 9s. 6d. was accepted, and a contract entered into between the parties. No mention was made in the specification that the certificate of the engineer was a condition precedent to payment. The schedule of quantities which the syndicate duly priced, contained, amongst other things, particulars of the storage cells, cable for connections, and the rates of pay for labour of erector, wireman, &c., and these last items were headed "Day Work," and the contention of the syndicate was that their scheduled prices for material did not include any labour, but that they were entitled to charge for all labour expended in erection, &c., according to the scale set out under the heading of day work. The contract confirms this view, as it states that the Corporation will pay to the contractors the sum of £846. 9s. 6d., *i.e.*, the amount of their tender, and this amount cannot be made up without including the charges for labour.

For the Corporation, the TOWN CLERK stated that this claim was evidently an afterthought on the part of the contractors. The schedule of quantities stated that the storage batteries were to be supplied "in complete working order as specified," and a reference to the specification showed that the contract was for the "supply, erection, setting to work, &c.," of the storage batteries. The note printed at the head of the schedule of quantities stated that the prices given in the schedule were to include "all details of construction, whether mentioned or not, and all labour and plant required in fixing . . . and the works are to be delivered over to the Corporation in complete and perfect working order for the amount named." The rates of pay for labour specified in the schedule were under the heading of "Day Work," and in the general conditions the special clause relating to "day work" stated that charges "by the day" were only to be made in the event of any additional or substituted work being ordered by the engineer. The certificate of the engineer was clearly stated in the contract to be a condition precedent to payment. The syndicate rendered various accounts during the progress of the works, and payments were made on the certificate of the engineer (Prof. H. Robinson). None of these accounts made any mention of labour, and the first certificate of the engineer was not objected to, although it stated that it was on account of work done and material supplied. The final accounts of the contractors, however, contained items for labour amounting to 5,089 hours, which the engineer disallowed in his final certificate. There were also items for cable, which were reduced by the engineer on the ground that it had been "supplied only."

No witnesses were called for either side, and the arbitrator reserved his award.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Grimsby Corporation require an assistant engineer for their electricity department. Applications to borough electrical engineer (M. W. A. Vignoles) by Dec. 13. See advertisement.

Perth Corporation require a resident electrical engineer. Further particulars are set out in an advertisement, and applications must be addressed to the clerk to the commissioners (Mr. John Begg), City Chambers, Perth, by 22nd inst.

York Corporation require a mains superintendent and a cable jointer for their electricity department. Further particulars are set out in advertisements, and applications must be sent to the city electrical engineer (Mr. C. A. Midgley) by 15th inst.

A meter superintendent, to take charge of the meter and testing department, is required for the Greenock electricity works. An advertisement gives further particulars, and applications must be sent to the burgh electrical engineer (Mr. W. M. Nelson).

The National Electric Supply Co., Preston, require a shift engineer. See advertisement.

A technical assistant is required in a works laboratory. For further particulars see advertisement.

An old-established firm manufacturing electric accumulators requires agents in the provinces. See advertisement.

A practical man for a small generating station is required by Messrs. Pryce Jones (Ltd.), Newton, Montgomeryshire. See advertisement.

Manchester Tramways committee require a foreman platelayer for their permanent-way department. Applications to chairman by 14th inst. See advertisement.

Battersea Borough Council require a resident electrical engineer. Applications on official forms to town clerk by Jan. 1.

Ilford District Council require a resident electrical engineer. Applications to clerk by Dec. 10.

Mr. Cyril E. Davies, of Bolton, has been appointed chief assistant electric tramways engineer at Cardiff, at a salary of £225 rising to £300 per annum.

Mr. J. D. Pember, chief assistant at York, has been appointed resident electrical engineer by the Farnworth (Lancs.) District Council.

On Tuesday the Worthing Town Council appointed Mr. G. Porter, assistant at one of the stations of the Westminster Electric Supply Corporation, borough electrical engineer at a salary of £250 per annum. There were 100 applicants.

Mr. Walter Telford has been appointed assistant engineer at the Middlesbrough Corporation electricity works.

Messrs. S. Lees (Bradford), W. Abraham (London), E. H. Lanham (Preston), and A. Granger (Morecambe) have been appointed charge engineers at Wigan.

Mr. Arthur R. Fearnley, manager of the Bradford Tramways Co., has been appointed tramways manager at Birkenhead at a salary of £300 per annum.

Mr. Howat has been promoted by the Southampton Corporation from the position of third engineer to that of second engineer at the electricity works at a salary of £110 per annum, and Mr. H. A. Pearson has been appointed third engineer at £90.

**Barrow-in-Furness.**—The Board of Trade have sanctioned the use of steam power on the local tramways till February. It is proposed to substitute electric traction, and negotiations are proceeding between the Council and the British Electric Traction Co. who have provisionally acquired the local lines.

**Bombay.**—Some time ago, offers were received by the Municipal Council for the concession for establishing electricity supply, and the committee appointed to report upon these tenders now recommend the Council to grant a concession for 42 years to Messrs. Killick, Nixon & Co., local agents for Messrs. Kilburn, who represent Messrs. Crompton & Co. in India.

**Bootle.**—Mr. A. P. Trotter inspected and approved the electrical equipment of the Derby-road and Rimrose-road tramway route last week. The route consists of 1½ miles of double track with span wires.

**Boston.**—The desirability of erecting electricity supply works is to be reported upon by Mr. Adrian C. Collins. A provisional order was obtained in 1900.

**Burnley.**—Extensions of the electric lighting mains, estimated to cost about £5,400, have been authorised by the Gas and Electricity committee, and the Council will advertise for tenders for from 20 to 30 electric tramcars for the trunk tramway lines when they are reconstructed.

**Cardiff.**—A joint meeting of the Electric Lighting and Tramways committees was held on Wednesday to consider lengthy reports of the electric tramways engineer (Mr. A. Ellis) and the engineer of the electric lighting department (Mr. N. Appelbee) on the subject of the supply of electric current for lighting and traction. After discussion, a motion proposed by Mr. Robinson that the committees be combined was rejected, and the joint committee then considered a resolution that Mr. Ellis should be appointed the electric tramways and lighting engineer of the borough, subject to confirmation of Council. Eventually the committee unanimously adopted the following resolution:—

That, subject to the approval of the Council, Mr. Arthur Ellis be asked to accept the position of borough electrical engineer and manager, and take entire charge of the electric lighting and tramway systems in the borough of Cardiff forthwith. Further, that for such additional services his salary be increased to £750 per annum, rising by annual increments of £50 to a maximum of £1,000, provided that he enters into an agreement and undertakes not to apply for another appointment during a period of five years.

Mr. Ellis, who was called in after the resolution was carried, accepted the conditions, and said that all he asked for was that he should have the support of the committees. At a subsequent meeting of the Lighting committee it was decided to defer the appointment of mains superintendent, and in the meantime Mr. Jones, who is acting in that position, was asked to continue at the rate of £150 a year.

**Colchester.**—On Saturday Mr. A. R. Sillar, who has hitherto acted as resident engineer for the contractors (Messrs. Siemens Bros. & Co.) commenced his duties as borough electrical engineer. Mr. Sillar was apprenticed to the United Electrical Engineering Co. (Ltd.) in 1889, and two years later joined the company's successors, Messrs. J. G. Statter & Co. In 1895 he was engaged by the London Gigantic Wheel and Recreation Co., and fitted up the plant and installation on the Big Wheel at Earl's Court. Subsequently Mr. Sillar entered the service of the Blackpool Gigantic Wheel Co., and at the end of 1896 the Blackpool Winter Gardens Pavilion Co. engaged him as resident engineer, and in that capacity he equipped the company's complete installation, which is of 1,000 H.P., cost £25,000, and is claimed to be the biggest private installation in the country. In March, 1899 he was appointed representative of Messrs. Siemens Bros. & Co. Mr. Sillar is 30 years of age, and has been actively engaged in electrical work for the past 12 years.

Extensions of the electricity supply works are to be carried out on the recommendation of the borough electrical engineer (Mr. Sillar) at an estimated cost of £12,000, and application has been made for sanction to borrow this amount. At the Council meeting on Wednesday, Councillor Barritt referred to the fact that the electricity works had passed into the hands of the Council. He thought a word of congratulation was due to Messrs. Siemens Bros. & Co. for the satisfactory manner in which they had executed their contract during two years. During the first year of the undertaking to Dec., 1899, the work proceeded quietly. Eighty consumers, and the equivalent of 4,254 8 c.p. lamps, were connected, and it was then only necessary to run the plant for a few hours on five evenings in the week. The year ending Dec., 1900, had been a very busy one. The number of consumers had increased from 80 in 1899 to 148, and the number of lamps had gone up from 4,254 to 9,421; the units generated being 44,432, and 88,131 respectively. The committee believed that during the coming year that rate of increase would be more than maintained. The committee had to face the fact that in some districts the distribution mains were becoming overloaded, and some consumers experienced a drop in voltage. In order to meet the increasing demand for current, the committee proposed to add another 250 H.P. set, bringing the total up to 940 H.P. This would enable them to deal with 20,000 equivalent 8 c.p. lamps. The proposed new set would just fill up the remaining space in the engine-house, and the set could be used for either lighting or traction. It was proposed to add another 400 H.P. condenser, and to erect a cooling tower. The committee had also to deal with overloaded mains, and to overcome this they proposed to increase the pressure, as being the least expensive course. It was therefore proposed to raise the voltage to 440.

**Corea.**—An electric tramway, equipped with U.S.A. plant, has been opened at Söul. This city is reported to possess the largest public electric lighting installation in the Far East, with the single exception of Tokio (Japan). In June last telegraphic communication was established between Fusan and Chemulpo (Corea), with various main towns in China, via Söul and Wiju. Altogether Corea is booming, in sympathy with the industrial development of the Far East.

**Croydon.**—The Corporation have applied for sanction to borrow £5,000 for wiring premises on the easy payment system. The basis of the Council's scheme is as follows:—

(1) Upon receipt of application a price is obtained from a contractor, and the consumer is asked to guarantee a minimum annual payment equal to 8s. per 8 c.p. lamp installed, this being sufficient to pay off the cost of wiring in six years, or of the wiring and fittings in 10 years if the latter be included, in which case the value of the fittings must not exceed 25 per cent. of the total cost of both wiring and fittings (if the latter are included).

(2) At the expiration of six years, the wiring becomes the property of the tenant or the landlord, as the case may be, and the fittings become the property of the tenant or landlord at the expiration of 10 years. At the end of every year the tenant has the option of purchasing his installation on payment of the balance unpaid of the cost price, plus 5 per cent.

**Darlington.**—The General Purposes committee recommend the Council to obtain a report from a tramway engineer as to their acquiring the tramways in the borough from the Imperial Tramways Co.

**Darwen.**—The Council have decided, on the recommendation of the Electric Lighting committee, to increase the salary of the borough electrical engineer (Mr. Stanley Clegg) from £200 to £250, and to pay him £50 for his additional work during the past year in connection with the electric tramways.

**Doncaster.**—Since the opening of the electricity works there has been a steadily increasing demand for current, and at present the equivalent of 8,300 8 c.p. lamps is connected.

**Dover.**—The Corporation are promoting bills to acquire the electricity and gas undertakings, and are making inquiries as to experts to report and advise on the matters in question.

**East Ham.**—An inquiry has been held into the application of the Council to borrow, among other sums, £2,640 for electric lighting.

**East Indian Railway.**—Some considerable extensions of electric light and power plant on the East Indian Railway are in hand or under consideration by the East Indian Railway Co., which has already working an installation in the locomotive shop at Jamalpur on the two-wire continuous-current system. The total capacity of this plant is 300kw. This is a preliminary installation, and it is intended eventually to drive the whole of the locomotive shops at Jamalpur electrically. There are also in hand small electric lighting plants on various parts of the company's line, and the company has in hand the equipment throughout of the new carriage and wagon shops at Lillooah, where a polyphase plant will be put in, intended eventually to be used as a central power station for this section of the line. The directors have under consideration, or partly in progress, the equipment of the new Howrah terminus, the extensive range of Calcutta offices, and the chief stations, traffic and locomotive yards throughout the system.

**Eccles.**—The electrical engineer (Mr. H. W. Angus) is to prepare a report on the proposed extension of the electricity works, and particularly as to supplying current for tramway working and for lighting the whole of the public thoroughfares.

**Electricity Supply in North London.**—The Councils of Tottenham, Edmonton, Enfield, Wood Green, Southgate, and Friern Barnet have deposited their bill to empower the Councils jointly to establish electricity works for the supply of electric current in their respective districts. The bill has, from the outset, been opposed by the chairman of the Wood Green Council (Mr. R. D. M. Littler, Q.C., C.B.), but on Friday last statutory resolutions were passed to proceed with the bill, the cost of which was estimated to be between £5,000 and £10,000. At the same sitting Mr. Littler, who has been chairman of the Council since its formation in 1888, resigned his seat. The resignation was accepted.

**Electric Pumping.**—The report of the engineers to the South Staffordshire Mines Drainage Commissioners states that in the Tipton district the new clearing works, in anticipation of electric pumping, have been pushed forward, and the large area at Bentley Hall is nearly completed. Other works are commencing with great promise of success in preventing escape of water into mines.

**Electric Traction in Italy.**—The Italian Minister of Public Works has received a demand for a concession for the construction and working of an electric railway, 315 kilometres in length, connecting Naples and Rome, via Mondragone, Mentorno, Terracina, and Cisterna, the journey being estimated to occupy three hours. Energy would be generated at hydraulic stations on the Volturno and other rivers en route. The plans of the scheme being considered insufficient the matter has been referred back with the request that the engineers seeking the concession should complete the plans and studies on the spot.

A concession has been granted for an electric tramway starting from Brusasco (at the terminus of the present steam tramway from Turin) and proceeding to Ozzano, a distance of 33 kilometres. The line is to be built with ordinary raised rails on one side of the National and Provincial highway. Various branch lines to be constructed hereafter will nearly double the present 33 kilometres of track. There is no water power in the immediate neighbourhood, and steam power will be used to generate current. For passenger traffic on this line the electric motors will be directly mounted on the trucks, and for freight traffic electric locomotives will be used. The system proposed to be used is three-phase alternating, with two overhead trolley wires.

The concessionaires of this line have also applied for a concession for a line from Brusasco to Ivrea, through another district not yet served by tramway or railway, and along the route of which there is a population of about 100,000 inhabitants. Another line studied by the same engineers, and of which the plans have been completed, crosses the line from Brusasco to Ivrea at almost right angles, and would cater for a population of about 100,000. Sufficient water power is available at three points on the routes to work the whole length of the proposed lines (about 90 kilometres), as well as for extensions of about 30 kilometres, surveys for which have already been completed. The maximum grades on these lines do not exceed 2½ per cent., save in one place on the Brusasco-Ozzano line, and the minimum curves have a radius of 35 metres. The maximum speed allowed is 30 kilometres per hour when fitted with continuous Westinghouse brakes, or 20 kilometres per hour when not so fitted. Owing to the construction allowed, i.e., raised rails and sleepers with ordinary ballasting, on roads already constructed by the National and Provincial Governments, it is estimated that the complete cost of construction and equipment, including hydraulic installations, will not exceed £4,000 per mile.

The Adriatic Railway Co. has proposed to the Italian Minister of Public Works to institute an electric automobile service between Modena and Bologna, the cars to be second and third-class and to have a carrying capacity of 68 persons. This new service is now being inaugurated.

**Exeter.**—There is an increasing demand for current for private lighting, and 50 additional customers had been connected during the past 12 months, bringing the total to 93, with an equivalent of 3,500 8 c.p. lamps. Plans, &c., of the new works at the Basin are to be submitted at the next meeting of the committee.

**Exhibition.**—The programme of the International Exhibition of Industrial appliances, which is to be opened in Rome on Dec. 15, and to remain open to Jan. 31, is now issued. The exhibits will include the apparatus and accessories employed in the electrical, mechanical, chemical, and automobile industries, amongst others. Communications relating to the exhibition should be made to Direzione della Terza Esposizione Campionaria, Rome, Italy. Exhibits have to be in by Dec. 10.

**Festiniog.**—Arrangements have been made with Mr. T. P. Osborne Yale for a supply of electric current for public lighting. The outer portions of the district, according to the present arrangement, are to be supplied with current by Mr. Yale, the Council to furnish poles, wires, &c. The central district is to be supplied direct by Mr. Yale, and the whole district is to be lighted electrically within three months.

**Galveston.**—Already this terribly devastated city is rising from its ashes, if such a metaphor is pardonable where saturation rather than cinders is referred to. The supply of electric current for lighting has been resumed, the electric tramways are in partial working order, and generally the city is slowly but surely resuming its old importance.

**Gillingham (Kent).**—The Council have accepted the tender of the Chatham, Rochester and District Electric Lighting Co. for supplying current to and maintaining nine arc lamps in High-street, New Brompton, at £18 per lamp per annum.

**Gloucester.**—The Gloucester Railway Carriage and Wagon Co. have applied to the Council for a temporary supply of electric current for power, and a sub-committee has been appointed to arrange terms on the basis of a report by the consulting engineer (Mr. Robert Hammond).

**Hanley.**—Sanction to the borrowing of £5,000 for electric lighting and £9,500 for refuse destructor has been received by the Council.

**Ilford.**—Current for motive power and heating is to be supplied at 8d. per unit for the first hour's maximum demand and 1d. per unit after, and for places of worship at 5d. per unit.

**Institution of Electrical Engineers (Dublin Section).**—On Thursday last week, the Dublin Section of the Institution of Electrical Engineers held their first conversazione. Prof. G. F. FitzGerald presided, and delivered a short lecture on "Rotating Magnetic Fields," illustrated experimentally, and a lecture was also given by Prof. W. F. Barrett on "The Permeability of Certain Alloys of Iron and Steel," illustrated by lantern slides. The proceedings included an exhibition of electrical experiments and apparatus by members and others. These exhibits included a new form of meldometer for determining the softening points of minerals, by Dr. J. Joly; the action of radio-active material on electrical discharge, by Dr. F. J. Trouton, an eighteenth-century frictional electrical machine, the original Page electromagnetic engine exhibited in the 1851 exhibition, a meteorological instrument with electrical recorders, an electric lamp movable on rails, a system of telephoning as applied to electric traction, an X-ray exhibition, electric tramway and power distribution, material and instruments, and several types of electric house meters.

**Insulated Gloves.**—A competition in respect of the best protective hand gloves for the use of working electrical engineers, has been organised by L'Association des Industrieles de France contre les Accidents du Travail. The competition closes on Dec. 31. Full particulars from the offices 3, Rue de Lutece, Paris.

**Insulating Materials for High Pressures.**—Mr. Fred. J. Down writes us as follows:—

With reference to the several recent casualties in central stations from accidental contact with exposed parts of switchboards or other high tension apparatus, I beg to say that by lapping such parts with a special cured rubber strip or splice such as I am now supplying they would be rendered quite harmless. I may say further that when such material is properly applied, and by slightly warming after each lap or layer, an actual rubber tube results, giving an insulation resistance well up to that of the usual classes of covered conductors in the market. For 'bus bars, &c., where such lapping cannot be applied without dismantling the switchboard, my "armalac" varnish or paint will also serve well. The makers claim that it gives a resistance equal to the puncture strain of 1,500 volts for each one thousandth of an inch in the thickness of the films in which it is applied, hence its great success amongst machine builders here and elsewhere. Whilst, however, calling attention to these most successful materials, I quite agree that, when possible, gear more modern and carefully designed should be brought into use as the most certain preventative; still, where such drastic alterations cannot be carried out, the before-mentioned means of insulation may appeal to the engineers of stations as the next best method of guarding their staff from similar mishaps.

Mr. Down has shown us samples of the insulating tape he refers to, and it appears to be a most excellent composition. Of course, Mr. Down's is not the only material suitable for the purposes he mentions.

**Kilmarnock.**—The Council on Wednesday decided to erect electricity works on the Riverbank site.

**King's Norton.**—A special Electric Lighting committee has been constituted to report upon the carrying out of the terms of the Council's provisional order.

**Lambeth (London).**—The relations between the new Borough Council and the South London Electric Supply Corporation are strained, owing to the question of refuse destruction. It will be remembered that when the company took over the Lambeth provisional order they undertook also to erect a refuse destructor and to destroy the refuse of the parish. The company were recently summoned for causing a nuisance at the refuse destructor works, and the magistrate laid it down that the burning of house refuse was not necessary for generating electricity, and insisted that Welsh coal should be used. Thereupon the South London Corporation notified that they would take no further deliveries of dust. Since that decision, the borough surveyor has had to provide for the refuse being taken away by barges on the Thames, and the company, in reply to a reminder that they are liable for penalties for non-fulfilment of their contract, wrote to the Borough Council pointing out that it was the Vestry that induced the magistrate to prevent the further use of the destructor, and thus, by its own act, put it out of the power of the corporation to carry out its contract. The company further insist that the Borough Council must now itself deal with the dust, and, moreover, compensate the corporation for depriving it of the use of dust as a fuel. Last week, however, the Wharf and Cleansing committee recommended that proceedings be taken against the corporation for the non-fulfilment of the contract, and this was agreed to.

**Leek.**—The Electric Lighting committee has appointed a sub-committee to report on the question of erecting joint electricity and refuse destructor works, and to obtain information as to gas-driven generating plant.

**Lincoln.**—The city electrical engineer (Mr. C. S. Vesey Brown) has been instructed to report as to the cost of constructing and working electric tramways along certain routes in the city. A sub-committee has also been appointed to report upon a municipal telephone exchange.

**Light Railways.**—The County Councils Association last week referred the questions of the administration of the Light Railways and Tramways Acts and the desirability of a uniform gauge being prescribed for light railways and tramways to their Parliamentary committee.

The following applications for light railway orders have been lodged :—

T. D. Lingard, A. L. Ormrod and T. S. Turnbull (for West Cumberland); T. Pollock and J. P. Bedson (for South Hayling, Hants.); Crewe Corporation (Extensions); Easington and Ashmore Light Railways Co. (Extensions and Amendment); Lancashire Light Railway Co. (for Bolton, Turton and Darwen); O. W. Bowen (to construct a light railway from Canterbury to Whitstable and Herne Bay); and Bath Corporation, Sir J. Sivewright and L. Hirsch (Extensions of Bath Light Railways) ;

**London County Council.**—At Tuesday's meeting Mr. Yates asked whether the Highways committee had seen letters in the Press with regard to the alleged vibration of houses arising from the deep tube railways, and, if so, was it possible to oppose such railways in the future in the interests of householders of premises under which such railways would pass. Mr. Benn said the Council had certain powers, but he did not know whether they applied to deep tube railways. A report on the matter should be prepared.

**London United Tramways.**—Mr. J. Clifton Robinson, C.E., managing director and engineer to the London United Tramways (Ltd.), has addressed an "open letter" to the local authorities of Fulham, Hammersmith, Kensington, Paddington, St. Pancras, Wandsworth, Richmond, Barnes, Esher, the Dittons, and other districts concerned in the question of electric traction within the London County Council area. The object of this "open letter" is to bring prominently and popularly before these local authorities the advantages of electric traction in particular, with especial reference to the question of whether this public need shall be supplied by the London United Tramways Company or by the London County Council. Illustrations showing a number of views of electric traction installations in various parts of the world are given, and a coloured map of the electric tramways and proposed extensions to come before Parliament in the session 1901 in which the London United Tramways (Ltd.) are interested.

**Maidstone.**—Sanction to a loan of £34,565 for electric lighting has been received by the Council.

**Malta.**—The government-owned electricity supply works at Malta provide, current chiefly for the military and civil authorities, outside consumers numbering only 84. The total capacity of the station is 575kw., and at Oct. 31, the equivalent 8 c.p. lamps connected was 11,632.

The telephone at Malta is owned by the Melita Telephone Exchange. The system has about 220 subscribers on its one exchange.

There is an opening here for cables for house wiring, lamp shades, lamp holders, switches, carbons, brackets, fan motors, arc lamps and ship fittings, for 80 volts to 110 volts.

**Manchester.**—In proposing the minutes of the Electricity committee at the Council meeting on Wednesday the chairman (Dr. Bishop) moved that a joint sub-committee consisting of representatives of the Electricity and Tramways committees be authorised to make final arrangements under corporate seal with the engineer who may be selected to advise the Electricity and Tramways committees as to the supply of electric energy, and to carry out existing contracts and works in progress and in contemplation. He said it was not very likely those works would be carried on without interruption during the coming winter, and the Bloom-street works would not be in a position to supply current for the tramways till next autumn. The sub-committees of the electricity and tramways departments had met and resolved that the best way of meeting the situation was to call in the aid of an expert, who would have the confidence of both committees, and who would undertake the completion of the generating works at the earliest possible moment. That position was practically forced upon them, because the committee had received several resignations of officials during the past few weeks. First there was the resignation of Mr. Wordingham himself, the chief of the department. Perhaps it would not be absolutely correct to use the word resignation, but Mr. Wordingham had sent a letter to the committee stating that he did not desire his agreement with the Corporation to be renewed, which was practically the same thing. That letter was accepted by the committee. Then a short time ago they received the resignation of the second engineer, who had been appointed as chief engineer at Bolton. This was followed by the resignation of the mains superintendent, which would take effect on Dec. 31. Altogether the circumstances were peculiar and urgent, and the special sub-committee felt that the only proper way out of the difficulty was to appoint an expert. The sub-committee had interviewed a number of gentlemen whose names were placed before them, but he was not in a position to say that one had been appointed or asked to take up the duties. They thought, however, they might be able to make a selection in a week or two.

Ald. Gibson said he did not quite understand why there should be so much hurry. There seemed to be a feeling that they were on the brink of an abyss. Mr. Wordingham was not going till March. Had anything happened to prevent Mr. Wordingham carrying out the work as he had carried it out before. Could anyone say a word derogatory to Mr. Wordingham's honesty, uprightness or fitness?

At the request of Mr. Lambert the following letter sent by Mr. Wordingham was read :—

As you are doubtless aware, in March, 1897, I entered into an agreement with the Corporation to remain as their electrical adviser for a minimum period of four years from that time. This period expires on March 31 next, and if I desire my engagement to then cease, I have, under my agreement, to give you notice to this effect on Dec. 31, 1900. I am not disposed to continue in the service of the Corporation, and I advise you of this now instead of waiting till December, in order to give you more time in which to make your arrangements. I have managed your undertaking for a period of seven years, and it is only necessary to refer to the published accounts of the department to see that the commercial results have been conspicuously successful, while the undertaking has attained such magnitude as to eclipse that of all others in the country. There are, however, at the present time a number of insinuations being made, both in the public press and elsewhere, to the effect that there is something faulty in the management of the department, but whether these allegations are against me personally or against the committee itself I am unable to ascertain. Having in view the services that I have rendered to the Corporation, I think I have a right, especially having regard to the fact that I do not intend to continue my engagement with them, to ask that if the committee have any allegations of any kind to make against me they should definitely state what those allegations are, and give me an opportunity of replying to them. I am not conscious of anything whatever amiss, and if anything definitely is alleged I am confident that I can disprove it, but a vague insinuation no one can meet.

Mr. Lambert said Mr. Wordingham had served the city faithfully for seven years, and he now declined to remain in the service of the Corporation after March 31 while certain insinuations were hanging over his head which had not been brought to any direct charge which he could answer or remove. No one having any regard for his position and reputation could remain in the service of the Corporation without its being stated clearly that there was no reflection upon him and no insinuations made which were not withdrawn. He understood Mr. Wordingham had had no reply to his letter except a formal acknowledgment of it, and no statement had been made to him as to whether these insinuations were persevered in or withdrawn, and no letter had been written to say whether any personal charge was intended to be made against him reflecting upon his capacity, his ability, his integrity, or his honour. That being so, it surely could not be a matter of surprise that Mr. Wordingham should say he did not intend to continue in the service of the Corporation unless these insinuations and charges were withdrawn. Two reports prepared by Mr. Wordingham had not been communicated to the members of the Council, although their substance had appeared in the press.

Dr. Bishop said the reports in question had not yet been considered by the General committee, because there had been no meeting since they were presented.

Mr. Lambert said the information contained in those reports should be in the possession of every member of the Council before they voted upon the proceedings of the committee. Those reports would convince every member of the Council that Mr. Wordingham, who had designed the scheme and carried it out for seven years, was quite as capable of carrying it out to its conclusion as any expert from either Glasgow or America, or anywhere else. He believed Mr. Wordingham would be perfectly willing, and would, indeed, be anxious, for the sake of his own reputation, to carry out and complete the work so long as he was treated in a proper manner and no insinuations made against him of improper conduct. He moved, as an amendment, that the resolution appointing the sub committee be altered, and that instead of the words "that they be empowered to act" the words "and to report thereon" be substituted.

Mr. Wilson said with regard to Mr. Lambert's statement that Mr. Wordingham would be willing to continue his service if he were approached in a proper manner, no suggestion of that kind had been made either in the Tramways or the Electricity committee.

Mr. Boyle said the insinuations referred to in the letter existed, he believed, only in Mr. Wordingham's own imagination. No one, so far as he knew, either in the Electricity or the Tramways committee had ever framed any charge. The only charge was in so far as the report of the special committee that had been appointed by the Electricity committee to inquire into the administration of the department reflected upon him.

Ald. Hopkinson asked the Council not to create a precedent by giving to a committee, much less a sub-committee, authority to appoint an important officer of the Corporation.

It was ultimately resolved that consideration of the question be deferred for a fortnight, that the information asked for by Mr. Lambert be furnished to members of the Council in the meantime, and that the Electricity committee then bring forward a recommendation as to appointing an expert.

Formal notice is to be served on the Manchester Tramways and Carriage Co. to sell so much of their tramway undertaking, authorised by the Company's Act of 1880, as is within the city of Manchester.

**Mica.**—A valuable discovery of mica has been made in the Uluguru mountains, to the West of Dar-es-Salaam (German East Africa).

**Monmouthshire.**—At an adjourned conference of delegates of West Monmouth local authorities on Monday it was decided to recommend the Abercarn and Risca District Councils to engage an expert to report upon the erection of joint electricity works for the two districts.

**Montrose.**—Edmundson's Electricity Corporation have notified the Burgh Commission of intention to start laying cables and mains in connection with the electricity supply scheme for the district.

**Municipal Telephony.**—The Hull Special Telephone committee are proceeding with their municipal telephone scheme, and are offering a service upon the alternative terms of—(1) £6. 6s. per annum, payable in advance, to cover an unlimited number of calls; or (2) £3. 10s. per annum, payable in advance, and 1d. for each call originated by the subscriber.

On Monday a deputation waited upon the Lord Mayor of Manchester (Mr. T. Briggs) in regard to the telephone question and the granting of a licence to the Mutual Telephone Co. A memorial urged that the Mutual Company was in a better position for giving a satisfactory service than the Corporation. It was asked that the Corporation should now comply with the only condition necessary for the company to obtain a licence, which was by confirming their resolutions in support of the licence passed in 1897. Mr. Scott said a full licence for the district could now be obtained by the Mutual Company if the support of the Manchester Corporation were given. The Lord Mayor said he would submit the memorial to the Council at the first opportunity. With regard to the Manchester Corporation taking the telephone service, he must say that, what with electricity and tramways, the Corporation had quite enough work in hand.

**Oldham.**—Sanction to the borrowing of £280,000 for electric tramway purposes has been received by the Corporation.

**Outward and Homeward Mails.**—The Peninsular and Oriental Steam Navigation Co. are distributing an attractive hanging list of the dates of the outward and homeward mails to and from the East for the year 1901. A fine view of the company's ss. "Persia" is shown.

**Parliamentary Notices.**—We conclude this week the particulars of applications for parliamentary powers for electric light and traction. Though the notices are not quite so numerous as last year, from the point of view of the magnitude of the proposed undertakings, they are more important. There is, however, an increase in the number of bills, special features being the number of applications to construct underground electric railways in London and the number of schemes for the supply of electricity in bulk. In addition many local authorities already engaged in electricity supply seek powers to extend their area of supply, to let motors and fittings on hire, &c., and thus extend the scope of their activity. Another novelty is the combination of local authorities to obtain parliamentary powers to supply electricity in their districts. Some doubts have been expressed as to the legality of this departure, and doubtless it will lead to a good deal of discussion in Parliament. We may also call attention to the number of gas companies which seek powers to supply electricity.

*Electric Lighting.*—The Crieff, Falkirk, Galashiels, Gourock and Oban Burgh Commissioners, the Macclesfield, and Stratford-upon-Avon Corporations, the Ashton-in-Makerfield, Aspull, Birstall, Briton Ferry, Cheshunt, Dungannon (Ireland), Ince, Kildare (Ireland), Mountain Ash, Ince-in-Makerfield, New Hunstanton, and Skipton District Councils; and also the Lewisham and District Electricity Supply Co. (for Lewisham and Penge) and Messrs. Crompton and Co. (for Dalkeith, Dollar, Jedburgh and Melrose, N.B.) have given notice to apply for provisional orders.

The Shannon water scheme has also been revived and the necessary plans, &c., of the new Bill have been lodged. It is now proposed to construct a weir across the Shannon, commencing in Errine, parish of Kilteraloe, county of Clare, on the western bank of the Shannon, at a point about 1,235 yards from the centre of the canal where it joins the Shannon.

*Electric Traction.*—The Colchester, Northampton, and Ashton-under-Lyne Corporations and the Denton District Councils are applying for provisional orders.

**Patents and Trade Marks at Pretoria.**—The following Government notice has been issued at Pretoria, dated Oct. 22, 1900:—

By virtue of the authority committed to me, I hereby give notice that from and after this date applications for patents can be registered with Mr. C. W. Thalman B. Juta, in the Government Buildings, until such time as the Patent Office shall be opened. Registration as above, if documents are in order, will grant protection; but the statutory time of protection will only begin to run from the date of the reopening of the Patent Office. Applicants are cautioned that they must see that all formalities, except as modified herein, of the Patent Law No. 10 of 1893, are complied with, and papers will not be returned to applicants by the registrar in order to correct mistakes. The applications for the present may be in English or Dutch, and legalisation will not be necessary until reopening of the Patent Office. The order of registration will be the order of priority. Applications for trade marks may also be registered under similar conditions with Mr Juta.—J. G. MAXWELL, Military Governor.

**Pemberton.**—Application has been made to borrow £20,000 for electric lighting.

**Presentation.**—Mr. A. S. Dunn, late telegraph superintendent of the Caledonian Railway Co., has been presented by Her Majesty the Queen with a beautiful silver ink-stand enclosed in a morocco case, with inscription as follows: "Presented to Mr. A. S. Dunn by Queen Victoria; November, 1900." The presentation has been made as a mark of Her Majesty's appreciation of the attentive personal service rendered by Mr. Dunn when travelling in Her Majesty's train to and from Balmoral.

**Rosario de Santa Fé (Argentine Republic).**—A correspondent informs us that the whole of the present horse service of traction in this city is in an extremely poor and unsatisfactory condition, and that electric tramways are badly needed. He expresses the view that a new concession for electric traction could be readily obtained from the municipality.

The Cia. Luz Electrica y Traccion de Rio de La Plata has an equivalent of 12,000 8 c.p. lamps installed with 440 consumers. The plant is steam-driven, with overhead distribution.

As it is probable that a direct current 24-hour service will shortly be installed here, there will be an opening for fans, small motors, and general electrical accessories and sundries for 220 volts. At present German and American goods are chiefly on the markets of the Republic.

**Russia.**—The Elektricitäts Actien Gesellschaft vormals W. Lahmeyer & Co., of Frankfort-on-Main, inform us that they have acquired the electrical department of their agent in Moscow (Herr Ph. J. Rosenthal), and have formed a subsidiary company for Russia entitled the "Elektricitäts Actien Gesellschaft vorm. W. Lahmeyer & Co. Abtheilung für Russland," of which Herr Rosenthal will act as manager.

**Ryde (Isle of Wight).**—The members of the Ryde Town Council have succeeded in placing themselves in a peculiar position. A provisional order, without the usual transfer clause, was obtained in 1899, and the Electric Lighting committee recently recommended that steps be taken to establish electricity works in accordance with the terms of the order and that the consulting engineers (Messrs. Kincaid, Waller and Manville) be authorised to prepare plans and specifications. This recommendation was, however, rejected, and in the absence of a transfer clause, the Council are reduced to the necessity of advertising as follows:

The authority will be obliged for any information from any local authority who, having obtained a provisional order without a transfer clause, have made any and what arrangements with a company to carry out the works.

**St. Helens.**—The borough electrical engineer (Mr. J. S. Highfield) reported to the Council on Wednesday that the equivalent number of 8 c.p. lamps connected on Oct. 31 was 17,419.

**St. Pancras (London).**—The question of obtaining powers for wiring premises and supplying fittings, &c., on hire was discussed by the Borough Council last week, and referred to the Parliamentary committee for report.

The electrical engineer (Mr. Sydney W. Baynes) reported that it was important the electricity department should commence early in the spring laying additional feeding mains into the King's Cross, Highgate road and Prince of Wales-road districts, which practically meant an increase of all the feeding mains to the portions of the parish controlled by the King's-road generating station. The probable lighting in each district covered by the feeders recommended had been carefully estimated, and the new feeders proposed would be proportioned to deal with about one-half of the ultimate load. The extensions would probably serve the Council for five years, when it would be necessary to readjust them. By Christmas the engineer anticipated they would have reached the maximum that they could deal with through the existing mains, both to Highgate and King's Cross. He estimated the total cost to be £29,399. The matter was referred to the Finance committee.

**Saltburn.**—The Council have decided not to proceed further with the proposal to acquire the electric lighting undertaking of the Cleveland and South Durham Assets Co. on the ground that the value placed upon the works by the company (£8,000) is too high.

**Southampton.**—An inquiry will shortly be held into the Council's application to borrow £12,000 for electric lighting.

**Southport.**—The Markets-Ash-street electric tramway route was opened for traffic on Monday.

**South Shields.**—The Electric Lighting committee recommend that the salary of the borough electrical engineer (Mr. Joseph A. Jeckell) be increased from £350 to £400 per annum.

**Stockport.**—The Tramways committee hope to have the electric tramways working by May. The Chairman (Ald. Giles Atherton) stated at the Council meeting on Wednesday that contracts had been let for cars and for construction and equipment of 4½ miles of double and single lines. Arrangements had been made with neighbouring local authorities permitting of a continuous service between Stockport and Hyde, through Bredbury, Woodley, and Gee Cross; and there would be an alternative route back to Stockport via Denton,

Gorton, and Reddish over the Manchester system, joining the Stockport system at Reddish.

**Sunderland.**—The first accident in connection with the electric tramways occurred on Saturday last when a telephone wire which crosses North Bridge-street broke and fell across the trolley wire. Except at this point, which is near the Wheatsheaf Junction, there are guard wires, and these terminate on one side some 20 yards from where the accident happened. The broken telephone wire therefore touched the trolley wire, and hung to the ground. A horse in a van came along, trod on the wire, and received a shock which apparently stunned it, and it fell to the ground with the wire underneath it, and in a moment or two it was dead. The driver said that when his horse first touched the wire he received a shock, and when he attempted to remove it with his whip he received another. The telephone wires at Sunderland are being rapidly placed underground.

**Swansea.**—It was reported, on Wednesday, that the equivalent of 5,115 8 c.p. lamps had already been connected with the mains, and extensions in College and Goat streets were authorised. A representative of the National Electric Wiring Co. is to meet the Electric Lighting committee and discuss a draft agreement providing for the wiring of premises in the district on the easy payment system.

**Vera Cruz (Mexico).**—The tramways of this city are to be re-laid and considerably extended. The existing tramways are to be converted to electric power, and the extensions will be electric, on the overhead system.

**Village Lighting.**—Last week a deputation from Reedley Hallows Parish Council waited upon the Burnley Rural Council in regard to the proposed electric lighting of Reedley Hallows. It was explained that the Parish Council wished the District Council to apply for a provisional electric lighting order, as they could not get satisfactory terms from Burnley Corporation. The consideration of the matter was adjourned for a month in order to ascertain the probable demand for current in the parish.

**Western Australia.**—The electric lighting industry in Perth is going ahead rapidly. The original plant has been dispensed with and the most modern machinery substituted. There are already small Lundell motors installed equal to nearly 80 H.P. The system of supply is three-wire continuous with overhead cables. The equivalent of 20,000 8 c.p. lamps were connected on Oct. 1, 550 consumers being on the books. The station plant includes six Willans engines, aggregating 650 H.P., coupled to shunt-wound Castle dynamos. There were 350,000 units of current sold last year, and a profit made of £5,000. The price per kilowatt hour for lighting is from 10d. to 8d., and for power from 8d. to 4d. A reduction in these charges is about to be made. The supply is at present in the hands of the Perth Gas Co., who are threatened with competition from the Perth Electric Tramway Co., who started running in October with 12½ miles of single track to a 4ft. 6in. gauge. The Tramway Company's power-house equipment consists of two 250 H.P. horizontal steam engines, made in Nova Scotia, and Babcock and Wilcox boilers. Two G.E. four-pole generators are coupled to the engines.

Electric lighting and electric tramways are about to be inaugurated at Freemantle, while Coolgardie, 400 miles distant, has already a company supplying current for lighting. At Boulder City there is a small lighting plant running, to which additions are about to be made.

At Kalgoorlie there is already an up-to-date plant installed by the local Council and this is, at the present time, being considerably increased. There is also an extensive supply scheme about to be inaugurated for supplying the mines in this extensive district "in bulk."* Nearly all the larger mines here have their own steam plant, and some go in for electric transmission, but it is anticipated that the more ambitious scheme mentioned above will result in power being taken generally from this source, and the abandonment of the smaller isolated power transmission installations.

**West Hartlepool.**—An inquiry was held here last week into the application of the Council to borrow £19,625 for electric lighting. Of this sum £9,182 was for excess of actual cost of work over estimate, owing partly to the considerable extension of the buildings and plant following the arrangement with the Tramway Company to supply current, and partly to the rise in the price of materials since the estimate was made; £7,112 was for extension of mains due to increased demand; £2,707 for probable extensions during the next 12 months: and £625 for additional arc lamps. There was no opposition.

**Walsall.**—The Council will be recommended on Monday to affix its seal to the conveyance from the South Staffordshire Tramways Co. to the Corporation of the tramways undertaking in the borough, and also to a lease of the lines to the South Staffordshire Tramways (Lessee) Co. The Tramways committee will also recommend that the duty of repairing and maintaining the tramways be added to the borough surveyor's department, and that the necessary plant and material be purchased, at an estimated cost of £1,000; also that certain tramways be laid down and equipped by the Council. It is proposed that the borough surveyor (Mr. Middleton) and the electrical engineer (Mr. A. Wyllie) prepare the necessary specifications, estimates of cost, &c.

* See abstract of report of Kalgoorlie Electric Power and Lighting Corporation, on p. 260.

**Wigan.**—The chairman of the Electric Lighting committee (Mr. Worthington) announced at the Corporation meeting on Wednesday that by the end of next week they hoped to be in a position to meet all demands for electric current.

**Willesden.**—At a meeting of ratepayers the Council's electric lighting and tramway proposals was outvoted, but it was decided to take a poll of the ratepayers on the question. At a meeting of the Council on Tuesday the electrical engineer (Mr. E. T. Ruthven Murray) replied to the criticisms passed on his scheme at the public meeting, and full confidence was expressed in it by members of the Council.

**Worcester.**—The Electric Light committee on Tuesday considered the applications for the position of mains superintendent, but in view of the re-arrangement of the staff of the electricity department to be made in January, the matter was adjourned.

**Worthing.**—The question of constructing electric tramways is engaging the attention of the Electric Lighting committee.

**York.**—An inquiry was held here on Tuesday into the application of the Corporation to borrow, among other sums, £20,000 for electric lighting, £2,387 being for excess expenditure on the original scheme, and £17,613 for extensions. The town clerk (Mr. W. H. Andrew) said the estimated expenditure on the original scheme was £20,000, which was to provide plant for the supply of current to the equivalent of 6,000 8 c.p. lamps. The supply was commenced on April 1, 1900, and since then there had been such an enormous demand for current that they had now an equivalent of 18,000 8 c.p. lamps applied for. To meet this exceptional demand, the Electric Lighting committee had to provide extra plant for the present winter season, and were also providing for the winter of 1901-2. The city electrical engineer (Mr. C. A. Midgley) supplied technical information.

## TRADE NOTES AND NOTICES.

*[Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.]*

### TENDERS INVITED.

*Extension of Time.*—The time for the delivery of tenders for the plant required by the Tramways committee of the burgh of Ayr has been extended to Friday Dec. 14. See advertisement.

*Oldham* Electricity committee require tenders for an ejector-condenser and two motor-driven circulating pumps. Specification, &c., can be obtained from the superintendent (Mr. A. Andrew), Gas and Water Offices, Oldham, and specifications and drawings can also be seen at (but not obtained from) the office of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, Westminster, S.W. An advertisement gives further particulars, and tenders must be sent to Mr. Andrew by Dec. 18.

The Visitors' committee for the County Asylum, *Winwick*, near Warrington, require tenders for wiring and fittings, &c. Specification may be obtained at the offices of the architects, Messrs. Crisp and Oatley and Mr. W. S. Skinner, Edinburgh Chambers, Baldwin-street, Bristol; and also from the clerk to the committee (Mr. J. P. Muspratt), County Offices, Preston, where tenders must be lodged by noon of Dec. 29. An advertisement gives further particulars.

As announced in an advertisement, the *Rathmines* District Council require tenders for boiler-house and engine-house plant, condensing apparatus and pipework, switchboard extension, mains, and public incandescent lighting. Specification may be obtained (by manufacturers) at the offices of the consulting engineer (Mr. Robt. Hammond), 64, Victoria-street, Westminster, London, S.W., after Dec. 6. Tenders, addressed to the clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, Co. Dublin, must be delivered by 4 p.m., Jan. 10.

*Middleton* Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves and accessories for their electricity works. Specifications may be obtained at the offices of the consulting engineers Messrs. Lacey, Clirehugh and Sillar), 78, King-street, Manchester, and tenders must be delivered at the offices of the town clerk (Mr. Frederick Entwistle), Town Hall, Middleton, by Jan. 2. An advertisement contains further particulars.

*Brighton* Corporation require tenders for unarmoured and armoured lead-covered electric cables for the year ended Dec. 31, 1901. Specifications may be obtained from the office of the town clerk

(Mr. F. J. Tillstone), Town Hall, Brighton, where tenders must be lodged by 10 a.m. 24th inst. An advertisement gives further particulars.

*St. Pancras* (London) Guardians require tenders for wiring their Cook's-terrace Infirmary. Further particulars are given in an advertisement, and tenders must be sent to the clerk (Mr. Alfred A. Millward), Town Hall, Pancras-road, London, N.W., before 3 p.m., Dec. 20.

*Worthing* Corporation require tenders for the supply and erection of a main switchboard. Specifications can be obtained from the consulting engineers (Messrs. Burstall and Monkhouse), 14, Old Queen-street, Westminster, S.W., and tenders must be sent to the town clerk (Mr. W. Verrall) by noon Dec. 31. An advertisement contains further particulars.

The directors of the *Highland Railway* require tenders for various stores for six months from Jan. 1, 1901, including brass and copper plates, sheets, bars, copper and brass tubes, steel and iron castings, galvanised wire, &c. Tenders to secretary (Mr. Wm. Gowenlock) by Dec. 12.

The directors of the *Caledonian Railway Co.* invite tenders for various stores for six or 12 months from Feb. 1, 1901, including telegraph and electrical appliances, &c. Tenders to secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by Dec. 17.

The directors of the *North Eastern Railway Co.* invite tenders for telegraph apparatus, telegraph wire and line stores for the six months ending June 30, 1901. Tenders to secretary (Mr. C. N. Wilkinson), York, by noon of Dec. 10.

*Ilford* School Board invite tenders for wiring and fitting (for about 200 16 c.p. lamps) their Melbourne-road Higher Grade School. Tenders to clerk (Mr. W. J. Rendall Moore), Cleveland-road, Ilford, by 4 p.m., Dec. 17.

*Portsmouth* Corporation invite tenders for permanent way construction and underground feeders in connection with their electric tramways. Tenders to town clerk, Town Hall, Portsmouth, by 10 a.m. Dec. 7.

*Glasgow* Corporation require tenders for asbestos covering for boilers and steam pipes at the St. Andrew's and Kelvinside electricity works. Tenders by 10th inst.

*Worthing* Council require tenders for steel roof trusses, cast-iron columns, wrought-iron windows and doors, &c., for their electricity works. Tenders by Dec. 17.

*Aberdeen* Electric Lighting committee invite tenders for storage batteries. Tenders to city electrical engineer (Mr. J. Alex. Bell) by Dec. 22.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal-buildings, Lavender-hill, S.W., before noon Feb. 1 next.

*Bristol* electrical commiteee require tenders for induced draught plant, steam, electric, feed and general service pumps and water-softening plant. Tenders by noon of Dec. 20.

*Swindon* Corporation invite tenders for three steam dynamos, balancer, and motor generator. Tenders to acting town clerk by Dec. 24.

*Bexhill* District Council require a water-tube boiler and pipework and a 150kw. steam dynamo. Tenders to clerk (Mr. E. Sholto Douglas), before noon Dec. 10.

*Wakefield* Corporation require tenders for a 550 H.P. steam engine and a 400kw. direct-driven alternator. Tenders to town clerk before Dec. 14.

*Hendon* District Council invite tenders for electricity generating plant and apparatus. Tenders to Clerk, Public Offices, The Burroughs, Hendon, by 4 p.m. Dec. 31.

*Blackpool* Corporation require arc lamp carbons and oils for one year. Tenders to Borough Electrical and Tramways Engineer by Dec. 17.

*Portsmouth* Corporation also require tenders for overhead electrical equipment of tramways. Tenders by 10 a.m. Dec. 7.

*Fulham* (London) Guardians require tenders for wiring the Children's Home. Tenders to clerk by 10 a.m. Dec. 20.

The *Metropolitan Asylums Board* require tenders for wiring the new asylum at Tooting Bec. Tenders by Jan. 2.

*Reigate* Corporation require electricity meters. Tenders by Dec. 19.

*Leigh* Corporation require mains, motors and starting switches, and about 1,000 220-volt incandescent lamps. Tenders by Dec. 17.

Tenders are invited until 10th inst., by *Jumet* (Belgium) Municipal authorities, for a battery of accumulators of 450 ampere-hours capacity. Tenders to le Bourgmestre.

French Post and Telegraph authorities invite tenders until 21st inst. for the supply of 583 tons of copper wire. Tenders to le Sous Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

The Direccion General de Obras Publicas, *Madrid*, require tenders for constructing and working an electric tramway in Barcelona between Casa Gomis and Los Josefets, with a branch line to Bonanova.

*Seraing* (Belgium) Municipal Council invite tenders until 22nd inst. for the concession for an electric tramway between Val Saint Lambert and La Chatquene.

## TENDERS RECEIVED AND ACCEPTED.

The Mexborough District Council have accepted the following tenders for electricity-generating plant, subject to obtaining borrowing powers :

| | | | |
|---|---|---|---|
| Callender's Co. (mains) | £5,585 | 5 | 2 |
| Mavor and Coulson (two 50kw. steam dynamos, balancer, and boosters, feed-water heater, and feed pump) | 1,785 | 14 | 0 |
| Ashmore, Benson, Pease & Co. (storage battery) | 1,050 | 0 | 0 |
| Tinkers Limited (Lancashire boiler) | 552 | 0 | 0 |
| B. Thomas (switchboard and connections) and 3s. 7d. per yard for battery connections. | 355 | 0 | 0 |
| Chatteris Engineering Co. (5 ton hand travelling crane) | 127 | 10 | 0 |

The contract for adapting public street lamps from gas to incandescent electric has not yet been let.

The directors of the Metropolitan and Metropolitan and District Railway Companies met on Monday for the purpose of opening the tenders submitted for electrically equipping the underground railway. It is stated that among the tenderers were Messrs. Mather and Platt, Crompton & Co., Thomas Parker (Ltd.), Dick, Kerr & Co., the Brush Company, the British Westinghouse Company, and the British Thomson-Houston Company. Tenders were also submitted by the Allgemeine Elektricitats Gesellschaft and the Siemens and Halske Actien Gesellschaft of Berlin, the Elektricitats Actien Gesellschaft vorm. Schuckert & Co. (Nuremburg), and Felten and Guilleaume Carlswerk A.-G., Mulheim, Germany. Two French tenders, from the Breguet Maison and MM. Houtin & Leblanc, of Paris, were also submitted.

Aberdeen Corporation have accepted the tender of Messrs. Mavor and Coulson for the supply of two 200kw. direct-coupled continuous-current generators, and a 120kw. balancing-set, and (as announced in our last issue) the tender of the Johnson Lundell Electric Traction Co. has been accepted for a 120kw. direct coupled continuous current generator.

Bootle Corporation received 65 quotations for a steam dynamo, and the Electric Light committee have decided to accept the tender of the Electric Construction Co. for an E.C.C. dynamo and Belliss triple-expansion engine at £2,263.

Swansea Corporation have decided to obtain their electricity meters from the General Electric Co. and the British Electric Meter Co., and the borough electrical engineer (Mr. J. H. Cawthra) has been authorised to purchase 50 meters from either of these firms.

Contracts have been placed with Messrs. Mather and Platt for the supply and erection of Archbutt-Deeley water-softening plant by the Electrical Power Distribution Co. for their Sutton electricity works, and by Messrs. Albright and Wilson, chemical manufacturers, Oldbury, near Birmingham.

The tender of Mr. W. Coles has been accepted for wiring the Swansea electricity works at £326.

The Colchester Corporation have accepted the tender of the Klein Engineering Co. for two coolers for the electricity works at £772.

Tenders were recently invited by the Imperial Russian Post and Telegraph Department for taking over the telephone service in St. Petersburg, Moscow, Warsaw, Odessa, and Riga, where the concession of the Bell Company is about to expire. In St. Petersburg the municipality submitted the lowest tenders, offering to give a service at an annual charge of 55 roubles. At Moscow the Swedish-Russian Telephone Co., with a subscription fee of 79 roubles, and at Warsaw the Sverddergren Company with 69 roubles were the successful tenderers. At Odessa Mr. Raffalovitsch proposed a price of 48 roubles, and at Riga the lowest tender was 57 roubles, offered by Messrs. Rukkert & Co. These tenders await confirmation by the Minister of the Interior.

## BUSINESS NOTICES.

Messrs. Nalder Bros. and Thompson (Ltd.), 34, Queen-street, London, E.C., write as follows :—

Notice has recently been published of a report of the liquidator of Nalder Bros. & Co. Ltd., who are winding up voluntarily. As some misapprehension may possibly arise owing to the somewhat similar name, we wish to point out that this in no way affects our business, which was purchased some four years ago from Nalder Bros. & Co., Nalder Bros. & Co. (Ltd.) being of later formation.

The notice referred to did not appear in our columns.

After the 25th inst. the Consolidated Telephone Construction and Manufacturing Co. (Ltd.) will remove to larger and more commodious premises at Members-mansions, 38, Victoria-street, London, S.W., which will be the address also of the Anglo-Portuguese Telephone Co. (Ltd.), and of the Edison-Gower-Bell Telephone Co. of Europe (Ltd.).

J. T. Niblett, M. Sutherland, and E. Marcuson (trading as Niblett, Sutherland and Marcuson), electrical engineers, 61, Chandos-street, London, W.C., have dissolved partnership.

### BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against A. W. Hirst (trading as Hirst & Co.), electrical engineer, St. Michael's-road, West Croydon, must be in by Dec. 21. Mr. A. Mackintosh, 24, Railway-approach, London Bridge, is trustee.

The Nuneaton Electric Co. (Ltd.) is to be wound up voluntarily in consequence of the sale of its undertaking to the District Council. Mr. H. B. Harris, solicitor, Nuneaton, is liquidator.

**Plant for Sale.**—The Leeds Lighting committee will receive tenders for electricity generating plant, including two 2,000 B.H.P. engines, two two-phase 1,400kw. alternators and exciter, and two sets of surface condensing plant. Further particulars are given in an advertisement, and conditions may be obtained from the manager of the department (Mr. Harold Dickinson), 1, Whitehall-road, Leeds. Tenders to the town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Dec. 31.

The Leeds Corporation also require tenders for the purchase of plant at present in use in connection with their system of electric tramways, particulars of which are set out in an advertisement. The plant will be available for removal about February next. Further particulars can be obtained of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W. Tenders should be sent to the Town Clerk's Office, Town Hall, Leeds.

Messrs. A. Verey & Co., Dover, advertise in another column some direct-current electric motors for sale.

**Electrical and Scientific Novelties.**—Mr. Archibald J. Wright, of the Islington Electrical Works, 318, Upper-street, London, N., has just prepared and published a new list of electrical, mechanical, and scientific novelties which dealers can obtain on application. These include pocket accumulators in transparent cases, allowing the condition of plates and amount of liquid to be seen at a glance; electric jewellery and flowers, small hand dynamos, pocket hand lamps, small electric launches, pocket galvanometers, electric alarm clocks, and a number of articles specially suitable for Christmas trade in the form of instructive mechanical and electrical apparatus.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Nov. 28 to Dec. 4, with the ports of destination:—

*Africa*—Alexandria, £1,342; Cape Town, £491 (including £82 telegraph apparatus); Durban, £321; East London, £346 (telegraph material); Port Elizabeth, £100. *Argentina*—Buenos Ayres, £59. *Australasia*—Christchurch, £56; Fremantle, £33; Hobart, £22; Melbourne, £2,101 (including £1,569 telegraph material); Port Chalmers, £65; Sydney, £3,680; Wellington, £1,013. *Belgium*—Ostend, £604. *Brazil*—Rio Janeiro, £50. *British Guiana*—Demerara, £996 (telegraph material). *Burma*—Rangoon, £60. *Canada*—Halifax, £164 telegraph paper). *Denmark*—Copenhagen, £122 (including £109 telegraph wire) *Germany*—Hamburg, £645 (telegraph material). *Holland*—Amsterdam, £40. *Hong Kong*, £150. *India*—Bombay, £252; Calcutta, £790. *Italy*—Genoa, £30 (telegraph material); Leghorn £81 (telegraph material). *Japan*—Hiogo, £79 (including £66 telegraph material); Kobe, £4,818 (telegraph material). *Malta*, £21. *Russia*—Kuro, £200. *Straits Settlements*—Penang, £65 (telegraph material). *Sweden*—Gothenburg, £22 (telegraph wire). Total £17,918, against £9,601 in the corresponding week last year (Nov. 29 to Dec. 5).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

September 21, 1900.

18,980. Crehore and Squier. Telegraphic apparatus.
19,818. Best. Construction of wicks for oil lamps which are electrically lighted.
20,572. Oppenheimer (Actiengesellschaft, Mix and Genest.) Air and water-tight telegraph transmitter keys for use in mines and other exposed places.
22,020. Thompson (Braun). Telegraphy without the use of continuous wires.
24,297. Relin and Rosier. Electric accumulators.

September 22, 1900.

16,865. D. P. Regan. Glasgow. Improvements in and relating to devices for carrying electric cables, wires, and the like.
16,881. S. G. Brown. London. Improvements in wireless telegraphy and telephony.
16,896. J. G. Davidson and J. Don. Peterhead. Electrical fittings for discharging cisterns.
16,898. G. C. Shankster. Portsmouth. Improvements in apparatus for electrically transmitting orders or signals, such apparatus being suitable for navigable vessels and other purposes where it is required to transmit a series of signals or orders.
16,903. W. V. Biggs. London. A new or improved device or apparatus for fixing electric lamps in the sockets of overhead electroliers, brackets, and the like, or for detaching them therefrom.
16,912. H. A. Jackson. London. Improvements in or relating to covers or lids of telephone cases or the like.
16,915 F. Dannert. London. Improvements in the production of filaments for incandescent electric lamps.*
16,916. J. Wetter. London. Improvements in or connected with electro magnets. (The Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co., Germany.)*
16,930. W. R. Edwards. London. Improvements in means and apparatus used for propelling boats by electricity.

September 24, 1900.

10,312a. C. E. Wilson. London. Improvements in and connected with wireless telegraphy. (Date claimed under Patents Rule 19, June 5, 1900.)*
16,966. A. E. Sauer. London. Improved electromotor.*
16,983. W. C. E. Faber. London. An improved electrograph.
16,993. J. O. Lister. London. Improvements in or relating to trolleys for use in electric traction.
17,003. C. Alias and J. J. Webber. London. An application of electricity to the imitation of snakes, reptiles and insects for theatrical and other purposes.

September 25, 1900.

17,033. P. W. Merfield and E. Tozer. London. An improved electric automatically indicating target for rifle practice.
17,037. P. S. Bates. Kingston-on-Thames. Improvements in instruments for reproducing sounds.
17,049. F. Kraemer and E. Weber. London. Improvements in coin-operated electric meters.*
17,077. H. S. Dodd and R. D. Bagnall, jun. London. Improvements in arc lamps.

### SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

19,785. Vereinigte Elektricitäts Actiengesellschaft and Klandy. Electro-chemical process for cleaning metal surfaces.
19,793. Round and Round. Electro-plating and burnishing of certain articles and apparatus to be used therein.
19,867. Crehore and Squier. Telegraphic apparatus.
20,216. Siemens Bros. & Co. (Ltd.). (Siemens and Halske Aktiengesellschaft.) Receiving apparatus for high-speed telegraphy.
20,346. Voelker. Manufacture of incandescing electric lamps.
20,390. Cerebotani. Apparatus for automatically connecting any two of a number of electric circuits branching from a central station.
20,877. Improved Electric Glow Lamp Co. (Ltd. and Barnes. Manufacture of reflecting opalescent surfaces for electric lamps or glass reflectors.
21,079. Sutherland. Time indicators for use in connection with a telephonic service.
22,143. Lugard. Electrical accumulators.
23,054. Siemens Bros. & Co. (Ltd.). (Siemens and Halske Aktiengesellschaft.) Coupling appliances for the electrical conductors of electrical railway and tramway vehicles.
23,154. Eckstein and Coates. Electrical indicator.
23,319. Atkinson. Electrical measuring instruments.
23,371. Sloan and Barnes. Switches, especially applicable to switches for electromotors and the like.

## COMPANIES' MEETINGS AND REPORTS.

### India Rubber, Gutta Percha, and Telegraph Works Co. (Ltd).

The directors report for the year ended Sept. 30, states that after provision for doubtful debts, the net profit amounted to £67,238. 18s. Adding £31,511. 8s. 10d. brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £86,250. 6s. 10d. The directors recommend the distribution of a dividend of 15s. a share, tax free, amounting to £37,500, and, making, with the interim dividend, 10 per cent. for the year; £48,750. 6s. 10d. is carried forward. The general business of the company has been fairly profitable, although the price of raw material has continued high. The cable steamer "Buccaneer" has been employed on charter to the Western Telegraph Co., and the ss. "Silvertown" laid a cable between New York and Canso (Nova Scotia) for the Commercial Cable Co. Since the closing of the financial year the manufacture and shipment of another cable for the same company has been completed, and the ss. "Silvertown" is now awaiting orders to

proceed with the laying between Waterville (Ireland) and Weston-super-Mare. The works at Silvertown and Persan have been maintained in their usual state of high efficiency. The employment of electricity for the transmission of power in the former is being extended. The board has sent a representative to South Africa with the view of opening an agency there.

**ELECTRIC TIMBER-SEASONING AND PRESERVATION CO. (LTD.)**—The report of the directors, presented at the meeting on Tuesday last, stated that the works were now finished and thoroughly equipped for efficient and economical operation, except for a few unimportant details, and that the working of the process had begun. Considerable delay was caused by the difficulty in fixing contracts at satisfactory prices for the erection of works and plant, and the great congestion of trade in this country and the difficulty in obtaining ironwork or machinery of any description had been the cause of still further delay. Mr. W. Claude Johnson and the Comte de Montaigu have resigned from the directorate. The drying chambers at the works are designed (says the report) on an entirely new principle, which ensures a uniform and easily-regulated rate of drying, which it is believed will be found to be a great improvement on anything previously devised. The design is the invention of Prof. Hearson, one of the directors, who has applied for a patent. The report was adopted.

**KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.)**—The first report of this corporation to Sept. 30 states that the directors regret that the progress of operations has from unforeseen causes been considerably delayed. The difficulties appear to have been chiefly in connection with the plant required to efficiently evaporate the salt water obtained from the well already sunk. A satisfactory solution has now been arrived at as regards both evaporating and condensing plant, but this involves the expenditure of more capital per horse-power than was originally intended, and it is now found that, instead of £150,000 producing a plant of 4,500 I.H.P., it will cost the corporation £135,000 to erect a plant capable of producing 2,400 I.H.P. The corporation's consulting engineers estimate that the net earnings on this plant will be about 16 per cent. on £200,000. The works have been so planned that additional horse-power will cost very much less in proportion, and further, when the Government water scheme is carried out, the production of electric current can be largely increased at a small cost. The directors, therefore, feel justified in recommending the erection of the plant before mentioned as quickly as possible, and orders for such portions as are at present difficult to obtain, owing to the congested state of engineering works, have been already placed and will shortly be ready for delivery.

**PROVINCIAL TRAMWAYS CO. (LTD.)**—This company are owners of tramways at Portsmouth, Gosport, Cardiff, Grimsby and Plymouth, and in the report of the directors to Sept. 30, just presented, it is stated that the tramways at Portsmouth are to be transferred to the Corporation on Jan. 1 next. At Cardiff, the Corporation has given the company notice of intention to acquire the tramways as from Dec. 31, 1901. At Grimsby, after considerable negotiations, an agreement has been arrived at with the Corporation, and has been confirmed by Parliament. The work of converting the line to electric traction is in progress, and it is hoped will be completed next spring. At Plymouth the company has been successful in negotiating with the Corporation for the transfer of their undertaking to the local authority and the working of the lines by electric traction under lease for 21 years. The conversion is to be put in hand next spring. The Corporations of Stonehouse and Devonport have made similar arrangements with the company. These arrangements are confirmed in the act passed last Session. At Gosport the company have been in communication with the District Council with a view to obtaining a lease of the tramways, in consideration of adopting electric traction and constructing additional lines. So far these negotiations have not been completed, but the company have given notice of a bill to carry out these objects. A dividend of 5s. and a bonus of 1s. per share, free of tax, is about to be declared, making, with 3s. paid in May, 9s. per £10 share for the year ended Sept. 30.

**VENEZUELA TELEPHONE AND ELECTRICAL APPLIANCES CO. (LTD.)**—The general meeting of this company was held on Tuesday, when the directors reported that for the year ended June 30 there was a profit of £6,763. 2s., to which was added £531. 18s. 11d. from 1899. After providing for interest on the first and second debentures, &c., and the dividend on the preference shares to June 30 there was a balance of £1 959. 10s. 6d. Since the accounts were made up a serious earthquake had occurred in Caracas, and the company's general manager had advised that it had caused little direct damage to the company's property, but, as it was likely to result in a temporary disturbance of trade, the directors recommended that no dividend be paid and that the balance be carried forward. The capital outlay for the year was £395. 5s. 4d., against £1,302. 3s. 2d. during the previous year. The company's property has been fully maintained in good working order and repair. The report and accounts were adopted.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**CROWN ELECTRIC HEATING SYNDICATE (LTD.)**—Registered Nov. 30, with a capital of £5,000, in £1 shares, to carry on the business of electricians, electrical engineers, manufacturers of electrical appliances for heating liquids, suppliers of electricity for all purposes, and to adopt an agreement with Messrs. A. R. Leask and H. Stewart.

**HIGGINBOTTOM AND MANNOCK LTD.**—Registered Nov. 30, with a capital of £60,000 in £1 shares, to take over the business carried on at West Gorton, Manchester, under the style of Higginbottom and Mannock, and to carry on the business of engineers, hoist and crane manufacturers, electrical and chemical engineers, electricians, &c. The first directors are L. Higginbottom, T. Mannock, and E. Broome.

**R. HOOD HAGGIE & SON (LTD.)**—Registered on Nov. 28, with a capital of £160,000 in £1 shares, to adopt an agreement with Messrs. R. Hood, S. and A. J. Haggie, to manufacture rope, cord and twine from metallic, fibrous and other materials, and to carry on the business of electric cable and appliance manufacturers, electrical and mechanical engineers, &c. The first directors are R. Hood Haggie (chairman), S. Haggie, A. J. Haggie, R. C. Nothwanger, L. Zollner, and A. M. Sutherland.

**NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)**—Registered Nov. 26, with a capital of £200,000, in £1 shares, to supply electricity for light, heat, traction, telephonic, and telegraphic services, or any other public or private purposes within the United Kingdom, and to carry on the business of electricians, mechanical and electrical engineers, manufacturers of electrical apparatus, &c. The subscribers are J. D. Milburn, C. W. Fairweather (engineer), C. S. Vesey Brown (electrical engineer), H. C. Harvey, J. Patterson, A. Scholefield, and S. Mitcalfe.

**PATERSON, COOPER & CO. (LTD.)**—Registered at Edinburgh on Nov. 30, with a capital of £20,000 in £1 shares, to acquire and carry on the business of electrical engineers and contractors now carried on at Paisley by Paterson, Cooper & Co. The subscribers are P. Rottenburg, R. Paterson (manufacturer), W. Marshall (electrical engineer), C. Ker, W. Crosbie, R. Cassels (iron merchant), W. S. Marshall (electrical engineer), and L. Rottenburg (electrical engineer). The first directors are A. McClelland, R. Cassels, W. Marshall, and L. Rottenburg.

**SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.)**—Registered Nov. 29 with a capital of £850,000, in £1 shares, to acquire the business, or the whole or part of the shares and debentures of the Lancashire Light Railways (Ltd.) and the South Lancashire Tramways Co., to adopt an agreement with Messrs. Jas. B. and Jacob Atherton, to equip, maintain and work by electricity or otherwise, tramways and railways, and to carry on the business of tramway, railway and omnibus proprietors, carriers, &c. The subscribers (each with 1,000 shares) are Sir John A. Willox, M.P., Hon. A. Stanley, M.P., E. K. Muspratt, J. B. Atherton, J. Beecham, J. Atherton, and the Hon. G. Stanley. The first directors are Sir J. A. Willox, Hon. A. Stanley, E. K. Muspratt, James B. Atherton, and Jacob Atherton.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29⅜d. per oz. (Dec. 6). Consols (2¾ per cent.) 97⅞—97⅛ for money, 97⅞—97⅞ for account; 2½ per cent. 97½—97⅛ (Dec. 6). Stocks and Shares Continuation Days, Dec. 11 and 24. Ticket Days, Dec. 12 and 27; Pay Days, Dec. 13 and 28; Mining Share Carry-over Days, Dec. 10 and 21.

**ALLGEMEINE ELEKTRICITATS GESELLSCHAFT.**—In reference to the note which appeared under this heading in our last issue, we should have stated that the output of the incandescent lamp factory had been again increased by 1,000,000 lamps more than last year, when the output was 10,000,000 lamps. It is stated that the number of lamps turned out by the company amounts to nearly half the annual number required for Central Europe.

**COMMERCIAL CABLE CO.**—A quarterly dividend of 1¾ per cent. and a bonus of 1 per cent. have been declared, payable Jan. 2, out of the earnings of this company. The transfer books will be closed from 20th inst. to Jan. 1 inclusive.

**EASTERN TELEGRAPH CO. (LTD.)**—This company announce the payment on Jan. 14 of a dividend at the rate of 3½ per cent. per annum (less

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation | Dec. 1 | 602 | + 165 | 26 | 18,708 | + 2,657 |
| *Birmingham Tramways | „ 1 | 4,231 | − 157 | 21 | 95,381 | + 2,438 |
| Blackpool Corporation | Nov. 29 | 185 | + 35 | 35 | 27,372 | + 7,201 |
| Blackpool and Fleetwood | Dec. 1 | 137 | − 25 | 22 | 19,713 | 25 |
| Bolton Corporation | ... | ... | ... | ... | ... | ... |
| Bradford Corporation | „ 2 | 637 | + 331 | 35 | 19,091 | + 5,203 |
| Brisbane Trams | Oct. 17 | 1,795 | + 257 | 15 | 27,908 | + 5,447 |
| *Bristol Trams & Carriage | Nov. 30 | 2,937 | + 291 | 22 | 73,261 | − 1,249 |
| *Buenos Ayres & Belgrano | „ 4 | 3,289 | + 835 | 18 | 43,711 | + 3,554 |
| Central London Railway | Dec. 1 | 5,765 | ... | 18 | 93,687 | ... |
| City & South London Ry. | „ 2 | 1,904 | + 851 | 23 | 35,860 | +14,299 |
| Cork Elec. Trams | Nov. 29 | 327 | − 32 | 48 | 19,647 | + 1,430 |
| Dover Corporation | Dec. 1 | 157 | + 3 | 35 | 8,051 | + 434 |
| Dublin & Lucan Rly. | „ 1 | 63 | + 9 | 22 | 2,160 | + 374 |
| Dublin United | Nov. 30 | 3,293 | + 364 | 22 | 91,676 | +10,671 |
| Dublin Southern Dist. | „ 30 | 651 | 14 | 22 | 22,243 | |
| *Dundee Corporation | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation | Dec. 1 | 8,999 | + 107 | ... | ... | ... |
| Hull Corporation | „ 1 | 1,332 | + 676 | 22 | 30,308 | +16,053 |
| *Liverpool Corporation | Nov. 24 | 7,962 | + 1,060 | 47 | 372,495 | +48,380 |
| Liverpool Overhead Rly. | Dec. 2 | 1,569 | − 178 | 22 | 36,643 | + 620 |
| *Sheffield Tramways | „ 2 | 2,654 | + 749 | 48 | 109,364 | +37,730 |

* Partly electrical

tax) on the preference stock of the company for the quarter ending Dec. 31, 1900, and an interim dividend of 1¼ per cent. on the ordinary stock (free of tax) in respect of profits for the quarter ended Sept. 30, 1900. The transfer books will be closed from Jan. 7 to 14 inclusive.

**EDMUNDSON'S ELECTRICITY CORPORATION** (LTD.)—Subscriptions have been invited this week for an issue of 13,363 6 per cent. cumulative preference shares of £5 each (£66,815), at a premium of 5s. per share (forming part of a total capital of £400,000, of which there now remains unissued £100,000). This issue is required to provide funds for the completion of electricity supply stations now in progress at Montrose, Brechin, Melton Mowbray, Lymington, and Sandown and Shanklin.

**ELECTRIC TIMBER-SEASONING AND PRESERVATION.**—It will be seen from our report of the general meeting of the shareholders of the Electric Timber-Seasoning and Preservation Co. (Ltd.) that the works have now been completed, and we learn that the shareholders expressed their satisfaction at the completeness of these works, which have been, we are informed, constructed and completed with a special view to the saving of labour in the handling of timber. Already customers' timber is being seasoned, and the company are prepared to receive samples from persons desirous of going into the question, and undertake to season these samples and return them to inquirers for such tests as may be considered desirable.

**ST. HELEN'S CABLE CO. (LTD.)**—This company have declared a dividend of 6 per cent. on their share capital. The transfer books are closed from the 1st to the 10th inst.

**SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.)**—Subscriptions have been invited for £750,000 4½ per cent. first mortgage debenture stock and £400,000 6 per cent. cumulative preference shares in this company, which has been formed to acquire and develop as parts of a single system concessions and rights now owned or to be obtained by the South Lancashire Tramways Co. (incorporated by Act of Parliament in 1900) and the Lancashire Light Railways Co. (Ltd.) The lines authorised under the 1900 Act referred to comprise 84¼ miles of single track. The South Lancashire Tramways Co. is also empowered by the act to supply electric energy in bulk to local authorities for all purposes. The list of applications closed on Wednesday.

**STOCK EXCHANGE NOTICE.**—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to the 4 per cent first mortgage debenture stock of the *London United Tramways (Ltd.)*

**WESTERN TELEGRAPH CO. (LTD.)**—An interim dividend of 3s. per share (at the rate of 6 per cent. per annum), free of tax, has been declared for the quarter ending Sept. 30. The dividend is payable on Dec. 21. The transfer books will be closed from 14th to 20th inst. inclusive.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. 28. | | Price Wednesday, Dec. 5. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Dec. 5. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'str'ct Elec. Lt. Ord. (fully pd.) | ⅝ | ⅞ | ⅝ | ⅞ | ... | ... | ... | ... |
| 15,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 16 1 | ... | ... | ... |
| 25,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | 10¼ | ... |
| £70,000 | Stock | 19/8 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | 6½ | ... |
| 30,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 5 1 | February and August | 10 | 9½ |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 0 | March | 6⅝ | ... |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,679 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 | 10 | 9 | 10 | 4 0 0 | February and August | 10 | 9⅛ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 13½ | 4 8 11 | January and July | 13½ | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 127 | 131 | 3 17 10 | June and December | 128 | 126½ |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | 9½ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 5 0 0 | March and September | 11½ | 11½ |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (allotd.) (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | ... | ... |
| 11,000 | 5 | ... | Folkestone Electric Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | House to House Elec. Light Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 11½ | 12½ | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 4% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 5 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2½ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4½ | 5½ | 5 9 1 | ... | 4½ | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 45,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 4 4 0 | April and October | 13½ | 12½ |
| £720,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 14 7 | June and December | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 101 | 97 | 101 | 3 10 7 | ... | 99½ | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | 13½ | 14½ |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 18 11 | " | ... | ... |
| 300,000 | 1 | 1/8 | Rand Electric | ¾ | 1 | ¾ | 1 | 12 16 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate E. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 6 13 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 180 | 200 | 170 | 190 | 4 4 3 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | 103½ | 102½ |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 5 | February and August | 15½ | 15½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | " " | 8½ | ... |
| £50,000 | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | ... | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 2 | ... | ... | ... |
| 55,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 3½ | 3½ |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12⅛ |
| 29,437 | 5 | ... | Do. Do. | 11½ | 12½ | 11½ | 12½ | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 108 | 104 | 108 | 4 16 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 23 | 24 | 23 | 24 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 13 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 121 | 118 | 121 | 3 6 1 | February and August | ... | ... |
| 13,600 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10½ | ... |
| 60,000 | 10 | 11/0 | British Elec. Trac. Ord. | 15½ | 16½ | 16 | 15 | 3 13 4 | ... | 16½ | 16½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 ... 9 | February and August | 12½ | 12⅛ |
| £300,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 124 | 121 | 123 | 4 1 4 | ... | 122 | 121½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 16 3 | ... | 4½ | ... |
| 25,000 | 5 | ... | Do. "B" | 4 | 4½ | 4½ | 5 | ... | ... | 4½ | 4½ |
| £120,000 | Stock | 5% | Do. 5 per Cent. Debentures | 101 | 107 | 101 | 107 | 4 15 5 | ... | ... | ... |
| £120,000 | Stock | 13/9 | Do. 5% 2nd Deb. Stock Prov. Certs. (all pd.) | 93 | 99 | 96 | 99 | 5 1 0 | ... | 95 | ... |
| 10,797 | 10 | 3/0 | Central London Ordinary | 10 | 10½ | 9½ | 9½ | 3 1 6 | June and December | 10½ | 9½ |
| £300,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 52 | 56 | 52 | 56 | 2 0 7 | February and August | ... | ... |
| 12,500 | 10 | 1/3 | Do. Ordinary Nos. 25,001 to 37,500 | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | ... | ... |
| £100,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | 100 | ... |
| £250,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | " " | ... | ... |
| £211,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 119 | 121 | 119 | 121 | 3 5 1 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896), Ltd., Ordinary | 17 | 18 | 17 | 18 | ... | ... | ... | ... |
| 54,997 | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Deb. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 21,000 | 10 | 7½% | Imperial Tramways Ordinary | 22½ | 23½ | 22 | 23 | 3 12 6 | March and September | ... | ... |
| 11,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 15 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & Distr'ct E. L. & Tr'ct'n 6% Pref. | ... | ... | ... | ... | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8½ | 9½ | 8½ | 9½ | 4 9 6 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13½ | 13½ | 13 | 13½ | 3 15 1 | " " | ... | ... |
| £120,000 | Stock | 4% | Do. 4 per Cent. Debentures | 101 | 103 | 101 | 103 | 3 17 0 | January and July | ... | ... |
| £61,000 | 100 | 5% | Montreal Street Railway Co. 5% Mort. Debs. (1908) | 101 | 104 | 101 | 111 | 4 15 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Do. 4½% Debentures (1922) | 103 | 105 | 101 | 105 | 4 6 4 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5 | 6 0 0 | May | 5 | ... |
| 14,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 10½ | 11½ | 10½ | 11½ | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 77/0 | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | 104½ | ... |
| £40,000 | Stock | 3% | Waterloo and City Ordinary | 92 | 95 | 95 | 96 | 3 2 10 | June and December | 95½ | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Nov. [illegible] | | Price Wednesday, Dec. 5. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Dec. 5. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 103 | 3 17 8 | January and July | ... | ... |
| 36,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 88 | 90 | 88 | 90 | 5 11 1 | ... | ... | ... |
| £352,720 | Stock | 15/0 | Anglo-American | 53 | 56 | 53 | 54 | 6 11 1 | Feb., May, Aug., Nov. | ... | ... |
| £3,044,640 | Stock | 30/0 | Do. Preferred | 98 | 100 | 97 | 99 | 6 1 5 | " " | 99½ | 9[illegible] |
| £3,[illegible],640 | Stock | 27/0 | Do. Deferred | 10½ | 11 | 10[illegible] | 10½ | 12 11 2 | " " | 10½ | 10½ |
| 13,333,300 | $100 | 8½ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 11 5 | Jan., Apr., July, Oct. | ... | ... |
| £1,5[illegible] | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 17 4 | " " | 103½ | 1[illegible]3 |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ | 7½ | 6 | 7 | 7 17 3 | February and August | 7 | 6 |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 14½ | 15½ | 15 | 16 | 6 5 0 | " " | — | — |
| 11,981 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | — | — |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | — |
| £[illegible],000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | .. | . |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 1[illegible] | 1[illegible] | 10½ | 6 1[illegible] 0 | Jan., Apr., July, Oct. | 10½ | 10½ |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 102 | 99 | 102 | 4 8 0 | June and December | ... | ... |
| £1,[illegible],000 | Stock | 25/0 | Eastern Ordinary | 161 | 165 | 15[illegible] | 16[illegible] | 4 19 7 | Jan., Apr., July, Oct. | 161 | 149 |
| £1,424,480 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 97 | 101 | 9[illegible] | 9[illegible] | 3 1 1 | " " | 97 | 96 |
| £1,452,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 112 | 116 | 11[illegible] | 11[illegible] | 3 1[illegible] 4 | May and November | 11[illegible] | .. |
| 253,000 | 10 | 2/6 | Eastern Extension | 14 | 14½ | 14½ | 14½ | 4 10 3 | Jan., Apr., July, Oct. | 14½ | 13[illegible] |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) [illegible] | 6½ | 6½ | [illegible] | [illegible] | ... | ... | . | ... |
| £[illegible],000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 | 115 | 113 | 115 | 3 8 7 | February and August | ... | — |
| £[illegible],000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 1[illegible] | 10[illegible] | 100 | 103 | 3 17 9 | February and August | ... | — |
| £[illegible],000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 101% | 99% | 101% | 3 14 5 | May and November | ... | — |
| 1[illegible],227 | 10 | 1[illegible] | Globe Telegraph and Trust | 10½ | 10½ | 10½ | 1[illegible] | 4 17 8 | Jan., Apr., July, Oct. | 10½ | 10[illegible] |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | " " | 15[illegible] | 1[illegible] |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 33 | 31 | 3[illegible] | 3 15 7 | January and July | 31 | 30½ |
| £[illegible]1,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 4 10 0 | June and December | ... | — |
| 17,000 | 25 | 12/6 | Indo-European | 4[illegible] | 5[illegible] | 4[illegible] | 52 | 4 16 2 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | ... | .. |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 101 | 104 | 101 | 104 | 3 14 3 | June and December | — | — |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | .. | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 125 | 130 | 121 | 12[illegible] | 4 13 0 | " " | 121 | — |
| 15,600 | 10 | ... | West African Telegraph | 2½ | 3½ | 3½ | 3½ | 4 9 3 | December and July | ... | — |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 103 | 9[illegible] | 102 | 4 13 3 | March and September | ... | .. |
| 30,000 | 3½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | — | .. |
| £160,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 101 | 103 | 101 | 103 | 3 14 4 | January and July | — | — |
| 88,321 | 10 | 6[illegible] | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | .. | — |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6½ | 7½ | 6 | 7 | 8 11 6 | " " | ... | — |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | . |
| £[illegible],000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 13 6 | January and July | — | ... |
| 297,930 | 10 | 1/0 | Western Telegraph (late Brazilian Submarine) | 14 | 14½ | 14 | 14½ | 4 1[illegible] 7 | Mar., June, Oct., Dec. | 14[illegible] | 14 |
| 476,000 | 100 | 5% | * Do. 5 per Cent. Debs. 2nd Series, 1906 | 103 | 106 | 102 | 104 | 4 14 4 | June and December | ... | — |
| £311,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | — |
| 224,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | [illegible] | [illegible] | [illegible] | [illegible] | ... | July | — | — |
| 172,680 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | [illegible] | [illegible] | [illegible] | 5 0 0 | November | — | — |
| 66,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 3/0 | National | 4[illegible] | 4½ | 4½ | 4[illegible] | 6 [illegible] | February and August | 4½ | 4½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 1[illegible] | 14 | 1[illegible] | 14 | 4 [illegible] 9 | " " | 13½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 1[illegible] | 14 | 12 | 14 | 4 [illegible] 8 | " " | ... | — |
| 250,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 1 | " " | 5 | — |
| £[illegible],000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 91 | [illegible] | 91 | [illegible] | 3 11 5 | June and December | ... | ... |
| £[illegible] | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 1[illegible] | 1[illegible] | 1[illegible] | .. | ... | 103 | — |
| 171,504 | 1 | 0/6 | Oriental | ½ | 1½ | ½ | 1½ | [illegible] | April and October | ... | — |
| 58,000 | 5 | 4/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 [illegible] | July | . | — |
| 15,689 | 5 | 3/6 | Do. 5% Cumulative Preference (fully paid) | 5 | 5½ | 5 | 5½ | 4 1[illegible] 11 | June and December | ... | — |
| 13,351 | 5 | ... | Do. do. (£3 10s. paid) | 3½ | 3½ | 3½ | 3½ | .. | .. | ... | — |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 105 | 107 | 105 | 107 | 4 13 6 | June and December | 107 | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 8d. | Alliance Electrical Co. 5% Cum. Pref. | ½ | 1½ | ½ | 1½ | 4 4 11 | ... | ... | ... |
| 14[illegible] | 1 | 7½d. | [illegible] Electricity Meter 6 per Cent. Cum. Pref. | ½ | ¾ | ½ | ¾ | 7 7 8 | March and September | 1½ | — |
| 65,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | — |
| 6[illegible],000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | — |
| £[illegible],000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 9[illegible] | 9[illegible] | 9[illegible] | 4 4 2 | ... | ... | — |
| 71,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 4 10 11 | July and February | ... | — |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 4 16 0 | January and July | ... | — |
| 100,000 | 5 | 3/0 | British W[illegible] Preference | 4½ | 5½ | 4½ | 5 | 6 0 0 | ... | 4½ | — |
| 90,060 | 2 | 1/1½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 8 4 | September | 1½ | — |
| 16,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 6 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 [illegible] 8 | " | 2[illegible] | 2½ |
| 15,731 | 2 | .. | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 111 | 103 | 111 | 4 0 11 | March and September | ... | — |
| £1[illegible] | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 10[illegible] | 103 | 10[illegible] | 4 [illegible] 0 | January and July | . | — |
| 34,000 | 5 | [illegible] | Callender's Cable Construction Ord. | 12½ | 13½ | 12½ | 13½ | 6 11 1 | " " | 1[illegible] | 12½ |
| 10,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5½ | 5 | 6½ | 4 8 11 | " " | 5½ | 5½ |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 18 11 | November and May | — | ... |
| 1[illegible],000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 5 0 | ... | ... | ... |
| £15[illegible] | Stock | 4½% | Do. 4½ First Mort. Deb. (red.) | 97 | 1[illegible] | 97 | 1[illegible] | 4 13 [illegible] | ... | 99½ | ... |
| [illegible],000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ½ | 1 | ½ | 1 | [illegible] 0 | March | ... | ... |
| 6[illegible],000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1½ | ¾ | 1½ | 5 6 5 | ... | .. | — |
| 51,000 | 3 | 2/[illegible] | Crompton and Co. [illegible] | 3½ | 4 | 3½ | 4 | [illegible] 4 | January and July | 3[illegible] | — |
| £1[illegible],000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 10[illegible] | 4 14 0 | " " | ... | — |
| 6[illegible],000 | 1 | 0/7½ | Davis and [illegible] per Cent. Cum. Pref. | ¾ | 1½ | ¾ | 1½ | 5 6 [illegible] | ... | 1 | — |
| 9[illegible],861 | 5 | 1/[illegible] | Edison and Swan United ("A" Shares, £3 paid) | 1½ | 2½ | 1½ | 2½ | 8 [illegible] 0 | February and August | 1½ | — |
| 17,[illegible]49 | 5 | 2/[illegible] | Do. £5 paid | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | — |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 5 | June and December | ... | — |
| £[illegible] | Stock | [illegible] | Do. [illegible] | 93 | 10[illegible] | 9[illegible] | 10[illegible] | ... | ... | ... | ... |
| 3[illegible] | 5 | 6/0 | [illegible] Electricity Corporation, Ord. | 4½ | 5 | 4½ | 5 | 6 0 [illegible] | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | [illegible] | 10[illegible] | [illegible] | 1[illegible] | 4 7 [illegible] | ... | ... | ... |
| 112,[illegible] | 2 | 1/2½ | Electric Construction Co. [illegible] | 2 | 2½ | [illegible] | 2½ | 5 [illegible] | January and July | 2½ | 2 |
| 2[illegible] | 2 | 2/[illegible] | Do. 7 per Cent. Cumulative Preference | 2½ | [illegible] | 2½ | 2½ | 4 [illegible] 2 | July | 2½ | — |
| £[illegible],500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 10[illegible] | 10[illegible] | 102 | 1[illegible] | 3 19 2 | January and July | ... | — |
| 11[illegible],500 | 1 | ... | [illegible] | ½ | [illegible] | ... | | ... | .. | ... | ... |
| 3[illegible] | 5 | 4/0 | Henley's Telegraph Works Ordinary | 12½ | 1[illegible] | 12½ | 13½ | 6 11 1 | February and August | 14½ | 12½ |
| 30,[illegible] | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5½ | 5½ | 5½ | 3 1[illegible] 3 | " " | ... | .. |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 11[illegible] | 112 | 1[illegible] | 112 | 4 [illegible] 6 | " " | 11[illegible] | .. |
| [illegible] | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 2[illegible] | [illegible] | 2[illegible] | 3 [illegible] 2 | " " | 21½ | 21½ |
| £1[illegible] | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 10[illegible] | 11[illegible] | [illegible] | 1[illegible] | 3 1[illegible] 3 | March and September | 11[illegible] | . |
| 3[illegible] | 12 | 12/[illegible] | Telegraph Construction and Maintenance | 3[illegible] | 4[illegible] | [illegible] | [illegible] | 4 [illegible] | March and July | 41½ | 3[illegible] |
| £[illegible] | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1900 | 10[illegible] | 10[illegible] | [illegible] | 1[illegible] | 3 1[illegible] 11 | January and July | ... | ... |
| 3[illegible] | 5 | 4/0 | Do. Manufacturing Ordinary | 10½ | 11½ | 1[illegible] | 11 | 5 1[illegible] | ... | ... | ... |
| 2[illegible] | 5 | 2/6 | Do. 6 per Cent. Cumulative Preference | 5½ | [illegible] | [illegible] | [illegible] | 4 6 1 | ... | ... | ... |
| 3[illegible] | 5 | 5/0 | Willans and Robinson, Ordinary | 1[illegible] | 11½ | 10½ | 11½ | 8 1 9 | April and October | 11½ | 10½ |
| 4[illegible] | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 [illegible] | " " | ... | .. |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | [illegible] | 11[illegible] | [illegible] | 1[illegible] | 4 0 11 | May and November | 1[illegible] | 10[illegible] |

* In calculating the yield on this security, allowance has been made for accrued interest, [illegible]

† The London Stock Exchange Committee refuses to quote these.

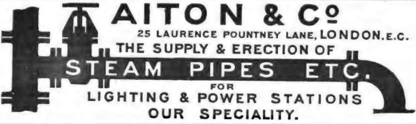
# WITTING BROS., Ltd., (ELECTRICITE & HYDRAULIQUE)

## ELECTRIC POWER AND TRACTION ENGINEERS,

Telegrams: "WITTING LONDON."
Telephone: 5795 BANK.

***London Office: 49, CANNON STREET, LONDON, E.C.***

---



# AITON & Co

25 LAURENCE POUNTNEY LANE, LONDON. E.C.
THE SUPPLY & ERECTION OF
STEAM PIPES ETC.
FOR
LIGHTING & POWER STATIONS
OUR SPECIALITY.

---

**NOW READY.**—Price **1s.** net; bound in leather, gilt edges, with pocket and elastic band, **1s. 6d.** net; postage **2d.**

THE "PRACTICAL ENGINEER"

## ELECTRICAL POCKET BOOK & DIARY, 1901.

**Thoroughly Revised and Enlarged.**

THE above Work, in addition to a large mass of information indispensable to Electricians, contains:—Notes on Electrical Units, Methods of Measurement of Current, Potential Resistance, Magnetism; Formulæ for Magnetic Calculations; Notes on the Design of Dynamos, Alternators and Transformers; Accumulators and Primary Batteries, Electrical Transmission of Power in Factories, Power Required for Driving Shafting Machine Tools, Modes of Transmission by Belts, Ropes and Gearing, Electric Cranes, Electric Traction, Mining and Welding; Electrolysis, Tables of Weights, Areas, Circumferences, Logarithms, &c., &c.

**TECHNICAL PUBLISHING CO., Ltd., 31, Whitworth St., Manchester,**
AND ALL BOOKSELLERS.

N.B.—In ordering, please quote *full title* of the book.

---

# Phœnix Fire Office

**19, LOMBARD STREET,**
AND
**57, CHARING CROSS,** } LONDON.

ESTABLISHED 1782.

**LOWEST CURRENT RATES.**

LIBERAL & PROMPT SETTLEMENTS,

**ASSURED FREE OF ALL LIABILITY.**

**ELECTRIC LIGHTING RULES (Copyright), Latest Edition, Supplied**

FRANCIS B. MACDONALD, *Secretary.*

---

JACKSON-MENSING
ARC LAMPS.
USED FOR STREET LIGHTING, PROMENADES, FACTORIES, IRON & STEEL WORKS, SHOPS, Public Buildings. ETC. ETC.
USED BY "WHITELEYS" & "FERRANTIS"
For Prices & Particulars Apply
P. R. JACKSON & CO. LTD.
Salford Rolling Mills,
MANCHESTER

---

## TEMPERATURE COEFFICIENTS OF "CONDUCTIVITY" COPPER.

To the Telegraph Engineer it is a matter of great importance to know with accuracy the temperature coefficient of a wire with which he is dealing, since the inferences to be drawn as to the perfection of the insulation of a cable laid in deep water depend largely upon a knowledge of the temperature of the sea bottom. In the absence of soundings with suitable thermometers, these temperatures can only be calculated from the resistance of the conductor.

The compilers of TEMPERATURE COEFFICIENTS OF "CONDUCTIVITY COPPER" (Messrs. CLARK, FORDE and TAYLOR, the well-known consulting engineers) have recently made fresh investigations of the temperature coefficient over the range of temperatures to which cables are usually exposed, and the results of their investigations are now published.

**Table I.** gives the resist. at different temperatures when the Res. at 32°F. = 1
**Table II.** gives the resist. ditto ditto when the Res. at 60°F. = 1.
**Table III.** gives the resist. ditto ditto when the Res. at 75°F. = 1.
And
**Table IV.** gives the log. reciprocals of coefficients in Table III.

*These Tables are strongly bound in cloth, price* **2s. 6d.** *net.*

**SHEET TABLE showing**
**LOG. RECIPROCALS of COEFFICIENTS for COPPER RESISTANCES**
At different temperatures from 32°F. to 84·9°F.
*Printed on strong cardboard, price* **6d.** *net.*

**"The Electrician" Printing & Publishing Co., Ld., Salisbury-court, Fleet-st., E.C.**

---

Very fully Illustrated, handsomely bound, on good paper, price **6s.,** post free.

# ELECTRIC LAMPS AND ELECTRIC LIGHTING.

By PROF. J. A. FLEMING, M.A., D.Sc., F.R.S., M.R.I.,
*Professor of Electrical Engineering in University College, London.*

**CONTENTS.**

Lecture 1.—ELECTRIC MEASUREMENTS. *14 Illustrations.*
Lecture 2.—ELECTRIC GLOW LAMPS. *40 Illustrations.*
Lecture 3.—ELECTRIC ARC LAMPS. *14 Illustrations.*
Lecture 4.—ELECTRIC DISTRIBUTION. *39 Illustrations.*

"THE ELECTRICIAN" PRINTING AND PUBLISHING CO., Ltd., SALISBURY COURT, FLEET STREET.

# WILLANS CENTRAL VALVE ENGINES

FOR

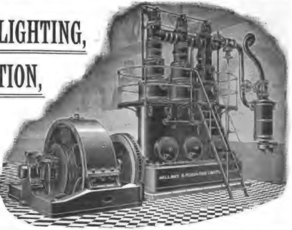
## ELECTRIC LIGHTING,

## ELECTRIC TRACTION,

&c.

**STANDARD PATTERNS 75 to 2,500 H.P.**

ECONOMY OF STEAM AND OIL,
ABSENCE OF VIBRATION,
DURABILITY, SILENT RUNNING,
HIGH SPEED, LIGHTNESS,
PERFECT REGULATION.



700 H.P. ENGINE, as supplied to Bradford Corporation for Electric Lighting and Traction.

## Over 360,000 H.P. in Use or on Order.

# WILLANS & ROBINSON, Ld.,

## RUGBY, ENGLAND.

# DAVEY, PAXMAN & CO., Ltd., Engineers, COLCHESTER.

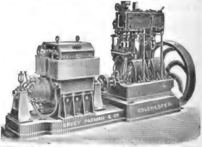
MAKERS of a GREAT VARIETY of STEAM ENGINES and BOILERS.

## SPECIALITY: Steady Running Engines for Electric Lighting.

Paxman's Patent "Economical" Boiler, from 8 h.p. upwards.

This Boiler is one of the Best Steam Generators before the public, not only for Efficiency, but for Economy and Durability. It contains particularly good features and high qualities.

PAXMAN'S PATENT
AUTOMATIC EXPANSION GEAR
and
ADJUSTABLE GOVERNORS
Ensure a Steady and Constant Speed
in any emergency.



"Windsor" Vertical Compound Engine, with Dynamo combined made in all sizes.

Telegraphic Address: "PAXMAN, COLCHESTER."

Catalogues and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ltd., Engineers, Colchester.**
LONDON OFFICE—78, QUEEN VICTORIA STREET, E.C.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,178. [No. 8. Vol. XLVI.] FRIDAY, DECEMBER 14, 1900. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Dr. J. A. Fleming's third Cantor lecture on "Electric Oscillations and Electric Waves," before the Society of Arts last Monday, was devoted to consideration of the properties of the medium in which electromagnetic waves are propagated. Starting with the logical necessity for a medium, the lecturer carefully and patiently led his audience step by step to the identification of this medium with the luminiferous ether. The required agreement between the refractive index and the specific inductive capacity was shown to exist in the case of a number of substances; but, disdaining to treat his audience as a popular one, Dr. Fleming had no sooner established this point than he flashed on the screen a table which seemed flagrantly to oppose and upset it. This striking series of discrepancies, once so puzzling to the disciples of Clerk Maxwell, was stated to arise from the existence of radicals in the chemical molecules of the substances which disobeyed the law, all the substances found to obey the law at ordinary temperatures having completely saturated molecules. The influence of chemical radicals was dealt with at some length by introducing an account of Profs. Fleming and Dewar's low-temperature researches on the specific inductive capacity of substances which exhibit discrepancy with Maxwell's law. It was probably owing to the limited time at his disposal, that Dr. Fleming's treatment of this part of his subject seemed to allow of the inexact impression that by suitably choosing the temperature any recalcitrant dielectric could be coerced into obedience to that law. The concluding portion of the lecture was devoted to an account of ether theories, more especially of Dr. Larmor's fearful and wonderful strain-ether and that twist-built ether cell, called an electron, upon which the hopes of modern physicists are now being reared very high.

Prof. FitzGerald gives in our correspondence columns this week a most interesting glimpse at some of his notions on various aspects of the connection between certain solar and terrestrial phenomena. Last week Dr. Lodge called the attention of our readers to, among other things, the remarkable hypothesis which had been propounded by Prof. FitzGerald to account for terrestrial magnetic disturbances; and this week Prof. FitzGerald speaks rather more definitely on this his own hypothesis. He tells us that even at the time when he first put forward this hypothesis he found, by using data gathered from cathode ray observations, that the rate of emission of ions or atoms required of the sun by his hypothesis seemed quite feasible. He does not say, however, to what extent the most modern developments of the electron theory support, or render probable, this projected-particle theory of magnetic disturbances. But he does suggest, or, at any rate he leads us to presume, that the failure of the Maxwellian radiation pressure doctrine to explain the remarkable and well-known behaviour of the tails of comets approaching the sun leaves a promising opening for the application of the projected-particle hypothesis. Of the complete failure of the attempt to explain that behaviour by radiation pressure Prof. FitzGerald's emphatically adverse comments, by the way, should remove all doubt.

But many questions arise as we ponder the proposition that into space in all directions a host of charged corpuscles is being projected continuously from the sun. To keep near home, we might ask, Does the earth's field, by deflecting the corpuscles, account in any proportion for the fact that the phenomenon of the aurora is confined to the poles? And if it is of sufficient strength to accomplish this concentration of effect, what difference between boreal and austral phenomena might we expect as a consequence of the difference between the polarities of the northern and southern hemispheres? The last paragraph of Prof. FitzGerald's letter will tend to reassure those of our readers who were appalled by Dr. Lodge's vision of a possible electrodynamic cataclysm.

There it is pointed out that M. Crémieu's experiments, if confirmed by other observers, might be brought into agreement with our electrodynamic conceptions of the functions of a moving charge by the assumption of a practicable hypothesis which Prof. FitzGerald now roughly outlines. In any case, till M. Crémieu's experiments have been repeated, and his results endorsed by others, our readers should follow Prof. FitzGerald's advice and submit to a suspension of judgment.

An important question in the distribution of electrical energy on the three-wire system is the disposition and the dimensioning of the feeders. It is the object of the three-wire system to balance the currents through the middle wire as accurately as possible and in as short a distance as possible. Naturally, if two circuits branched through one service box from the opposite sides of the system took precisely the same current at all times, no third wire would be needed; but as this case is a purely hypothetical one, a middle wire of about half the sectional area of the outers is usually provided. The question still remains: How should this middle wire be connected to the station?

In a small network fed only at one point, the three poles are, of course, brought in to the balancing machine. When we come to slightly larger networks, however, with some half-dozen feeding points, a frequent practice is to run three-wire feeders to each feeding point, as otherwise the circuits are liable to get very much out of balance locally, and a dead earth on one side might result in a sufficient increase in pressure on the other to burn out a number of lamps. Some engineers consider it sufficient, however, to feed the outers only, and just to bring the middle wire of the distributing network in at one point for the purpose of balancing. This is done in a number of large networks, where the interconnection of the distributing mains is such that balance is well assured under normal conditions, and in which, since large currents are always flowing, the relative effect of a dead earth is not so great. Another point arises, however—in connection with testing for faults. Thus, in Manchester the feeders are only in pairs connected to the 400-volt outers at every feeding point, and in the case of the original network two sets of five-wire distributors were brought in to the station for the purpose of balancing, the balancing current being supplied by four independent steam-driven 100-volt machines. Since then, as the network increased in size, a third set of distributors was brought into the station, and motor-generators were substituted for the steam dynamos. The chief object of bringing in another set of distributors was to facilitate the localisation of faults by dividing the network into separate sections, which could be balanced independently. For this purpose, also, three-wire feeders (or five-wire in the case of a five-wire network) to some of the feeding points are undoubtedly advantageous.

In contrast to the practice at Manchester, the Charing Cross and Strand Electricity Supply Corporation has laid a middle wire to every feeding point, this having been found necessary on account of the number of large load consumers, such as theatres, printing works, &c. This middle wire feeder is, as a rule, half the sectional area of the outers, but frequently, when it has been necessary to add to the sectional area of a particular feeder, the outers only have been doubled. But when the generating station is not near the centre of the network, there is no doubt that three-wire feeders are an unnecessary luxury, and that balancing is performed cheaper and better by balancing transformers in sub-stations. Theoretically, the proper place for the third-wire copper is in the distributors rather than in the feeders, for the nearer it is to the lamps the greater is its utility. This principle is, we believe, being acted upon by Mr. Frank Bailey in converting the present network of the City of London Electric Lighting Co. At Manchester, also, Mr. Wordingham has some balancing transformers on his network.

Evidently the problem is one of design to meet the special circumstances of each case, and no hard-and-fast rule can be given either in favour of two-wire or three-wire feeders. It is a matter for regret, however, that such practical points as these are not discussed more frequently by those who have had to solve them. At the meetings of the Institution of Electrical Engineers, the Municipal Electrical Association, and kindred societies, it is unfortunately becoming rather unusual to consider such technical matters unless they are prompted by trade or personal interest; but we remind those engineers who have had useful experience the recording of which would be of interest and service to their fellows, that our columns are always open to them for such purposes.

**Personal.**—We regret to learn that Prof. J. Chunder Bose, of Calcutta, who is paying a visit to this country, is now somewhat seriously ill, and we sincerely wish him a speedy recovery.

**National Physical Laboratory.**—It has been announced that for the purposes of a National Physical Laboratory the Queen has granted to the Royal Society, Bushey House, Bushey Park, which was formerly occupied by the Duc de Nemours.

**Royal Society.**—Among the Papers down for reading yesterday were: "On the Spectrum of the More Volatile Gases of Atmospheric Air, which are not Condensed at the Temperature of Liquid Hydrogen. Preliminary Notice," by Prof. Liveing and Prof. Dewar; and "Elastic Solids at Rest or in Motion in a Liquid," by Dr. Chree.

**Cable Interruptions and Repairs:**—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Tangier—Tarifa | Jan. 3, 1900 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Zanzibar—Mombasa | Sept. 20, 1900 | Dec. 9, 1900 |
| Falmouth—Bilbao | Nov. 19, 1900 | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | — |
| Pernambuco—Ceara | Nov. 29, 1900 | — |

**The Society of Model Engineers.**—The second annual conversazione of this society was held at the Memorial Hall, Farringdon-street, E.C., on December 1st, about 400 members and friends being present. The guests were received by the chairman, Mr. Percival Marshall and Mrs. Marshall, and a very attractive programme was provided. A collection of engineering models was on view, some of these being shown at work. Several model locomotives made by members of the society were shown running under steam.

**Society of Engineers.**—The forty-seventh annual general meeting of the Society of Engineers was held on the 10th inst. at Westminster. The chair was occupied by Mr. Charles

Mason, vice-president. The following gentlemen were duly elected by ballot as the council and officers for 1901, viz.: As president, Mr. Charles Mason; as vice-presidents, Messrs. P. Griffith, J. P. Barber, and D. B. Butler; as ordinary members of council, Messrs. J. Bernays, G. A. P. Cuxson, W. H. Holttum, R. St. George Moore, Henry Sherley-Price, Nicholas J. West, J. W. Wilson, and M. Wilson; as hon. sec. and treasurer, Mr. G. Burt; as hon. auditor, Mr. Samuel Wood, F.C.A. During the scrutiny the chairman addressed the meeting, bringing before the members the salient points of the work of the past year. He announced that the hon. treasurer, Mr. George Burt, had presented to the Society a president's badge of office in gold and enamel.

**Carbide Works in Switzerland.**—During last month some new carbide works commenced work at Flums, in the canton St. Gall, Switzerland. The works are the property of Messrs. P. and H. Spoerry, of Flums, and have been built from designs and under the direction of Messrs. Brown, Boveri & Co. The whole electric equipment of the power station and carbide works has been supplied by the above firm, whilst Messrs. Speyerer & Co., of Berlin, supplied the preparing and transporting machinery. Water-power of 2,400 H.P. with a head of 820 metres is available, and furnishes three-phase current at 5,000 volts. The hydraulic part of the power station was built by Messrs. Sulzer, of Winterthur, Messrs. Escher, Wyss & Co., of Zürich, supplying the turbines. The annual output of carbide is estimated at 2,400 tons. This is the third installation of the kind put down in Switzerland during the last year by Messrs. Brown, Boveri & Co.

**A 2,700kw. Railway Generator.**—The Boston Elevated Railway Co. have now in use probably the largest electric traction generator ever made. It is of 2,700kw. capacity and was supplied by the Westinghouse Electric and Manufacturing Co., of Pittsburg. The contract for this large unit was originally awarded to the Walker Company, but when that company was absorbed by the Westinghouse Company this contract was taken over and the machine altered considerably to conform with Westinghouse principles. Among the chief changes introduced in the generator were the design and construction of a new type of commutator, different form of armature winding and coil insulating, methods of ventilation, and the addition of the well-known Westinghouse arrangement for securing electric balance in armatures. This large machine is complete and the results of tests have proved it to be entirely to the satisfaction of the railway company. Another generator of the same capacity, but entirely of Westinghouse design, is now under construction for the same railway company.

**Société Francaise de Physique.**—The first meeting of the session was held on the 16th of last month, the president, M. Cornu, being in the chair. The president, in his opening address, announced the accomplishment of the publication of the Papers presented to the International Physical Congress which met from August 6th to August 12th last, on the occasion of the Exhibition. M. Cornu tendered to all those physicists who had submitted Papers to the Congress the most sincere thanks of the Society—to whom the summoning of the Congress was due. In particular, M. Cornu referred in graceful terms to Lord Kelvin, who, at the opening meeting of the Congress, was acclaimed its honorary president. "Eminent physicist, profound mathematician, incomparable engineer, Lord Kelvin unites with his great scientific qualities a friendliness and an unaffectedness which have gained for him universal esteem. . . . It is particularly agreeable to French scientists to recall that Lord Kelvin is fond of saying that he owes much to French science. When, loaded with honours, he left Cambridge he came to Paris as a simple student, lodged modestly in a garret in the Rue Monsieur-le-Prince, discussed with Liouville, Serret and Joseph Bertrand the works of Laplace and Fourier, and introduced the works of Green—at that time unknown even in his own country."

**Royal Institution.**—The following are the lecture arrangements at the Royal Institution, before Easter: Sir Robert Ball, six lectures (adapted to young people) on "Great Chapters from the Book of Nature"; Prof. J. A. Ewing, six lectures on "Practical Mechanics (experimentally treated): First Principles and Modern Illustrations"; Dr. Allan Macfadyen, Fullerian Professor of Physiology, R.I., four lectures on "The Cell as the Unit of Life"; Dr. Arthur Willey, three lectures on "The Origin of Vertebrate Animals"; the Rev. H. G. Graham, three lectures on "Society in France before the Revolution"; Prof. Percy Gardner three lectures; Sir Wyke Bayliss, two lectures on "Shakespeare in Relation to his Contemporaries in Art"; Prof. R. K. Douglas, two lectures on "Government and People of China"; Mr. F. Corder, three lectures on "Vocal Music, its Growth and Decay" (with musical illustrations); the Right Hon. Lord Rayleigh, six lectures on "Sound and Vibrations." The Friday Evening Meetings will begin on January 18th, when a discourse will be delivered by Prof. Dewar on "Gases at the Beginning and End of the Century." Among succeeding discourses will be: Feb. 1, the Right Rev. Monsignor Gerald Molloy, on "Electric Waves"; Feb. 8, Prof. G. H. Bryan, on "History and Progress of Aerial Locomotion"; Feb. 15, Prof. J. J. Thomson, on "The Existence of Bodies Smaller than Atoms"; Feb. 22, Sir W. Roberts-Austen, on "Metals as Fuel"; March 8, Mr. W. A. Shenstone, on "Vitrified Quartz"; March 22, Dr. Horace Brown, on "Some Recent Work on Diffusion"; and on March 29 a discourse by the Right Hon. Lord Rayleigh, the subject of which is not yet announced.

**Institution of Electrical Engineers.**—In deference to a generally expressed wish, the Council, as we have already announced, has arranged for members of the Institution to have an early opportunity of welcoming the Active Service Contingent of the Electrical Engineer Volunteers. It has therefore decided to hold a reception on Tuesday next, the 18th inst., in the Covent Garden Opera House, which has been generously placed at its disposal for the purpose by Mr. Frank Rendle and Mr. Neil Forsyth. Admission will be by ticket only. So far as space permits, each member (of any class) will be entitled to one ticket for himself and one for a lady; but, as the number that can be accommodated is limited, tickets are being allotted in order of application up to the maximum permissible. If by to-day (Friday) the tickets are not all appropriated, applications for extra tickets will be dealt with in rotation. The reception will be held on the floor of the auditorium, on which a space will, it is hoped, be kept by a guard of honour provided by the Corps. With the exception of this space, and of a portion reserved for ladies accompanying the guests of the evening and those who are to receive them, practically the whole of the auditorium (including the balconies and galleries) will be free to the members and the ladies with them. The doors will be opened at 8 p.m. It is requested that all should be in their places by 8:45 p.m. at latest. Arrangements are being made for the band of the Royal Engineers to play before and after the reception, and for a selection of vocal music to be performed during the evening. Carriages may be ordered for 11 p.m. Light refreshments will be provided. The officers and men of the active-service contingent, led by Lieut.-Col. Crompton, will be received by the President and Council, who would be glad to be supported on the platform by any members of the Institution who hold a commission in Her Majesty's regular or auxiliary forces.

**Electricity on War Vessels.**—Lieut. Steigner, of the U.S. Navy, has recently handed in his report on the use of electricity on warships. The report is based on an inspection of the vessels of many navies. It shows that the principal advance in the use of electricity on board warships has taken place in the application of motors for driving auxiliaries, such as capstans, ammunition hoists, ventilating blowers, machine shops, turret gear, boat cranes, steering gear, pumps, &c. As the report points out, motors for use on board ship should be of the enclosed type, should be capable of bearing the sudden imposition of a large load, and should be simple in arrangement and easily accessible. Speaking of the British Navy, the report observes that it is customary to place three or four dynamos of 600 amperes and 80 volts in the large vessels, and three dynamos of 400 amperes in the smaller cruisers. Some of the large cruisers

and battleships are supplied with 1,000 to 1,500 lights. Of recent years motors have been used for boat hoisting, for coal and ash hoists, and in the "Terrible" for training the 9·2in. guns. The "Powerful" and "Diadem" classes have been supplied with electric ammunition hoists, but this is not the usual practice in the British Navy. The switchboards are not arranged for parallel working, so that the different circuits have to be thrown on one or the other of the dynamos. The bars are arranged in a horizontal position. Double-wire circuits, lead-covered, with vulcanised india-rubber insulation, have been used. The wires and cables are run along uncovered battens, fastened to the bulkheads, so that they are visible for inspection and repairs. The Barr and Strond transmitting and receiving instruments have been experimented with by the British Navy, and have been placed in the "Canopus." Some of the Japanese ships have been fitted with these instruments, and several governments are experimenting with them.

Power-Gas Generation.—The current number of the *Engineering Magazine* contains an abstract of a Paper read by Herr Johann Korting before the Verein Deutscher Ingénieure. Herr Korting emphasises the fact that there is often confusion in speaking of various kinds of fuel gas, and that water gas is not infrequently confounded with Dowson or other producer gas, and so he is careful to note the distinction in chemical composition, as well as in the methods of making. Producer gas, being generated by the incomplete combustion of carbon in the form of coal, coke, or other fuel, is composed principally of nitrogen and carbon monoxide, there being from 28 to 30 per cent. of carbon monoxide, 50 to 65 per cent. of nitrogen, with a little carbon dioxide and hydrogen. Water gas, on the contrary, being made by passing steam through incandescent coke or other fuel, contains a much larger proportion of hydrogen, the proportions ranging about 40 per cent. carbon monoxide, 50 per cent. hydrogen, 3 per cent. to 6 per cent. nitrogen, with a little carbon dioxide and marsh gas. The superior calorific value of the latter is apparent, and the commercial difference must, therefore, be mainly one of the cost of generation. When the lean gas, as producer gas has often been called, can be obtained either as a by-product (as in the case of blast-furnace gas) or by the use of inferior grades of fuel (as is the case in some of the more recently devised forms of producers), its low cost renders it available—especially for use in internal combustion motors, where a slight increase in size of motor, and an elevation of the cylinder compression will render equal power and higher efficiency possible over illuminating or other fuels. In other instances it may be found advantageous to generate the richer water gas, especially in view of the recent advances which have been made in the process. The original process of making water gas consisted in using a cylindrical producer filled with coke, this being raised to incandescence by an air blast from beneath, steam being passed through the coke after a full incandescence had been secured. As the coke became cooled, the steam was turned off and the air blast renewed, and so the operation continued intermittently. This process naturally consumed a large portion of the coke, thus carrying away a large percentage of the calorific value of the fuel, and in spite of attempts to utilise the heat thus generated, either under boilers or in connection with regenerators, only about 40 per cent. of the calorific value of the coke appeared in the resulting gas. Two processes have been devised which enable a higher efficiency than this to be obtained, namely the Dellwik-Fleischer and the Strache. The latter is intended to use any kind of fuel, usually coal or a mixture of coal and coke, the coal being coked in the course of the blow, the resulting producer gas passing through a regenerator which serves to increase the efficiency by conserving a portion of the heat which would otherwise be carried away. The system thus produces both water gas and producer gas, and as these are delivered separately they can be applied to appropriate uses; the producer gas may be considered as a by-product of the water-gas generator. The Dellwik-Fleischer system generates no producer gas, but aims at burning the fuel, coke or non-bituminous coal completely to carbon dioxide, and thus utilising the greater heat developed for the decomposition of the steam. Since 1kg. of carbon burned to carbon monoxide generates only 2,442 calories, while 8,080 are evolved by its combustion to carbon dioxide, it is evident that a higher efficiency will be secured by completing the combustion. This Dellwik accomplishes by using a much less depth of fuel in the producer, together with side charging apertures which enable the fuel bed to be maintained at a constant depth. The air pressure is also controlled so as to effect the desired combustion, and thus the full available amount of heat is obtained. The result is an efficiency of about 75 to 80 per cent. instead of 40 to 45 per cent., and thus water gas is made available commercially where formerly the cost was prohibitory. Herr Korting also discusses the cost and efficiency of coal gas, and concludes that, when the plant is to be used only for power generation, producer gas will not be replaced by any of the others, since it gives a more complete utilisation of the fuel, less expensive operating force and a cheaper original plant. When high temperatures are to be produced, however, water gas, he says, holds the first place, and for many uses cannot be excelled. Especially by preheating the air blast the temperatures may be materially increased.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY,) December 14th.**

PHYSICAL SOCIETY.

*5 p.m.* This meeting will be held in the Physical Laboratory of the Royal College of Science, Exhibition-road, South Kensington. Agenda: (1) "Electric Inertia" and (2) "The Effect of Inertia on Electric Currents in a Rotating Sphere," by Prof. A. Schuster, F.R.S. (3) Exhibition and description of a Quartz-Thread Gravity-Balance, by Prof. R. Threlfall, F.R.S. (4) "On the Theory of Magnetic Disturbances by Earth Currents," by Prof. A. W. Rucker, F.R.S. (5) "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents," by Dr. R. T. Glazebrook, F.R.S. (6) "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rucker, F.R.S. (7) Exhibition of a set of Half-second Pendulums, by W. Watson.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

*7.30 p.m.* General Meeting in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Included in the agenda is the resumed discussion on Mr. E. L. Orde's Paper on "Liquid Fuel."

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting, when the following Paper will be read and discussed: "Power Gas, and Large Gas Engines for Central Stations," by H. A. Humphrey.

**MONDAY, December 17th.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture IV. on "Electric Oscillations and Electric Waves," by Prof. J. A. Fleming, F.R.S.

**TUESDAY, December 18th.**

INSTITUTION OF CIVIL ENGINEERS.

*8 p.m.* Ordinary Meeting to continue the discussion on the Papers read last week dealing with signalling on electric railways.

**WEDNESDAY, December 19th.**

ROYAL MICROSCOPICAL SOCIETY.

*8 p.m.* Meeting at 20, Hanover-square, W.

ROYAL METEOROLOGICAL SOCIETY.

*8 p.m.* Meeting at 20, Hanover-street, W.

**THURSDAY, December 20th.**

INSTITUTION OF ELECTRICAL ENGINEERS (DUBLIN SECTION).

*7.30 p.m.* Meeting in the University College, St. Stephen's Green, Dublin. Paper to be read: "On Electric Currents of High Tension and Great Frequency, with Suggestions as to the Possible Electric Light of the Future," by the Right Rev. Monsignor Molloy.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Lieut.-Col. Crompton will give a lecture "On the Electrical Engineers (R.E.) in South Africa," which it is hoped will be illustrated by lantern views.

**FRIDAY, December 21st.**

INSTITUTION OF CIVIL ENGINEERS.

*8 p.m.* Students' Meeting. Paper to be read: "The Use of Geometrical Methods in Investigating Mechanical Problems," by C. E. Inglis.

## THE MANUFACTURE OF CALCIUM CARBIDE.

BY JOHN B. C. KERSHAW, F.I.C.

(*Concluded from page 246.*)

### I.—COMPARATIVE FURNACE EFFICIENCIES.

**The Deutsche Gold und Silber Scheide Anstalt Form of Carbide Furnace.**—The latest form of furnace designed by this company is shown in Fig. 1. The furnace consists of two parts—a fixed brickwork stack or hood and a movable hearth. The latter is constructed in the form of a small bogie waggon, and after charging with a portion of the raw materials it is run in under the stack and is raised by chains and pulleys until its upper edges form a gas-tight junction with the inner walls. This box waggon is lined with coke, and itself forms the second electrode of the furnace. The other electrode passes through an opening in the upper or hood portion of the furnace, and is so arranged that a vertical movement can be given to it, and the resistance maintained fairly constant. Two openings for charging raw materials, and a third for leading away the gases resulting from the reaction between the lime and coke, are also provided in the upper portion of the furnace.

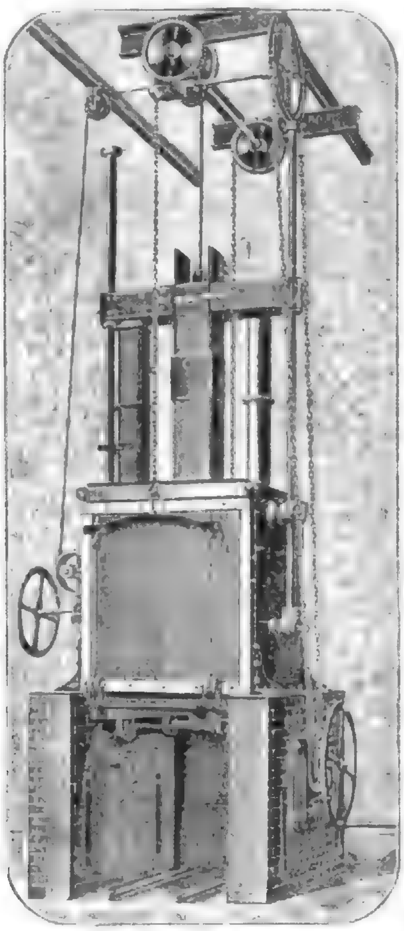


FIG. 1.—The Deutsche Gold und Silber Scheide Anstalt Carbide Furnace.

The best E.M.F. to use in working this form of carbide furnace is 60 to 65 volts, and at this pressure a current of 2,000 to 3,000 amperes is usually employed. The furnace is worked upon the intermittent principle—the carbide is not tapped from the lower portion of the furnace—but the small box waggon, when the operation of carbide-making is completed, is lowered and taken away upon the tramway lines provided for this purpose, and another charged box waggon is run in under the hood, raised into position, and the process recommenced. It is claimed that by working in this way the heat stored in the mass of carbide is utilised in forming fresh carbide from the lime and coke surrounding the central portion of the semi-fused mass, and that a higher output of carbide per kilowatt day is obtained. The company guarantee that these furnaces shall produce 5kgs. 85 per cent. carbide per kilowatt day; and it is stated that in some cases the yield has been as high as 8kgs.

The raw materials used for charging the furnace are not ground finely, but are broken down to the size of hazel-nuts, and it is claimed that here, again, important gains are effected in the conduct of the furnace process, and that loss of raw materials as dust is avoided. The theoretical requirements of lime and coke are 1,440kgs. per metric ton of carbide produced. Under the old system of working, 8,000kgs. were often required to yield this weight of carbide, while at Frankfort the normal consumption with the coarser material is estimated to be from 1,600 to 1,700kgs. only.

The advantages claimed for the furnace and process of manufacture described above, may be summarised as follows:—

1. Although the process is intermittent the utilisation of the electrical energy is continuous. This is effected by the rapid removal of the charge-box of each furnace, and by the grouping of several furnaces in parallel on the same supply mains.
2. The output of carbide per kilowatt day is higher than by any other system or furnace; the working costs are lower.
3. The consumption of raw materials is lower than by other processes of manufacture.
4. The consumption of the special movable electrodes is only about 50kg. per ton of carbide produced.
5. The formation of dust—during the furnace operation—is totally avoided.
6. The carbonic oxide gas is conducted away from the furnace room and can be utilised for heating purposes.
7. The health of those attending this furnace is not injured by breathing an atmosphere charged with dust and carbonic acid gas.

**The Willson Form of Carbide Furnace used at Foyers.**—According to Lewes the furnaces used by the Acetylene Illuminating Co. at Foyers for the production of carbide are a modified form of the original Willson furnace. This furnace consisted of a brickwork chamber, through the arched roof of which the upper carbon electrode passed, and a removable truck or bogie mounted on wheels, the heavy cast-iron base of which formed the lower or second electrode of the furnace. The furnace was thus somewhat similar in construction to that described above; but in the Willson furnace no attempt was made to exclude air from the interior of the brickwork chamber, and the whole of one side of this chamber was only loosely closed by iron doors when the furnace was at work. The liberation and burning of the carbon monoxide gas inside this chamber caused much loss of raw materials as dust and rapid consumption of the upper electrode of the furnace. These and other difficulties met with in its practical operation, led to its modification. At Foyers the two ends of the bogie car containing the raw materials were made removable, and were built up of heavy cast-iron bars, each provided with a central hole for escape of the carbon monoxide gas produced by the reaction laterally, instead of vertically through the mass of materials above. In this way some of the difficulties mentioned above were overcome, and the yield of carbide named by Lewes was obtained. But this modified form of furnace has not proved entirely satisfactory. The writer has been informed that the British Aluminium Co., who have now taken the manufacture of carbide at Foyers into their own hands, have adopted a new form which is in many points much superior to that described above.

The new furnace is continuous in operation—that is to say, the carbide is tapped. The raw materials used are crushed to pea-size and well mixed before charging. Further details are not available. With this furnace one electrical horse-power year yield 1¼ tons 80 per cent. carbide. This equals 4,914 kw.-hours per ton 80 per cent. carbide, and the consumption of electrical energy per ton of carbide produced is therefore over 30 per cent. higher than with the form of furnace described by Lewes. Whether the saving in working costs (labour, &c.) more than balances this increased consumption of electrical

energy, is a question which can only be answered by those in charge of the works at Foyers. Efficiency is, however, being sacrificed to simplicity of working—and it would certainly be preferable to attain both.

**The Gin and Leleux Form of Carbide Furnace used at Meran.**—This furnace closely resembles in construction the original Willson furnace. It consists of a brickwork chamber having one side open for the passage of a four-wheeled bogie truck, containing the raw materials of carbide manufacture. The base of this truck is connected to the negative leads, and forms the secondary electrode of the furnace.

The points in which the operation of this form of furnace differs from that of the Willson furnace are two. The brickwork chambers, through the arched roof of which the upper carbon electrodes pass, are connected with a powerful fan, and the gases produced by the reaction between the lime and coke at the high temperature produced in the furnace, are withdrawn from the bogie by lateral openings.

The heat contained in these waste gases, though much below that of the furnace, owing to the large volume of cold air drawn in at the front of the furnace, is utilised in other chambers for a preliminary heating of the raw materials. The difficulty due to the burning of the carbon monoxide inside the furnace, and consequent destruction of the upper carbon electrodes and their holders, is thus avoided by diluting this gas and withdrawing it from the furnace before combustion occurs. The furnaces are worked on the intermittent principle, and the carbide produced is allowed to partially cool in the bogies in which it is first made. By building the furnaces in pairs, and by using one upper electrode for the two furnaces alternately—a plan which is facilitated by the manner in which these electrodes are suspended from overhead rails—a practically continuous utilisation of electrical energy is obtained.

**Conclusion.**—These descriptions of the three most efficient forms of carbide furnace show that the *highest yields* found amongst the figures coming under examination, have been obtained in furnaces working on the intermittent system, with movable box-hearths, in which the carbide produced is allowed to cool. The adoption of another form of furnace and of the continuous system of working at Foyers, for the sake of a saving in the cost of labour, does not detract from the correctness of this conclusion. Where electrical power is developed at a very low cost, and manual labour is costly, it may be wise to expend more kilowatt hours per ton of carbide produced, in order to obtain a reduction in the wages bill.

The continuous type of furnace, from which the carbide is tapped at intervals, is therefore being adopted in localities where power is cheap and labour dear, while the intermittent form is in use where the opposite conditions obtain. Dr. Frohlich, the electro-metallurgical expert to Messrs. Siemens and Halske, of Berlin, in a recent article,* has indeed asserted that the continuous furnace will in time be *generally* adopted for carbide manufacture; but until reliable figures have been published by Dr. Frohlich, or other competent authorities, showing the output of these furnaces under actual working conditions, the writer must agree with Carlson* in his views on this subject.

With both types of furnace, however, there would appear to be possibilities of improvement in regard to the utilisation of the carbon monoxide gas. It is certainly a mistake to allow this gas to burn away without any utilisation of its heating power. The Deutsche Gold- und Silber-Scheide Anstalt form of furnace is to be commended as the best of the intermittent furnaces yet studied by the writer, in that it provides for the recovery of this gas—undiluted by air—and capable of application to any heating operation.

As most carbide works are run by water power, the only possible outlet for the utilisation of this gas is the preliminary heating of the raw materials of manufacture. Some authorities consider that the cost of the plant required for this utilisation of the waste gases of carbide furnaces would render the plan uneconomical, but the writer disagrees with this view, and is of opinion that some simple and efficient means of achieving this object will be evolved.

The other direction in which greater efficiency and economy may be expected is in connection with the preparation of the raw materials.

The idea that it is essential to have these finely ground and thoroughly mixed, in order to produce good carbide, is now proved to be incorrect; and the "dust" difficulty has been disposed of, by only reducing the lime and coke down to pea or hazel-nut size, and by allowing no finer material to enter the furnace.

It may be found that the raw materials of carbide manufacture can be used in a still coarser state, without any deterioration in the quality of the carbide produced, and important savings in the cost of preparing the lime and the coke for the furnace may thus be effected.

If, as asserted by some authorities, the lime acts as a solvent for the coke at the high temperature attained in the electric furnace, there would seem to be little objection to using both raw materials without any crushing at all, provided that the proportions by weight in which they were charged into the furnace were correct. Further practical experiments in this direction are therefore desirable.

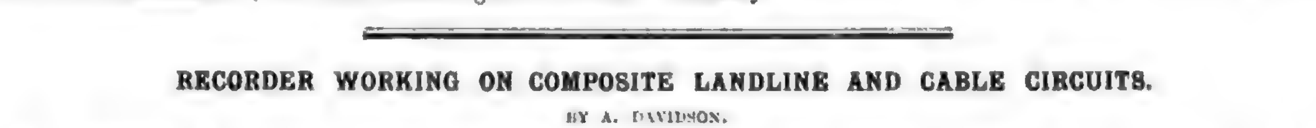
Finally, the writer may repeat the remark with which he opened this series of articles.

Carbide manufacture has now entered upon the third stage of its development. The supply exceeds the demand, and a severe fall in selling price has occurred. Only those factories which obtain a high furnace efficiency, combined with low working costs, can survive in the competition which is now bound to occur between the different producing firms. As a contribution to the study of furnace efficiency the figures given in these articles are worthy of careful study, by those interested financially or otherwise, in the calcium carbide industry.

## RECORDER WORKING ON COMPOSITE LANDLINE AND CABLE CIRCUITS.

BY A. DAVIDSON.

The application of Harwood's duplex arrangement to circuits composed of cables and landline, as shown in the accompanying diagram, is, so far as I am aware, novel; and, in view of the extending use of the siphon recorder for landline work, cases may happen where it would be useful. The diagram is almost self-explanatory, and I will only offer a few remarks on the working of this system in practice. B and C are the terminal stations of the landline. The signals from station D, received at C in the usual way, are transmitted direct to station A. Signals from A are similarly transmitted by B to station D. The landline recorders at B and C are permanently in circuit in order to give a record of what is passing through and also to show the state of the balance. If B's recorder is practically unaffected when B is sending



to D, while the signals from C to A are of legible size, the same state of things will obtain at A's recorder and duplex working will be possible. The arrangement can be divided up for sectional working by introducing earths at B and C on the apex to apex lead. The principal source of disturbance is, of course, the variation of the insulation of the landline, but the recorders at A and D are so far away electrically that the landline balance must be out very considerably before

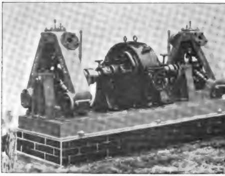
* *Zeits. f. Elektrochemie*, Vol. VII., pp. 1—10.

* *Zeits. f. Elektrochemie*, Vol. VI., p. 413.

the incoming signals are affected. I think it will be found, in all cases, that the effect of the cable capacity on the landline balance can be sufficiently compensated by tapping on a large capacity near the end of the landline artificial lines. In many cases this will be unnecessary, and a balance, so far as the distant recorders are concerned, will be obtained by means of a simple resistance. I should point out that the lower the resistance of the landline the better the balance will be. Well-insulated signalling batteries and cable transmitters at B and C are essential. There is no great practical difficulty in maintaining this condition as most stations are (or should be) provided with a direct reading voltmeter and milammeter, with which rapid daily tests of the general condition of the batteries can be taken. On a duplex human relay system the arrangement practically amounts to the elimination of one station without introducing any extra contacts or moving parts. I may add that the system has been worked successfully over a tropical landline subject to heavy varying leakage.

## ELECTRICALLY-DRIVEN THREE-THROW PUMPS AT THE BRISTOL ELECTRICITY WORKS.

The accompanying illustration is from a photograph of an electrically-driven twin three-throw feed pump plant recently supplied for the Bristol Corporation electricity works by Messrs. Merryweather & Sons (Ltd.), of Long Acre. The general arrangement of the plant is clearly shown by the illustration, and consists of a continuous-current motor placed in the centre of the bedplate, upon either end of which is carried a three-throw pump built direct on the motor axle, with a claw clutch interposed between the motor and the pumps at either end. The motor shaft runs at 400 revs. per min., and at this speed the combined pumps are capable of delivering 12,000 gallons of water per hour against a normal boiler pressure of 130lb. per square inch. For compactness, solidity of design and construction, and for the arrangement of the parts with a view to the minimum loss of power, this particular combination of motor and pumps appears to be deserving of high praise.



**Wireless Telegraphy.**—Col. Hozier, on behalf of Lloyd's Committee, has notified Glasgow shipowners that it had been decided to establish experimentally the reporting of vessels by wireless telegraphy at Inishtrahull, North of Ireland. It is expected that the installation will be ready by the middle of January. Arrangements are also being made for night signalling as well as day at Kildonan, Isle of Arran.

## ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.[*]

BY W. DUDDELL.

It may be thought by some that the title of this Paper is rather contradictory in that there should not be any variation in the current through a direct-current arc. I will therefore explain at once that I simply use the term "direct current" as implying that the current is supplied by cells or by a direct-current dynamo, and not as implying that the current is necessarily constant in value. It may also be as well to state that by *arc* I do *not* mean *arc lamp*, as all the effects to be described are quite apart from those produced by regulating mechanisms.

The effect of varying the current through the direct-current arc very slowly, so slowly, in fact, that the carbons have time to burn into shape corresponding to each value of the current, has been investigated by many experimenters, but it is to Mrs. Ayrton[†] that the honour belongs of giving a complete investigation of all that occurs when any of the variables in the direct-current arc are changed in any way. The other extreme, namely, very sudden changes in the current, has also been investigated by Mrs. Ayrton,[‡] thus leaving a gap in the experimetal evidence as to what occurs between very slow variations and isolated sudden changes in the current. The present Paper is an attempt partly to fill this gap by giving an account of what occurs when the current is periodically varied more or less rapidly over a range which is very small compared with the mean value of the direct current. The current through a direct-current arc supplied with power from any circuit may vary either owing to changes taking place in the circuit, such as variations in E.M.F. or resistance, or owing to effects in the arc itself, such as hissing, humming. Although any variation in the current naturally entails a corresponding change in the arc itself, it will, I think, be found convenient to classify the observed effects according to whether the primary cause of the variation is in the arc or in the circuit which supplies it.

### PART I.—CAUSE OF THE VARIATION OF THE CURRENT IN THE CIRCUIT SUPPLYING THE ARC.

The effects of varying the current may be divided under four heads, viz., the effect on the P.D. between the terminals of the arc, on the light emitted, on the shape of the craters, and on the vapour column. These will be considered in order. I shall assume in all cases in Part I. that the amplitude of variation of the current from the mean is small, generally much less than 10 per cent., and that the arc experimented on is neither hissing nor humming.

*Effect on the Potential Difference produced by Variations of the Current.*—If the current varies very slowly, then the relation between the P.D. current and length is that given by Mrs. Ayrton's curves. Directly the rate of variation is increased so that the carbons have not time to burn into shape, corresponding with the instantaneous values of the current, the relation will be changed, and it is conceivable that *if* the rate of variation were high enough and the amplitude small enough, the conditions of the arc would in no way be changed, so that the ratio of the change in P.D. to the corresponding change in current, would be a constant and equal to the true resistance of the arc. I shall show later that this assumption, which is the basis of several experiments on the resistance of the arc, notably those by Messrs. Frith and Rodgers,[§] requires a much higher rate of variation of current than they employed. One of Mrs. Ayrton's curves, contained in a letter by Prof. Ayrton to *The Electrician*, illustrates very well how the connection between the P.D. and current depends on the rate of variation of the latter. This curve shows that the *first* effect of *suddenly increasing the current* through a cored solid arc[¶] is to cause a *transient rise in the P.D.* between the terminals; the effect of a *slow increase of current* being, as is well known, to produce a *decrease in the P.D.* This first transient rise in the P.D. which was obtained with a cored-solid arc, was also, I believe, obtained with a cored arc, but I am unaware of its having been observed for a solid arc. Thinking that this might be due, as pointed out by Prof. Ayrton, to the extreme quickness of the phenomenon when *both* carbons were solid, I tried to record the transient rise in P.D. for the solid arc by means of an oscillograph, the sudden increase of the current being obtained by discharging a condenser through the arc. This experi-

---

[*] Paper read last night before the Institution of Electrical Engineers.

[†] *The Electrician*, Vols. XXXIV., XXXV., and XXXVI.

[‡] *The Electrician*, 1895, Vol. XXXIV., pp. 471, 541.

[§] *Proceedings* of the Physical Society, 1896, Vol. XIV., p. 307.

*The Electrician*, 1896, Vol. XXXVII., p. 321.

[¶] "Solid," "solid-cored," and "cored" arc mean, respectively, arc between two solid carbons, between one solid and cored, and between two cored carbons; the top or + electrode being always placed first.

E

ment was successful, and a transient rise in P.D. was observed, *the P.D. and current increasing together, but only for about $\frac{1}{5000}$sec.* At the end of this very short time the P.D. decreased with an increase of current in the ordinary way.

If it can be assumed that during this first $\frac{1}{1000}$sec. the conditions of the arc are not changed, then the solid arc has a positive resistance, contrary to the results obtained by Messrs. Frith and Rodgers, and it is at any rate evident that, had the frequency of their superimposed alternating current been 5,000 ∽ per sec. instead of 250 ∽ per sec., the sign of the resistance as obtained by them would have changed, though I do not say that even at that frequency its true value would have been obtained. In any method for measuring the resistance of the solid arc which depends on the change in the P.D. produced by a change of current, these changes must, therefore, take place in less than $\frac{1}{1000}$sec. in order not to allow the arc conditions to change; results to be described later indicate a still shorter time. I will not, however, pursue this subject any further, as it would unduly extend the length of this Paper to include a description of a complete series of experiments on the resistance of the arc which I have recently completed.

*Effect on the Light Emitted produced by Variations of the Current.*—It is well known that the light of the arc varies when the current is changed, though how small and rapid the variation in current may be and yet produce a perceptible change in the light does not seem to have been investigated. Prof. Fleming and Mr. Petavel * and Mr. Burnie † have determined the instantaneous values of the light and current in the case of alternate-current arcs, and have found that the variation in light roughly follows the variation of the current; the maximum luminous intensity occurring about $\frac{1}{1000}$sec. later than the maximum current. Herr Görges ‡ has also noticed that the variations in the current due to the teeth on the armature of a dynamo produced an appreciable variation in the light at the rate of 300 per sec.

In order to test how rapid and how small a variation of the current from the mean could be detected in the light of the direct-current arc, I arranged an arc so that its image as seen through a central slit parallel to the carbons was projected on to a rapidly-falling photographic plate, the instantaneous value of the current being recorded simultaneously on the same plate by means of an oscillograph. The small, quick variations of the current through the arc were produced by passing the oscillatory discharge of a condenser in series with a self-induction through it, so that the arc current consisted of a large constant part on which was superimposed a small ripple which died away after a few oscillations. By this method I find that in an 8-ampere solid arc *a distinct variation is produced in the light emitted by both the + crater and the vapour column when the amplitude of the variation of the current from the mean is only 3 per cent. and the frequency of these superimposed variations is as large as 4,300 ∿ per sec.* At this frequency the variation in light became indistinguishable when the amplitude of the variation of the direct current was reduced to 2 per cent. Owing to the difficulty in estimating the points of maximum density in the band on the plate which represents the light emitted in consequence of the smallness of the variation of the current and therefore of the light, I was unable to be certain whether the maximum light lags behind the maximum current; but if it does, the lag is very slight, not exceeding $\frac{1}{10000}$ sec. for an 8-ampere solid arc. It must be remembered that the above variations of light are those of the actinic rays which affect the photographic plate; the visual rays will probably vary in a similar manner, though possibly not to the same extent.

*Effect on the Craters produced by Variations of the Current.*—Mrs. Ayrton tells me that she noticed that the variations in the current used by Messrs. Frith and Rodgers, who superimposed an alternating current of 0·5 to 1·0 ampere R.M.S. value at frequency of 100 ∿ per second on a 10-ampere direct-current arc, so altered the shape of the ends of the carbons that she could easily distinguish them from normal carbons formed without any variation in the current. I find that if the superimposed alternating current be reduced to 0·1 ampere under the same conditions, the ends of the carbons appear unaffected.

*Effect on the Vapour Column produced by Variations of the Current.—Sounds.*—Corresponding with each value of the current through the arc there is probably a definite cross-section of the vapour column, so that if the current varies rapidly through an arc of fixed length the volume of the vapour will also vary and sound-waves will be given out. This, I believe, is the generally accepted explanation of the humming of the alternate-current arc. In the case of the direct-current arc, sounds are also emitted even when the variations in the current are very slight. For example, the variation of current caused by the commutator segments of a direct-current dynamo passing under the brushes can be heard in the arc. This variation of the current caused by the commutator segments, even when in good condition, was found by Messrs. Frith and Rodgers* in the case of a 5kw. two-pole machine to vary between 2·5 per cent. and 9 per cent. of the mean current according to the position of the brushes.

Another striking example of how sensitive the arc is to small variations in the current is furnished by the fact that a Wehnelt interrupter, working an induction coil on the direct-current street mains, will cause any arc supplied by the same mains to give out the same noise as the interrupter itself, even when a considerable distance intervenes between the place where the arc is connected with the mains and where the interrupter and coil are joined on, as observed by Herr Simon,† Mrs. Ayrton, and Mr. Jervis Smith.‡ It must be clearly understood that the arcs here referred to are normal silent arcs—that is, if they were supplied with a really steady current they would have been practically silent.§

In order to determine what variation in the current was necessary to cause the arc to emit a clearly audible note, the current from a high-frequency alternator, kindly lent by Sir D. Salomons, was superimposed on the direct current by the method shown in Fig. 1.

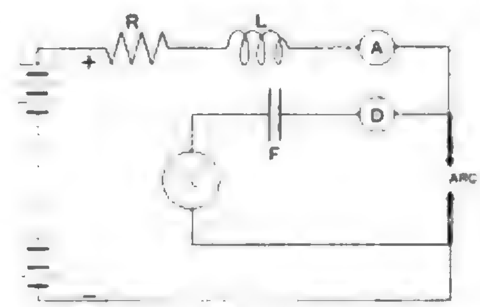


FIG. 1.

The current from the alternator passes through a condenser, F, a dynamometer, D, and the arc in series; and it is practically prevented from flowing through the cells which supply the arc by the self-induction L. The direct current is prevented from flowing through the alternator by the condenser F. It was found by this means that a 10-ampere direct current, solid or cored arc, length 3mm. to 6mm., would produce a distinct note, even if as small a R.M.S. current as $\frac{1}{1000}$ ampere, as measured by D., was superimposed on the direct current for frequencies of the added current from a few hundred up to 8,000 ∿ per sec. Thus *a variation of the order of 1 part in 10,000 from the mean current will alter the vapour column sufficiently to produce sound-waves.* Further experiments with another alternator and R.M.S. superimposed currents of $\frac{1}{20}$ ampere to $\frac{1}{10}$ ampere on a 10-ampere solid arc, proved that the sounds only became inaudible at frequencies approaching 30,000 ∿ per sec. At these frequencies I am uncertain whether the arc had really ceased to give a note, as the ear fails to detect sounds of so high a pitch. This sensibility of

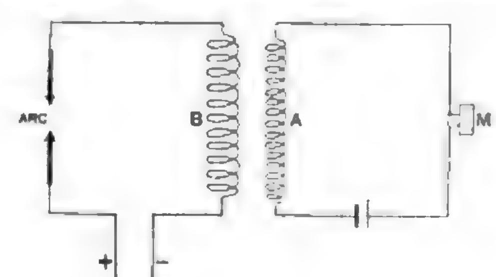


FIG. 2.

the arc for very small changes in its current explains the fact that not only can rapid variations of current in any circuit supplied from the same generator as the arc be heard in the arc, but also variations of current which occur in a totally independent circuit supplied by a separate generator can be detected in the arc due to mutual induction between the two circuits.

*Arc as a Telephone Receiver.*—The fact that the arc is sensitive to such small variations in the current and over such a wide range of frequency, at once suggests that the direct-current arc might be used as a telephone receiver. This suggestion, which was made in a leader of *The Electrician* in 1899, had already been carried out by H. Simon‖ in 1898. The method used by H. Simon for superimposing a microphone current on the main arc current is shown in Fig. 2, in

* *Proceedings* of the Physical Society, 1896, Vol. XIV., p. 115.
† *The Electrician*, 1897, Vol. XXXIX., p. 849.
‡ *Electrotechnische Zeitschrift*, 1895, Vol. XVI., p. 548.

* *Proceedings* of the Physical Society, 1896, Vol. XIV., p. 307.
† *Annalen der Physik und der Chemie*, 1898, Vol. LXIV., p. 233.
‡ *The Electrician*, 1899, Vol. XLIV., p. 16.
§ Absolute silence is almost impossible, as the least want of homogeneity or impurity in the electrodes causes small spits and sounds.
‖ *Annalen der Physik und der Chemie*, 1898, Vol. LXIV., p. 233.

which A and B are two coils having mutual induction, and M the microphone. The current through A varies when M is spoken into and induces E.M.F.s in B, which vary the current through the arc in such a way that it reproduces sounds and even speech distinctly. The variation of the current through the arc obtained by this method is not as large as it might be, as the E.M.F.s induced in B have to send currents round the whole arc circuit, including any steadying resistances, and also through the self-induction in the armature, if a dynamo is used, instead of only through the arc where the varying currents are actually required. I have obtained a better result by replacing the alternator of Fig. 1 with a microphone and mutual induction as shown in Fig. 3. A and B are the two coils of a mutual induction, F a condenser of about two or three microfarads, and L a high self-induction, the object of the self-induction being to prevent the microphone currents flowing round the cells instead of through the arc. With this arrangement and suitable arc conditions, to be explained later, *the arc will speak sufficiently loudly and clearly to be heard at a distance of 10ft. to 12ft. in a quiet room.* The sound-waves

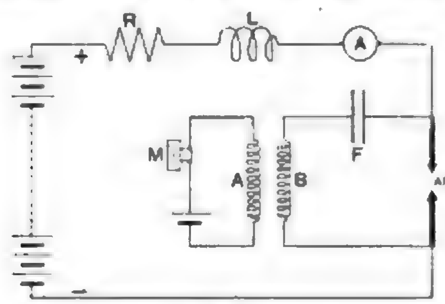


Fig. 3.

given out by the arc are, therefore, of such an intensity that when the energy is spread over an area of 20ft. diameter, the ear placed at any point can hear speech distinctly. It seems probable that if all the energy available could be collected and concentrated on the ear, very powerful sound-sensations might be produced.

The loudness of the sounds given out by the arc is increased by lengthening the arc, as this increases the volume of the vapour column which emits the sounds. It would also seem as if increasing the main current which increases the cross-section of the arc should also be beneficial, but experimentally I have not found any appreciable gain. The best results have generally been obtained with a current of 10 amperes to 12 amperes, carbons 11mm. to 13mm., and an arc length of 20mm. to 30mm. To obtain these long lengths with ease, it is necessary to use cored carbons or some other means of introducing foreign bodies, such as salts of potassium and sodium, into the arc, for there is not much doubt that the stability of the arc between ordinary cored carbons is due to the presence of potassium silicate in the core.* (See also Appendix I.) These

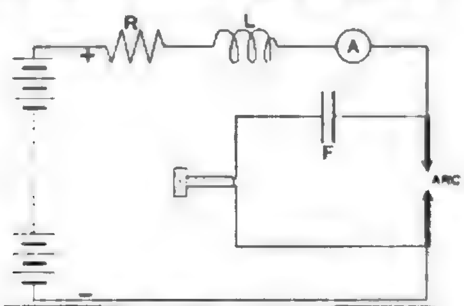


Fig. 4.

salts may be introduced either by soaking the carbons in their solution, or by using them as cores. Mr. Jervis Smith has recommended the insulator glass as a core, which I find works well.

*Arc as a Telephone Transmitter.*—Before leaving the subject of the use of the arc as a telephone, it will be convenient to consider its use as a telephone *transmitter*, though this subject strictly belongs to Part II. of this paper. H. Simon found that if he replaced his microphone in Fig. 2 by a telephone receiver, *any sounds made near the arc were heard in the receiver*. In this case, as before, I find it preferable to modify his method by connecting the receiver in series with a condenser between the terminals of the arc, as in Fig. 4. A sound wave striking the arc may affect it in two ways, either by vibrating the arc as a whole and varying its length, or the waves of condensation and rarefaction may alter the cross section of the arc; both of these effects will tend to alter the apparent resistance of the arc, and hence vary the current through it. The sounds obtained in the telephone receiver when using the direct-current arc as a transmitter are not generally very satisfactory, as, besides not being very loud, they are obscured by the extraneous sounds due to the small spits and hisses which occur in the arc each time the air gets to the + crater due to any slight defect in the carbons. If a common pair of carbons be used containing cracks and impurities, the noise in the receiver is sometimes unbearable, although there is no outside source of disturbance of the current through the circuit.

In all experiments on the arc as a telephone transmitter or receiver, it is essential that the current generator should be free from rapid variations, or extraneous sounds will be produced. If a dynamo has to be used, then the variations of the current produced by the commutator segments may be minimised by inserting a large self-induction in series with the arc, as in Figs. 1, 3, and 4. This self-induction serves the double purpose of keeping extraneous variations of the current out of the arc, and of preventing the variations we desire to observe from being dissipated in the source of supply. Thus we see that *the direct-current arc is not only extremely sensitive to small variations in its current of almost any frequency, but also that it is affected by such small changes of outside conditions as sound-waves produce.* Whether this sensibility can be turned to useful account in telegraphy or telephony remains for future experiment to decide.

## PART II.—Current caused to vary by the Arc.

*Humming.*—Mr. Trotter* discovered that the direct-current humming arc rotates, including a coma-like appearance at the + crater, and he also found that the current through the arc varied periodically, the frequency of these variations being the same as the pitch of the humming sound produced, and as the speed of rotation of the arc. In order further to investigate the connection between the variation of the light P.D. and the current, I have recorded the P.D. and current by means of an oscillograph, the humming arc experimented on being used as the source of light to illuminate the oscillograph mirrors. The arc was so inclined that only the light from the + crater and a small part of the vapour column reached the mirrors. So that the density at any point of the lines represents the photographic intensity of the light emitted at that instant in the direction of the mirrors by the + crater and part of the vapour column, and the distance of the point from this zero line measures the P.D. or the current as the case may be.†

A typical example of the variations observed in the humming arc is given in Fig. 5, from which it will be seen that the P.D. current and light emitted in a fixed direction vary in a regular periodic manner with the same frequency. The variation of the current, which is about 6 per cent. from the mean, is not sufficient to account for the large variation in the light emitted in the direction of the mirrors. This periodic variation of the light is most probably due to the fact that the arc rotates so that the + crater alternately either supplies light to the oscillograph mirrors, or is prevented from doing so by being on the other side of the + carbon. The periodic time of the variations of the light will, of course, be unaffected by a change in the position from which the arc is observed, but the times at which the light maxima occur relatively to the times at which the current is a maximum will depend on this position. *Thus besides the rotation of the humming arc and the variation of the current observed by Mr. Trotter, I find that the light and P.D. vary with the same frequency, so that in the humming arc the frequencies of the rotation of the arc, and of the variations in the P.D. current, and light emitted in a given direction, are identical with the pitch of the note given out.*

*Hissing*—It has been shown by Messrs. Frith and Rodgers‡ and by Messrs. Duddell and Marchant,§ that when a direct-current arc supplied from a constant source hisses, the current through it and the P.D. between its terminals vary rapidly; and M. Blondel‖ and Mr. Brown¶ have also found that the light emitted varies. If the current through the humming arc be increased until the arc hisses, the variations in P.D., current, and light change, I find, in a most striking manner from the regular periodic variations of Fig. 5 to the very irregular variations shown in Figs. 6 and 7. In spite of the very irregular nature of the variations, which irregularity is not surprising in view of Mrs. Ayrton's explanation of the cause of hissing given before this Institution last year, I think that they can be separated into two kinds, a large comparatively slow variation, and a rapid superimposed one. The light given out is alternately bright, with rapid variations in intensity, $a$ to $b$, Fig. 6, and dull with hardly any variations, $b$ to $c$; the slow variation of the light corresponding with the larger variation of the current: the maximum light and current do not, however, occur simultaneously.

* See Duddell and Marchant, *Proceedings* of the Institution of Electrical Engineers, 1899, Vol. XXVIII., p. 66; Blondel, International Congress of Electricity, Paris, 1900.

* *The Electrician*, 1894, Vol. XXXIII., p. 298.

† In Figs. 5, 6 and 7, the centre line is not the zero line, but represents 20 amperes and 40 volts.

‡ *Proceedings* of the Physical Society, 1896, Vol. XIV., p. 320.

§ *Journal* of the Institution of Electrical Engineers, 1899, Vol. XXVIII., p. 86.

‖ *La Lumière Électrique*, 1892, Vol. XLIII., p. 51.

¶ *Physical Review*, 1898, Vol. VII., p. 210.

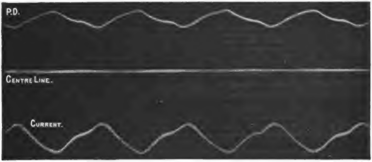


FIG. 5.—HUMMING ARC.

Carbons: +11mm. and −9mm. Solid "Apostle."
Mean P.D. = 50·5 volts. Mean Current = 15·2 amperes.

Scales: 1mm. = 0·5 volt = 0·186 ampere = [illegible] second.
Centre Line = 40 volts = 20 amperes.

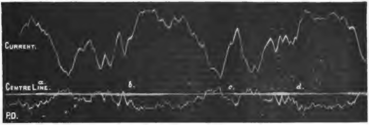


FIG. 6.—HISSING ARC.

Carbons: +11mm. and −9mm. Solid "Apostle."
Mean P.D. = 38 volts. Mean Current = 22·3 amperes.

Scales: 1mm. = 0·5 volt = 0·1 ampere = [illegible] second.
Centre Line = 40 volts = 20 amperes.

FIG. 7.—HISSING ARC.

Carbons: +11mm. and −9mm. Solid "Apostle."
Mean P.D. = 44·5 volts. Mean Current = 19·5 amperes.

Scales: 1mm. = 0·5 volt = 0·1 ampere = [illegible] second.
Centre Line = 40 volts = 20 amperes.

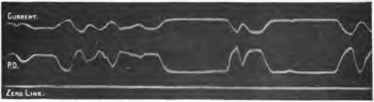


FIG. 8.—VERY STRONG HISSING ARC.

Carbons: +11mm. Cored "Apostle." −9mm. Solid "Apostle."

Scales: 1mm. = 1·5 volts = 1·0 ampere = [illegible] second.

In view of the explation given in the case of the humming arc that the large variations of the light is due to its rotation, and in view of the fact that the hissing arc is also probably rotating, as pointed out by Mrs. Ayrton, I think that the larger variations of P.D., current, and light in the hissing arc must also be due to the rotation of the arc. If this is the case, then the brighter parts of the curves are produced by light from the + crater, and the rapid variations of density chiefly present in these parts of the lines are due to the rapid variation of this light from the + crater. Now these rapid variations in the light correspond with the small rapid changes in the current and the P.D., so that *the rapid variations of P.D. and current correspond with the variations of the light emitted by the + crater, and the large slow variations with the rotation of the arc as a whole.* Considering one of the larger light maxima, say from *a* to *b*, or *c* to *d*, Fig. 6, during which the oscillograph mirrors receive the light from the + crater without being obstructed by the carbon, it will be seen that in many cases the maximum light and minimum P.D. occur practically at the same instant, whilst the *maximum current occurs later than the light maximum.* This is the opposite to what occurs when the current through the arc is varied by any *change in the circuit*, for in this latter case *the maximum current occurs before the light maximum.*

The periodically recurring sequence of events in the hissing arc is thus probably as follows, putting aside the rotation of the arc as a whole. Owing to the crater becoming too large for the end of the +carbon, the air obtains access to the crater surface as found by Mrs. Ayrton, the oxygen of the air there combines with the carbon, causing a rise of temperature, an increase of brilliancy, a drop in the P.D., followed very slightly later by a rise in the current. I think that the above observations on hissing and humming are explained by, and confirm, the fundamental nature of Mrs. Ayrton's discovery of the cause of the hissing of the arc.

*Sounds Emitted by Very Short Arcs.*—A very short hissing arc, so short that practically no light can get out from between the carbons, sometimes produces a shrill whistling sound, accompanied by a small tongue of green flame. The variation of P.D. and current for such an arc are given in Fig. 8, in which the current and P.D. have varied between two limits—viz., 22·5 amperes at 24 volts, and 28 amperes at 9·5 volts, the former of which would produce a hissing arc, while the later values of the current and P.D. can only be explained on the assumption that the arc is short-circuited by a bad contact, such as a loose piece of carbon. The whistling sound is probably due to the periodical short-circuiting and re-lighting of the arc.

*Sounds Emitted by Very Long Arcs.*—The frying sounds emitted by very long arcs, noticed by Mrs. Ayrton,* are probably due to the fact that long arcs are very sensitive as telephone receivers, as mentioned in Part I., so that very slight variations in the current will cause them to give out sounds. In confirmation of this it may be mentioned that a *very long silent* arc can be obtained if the arc is supplied with current from *accumulators* which are *not* in use for *any other* purpose, and if the arc circuit be so arranged that *no* variations of the current can be induced or produced in it by causes outside the arc. If, on the other hand, the direct-current arc be supplied by a dynamo, or if the arc circuit be placed so that there is mutual induction between it and leads carrying a dynamo current, then the long arc will give out a sound corresponding with rate at which the dynamo segments pass the brushes. This explanation was, I believe, first suggested by Prof. Ayrton and Mr. Mather.

*Intermittent Arcs.*—If a direct or alternate-current arc be blown out by means of a jet of air or $CO_2$, or by means of a transverse magnetic field, it will, under suitable conditions, re-light itself; and if the blowing be continued, the arc will be extinguished and relight itself again and again with great rapidity, giving out a harsh sound. The rapidity of these intermittances may be very great; M. Blondel† has found them to be as high as 3,000 to 4,000 per sec. in the case of the alternate-current arc, and M. Abraham‡ has obtained 100,000 per sec. in the case of the flame discharge. It was suggested by Prof. Fitzgerald that this intermittance of the arc might be used to produce some high-frequency alternating current which I required. I therefore tried rendering a direct-current carbon arc in series, with a self-induction intermittent by means of a magnet. With this arrangement the rate of intermittance was irregular and not very high, probably owing to the E.M.F. of my source of supply being too low, although E.M.F.s up to 300 volts were employed. In order to try and overcome this irregularity, I connected a condenser (about 5mf.) between the terminals of the arc, when to my surprise I found that the direct-current arc was intermittent even when *not* blown in any apparent way either by a stream of gas or by a magnetic field, and further, that no self-induction in series with the arc was necessary.

Here, then, was a puzzle—a direct-current solid arc burning under ordinary conditions with resistance in series, and supplied with current from accumulators, became intermittent and gave out a musical note on simply shunting the arc with a condenser. Leads were, of course, employed to connect the condenser as a shunt to the arc, and on twisting these leads together so as to destroy the small amount of self-induction which they possessed, I found that the musical note stopped, to be started again on separating the leads; and on interposing in the condenser circuit a loose coil of wire, the sound was greatly magnified. Hence the true statement of the facts is that given in the next paragraph.

*(To be concluded.)*

* *The Electrician*, Vol. XXXIV., p. 338.
† *La Lumière Electrique*, 1893, Vol. XLIII., p. 54.
‡ Société Française de Physique, "Séances," 1899, II., p. 70.

## ON THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.

*(Concluded from page 239.)*

**The following is an abstract of the conclusion of the discussion on Mr. Langdon's Paper on the above subject before the Institution of Electrical Engineers, which took place on December 7th:—**

Mr. ROBERT HAMMOND remarked upon the immense new field which the Paper showed was opening out for the young as well as for the old electrical engineer. It was impossible, in thinking of this vast field, not to be reminded of the great achievements that electricity had made in the past. Mr. Langdon, in a most painstaking Paper, had pointed out still another field for the electrical engineer—viz., the supersession of the steam locomotive. There had been some very bold conceptions in that Institution, but, as a constant railway traveller, there hardly seemed to him a happier suggestion than that we should do away with the period when we rode behind a chimney and got very uncomfortable with dirt or dust, just in the same way as we formerly were content to be illuminated at night with a light that was competing with us for the oxygen that was necessary for our life. Mr. Langdon was entitled to their thanks because he not only came forward and said that such a thing in his opinion was possible, but he showed from A to Z how the thing could be carried out. He did not hesitate to suggest certain methods of generation and distribution of electrical energy. He set out the capital outlay that his scheme would cost; he dealt with an actual 50 miles of line and went into the question as to how he would place his substations; of his primary and secondary voltage, and worked out the actual cost. He finally compared his costs with those which have been recorded by the great railways for so many years, and had shown that on the average costs of a large number of years he was prepared to see a saving of over a quarter of a million, and, moreover, in taking the average cost for a great many years he was taking a figure which was really unfavourable to his argument because it was well known amongst railway men that costs had tended to increase. Mr. Raworth, in a particularly happy speech, at the last meeting deprecated criticism of the details of the author's scheme, and begged us to confine ourselves to the financial aspect. Well, it was manifest to all of them that, as far as railway directors or shareholders were concerned, they cared little about the methods, and they would adopt this new plant or not, accordingly as it would increase or make more certain their dividends. But he could not follow Mr. Raworth in his suggestion that the proper way of dealing with the Paper was to deal with it as a question of principle. A certain scheme had been laid before them, and it ought to be studied. Mr. Robinson, for instance, had pointed out that, in his opinion, instead of having one central station economy might be obtained by having some five stations, and the best compliment to pay Mr. Langdon was that they should discuss the details of his Paper instead of confining themselves to the general principle. Of course, the Paper could easily be summed up. The two main points were: (1) Was the plan of running full-gauge railways by electricity feasible? and (2) were the estimates laid before them in connection with this scheme sound or not? With regard to the feasibility, he thought they might unhesitatingly let it go forth to the world that the opinion of the Institution was that railways could be run electrically. They had sufficient data before them to uphold this opinion, and, moreover, it was being done at the present time. For the past 18 months the Burgdorf-Thun line had been running, which, as many of them knew, was a full-gauge railway. It had a length of 25 miles, and, comparing it with the plan laid down by Mr. Langdon, he mentioned that the primary voltage on that line was 4,000, and was reduced to 750 volts on the cars. In addition, there was a line actually in course of construction by Messrs. Schuckert and Messrs. Ganz & Co., in Northern Italy. The first section was for 70 miles, and this eventually would be increased to 110 miles. On the Burgdorf-Thun line the sub-stations were placed 2 miles apart, whereas on this Italian line they were placed 10 miles apart, and the extraordinary plan was being put into vogue of running with a primary voltage of 20,000, and reducing only to 3,000 volts on the cars. When he was in Budapest a short time ago he, in company with Mr. Otto Blathy, went over the trolley portion of the line there, and there again they were using a secondary voltage of 3,000. He had gone carefully through the figures in the Paper, and considered the estimates of working costs sound. He also considered the idea suggested by Mr. Robinson worthy of consideration, but the question of water facilities supported the large central station theory. The problem in England differed from the problem in any other part of the world, in that we had coal at 7s. 11½d. per ton, which could easily be taken to the point where it can be best used.

Mr. HOY, of the Lancashire and Yorkshire Railway, sent a letter pointing out what he thought was a misconception on Mr. Langdon's part, in the following sentence: "The main gain, however, is to be found in the economy of a stationary, as against an itinerant generator, as well as in the fact that much coal is consumed by goods and mineral trains when

shunted, and by all trains when standing at stations, the whole of which would be saved if worked by electricity." He begged to say that this was not so, very much the reverse. Mr. Langdon's stationary engine would be continually revolving, and coal would be consumed to produce these revolutions, although it may not be doing any legitimate work. On the other hand, the moment a locomotive came to a standstill the wheels ceased to revolve. Therefore the consumption of fuel in the fire-box was a negligible quantity, and the conditions of economy were more favourable than those which took place in a domestic firegrate. The engine driver who knew his business closed his damper when he was put into a siding or was stopped for any length of time, a course of treatment which, if continued, would result in the fire going out altogether. The fire was, therefore, very sensitive to fluctuations of load, hence the economy.

Prof. GEORGE FORBES thought it was hardly a Paper to be brought before the Institution. To his mind it was of a too general a character, and evidently had not been worked out in its fullest details. The result that a stationary engine was cheaper than a locomotive had been known for years, and if Mr. Langdon had read the Paper before the Society of Arts, or published it before some popular audience, it would have deserved unqualified praise in every way, as bringing attention to a subject which had been interesting engineers for a large number of years. The subject was an old one, and if, in discussing the point, he drew attention to the work he had done himself, it was not with the least idea that he stood alone. The subject had been common conversation for the last 25 years, but the only new facts brought to light which had not been common knowledge for 25 years were the number of trains passing between two Midland stations. The rest of the facts in the Paper were perfectly accessible to everybody who had been discussing the matter. While alluding to the two stations he pointed out that Mr. Langdon had chosen the most favourable instance that was within his cognisance to illustrate the electrical side of the question, but no system such as has been considered for supplying electric power from central stations would prove advantageous unless there was an almost continuous service of trains. With a train every two hours or so the stationary engine lost a good deal of its economy. He first drew attention to the great desirability of introducing electricity on lines of railway in a lecture in Glasgow in 1879; in 1881 he communicated an account of the same thing to *The Times* and the Society of Arts, and continuously from that time onwards himself and others had been discussing the problem and had long ago arrived at the conclusion that a stationary engine consumed less coal than a locomotive. In the ordinary course of his profession he had been obliged to investigate very closely the different methods upon which such a service can be given. Consequently, at the time when the City and South London line was started, Mr. Greathead had asked him to report upon different methods and the way in which that railway could be operated. This line was originally intended for a cable railway and this was the first job for which he had had to estimate figures for costs and working expenses. In 1897-98 he was employed by the Egyptian Government in surveying and reporting upon the Nile cataracts, and this had resulted in the then Sir Herbert Kitchener consulting him about the desert railway from Wady Halfa, a distance of 150 miles. The Sirdar fully saw the point laid before him—viz., introducing stationary engines at Wady Halfa and laying down wires to work electric locomotives to carry materials for construction and the water, but time was pressing and it was impossible to get the materials up. He had also been asked by Sir William Garston, Assistant Secretary of Public Works, to pay particular attention to the feasibility of working the Nile railways electrically, and consequently he had had to go into the question of capital cost and working expenses. He had also had to treat with other railways in other parts of the world. In 1897 the editor of the *Engineering Magazine*, whom he was not acquainted with, happening to know that he had done something in this direction, asked him to write an article for that magazine which was simply a very popular account. He then gave several extracts from his article which, he said, really contained the same conclusions arrived at by Mr. Langdon. In conjunction with Mr. Hammond's proposition that the details of the scheme should be discussed, he did not think Mr. Langdon would claim to have gone into all the different ways in which this could be done. Otherwise he would criticise them very severely: at any rate he would put forward the very opposite opinions. Mr. Langdon said: "Midway in the 50 miles of railway is the central station containing four 2,500kw. three-phase or other characteristic 10,000-volt generators. At this pressure current is distributed to sub-stations, each serving 10 miles of railway, where the potential is converted to 600, from whence it is carried to the contact rail. Or the centre 10-mile section may be provided for by direct current generators served from the same steam plant." He could only say that there was not a single item in that that seemed to be the right thing for the purpose. He knew it was not fair to state an opinion in that general way but if he were to go into the whole of the methods by which he considered that such a line ought to be worked upon, too much time would be occupied besides involving much more laborious calculations than the Paper itself. But since Mr. Hammond asked that they should go into details he had looked into some of the figures, to a slight extent, as to the cost of the go and return cables upon which Mr. Langdon proposed to spend £70,000. As this was based upon 600 volts pressure and had to serve a distance of 5 miles from each sub-station his own general result was that these copper conductors would be 6·6 sq. in. to give a 10 per cent. loss at the midway point. This being so, the total expenditure on this head, if he had understood the Paper, would be some £330,000 and not £70,000. In conclusion, he said that he probably had seemed more critical than he intended to be, and repeated his previous statement as to the desirability of the Paper for any other institution than the Institution of Electrical Engineers.

Mr. HUDDLESTON, chief engineer of construction of the Central London Railway, was of opinion that points of detail should be discussed, especially those dealing with the various savings anticipated by the author, and he chiefly confined himself to the question of coal consumption. But first of all, he thought Mr. Langdon had entirely under-estimated the work required to be done on heavy railways such as was encountered in connection with steam locomotives. As Mr. Raworth had pointed out, the tractive efforts, given in column 7, Table IV., were only applicable to high speeds, and, moreover, were calculated for a comparatively straight and level road. But these things did not exist in practice. In reality they should calculate for very uneven roads and heavy loads. If they divided the tractive effort by the load they would find that Mr. Langdon had obtained the startling result that a mineral or goods train gave a resistance of only 5½lb. This was impossible on railways in England. The ordinary goods train unloaded had a natural resistance of 10lb. on a straight road, whilst on an ordinary average road the resistance was increased enormously. Going uphill the engine had to pull, and coming down hill it was usually necessary to apply the brakes, and there was frequent starting and stopping. The power given out was very much larger than that estimated—viz. 183 H.P. to drag 500 tons; and figures in Mr. Johnson's Paper, mentioned by Mr. Langdon, bore out his statement in this respect: figures, moreover, which related to a series of tests on the Midland Railway. A Paper had also been read before the Institution of Civil Engineers giving figures relating to an elaborate set of tests on the South Western Railway to determine the coal consumption. Express trains had been utilised, which, weighing 250 tons, took about 30lb. of coal per train mile on a fairly easy road. Mr. Smith, in a Paper before the Institution of Mechanical Engineers, obtained a figure of about 40lb. in a set of tests on the North Eastern line with ordinary good north country coal. Webb, on the North Western Railway, only a year ago, with a 420-ton train, obtained a coal consumption, with a compound engine, of about 44lb. per train-mile. All these averaged about the same. The horse-power required in the tests mentioned were: South Western 600 H.P., and the North Eastern from 550 H.P. to 800 H.P. Mr. Langdon gave an average of 477 H.P. for express passenger trains, which ought to be taken at a higher figure, say 600 H.P. Mr. Langdon's figures for ordinary passenger trains seemed to suggest that very little power was required for the weight of the train—viz., 182 H.P. per train hour for a 300-ton train. But there was a lot to do on account of acceleration due to stopping and starting, and the figures were evidently calculated assuming that the speed was regular and the load regular. The last two items in this column 8—viz., 295 H.P. for a train weight 400 tons and 183 H.P. for a goods train of 500 tons should both be nearer 400 H.P. each. Certainly no locomotive superintendent would say that a mineral train of 500 tons would take less than 400 H.P., a statement which could be proved if necessary. In fact, generally speaking, Mr. Langdon had under-estimated the whole of his power. Again, he had estimated for a coal consumption in the power-house of only 3lb. per kilowatt, a figure that had not yet been obtained with the steadiest load in any power-house in England, and with a railway a steady load was not to be obtained. It might vary from 60 per cent. to 140 per cent. Curiously enough, there were several electric railways in England, and two of them were well known to him. Both of them had compound engines in the power-house: both had more trains per hour than Mr. Langdon estimated, yet their coal consumption did not compare favourably with the District Railway. Mr. Cunningham had given an average of 0·4lb. for the Central London, but this could not be compared with the kind of railways Mr. Langdon had taken as his basis, because on the Central London there were short distances between the stations and consequent frequent starting and stopping. A similar state of affairs existed on the Underground, with this difference—the Underground was a practically level line, whereas the switchback construction of the Central London performed 30 per cent. of the work of acceleration, yet the coal consumption on the District was only 0·25lb. per ton-mile. He was quite aware of the fact that the best quality of coal was used on this line on account of the fumes, yet all this difference could not be traced to the fact of burning South Wales coal. Probably on the electric lines their coal consumption would come down to 0·3lb. with South Wales coal, but they would have a hard job to get past 0·25lb. All this proved his statement that Mr. Langdon had under-estimated considerably, and with our present knowledge of electricity he did not see how they could expect an economy of this sort.

Mr. A. A. C. SWINTON disagreed with Prof. Forbes as to the suitability of the Paper for the Institution. Until he had heard Prof. Forbes speak he was under the impression that everybody thought it eminently suitable, and he himself thought it one of the most interesting and suggestive Papers we had had for a long time. It was only about a year ago that he had had a conversation in London with a very eminent authority upon matters of this kind—viz., Mr. George Westinghouse, and he had gathered from this conversation that Mr. Westinghouse did not contemplate the possibility of the adoption of electricity for main line trains in the least. However, very shortly Mr. Westinghouse thought that suburban traffic in America would be run almost entirely electrically. Personally, he had looked into the question with regard to a contemplated line and had made some estimates of what the scheme would cost. The line was about the same length as that taken by the author—viz., just over 50 miles, whereas Mr. Langdon's was just under 50 miles, and his calculations gave him £523,000 against £500,000, but there the resemblance, he was sorry to say, stopped. He confessed that he did not understand Mr. Langdon's figures with regard to what Prof. Forbes had called attention to—viz., cables and contact rails. How was he going to do what was necessary in this direction for £140,000? It would be very interesting if Mr. Langdon would give further details of these two items. In his (Mr. Swinton's) case the power required was very much less because there were fewer trains running at one time, and, although his total expenditure came to about the same as Mr. Langdon's, much less was represented by generating plant, and a great deal more by plant for distribution in cables and trolley wire. But there was one point where an economy might be obtained, and of which Mr. Langdon had not

taken advantage. Mr. Hammond had already referred to the Burgdorf-Thun line, and they knew that this was worked directly by three-phase currents. There were no rotatory transformers, and he believed that the voltage on the motors was 750. This was not very different to the voltage allowed by Mr. Langdon, while Mr. Hammond had referred to a line where they were going to use 3,000 volts on the motors. He did not know of anything—except, perhaps, the Board of Trade regulations—which was to prevent the use of considerably higher voltages than 600 upon the motors, and if in using higher voltages we could successfully employ three-phase motors, and save the rotatory transformers, there would not only be a considerable saving in capital cost, but also an increased efficiency, and, more important still, no necessity for attendance at the sub-stations. Where they employed rotatory transformers they must have attendance, but static transformers could be shut up and left to themselves. Since the reading of the Paper he had seen Mr. Brown, of Brown, Boveri & Co., who in answer to a question had stated his intention, if asked to design a line of railway in England, of following exactly the same practice as had had been used on the Burgdorf-Thun line—viz., three-phase motors without rotatory transformers. His last point was in connection with Mr. Robinson's remarks—viz., the question of the economy of large stations. Some of them had spent many weeks last year in trying to persuade a Committee of the House of Commons—and they did persuade them—that there was economy in large stations. If there was no economy in large stations there was no advantage in electric power bills: it was the whole gist of the matter. Mr. Robinson and some people seemed to think that the whole matter was merely a question of how many pounds of coal were required to produce a horse-power in an engine; but coal was only a small item. There was the question of capital cost. Did Mr. Robinson or anybody else suggest that a station for 10,000kw. costs ten times as much as one for 1,000kw.?

Mr. ROBINSON: It costs twice as much as one for 5,000kw.

Mr. SWINTON thought this might possibly be the case, but he would not agree to it. Further, when using a 10,000kw. station it was possible to do all manner of things that could not possibly be done with a 1,000kw. station, and which they could not afford to do with 5,000kw. Personally he would not put in 10,000kw., but was more inclined to put the figure at 100,000kw. In fact, he did not think the limit could be put anywhere. The bigger the station the more the economy, and the easier it was to go in for all manner of different economies in the shape of coal-conveying apparatus, and various things of that kind. One big disadvantage in this connection he pointed out—viz., that if, as Mr. Robinson and Mr. Hoy had suggested, a station was erected about every mile along the line, how were they going to get a constant load? Each station would be working for about five minutes, and then it would have to be shut down. They could only get a constant load by having one station to work a long length of line.

Mr. A. H. WALTON did not agree with Mr. Hammond that everything was as it should be in this Paper. Mr. Langdon had put the case before them in a very broad manner, but he thought he was wrong in his result for the tractive effort. The figures for mechanical horse-power were far too low, and as an instance he referred to Mr. Langdon's express train, which was given as low as 26 watt hours per ton-mile. The best he had ever heard of was a little over 40 watt hours per ton-mile, and if Molesworth's formula were taken instead of Mr. Langdon's, the result would be more near the correct one. He agreed with Mr. Huddleston on the question of coal consumption: 4lb. to 5lb. per kilowatt in practice was a fairly good result, and they would all be very well satisfied if this could be maintained in the many schemes now before them. Mr. Cunningham last week had stated that on the Central London line the watt hours per ton mile were 70, irrespective of lifts and lighting. But this line had been closely watched since completion under Mr. Huddleston's supervision, and the watt hours per ton mile were 64 9 for everything. An average of 50 had been obtained at the third rail during the last two months, and this had been checked by one-second readings on three or four round trips from the Bank to Shepherd's Bush. Mr. Cunningham had also stated the coal consumption to be 0·5lb., but in watching this item they found the actual figure per kilowatt hour was 0·44lb., which worked out at 6·6lb. per kilowatt hour per ton mile. This seemed rather high, but he questioned whether in discussing this question of coal consumption they were not working in the dark, and he suggested the standardisation of the question. Everybody was burning a different class of coal—no one gave the calorific value of their particular fuel—and therefore to his mind the results and figures given from time to time were not to be taken seriously. He thought Mr. Langdon's estimate of 2½ per cent. for leakage on the line was very excessive. Taking the five sections, this meant 34 amperes per section, or a total loss of 170 amperes, and if they took the resultant E.M.F. of the current which was passing, the most extraordinarily low insulation resistance of 3·5 ohms was obtained. Was there any line going to work on that? Mr. Langdon had been rather too liberal in this instance.

Mr. A. J. LAWSON, while agreeing with Mr. Huddleston on the question of coal consumption, considered Mr. Langdon had done an injustice to his own argument by assuming much too low efficiencies for his motors and distribution throughout. He could get nearly 90 per cent. out of his motors, instead of 85 per cent., an ohmic loss of 5 per cent., and an efficiency of 97 per cent. in his static transformers instead of 93 per cent., as well as 95 per cent. in his high-tension transmission instead of 90 per cent. Even if he used three-phase transmission and eliminated altogether his rotatory converters, by taking the above efficiencies he (Mr. Langdon) could still obtain 62½ per cent. instead of 58 per cent., whilst taking the efficiencies of transformers at his (Mr. Lawson's) estimate an efficiency of 75 per cent. for the whole system could be obtained. This would go very far towards reducing the coal bills.

Mr. ALEXANDER SIEMENS drew attention to the title of the Paper, viz.: the Supersession of the Steam Locomotive, and that the discussion had resolved itself into the question of as to whether a railway with 11 trains or 12 trains per hour was cheaper to run electrically than by steam. We all know that: Prof. Forbes had already pointed this out, and it did not want proof. But Mr. Langdon proposed that the Midland Railway should go on converting its line gradually, 50 miles by 50 miles. Was he going to stop the Scotch express at Bradford to change engines because his conversion had only reached as far as that? And what was Mr. Langdon going to do on those parts of the Midland where there were only a very few trains per day? It was absolutely true that, for suburban traffic, where there were 11 trains or 12 trains per hour and upwards, electricity was the thing, but for the long main line trains, and for that part of a system where there only a few trains per hour, there was no chance of getting an economical electric traction system.

Major CARDEW thought Mr. Walton and Mr. Huddleston might have been misled in regard to column 8 in Table IV., where the mechanical horse-power per train hour did not mean mechanical horse-power on the train. It practically included all stops.

Mr. LANGDON: Yes, the table reduces everything to an hour's work.

Major CARDEW, continuing, said that therefore the horse-power was not intended to express exactly what was the maximum horse-power being used at any time. He agreed with Mr. Walton that the tractive effort was too low. One thing he noticed in the tables given in the Paper was the extremely small amount of work accomplished per week by a steam locomotive, viz., 314 train miles. Here evidently considerable economy could be obtained by electrical running, as this did not seem to be much to get out of a locomotive. He considered the wages bill as regards drivers, &c., on a steam railway came out enormously high, and a good economy was possible in this direction. The possibility of reducing the number of employés in connection with electrical working was made easy by reason of the fact that the work was reduced to absolutely nothing but attention. There was so much time taken up with steam locomotives during coaling and taking in water, and also before starting and after returning to the shed, while in the case of main-line trains three-quarters of an hour was allowed the drivers and firemen before starting, and the same after returning, to the shed, so that economy was certainly to be expected. There was another direction from which economy would result: Mr. Langdon dealt with the traffic as it existed at present; but, with the new means of working, no doubt the tendency would be to run a more frequent service. Then again at terminal stations with motors at each end of the trains these would be cleared out of the stations in very much quicker time than an ordinary train took to be shunted. In the same way the goods traffic could be re-arranged and worked on much better lines. As regards shunting a good deal of use was being made on the Continent of locomotives with accumulators, and they really fulfilled a very desirable object. In shunting neither a large power or speed was required, and these accumulator locomotives saved a good deal of expense in the equipment of sidings. He had seen the experimental line at Budapest, had closely studied it, and was quite satisfied with its working. The arragement of the three-phase motors in series, whereby they tended to halve the speed, resulted in a great saving being effected after the start.

Mr. E. C. DE SEGUNDO thought Mr. Langdon had tackled a question which in the near future would be one of national importance. Referring to the coal consumption, he had looked through some figures, and found that the consumption of coal per kilowatt hour on the Dublin tramways worked out at 2·1lb. on the basis of the boilers evaporating 8lb. per pound of coal. At Dortmund it was 2·8lb. and on the Berlin tramways 2·3lb., using saturated steam, and 2·1lb. using superheated steam. He had also worked out the average coal consumption per kilowatt hour at a number of important Continental stations and this worked out at 4·5lb. But although these figures proved Mr. Langdon's estimate to be somewhat narrow, one had yet to be quite sure as to the nature of the load under the conditions which Mr. Langdon's figures were to be obtained. So far there had not been a sufficiently extended record of the performance of electric locomotives in railway work under the conditions which obtain on any ordinary main steam line to enable anything more than a guess at the nature of the load factor.

Mr. FRANK SPRAGUE thought he was making a perfectly safe statement in that electric railways would not be conducted on the lines of steam railways, and that the question was not the supersession of the steam locomotive. The electric locomotive in the sense that we spoke of the steam locomotive would not exist. When a locomotive was rated we spoke of the continuous output it was capable of. It must run for so many hours with only a certain temperature rise. In other words the heating conditions were such that the machine had to be in the nature of a permanent machine. When dealing with stationary engines it was a different matter. It was to be a machine capable of giving a certain horse-power. Manufacturers of electric motors had adopted an entirely different method. We heard of motors of 50 H.P., 75 H.P., and up to 160 H.P., the latter being probably among the largest units manufactured. But this was not the rating of a railway motor, properly speaking. Common-sense would teach that an electric locomotive to be put against a steam locomotive should be a machine of equal service and equal reliability. There was only one way to rate a railway motor, and that was on what it could do hour after hour on active service. He agreed with Mr. Huddlestone that the figures in Table IV. were under-estimated, as regards the actual horse-power required. To his mind, electric locomotion would not take the place of steam locomotion. There must be small units simply because these were limited in capacity. If longer trains were used, then not only must the number of units be extended, but they must all be controlled at the distributing end of the different cars. He had had to face the fact in practice that sufficient machine power could not be put upon one end of a train; it must be distributed. It was perfectly possible to distribute any number of units at the car ends equipped with any amount of power and for trains of any length. It was not a sufficient reason for the adoption of electric traction that so much coal could be

saved: this should be a secondary consideration. Trunk line service must be changed. The question resolved itself into the number of units operating between two points. With an increased number of units, and an increased speed of service, then, there was field for electrical application, and then only.

Prof. C. A. CARUS-WILSON inclined to the opinion that it was not upon main lines that electricity was going to make its first introduction in this country. There were three fundamental reasons why electricity should not be introduced upon main lines of steam railways: (1) Branch lines were not a profitable part of any railway system as existing at present. Taking the whole mileage of a railway system, it would be found that the branch lines were the unprofitable mileage of that system, and therefore it was to the interest of a railway company to make them more profitable. From the most recent Board of Trade returns the data concerning the Midland Railway showed that the average profit per passenger per train-mile was 10d. The average number of branch line trains was not more than six per day, and the profit only about 5s. per day per train. Taking the number of main line trains passing through Bedford on the average at about 13 passenger trains per day, the profit here was 25s., thus showing that the Midland main line was about five times as remunerative as the branch lines. (2) Branch lines were greatly responsible for the unpunctuality on a railway system. The existing traffic on branch lines did not permit of a sufficient staff to handle it as it should be handled, chiefly on account of the infrequent service. The traffic on these lines usually came up with a rush, the staff was not capable of managing it promptly, and the result was unpunctuality and unpopularity. (3) On account of the unpunctuality and infrequency of branch-line service this was being menaced by new electric tramway systems which were springing up. Main lines were safe in this respect, but the branch lines were not, and the management was bound to consider the possibility of running a better service on such lines electrically. On the Midland there were four lines radiating out of Bedford, and on the average there were six trains per day each way on each of these four lines. What had to be considered was the amount each one of these lines contributed as profit to the revenue of the company. He assumed that on the Midland Company's branch lines radiating from Bedford on a rating of six trains per day each way, the number of 1d. passengers required per mile in order that each mile of these lines should contribute its share to the profits of the company would have to be 265.000. In order to increase the service to meet in any degree the service existing on the main lines—and this was the great difficulty—the number of trains would have to be increased from six to 24 per day, or one every half-hour. On this calculation an increase of 75 per cent. in the passengers carried would be necessary in order to pay expenses. This was based on a certain fixed charge due on every mile of the system before any profit could be made—viz., 11d. per steam train mile. This was the result obtained by increasing the present steam service. But to do it electrically he proposed to break up the ordinary passenger train into four parts equipped with motors, and let each one of these parts take a trip every half hour. To get a half-hourly service with steam an increase in the 1d. passengers of 75 per cent. was necessary, and the cost would be approximately 11d. per steam train mile. Go through the whole of the calculations with electrical working, and they could get a 60-ton train every half-hour with only a 30 per cent. increase in the passengers in order to pay expenses, and also do it for 6d. per train mile. This was a 1d. less than Mr. Langdon's estimate. It was reasonable, however, to anticipate, with an accelerated service, an increase of more than 30 per cent. in the passengers, and everything above this was clear profit. By this means railway companies could get a better service, compete with the tramways and make good connection with their main lines.

Mr. W. LANGDON, in reply, said that to his mind the applicability of electric power had been fully demonstrated, and the only question to be determined were the economies attending its use should it be found applicable in connection with our large steam railways. He had been attacked for bringing the Paper before the Institution of Electrical Engineers, but it certainly appeared to him that it was a question intimately concerning their Institution and that no better body could be found to discuss its merits or demerits. He quite expected that some of his deductions might be erroneous, but he had endeavoured to deal with the matter in an unbiassed manner. He did not suppose that if electric traction were applied—as it undoubtedly would be—it would be in his time. Although Prof. Forbes thought the Paper ought to have gone elsewhere he had to a certain extent criticised some of the deductions arrived at by it. But the matter had been dealt with in an abstract manner and its purpose was to evolve, if possible, some result as to the economy or other advantages that might attend the use of electricity on our main railways, and it had appeared to him that there was much more chance of a successful issue if applied on lines which were full of trains with a great deal of work going on. For this reason he had chosen the London-Bedford section. On the question of the fallacy of his traction formula he said it had come to him from actual experiments with respect to all kinds of passenger trains. He felt convinced that Mr. Robinson's remarks on the question of large versus small generating stations were made in a bona-fide manner, but at the same time, he was of the opinion that with a central generating station it was possible to transfer the load from one section to another. If local generating stations were established provision would have to be made for the maximum number of trains ever likely to be in that section, and the power must be there always. This meant an increase in the plant, whereas the load would not be constant, therefore the same economy with regard to coal bill would not be effected as in the case of a large central station. Since the last meeting he had gone into the question of establishing these local generating stations, and it has transpired that, with regard to the primary outlay, instead of £470,000 it would be £430,000. With regard to working expenses, however, this worked out at 0·8233d. per kilowatt, as against 0·6726d. for the central generating station; and per train mile the figure was 7·160 against 7·021. If the interest on the outlay were added they got the result of 0·9233d. per kilowatt for the local generating station as against 0·7716d. for the large station, and 8·0208 per train mile as against 7·962. In making these calculations he had allowed coal at 4lb. per kilowatt. However, the question as to whether a section of the line could be worked more economically or with greater advantage from a central station feeding so many sub-stations, or whether the lines should be subdivided into sections, and each section supplied by its own generating plant, was one which might be carefully considered at a time when railway companies invited proposals on the matter. His coal consumption had been stated to be insufficient, and Mr. Cunningham mentioned 3·6lbs. as the lowest he was aware of. Mr. Parsons had suggested 2·5, but only a short time since *Engineering* had published some data upon the subject from which he abstracted the following: On the Chicago elevated line it was 1·75lb.; Boston, 2·61lb. to 4·13lb., the average working out at 3lb.; Baltimore City, 3·23lb.; Brooklyn City, 3lb. Again, in the *Engineer* for May 25, in reference to the Berlin tramways it was stated that 2·1lb. of coal were used with superheated steam, and 2·3lb. with saturated steam. The cost of drivers had been mentioned more than once, and Mr. Crompton considered that a less wage might be paid to the class of driver who would be required to handle an electric locomotive. Possibly this might be so, for he had, in all his charges, endeavoured to deal with them in such a liberal manner that no critic could say he had favoured his own argument. There was no doubt that the cost of drivers was a very heavy charge indeed, but he did not see how it was in any way to be modified unless the traffic arrangements were also modified. His estimate for repairs and renewals—viz., 2d. per train mile, had been considered excessive, and it was correct, as Mr. Crompton had mentioned, that the chief repairs on a steam line—viz., the locomotive boilers, were eliminated altogether. Polyphase working would require two contact rails, which would introduce a great deal of complication. One only should be used, and generally the whole gist of the matter lay in the method by which the current was to be conveyed to the trains; and for this reason, if possible, he advocated the placing of the contact rail *outside* the ordinary rails. Time prevented Mr. Langdon from replying at greater length, and a more complete reply will be found in the *Journal*.

A vote of thanks to the author terminated the proceedings.

## LIQUID FUEL.*

BY E. L. ORDE.

The early history of liquid fuel has been so ably put before this Institution by the late Mr. B. G. Nichol, and later in the admirable Paper of Mr. Wallis, that there is no need to-day to recapitulate what has been done up to the present time with this form of combustible. The writer, however, ventures to think that the practical results of some experiments with which he was entrusted, and the conclusions to which they have led, may be not without interest to the members of this Institution, and may, at all events, form the basis of a profitable and interesting discussion. It is only within the last few years that liquid fuel has come within the province of engineers in this country, owing to the fact that hitherto it has only been practically obtainable in the vicinity of the Caspian Sea at such a price as renders it commercially possible. Within the last few years, however, a considerable change has taken place. New oil fields have been discovered, and the number of places along the eastern route at which liquid fuel can be obtained has increased so enormously that it becomes a serious question for shipowners to consider whether it is not an absolute economy to use it in preference to coal on vessels trading to the eastward. The solution of this question lies first in the cost of the fuel and its practical calorific value as compared with coal. Secondly, in its effect on the life of the boiler furnaces in which it is burnt; and thirdly, perhaps the most important of all, its immunity from danger. The first point is, of course, constantly varying, and is one which the writer is not in a position to pursue. The two latter practically resolve themselves into one—the efficient combustion of the fuel. The existing appliances designed for the purpose may be broadly divided into three.

1st. Those in which the liquid fuel is injected into the furnace in the form of a spray by purely mechanical means.

2nd. Those in which the spray is produced by the introduction of a gaseous medium. And

3rd. Where the liquid fuel is introduced into the furnace in the form of vapour.

Before considering the respective merits of these three classes of apparatus it will be advantageous to realise the actual possibilities of the fuel. The experiments which the writer carried out were made with crude Borneo oil, which is in all respects an excellent fuel oil, and is to be obtained in large quantities. Its composition is:—

| | | |
|---|---|---|
| Carbon.................. | 87·09 | per cent. |
| Hydrogen ........... | 10·78 | do. |
| Oxygen .............. | 1·24 | do. |

The flash point is 211° F.; the boiling point is 395 F. The calorific value determined by the bomb calorimeter is 18,831 B.T.U. It is an exceptionally clean and mobile fuel oil, and with its high-flash point the risk of adventitious explosion is reduced to a minimum. All fuel oils are exceedingly complex, in as much as they are made up

* Paper read before the North-East Institution of Engineers and Shipbuilders, Nov. 16.

of a number of combinations of carbon and hydrogen which only a chemist who has devoted himself to investigating hydrocarbons can appreciate at their true significance. The importance of this point for the practical purposes of the engineer lies in the fact that the various constituents of the fuel give off vapour at temperatures varying from about 100°F., up to the boiling point of the oil, and when the boiling point is approached—unless special precautions are taken—a residue of solid carbon is formed which will soon choke any pipes or narrow passages through which the fuel may have to pass. Having thus considered the characteristics of a typical fuel oil, we may now return to the consideration of the apparatus for burning it.

In the first type—the purely mechanical spray—the oil is discharged under pressure into what is commonly called a burner, which is made of such a form that the effluent jet is broken up into particles sufficiently small to burn readily at the firing point of the fuel. The full efficiency of the system can only be obtained by lining the furnace with firebricks, or other non-conducting material, so as to raise the furnace temperature (by preventing the absorption of heat into the boiler) until it is sufficiently high to vaporise the greater portion of the oil before it is burned. The quantity of air required to complete combustion is very largely in excess of what is chemically necessary, and the furnace space required for oxidation is large. The advantages of the system are: First, its simplicity; and secondly, its noiselessness. As regards efficiency, the best results that the writer has been able to find recorded show an evaporative efficiency of about 12·5lb. of water from and at 212deg. per pound of oil. With Borneo oil this gives a fuel efficiency of 64·6 per cent. In the second class the oil is introduced into the furnace in the form of a spray in the presence of a gaseous medium—be it steam or air. In most of these appliances a partial lining of firebrick is fitted in the furnace, and a brick bridge or baffles of various forms are built with a view of obtaining complete oxidation of the fuel. The earliest form of this apparatus consisted simply of two pipes lying one above the other, and having their ends flattened so as to spread the streams of oil and steam. Oil is admitted to the upper pipe, and is allowed to drop from the orifice into the jet of steam which passes through the lower pipe and meeting the oil breaks it up into particles sufficiently small to ignite as soon as the firing point is reached. This simple device has been improved upon by numbers of engineers, and most of the improved burners of this type take the form of concentric tubes, through which the oil and steam are passed. Adjusting arrangements are always provided, so that the supply of the two elements can be regulated at will. This type is better known than any other, and has, so far, given the best results. The evaporative efficiency of the best burners of this type seems to be about 13·14lb. from and at 212deg., but the supply of air required for oxidation though smaller than that demanded by the first class of burner is much above what is chemically necessary. The difference between steam and air as spraying media will be touched upon hereafter. The third class of apparatus, that is, in which the fuel oil is wholly or partially vaporised, promises to give the best results.

Attempts have been made so long ago as 1867 to produce an apparatus on the system, and Colonel Foote claimed remarkable results for his method of solving the problem; these results, however, seem not to be well authenticated. Later, Messrs. Dorsett and Blyth attempted to boil the fuel in one boiler and burn the resultant vapour in the furnace of another. This, however, does not seem to have been very successful. Mr. Thwaite has since then made an apparatus consisting of a retort which is maintained at a red heat, and into the retort a spray of steam and oil is blown; the oil is immediately volatilised and passes through holes in the retort into the furnace, where it is met by a stream of air in which the vapour burns with a clear blue flame. The results are said to be satisfactory, but it is difficult to see how such a process can be carried out with ordinary fuel oils without producing a large deposit of carbon in some form in the retort. An experiment tried by the writer with an apparatus on this principle showed that it was possible to produce a high-furnace temperature and a smokeless fire, but the retort was soon completely choked with solid carbon, or, if the temperature was allowed to fall with a pitch-like substance. This deposit presents the greatest difficulty in the way of vaporising so complex a body as the ordinary fuel oil. As has been pointed out before, the oil consists of a number of hydrocarbon combinations, each of which has a different boiling point.

Another important characteristic of these hydrocarbon compounds is that in the presence of superheated steam they can be completely distilled without cracking, and the explanation of this fact (on which depends the Ragosine process for refining petroleum) has been stated to be that in the presence of superheated steam the boiling point, or, more correctly, the mean boiling point, of the oil is lowered. This distillation, however, does not apparently take place with any other medium but steam. To ensure distillation it is necessary that the temperature of the oil should be raised to as near the boiling point as possible before it is admitted into the presence of the steam, and it is in this part of the process that the danger of cracking appears. In the apparatus fitted by the firm with which the writer is connected the difficulty has been overcome, and so far as it has been possible to ascertain, by ordinary means, complete vaporisation has been secured. The vapour thus produced can be completely oxidised by the amount of air chemically necessary, and a larger quantity of oil can therefore be treated in the same furnace space than by either of the two other systems, while the combustion, as shown by the analysis of the waste gases, is complete. Two typical analyses are given below:—

| *Analysis of Waste Gases.* | | *Analysis of Waste Gases.* | |
|---|---|---|---|
| Carbon dioxide | 13·2 | Carbon dioxide | 12·6 |
| Oxygen | 3·6 | Oxygen | 4·0 |
| Carbon monoxide | 0·0 | Carbon monoxide | 0·0 |
| Hydrocarbon gases | 0·0 | Olefines, &c. | 0·0 |
| Hydrogen | 0·0 | Hydrogen | 0·0 |
| Nitrogen | 83·2 | Nitrogen | 83·4 |
| | 100·0 | | 100·0 |

The only feature calling for remark is the somewhat large percentage of uncombined oxygen, which is no doubt due to leakage around the smokebox. As regards efficiency an evaporation of from 15-16lb. from and at 212deg. should always be obtained with dry Borneo oil.

The hydrocarbon vapour is exceedingly unstable and appears to depend for its existence entirely on temperature. Efforts have been made to collect samples for analysis, but without success. In appearance it is of almost milky whiteness, closely resembling the vapour given off from the retort used in the Pintsch gas system. The smell is pungent, and severe irritation is set up in the membranes of the mouth and throat if the vapour is inhaled. At the temperature of the external air (60deg.) it was found almost impossible to ignite it, and the outer surface of the jet was at once condensed and formed an oil deposit of a very much lighter colour than the fuel oil itself. The flame when the vapour is burned in a boiler furnace over a layer of broken firebrick is of dazzling whiteness and becomes almost transparent as it approaches the bridge. The exact form in which the combustion of these hydrocarbon vapours takes place does not seem to be clearly understood. The appearance of the flame at a distance of a few inches from the nozzle of the burner suggests that at that point the hydrocarbons are burning in the form of acetylene. All gaseous hydrocarbons when exposed to a temperature of 1,000 F. become acetylene, and it seems fair to assume that the vapour will do the same. As the flame proceeds further into the furnace, however, and the temperature becomes higher, the hydrocarbon combination must break up and the rest of the vapour is probably burned as carbon monoxide and hydrogen. This theory is put forward with diffidence in the hope that the reaction, which takes place may be more worthily dealt with in discussion. There seems to be no doubt that the efficiency of liquid fuel lies in the fact that it is capable of being turned into vapours of high calorific power, and that the vaporising process does not demand a large heat expenditure.

The two classes of apparatus first described do not vaporise the fuel before combustion begins, which means that of the heat generated in the furnace some considerable part is absorbed for this purpose, and is therefore not available for evaporating water. To attain to the temperatures required for complete vaporisation, part, at all events, of the constituents must be exposed to the heat of the furnace, but with careful design the quantity of heat thus abstracted can be reduced considerably below that which is necessary to carry out the process when the fuel is simply injected into the furnace as spray. The fact that superheated steam lowers the boiling point of hydrocarbon oils, and therefore prevents cracking, renders its employment essential if it is desired to burn the fuel as vapour. The objection to using it on board ship is, of course, the loss of fresh water and the amount of heat lost in making this loss good by distilling sea water; this loss, however, is—the writer ventures to think—more than compensated by the gain in efficiency due to using steam as a distilling agent. Mr. Morison has published some calculations of the quantity of fuel required for distilling purposes and applying these calculations to a steamer with engines indicating 2,000 H.P. at sea, the quantity of oil fuel required to make up in the evaporator the water lost in the burners only amounts to one quarter of a ton per day of 24 hours. In this calculation, Mr. Morison's calculated result has been multiplied by *four* to allow for deposit on the surface of the evaporating coils. With air as a spraying agent, there is, of course, no loss of fresh water, but it is questionable whether the quantity of steam used in the air compressors is not greater than that required in the burners and evaporators together. The complete combustion of petroleum spray depends, firstly, on the correct relation between the volumes of the oil and the spraying agent, and secondly, on the velocity of the spraying agent, both of which requirements place air at a considerable disadvantage as compared with the steam. The general conclusions produced from the investigations the writer has made are as follows:—

1. Liquid fuel of good quality, such, for instance, as Borneo oil, used in boiler furnaces, if efficiently treated, should show a reduction in consumption of about 40 per cent. as compared with coal.

2. A reduction in bunker space of about 15 per cent. for the same weight of fuel; a reduction of about 50 per cent. for the same radius of action.

3. A reduction in the stokehold staff of at least 50 per cent.

The advantages of liquid fuel as regards ease of manipulation, cleanliness, absence of smoke, reduced temperature of stokehold as compared with coal, increased life of boilers owing to constant temperature, improved performance of engines owing to constant steam pressure, need not be enlarged upon to the members of this Institution, but the question of immunity from danger requires some consideration. With a fuel oil of which the flash point is 200°F. or over there should be no risk of explosion whatever, and unless there is want of ordinary care in the management of the burning apparatus and the fuel supply the danger of fire ought not to exist. Still, fires have occurred, and it may be well to consider the causes from which they have originated. The most fruitful cause appears to be intermittent action of the burning apparatus. This may arise from dirt in the oil or from the presence of water. To get rid of the dirt it is only necessary to provide an efficient filtering apparatus, and this should form a part of all liquid fuel installations. The second cause, the presence of water, presents a more difficult problem. All crude oils have a certain proportion of water intimately mixed with them, and as the specific gravity of most fuel oils is from 0·9 to 0·98, and in the case of some shale oils even higher, it is obviously exceedingly difficult to eliminate this water by gravitation unless the temperature of the mixture is comparatively high. The expansion of oil under increase of temperature is considerably greater than that of water, and some arrangement whereby heat can be applied to the contents of the bunker seems to be necessary where crude oil is used. In furnaces where the oil fuel is burned in the form of vapour the danger of extinction from the fact that water is present is of course considerably reduced, for any temperature that is sufficiently high to vaporise a fuel is more than sufficiently high to evaporate water, so that when water passes into the apparatus with the oil it flashes into steam, and though it breaks up the stream of hydrocarbon vapour does not prevent each fraction from burning unless the amount of water is abnormally large. An experiment made by the writer showed that the fire was not extinguished when water was present in the proportion of five parts of water to three of oil. The water in this case was added gradually, and the contents of the bunker were constantly stirred so as to secure as complete an admixture of the oil and water as possible. With a burning apparatus of the second type, where the oil fuel is introduced in the form of spray, the danger of extinguishing the fire when water is present is of course much greater, but with a well-designed installation and proper care on the part of the attendants such accidents as fires should be impossible.

## ELECTRICITY WORKS ACCOUNTS.

### The Newcastle and District Electric Lighting Co. (Ltd.).

The steady and excellent progress of this undertaking is being well maintained. The accounts for 1899 show that again the aggregate costs have been lowered, and this, in spite of material increases in the fuel charge, in rents, rates and taxes, and in law expenses. Although the fuel item has risen from the 0·59d. of 1898 to 0·615d. last year, the latter figure is distinctly below the average fuel charge in company-worked stations of similar output and load-factor last year. The item of oil, waste, &c., was certainly above the average. "Wages at station" exhibits a normal figure, while "Repairs and maintenance at station," at 0·095d., is abnormally low, the 1898 result in this respect being even slightly below the average.

The resulting generating costs are, perhaps, about a farthing per unit under what they might have been expected to stand at.

As compared with that of 1898, the output shows an advance of nearly 80 per cent., the number of units sold being 963,622, resulting in a total revenue from all sources of 3·97d. per unit. In relation to this moderate average price the working profit of £7,959 was a very commendable result. That this working profit, in its relation to the mean expended capital, was so much smaller than in 1898 was largely due to the additional and unproductive capital expenditure.

As may be seen from the following table, the lamp connections indicate a great acceleration in the rate of increase, having risen by nearly 33 per cent. The load-factor has advanced from 12·7 per cent. to 14·6 per cent.

| Year. | No. of consumers. | Lamp connection. 8 c.p. equiv. | Output. Units sold. | Plant capacity (Kw). | Max. supply demanded. Kw. |
|---|---|---|---|---|---|
| 1891 | 150 | 11,000 | 206,000 | ... | ... |
| 1892 | 161 | 14,000 | 290,500 | ... | ... |
| 1893 | 182 | 18,500 | 283,500 | 820 | 320 |
| 1894 | 226 | 23,510 | 431,070 | 969 | 360 |
| 1895 | 260 | 27,515 | 472,000 | 969 | 404 |
| 1896 | 280 | 28,000 | 541,139 | 1,269 | 460 |
| 1897 | 323 | 33,000 | 600,974 | 1,269 | 559 |
| 1898 | 350 | 37,500 | 743,489 | 1,269 | 667 |
| 1899 | 445 | 49,671 | 963,622 | 1,600 | 766 |

### The National Electric Supply Co. (Ltd.), Preston.

The Preston accounts for 1899 record some most interesting and commendable results. We had occasion last year, in discussing the 1898 accounts of this undertaking, to remark on the excellent character of the costs, especially relatively to the output and load-factor. This year we find still better figures, and we have warmly to congratulate the engineer at this station on having secured three record figures among company-owned stations during 1899. At 0·91d. and 1·02d. respectively, the generating and works costs are the lowest among the company stations last year. These figures are both quite three-farthings per unit below the average 1899 costs in company stations of similar output and load-factor. It is also to be noticed that, with the comparatively very moderate total revenue figure of 4·6d. per unit, the ratio of total costs to revenue is, at 87·4 per cent., the lowest we have dealt with for 1899 accounts.

The management and property charges present a most satisfactory figure, while all the several items of generating costs are considerably under the average.

Not only in the matter of economy of working, however, is this undertaking progressing. As compared with 1898, the lamp connections rose by 30 per cent. and the output by over 34 per cent. It is satisfactory to find the low load-factor improving. Its value last year was 9·7 per cent., as compared with 8·5 per cent. in 1898.

The necessary extensions of the station are proceeding; adjoining land has been purchased, and a new boiler and engine house is being built.

---

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)......Oct. 12, 1900
Ayr (Municipal)..........Nov. 2, 1900
Bath (Municipal) ..........April 20, 1900
Bedford (Municipal) ......Aug. 3, 1900
Belfast (Municipal) ....... July 6, 1900
Birmingham (Company)....Sept. 15, 1899
Blackburn (Municipal) ....Jan. 19, 1900
Blackpool (Municipal) ....Oct. 5, 1900
Bournemouth (Company) ..Sept. 7, 1900
Bolton (Municipal) ........Nov. 30, 1900
Bradford (Municipal) ......June 22, 1900
Brighton (Municipal) ......May 4, 1900
Bristol (Municipal) ........Aug. 24, 1900
Bromley (Kent) (Co.) ......June 15, 1900
Brompton & Kensington (Co.) Mar. 23, 1900
Burnley (Municipal) ......Nov. 30, 1900
Burton-upon-Trent (Mun.) April 21, 1899
Bury (Municipal) ..........Sept. 28, 1900
Cambridge (Company)......April 13, 1900
Canterbury (Municipal) ....Oct. 26, 1900
Cardiff (Municipal) ........Dec. 15, 1899
Charing Cross (Company) ..Mar. 9, 1900
Chelsea (London) (Co.)......Mar. 23, 1900
Cheltenham (Municipal)....Nov. 10, 1899
Chester (Municipal)........Aug. 3, 1900
City of London (Company)..June 15, 1900
Clerkenwell (Company) ....May 18, 1900
Coventry (Municipal) ......Feb. 23, 1900
Croydon (Municipal)........July 20, 1900
Derby (Municipal) ..........Jan. 26, 1900
Dewsbury (Municipal)......Nov. 24, 1899
Dover (Company) ..........April 27, 1900
Dundee (Municipal).........Nov. 9, 1900
Eastbourne (Company) ....May 4, 1900
Edinburgh (Municipal) ....Dec 7, 1900
Exeter (Municipal) ..........Aug. 5, 1898
Folkestone (Company) ....April 27, 1900
Glasgow (Municipal) ......Sept. 14, 1900
Guildford (Company) ......Oct. 19, 1900
Halifax (Municipal)..........Sept. 21, 1900
Hammersmith (Vestry) ....June 29, 1900
Hampstead (Vestry) ........Oct. 19, 1900
Hanley (Municipal) ..........July 27, 1900
Harrogate (Municipal) ....Oct. 20, 1899
Harrow (Company) ..........June 16, 1899
Hast'gs & St. Leonards (Mun.) Sept. 7, 1900
Hove (Company) .......... July 6, 1900
Huddersfield (Municipal) ..Aug. 17, 1900
Islington (Vestry) ..........Nov 23, 1900
Kensi'gton & Knightsbr'(Co.) Mar. 16, 1900
Kingston-upon-Hull (Mun.) July 13, 1900
Kingston-on-Thames (Mun.) July 20, 1900
Lancaster (Municipal).......Jan. 19, 1900
Leeds (Municipal)...........Dec. 7, 1900
Leicester (Municipal) .......Jan. 26, 1900
Leyton (Municipal) ..........Sept. 8, 1899
Liverpool (Municipal).......June 22, 1900
London (Company) ..........June 8, 1900
Londonderry (Municipal) ..Feb. 16, 1900
Manchester (Municipal) ....Sept. 14, 1900
Newcastle and District (Co.) Oct. 6, 1899
Newcastle-upon-Tyne (Co.) Oct. 12, 1900
Newport (Mon.) (Municipal) Dec. 15, 1899
Northampton (Company) ..Oct. 20, 1899
Norwich (Company)..........Nov. 17, 1899
Notting Hill (Company) ....Mar. 16, 1900
Nottingham (Municipal) ..Sept. 21, 1900
Oldham (Municipal) ..........Dec. 1, 1899
Oxford (Company) ..........April 13, 1900
Pontypool (Company) ........Sept. 28, 1900
Portsmouth (Municipal)....Aug. 24, 1900
Prescot (Company) ..........Dec. 8, 1899
Preston (Company) ..........Sept. 29, 1899
Reading (Company) ..........Oct. 13, 1899
Richmond (Company) ........June 29, 1900
Salford (Municipal) ........Feb. 23, 1900
Scarborough (Company)....July 13, 1900
St. Helens (Municipal) ....Dec. 8, 1899
St. James' & Pall Mall (Co.)..Feb. 16, 1900
St. Pancras (Vestry)..........June 8, 1900
Sheffield (Municipal) ........Dec. 29, 1899
Shoreditch (Vestry) ..........Nov. 23, 1900
Southampton (Municipal) ..Nov. 10, 1899
Southport (Municipal)........July 7, 1899
South Shields (Municipal)..Nov. 2, 1900
Stafford (Municipal)..........Aug. 17, 1900
Sunderland (Municipal)....Nov. 9, 1900
Taunton (Municipal) ........June 16, 1899
Tunbridge Wells (Mun.) ..Sept. 1, 1899
Wakefield (Municipal) ......Dec. 1, 1899
Walsall (Municipal)..........June 23, 1899
Wandsworth (Company) ....May 18, 1900
Westminster (Company) ....Mar. 9, 1900
Whitehaven (Municipal) ....July 28, 1899
Winchester (Company) ......Oct. 26, 1900
Windsor (Company)..........Dec. 22, 1899
Woking (Company) ..........Dec. 22, 1899
Wolverhampton (Municipal) July 27, 1900
Woolwich (Company) ........Jan. 12, 1900
Worcester (Municipal) ......April 20, 1900
Yarmouth (Municipal) ......Nov. 3, 1899

| | NEWCASTLE-UPON-TYNE. | | | | PRESTON. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Newcastle & District Elec. Lighting Co. (Ltd.) | | | | The National Electric Supply Co. (Ltd.) | | | |
| *Date of Commencement of Supply* | January, 1890 | | | | August, 1892 | | | |
| *System of Supply* | Alternate current transformers. | | | | Partly 3-wire & 2-wire con. current with batts. & partly alt.-cur. with street trans. | | | |
| *Chief Engineer* | W. D. Hunter. | | | | J. H. Tonge | | | |
| **YEAR ENDED** | DEC. 31, **1898.** | | DEC. 31, **1899.** | | DEC. 31, **1898.** | | DEC. 31, **1899.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 1 205,382 | | 1,571 650 | | 521,809 | | 722,491 | |
| " SOLD (TOTAL) | 743.489 | | 963 622 | | 448.037 | | 601.519 | |
| " sold to consumers | 714,989 | | 934,622 | | 403,116 | | 545,668 | |
| " sold for public lighting, &c. | 28,500 | | 29,000 | | 44,921 | | 55 851 | |
| " used on works | 35,339 | | 45,000 | | 37,500 | | 61,500 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 18·7 | | 19·3 | | 26 7 | | 18 3 | |
| Maximum supply demanded | 657 kilowatts | | 756 kilowatts | | 602 kilowatts | | 7[illegible] kilowatts | |
| Number of public lamps | 10 arc | | 9 arc | | 42 arc [a] | | 42 arc [a] | |
| Number of consumers | 350 | | 415 | | 650 | | 712 | |
| Connections to mains in 8 c.p. lamps | 37 500 | | 49,671 | | 30,350 | | 40,102 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 39,660 | | 50.000 | | 16.800 | | 32.900 | |
| CAPACITY OF PLANT IN KILOWATTS | 1 269 | | 1.600 | | 538 | | 1 052 | |
| **CAPITAL—** | Total. | Per kilowatt capacity | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity |
| AUTHORISED (TOTAL) | £132.728 | £105 | £140 000 | £87 5 | — | — | — | — |
| Share | 100 000 | 78·8 | 100,000 | 62 5 | £84,944 | £158 | £84,944 | £80 8 |
| Loan (including Debenture charges) | 32.728 [a] | 25 8 | 40,000 [a] | 25 0 | — | — | — | — |
| RECEIVED (TOTAL) | 74 357 | 58 6 | 88 900 | 55 6 | 74,694 | 139 | 84.944 | 80 8 |
| Share | 65 457 | 51 6 | 80,000 | 50 0 | 44,694 | 83·0 | 54,944 | 52·2 |
| Loan (including Debenture charges) | 8 900 | 7·01 | 8,900 | 5 55 | 30,000 | 55·8 | 30,000 | 28·5 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | 58.371 | 46 0 | 51.100 | 31 9 | — | — | — | — |
| Share (unissued) | 820 | 0·646 | — | — | 40,250 | 74·8 | 30,000 | 28·5 |
| Share (uncalled) | 33,723 | 26·6 | 20,000 | 12·5 | — | — | — | — |
| Loan (including Debentures) | 23 828 | 18·8 | 31,100 | 19·4 | — | — | — | — |
| REPAID (TOTAL) | — | | — | | — | — | — | — |
| RESERVE OR SINKING FUND | 1,000 | 0 788 | 2,000 [a] | 1·25 | — | — | — | — |
| DEPRECIATION FUND | 6 000 | 4 73 | 7 000 | 4·37 | 3 119 | 5 80 | 4 619 | 4 39 |
| EXPENDED (TOTAL) | 88.995 | 70 1 | 126.801 | 79·2 | 77,960 | 145 | 93,350 | 88 7 |
| Lands and buildings | 11,683 | 9·20 | 32,946 | 20·6 | 6 878 | 12·8 | 9,447 | 9·96 |
| Plant | 55 552 | 43·8 | 68 233 | 42·6 | 34 315 [b] | 63·8 | 41.270 | 39·2 |
| Mains | 20,909 | 16·5 | 24 712 | 15·4 | 34,016 | 63·2 | 39,867 | 37 9 |
| Miscellaneous | 853 | 0·672 | 909 | 0·568 | 2,751 | 5·11 | 2,787 | 2 65 |
| BALANCE OF CAPITAL ACCOUNT | 14 638 [b] | 11 54 | −37,901 [b] | −23 7 | 3,266 | 6 07 | −8 407 | −7 99 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total | Per unit sold |
| TOTAL | £13.863 | 4·455d. | £15.949 | 3 973d. | £9,150 | 4·900d. | £11,520 | 4·598d. |
| Revenue from supply | 13,088 | 4·219d. | 14,496 | 3,611d. | 8 085 | 4 330d. | 10,368 [b] | 4 139d. |
| " meters, &c. | 763 | 0 246d. | 860 | 0 214d. | 314 | 0 168d. | 384 | 0 155d. |
| " public lighting | — | — | 420 | 0·105d. | 730 | 0 391d. | 739 | 0 295d. |
| " sale of lamps, &c. | — | | — | — | 22 | 0·012d. | 21 | 0·008d. |
| " miscellaneous sources | 2 | 0 001d. | 172 | 0 043d. | | | 3 | 0·001d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £6 257 | 2·019d. | £7 990 | 1 990d. | £3 868 | 2·072d. | £4 313 | 1 720d. |
| WORKS COSTS | 4 725 | 1 525d. | 5.689 | 1·417d. | 2 137 | 1·145d. | 2.567 | 1·024d. |
| *Generation of electricity* | [illegible] | [illegible] | 4,987 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 1 825 | 0 590d. | 2 467 | 0·615d. | 646 | 0 346d. | 1 121 | 0·447d. |
| Oil, waste, water, stores | 521 | 0 168d. | 691 | 0 172d. | 186 | 0 099d. | 177 | 0·071d. |
| Wages at station | 1 260 | 0 407d. | 1 450 | 0 361d. | 712 | 0·381d. | 784 | 0·313d. |
| Repairs and maintenance at station | 541 | 0 175d. | 380 | 0·095d. | 241 | 0 129d. | 200 | 0·080d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 578 | 0·187d. | 701 | 0 175d. | 170 | 0·091d. | 118 | 0·047d. |
| Repairs, renewals of mains, &c. | — | | — | — | | | | |
| *Public lighting* | — | — | — | — | [illegible] | [illegible] | [illegible] | [illegible] |
| Attendance | — | — | — | — | 197 [c] | 0 105d. | 168 [c] | 0·067d. |
| Renewals | — | — | — | — | | | | |
| MANAGEMENT AND PROPERTY CHARGES | 1 532 | 0 495d. | 2.301 | 0 573d. | 1,731 | 0 927d. | 1.746 | 0 697d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | 0·179d. | [illegible] | [illegible] | [illegible] | 0·177d. | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | [illegible] | 1,522 | 0·815d. | [illegible] | [illegible] |
| Salaries | 567 | 0 182d. | 607 | 0·151d. | 981 | 0·526d. | 936 | 0 373d. |
| Stationery, &c. | 336 | 0 108d. | 338 | 0 084d. | 58 | 0 031d. | 73 | 0 029d. |
| Establishment charges | | | | | 80 | 0 043d. | 89 | 0·036d. |
| Law charges, &c. | 81 | 0 026d. | 432 | 0·108d. | 402 | 0 215d. | 378 | 0 151d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. expended | Total. | % to mean cap. expended | Total. | % to mean cap. expended | Total. | % to mean cap. expended |
| WORKING PROFIT FOR YEAR | £7 546 | 9 10% | £7.959 | 7·37% | £5.282 | 7 13% | £7.207 | 8·41% |
| Sum carried to Depreciation Fund | 1,400 | 1·69% | 1,000 | 0 926% | 1 100 | 1·49% | 1,000 | 1 87% |
| Sum carried to Reserve or Sinking Fund | | — | 147 | 0 136% | — | — | — | — |
| Net interest on loans (incl. Debenture charges) | 516 | 0·623% | 975 | 0·903% | 1,132 | 1·95% | 1,450 | [illegible] |
| BALANCE FROM LAST ACCOUNT | 133 | 0 160 | 307 | 0 284 | 13 | 0 018 | 18 | 0·021 |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 5.763 | 6 95% | 6 143 | 5 69% | 2 763 | 3 73% | 4.173 | 4 87% |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | 8 | — | 8½% | — | 6 9 | — | 9 7 | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 45 3% | | 50 1% | | 42·3% | | 37 4% | |
| Expenditure per kilowatt capacity | £5. 1[illegible]s. 6d. | | £4. 19s. 10d. | | £7. 3s. 11d. | | £4. [illegible] | |
| REVENUE PER KILOWATT CAPACITY | £10. 17s. 7d. | | £9. 19s. 5d. | | £17. 0s. 0d. | | £10. 19s. 3d. | |
| Expenditure per 8-c.p. lamp capacity | 3s. [illegible] | | 3s. 2½d. | | 4s. 7½d. | | 2s. [illegible] | |
| REVENUE PER 8 C.P. LAMP CAPACITY | 6s. 11½d. | | 6s. 4½d. | | 10s. 10½d. | | 7s. 0d. | |
| REVENUE PER 8 C.P. LAMP CONNECTED | 2s. 9d. | | 6s. 5d. | | 5s. 11d. | | 5s. 9d | |
| Price charged for lighting, per unit | 6d. | | 6d. | | 7d. to 1d. | | 7d. to [illegible] | |
| Price charged for power, per unit | 3d. | | 2½d. to 1d. [illegible] | | 7d. to 1d. | | 7d. to 1[illegible] | |
| Price charged for public lighting | [illegible] | | £12 per lamp [illegible] | | | | — | |

NEWCASTLE-UPON-TYNE. [illegible]

PRESTON. [illegible]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence ; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under :—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| **United Kingdom** | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| **Postal Union ...** | 30s. 0d. ... | 15s. 0d. ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## ELECTRIC TRACTION ON STANDARD RAILWAYS.

Using the term "railway" in its most general sense, there are three distinct classes of permanent railway recognised in this country by engineers and by the laws of the land—viz., tramways, light railways and standard railways. The problem of employing electric traction on these three classes of railway possesses important elements of difference in each case, partly on account of the diversity in the engineering conditions, and partly because of the special laws and departmental regulations which have been framed for the different descriptions of line. In the United Kingdom no attempt has yet been made to introduce electric traction on standard railways ; but in the United States and in some few places on the Continent short lengths of standard lines have for some time been worked electrically with both engineering and financial success. The New York, New Haven and Hudson River Railroad Co., for example, some years ago equipped a branch line running to Nantasket Beach ; and so markedly successful was this experiment that greater lengths of main line were subsequently equipped on the same system. Our readers will remember that the Baltimore and Ohio Railroad Co. also employed electric locomotives to haul their trains, many of them of the heaviest description, through their long tunnel at Baltimore ; and figures supplied to us by their engineer on the occasion of a visit to this tunnel show that the adoption of electric traction was commercially economical. More recently an example of standard railway construction, in which electric traction is employed, has been furnished by the Burgdorf-Thun three-phase railway, in Switzerland, though this, by the way, is an example of electric power being employed from the outset, rather than affording an instance of the actual supersession of the steam locomotive. But although other countries are thus able to point to the experiment of electric traction on standard railways having already been practically attacked, there is nothing in any of these interesting experiments to show directly and conclusively that electric traction might be successfully adopted for the standard railways of the United Kingdom. The conditions of railroading are largely peculiar to each country, and what is commercially successful in the

United States or in Switzerland might conceivably be undesirable in this country. On the other hand, electric power has so abundantly justified its use for tramway and light railway traction that there is strong presumption in favour of its adoption on railways of a heavier type. The problem, indeed, resolves itself into one that involves only financial considerations, as to whether the replacement of steam by electric traction would really pay the railway companies. No doubt can now exist as to the engineering feasibility of equipping and running a standard railway electrically.

In view of these facts, Mr. LANGDON was abundantly justified in restricting himself to comparative financial considerations in the Paper in which he recently placed before the Institution of Electrical Engineers the important question of "The Supersession of the Steam by the Electric Locomotive." This timely Paper has been reprinted in our last two issues, and we bring to a conclusion in our present issue our report of the lengthy and useful discussion upon it. Probably the highest compliment that can be paid to the author of any Paper is to say that it has given rise to one of the best and most timely of discussions, and we are glad to be able to pay Mr. LANGDON that tribute of praise. Within the first decade of the now imminent twentieth century the problem of electric railroading will be prominently occupying the attention of every large railway company; it was fully time, therefore, that electrical engineers should have an opportunity to discuss this, the next great problem of electrical engineering. The keynote has been struck in Mr. LANGDON'S Paper; the discussion has been well begun; but it will be a long time before all the matters involved in this great problem are satisfactorily settled. For the present, however, we must confine ourselves to the broad question embodied in Mr. LANGDON'S Paper. The Paper itself consists chiefly in a comparison between actual steam railroading costs and estimated electric railroading costs, on a section of the Midland Railway between Bedford and London. For the first-named costs, Mr. LANGDON has the unimpeachable authority of Mr. S. W. JOHNSON, the locomotive engineer for the Midland Railway. For the electrical costs, Mr. LANGDON has made a number of assumptions, which, although he attempts to justify them in his Paper, were almost without exception severely criticised during the discussion. In the first place it should be observed that, while the steam costs are for the actual practical work of running trains, including all starting, stopping, acceleration, gradient-climbing, &c., Mr. LANGDON has assumed for the electric costs which he pits against these steam costs a condition of affairs which is decidedly theoretical and impracticable. He ignores the additional energy and cost involved in acceleration and hill-climbing, and has assumed the undoubtedly simple but practically impossible conditions of uniform speed over a perfectly level track, without any intermediate stops or starts. Comparisons of cost based on such assumptions are, to say the least of it, open to criticism. A proper recognition of the effect of acceleration and of gradients and curves, in increasing the power required for propelling a train, would undoubtedly lead to very considerable increase in Mr. LANGDON'S estimate of the capital outlay necessary for electrically equipping the railway; it would also point to a large augmentation in the annual cost of working. But though in these, as, indeed, in other respects, the Paper itself advances views and estimates that could not receive the sanction of expert electric traction engineers, it must be conceded that the Paper on the whole afforded by no means an unsuitable peg on which to hang a useful discussion on the subject.

The greater part of the discussion was devoted to considerations of the question based on the supposition that the railway service would remain practically as it is at the present time—*i.e.*, that heavy trains would be drawn by a separate locomotive at comparatively lengthy intervals of time. It was thus taken for granted that electricity could exert no beneficial influence on railroading beyond the simple matter of replacing the existing steam locomotive. This narrow view of the question, however, was held to be wrong by two of the speakers—viz., Mr. F. SPRAGUE and Prof. CARUS-WILSON, both of whom can boast an extensive American experience in electric traction. This aspect was, perhaps, more emphatically brought forward, in its most general terms, by Mr. SPRAGUE; for Prof. CARUS-WILSON confined his remarks to the question of branch line traffic. We are in perfect agreement with Mr. SPRAGUE in his declaration that the claims of electric traction involve far more than the mere supersession of the steam locomotive—that, in fact, the influence of electricity in permitting of a faster and more frequent service of vehicles may, in the end, prove even a greater inducement to its adoption by the railway companies than the bare question of relative cost. Electricity can not only supply cheaper traction than steam, it can accomplish things that steam cannot by any means be made to do. Herein, in our opinion, is the true key to the ultimate adoption of electric traction on existing steam railways. It will not be the mere question of cheapening the cost of the present service that will impel, and indeed compel, railway directors to abandon steam locomotion; but it will be the ever-increasing pressure of competition by rival electric lines, running a much faster and more frequent service of trains than can be done by steam. The multiplication of lines constructed on the high-speed system proposed for the Manchester and Liverpool Express Railway would seriously menace the steam railways running between the same places. The gradual growth of this menacing competition must ultimately lead to universal recognition of electricity as the most suitable agent for traction on every description of railway. When that time shall have arrived, railway directors will not be found to waste much time over academic considerations of relative costs. Electric traction will not be merely a superior thing; it will be the only thing possible. But much must happen before that time arrives.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Gas Batteries.*—Chemical studies have enabled F. Haber to put forward the proposition that the oxidation potential of hydrogen peroxide, together with its reduction potential, represents the oxygen potential. This result, which may be deduced from thermodynamical considerations, implies that for fixed values of the hydrogen concentration and the oxygen concentration there is only one stable value for the hydrogen peroxide. That value obtains at the oxygen electrode, and remains constant as long as that electrode operates in a reversible manner. But the concentration of the hydrogen peroxide does not affect the dynamics of processes in which the maximum work is yielded, and which can be reduced to the work of a battery of the form

Metal | metallic ions | hydroxyl ions | oxygen electrode.

When the processes are rapid, however, certain metastable conditions may occur, and it is to such conditions that the author attributes the phenomena observed at a platinised platinum electrode dipping into hydrogen peroxide solution, as well as the catalysis of hydrogen peroxide by finely divided platinum.

[F. HABER, *Phys. Zeitschr.*, December 1, 1900.]

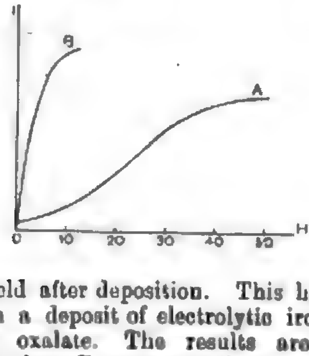
*Ionic Shooting.*—In many cases the flow of electric current in gases is a process strictly analogous to the flow of electric current in liquids. It consists of a migration of ions in two opposite directions, the direction varying in accordance with the force, and the velocity being proportional to that force. But in the case of gases, with their greater free path, it is possible that an ion retains its velocity after arriving at a point where the electric force is feeble. This process has been termed "ionic shooting" by J. Stark, and he now mathematically investigates several of its aspects. When the ionic shooting is combined with a diminution of the electric force in the direction in which the ions "shoot," as well as a diminution of their velocity by collision, internal charges are produced. Thus, if a vacuum tube is constricted at a point situated within the positive-light column, the electric force, being greater at the constriction than in the wider spaces on either side, produces a positive charge on the cathode side and a negative charge on the anode side of the constriction. Ionic shooting tends to the preservation and exaggeration of any existing minima and maxima of electric force. This is exemplified in the stratified discharge. If the path of the discharge is curved, ionic shooting brings about a certain centrifugal force which throws the ions out of their natural path.

[J. Stark, *Phys. Zeitschr.*, December 1, 1900.]

*Use of a Polarising Cell in the Telegraphone.*—It has already been announced that the introduction of a polarising cell in the circuit of the recording electromagnet considerably increases the sharpness and clearness with which the sound is rendered. This observation is now explained by E. Ruhmer. The preliminary magnetisation probably never exceeds 12,000 units, and after the wire leaves the neighbourhood of the electromagnet its magnetic intensity probably falls to about 8,000 units. When the wire is used for recording, its remanent magnetism will then induce pretty high magnetisations in the core of the recording electromagnet, with a maximum of some 8,000 units. Now this value, when looked up on the curve of magnetisation, is seen to correspond to a low permeability, where comparatively large variations of the magneto-motive force only produce small variations of the magnetic flux, and therefore, also small amplitudes of the magnetic waves to be impressed upon the wire. But for loud records it is important that the variations of the magneto-motive force should take place on a steep portion of the magnetisation curve. That condition is fulfilled by introducing a cell in the circuit which shall just compensate the magnetism induced by the wire in the core of the electromagnet. In Poulsen's case the E.M.F. required is only 1 volt.

[E. Ruhmer, *Phys. Zeitschr.*, December 1, 1900.]

*Magnetisation of Electro-Deposits.*—It is interesting to compare the magnetisation of a deposit produced in a magnetic field with the magnetisation of the same deposit exposed to



the magnetic field after deposition. This has been done by C. Maurain with a deposit of electrolytic iron obtained from iron-ammonium oxalate. The results are shown in the annexed curves, where B represents the magnetisation during deposition produced by various constant fields, and A the magnetisation produced by the same fields when applied subsequent to non-magnetic deposition. That A does not start with zero magnetisation is due to the earth's magnetic field, which it is very difficult to eliminate altogether. B shows no point of inversion whereas A does. B indicates apparently the maximum intensity of magnetisation which the substance is capable of acquiring in a given field, and shows that that maximum can only be attained when the molecules range themselves in obedience to the magnetic force while still in the state of liquid aggregation. At the same time, that maximum only relates to the field in question, and it is clear that the absolute maximum is not attained in fields below 10 C.G.S. units, in spite of the comparative freedom of the molecules.

[C. Maurain, *Comptes Rendus*, November 26, 1900.]

*Separation of Wireless Messages.*—P. Jégou has devised a differential apparatus which, while not preserving the secrecy of wireless messages, enables the sender to communicate at will with one or another of two stations situated at different distances. The principle adopted is that already proposed of employing mast-wires of different ranges. Four such mast-wires are employed, two at the sending station and two at the receiving station. Their heights are so arranged that one of them covers, say, a range of 5 miles, while the other does not. The circuits of the coherers attached to the two mast-wires are so arranged that their simultaneous action produces no effect upon the galvanometer. But at a distance of 5 miles the galvanometer will respond to a message from the sending station addressed to both coherers, as only one of them is brought into action. At half that distance, when both coherers are within range, no effect is produced on the galvanometer. Thus, at all events, something of the nature of separation by distance is obtained, though it is open to the obvious criticism that complete neutralisation of the two effects is only produced at one definite value of the distance. It would be better if the message itself were limited to this value instead of the absence of the message.

[P. Jégou, *Comptes Rendus*, November 26, 1900.]

*Magnetised Chronometers.*—A. Cornu has turned to good account an accident which befel a chronometer when it was brought near a large dynamo. He reasoned that if it could be kept going for 24 hours it would keep going indefinitely if wound up only once daily, as all the moving parts would be in the same relative positions. Moreover, many of the actions, like the accelerations and retardations of the balance-wheel, would neutralise each other, and there would be no magnetic adhesion, as steel contacts are avoided in the construction of chronometers. In studying the behaviour of this particular chronometer he found that it was considerably influenced by the earth's magnetic force. There was, in fact, a definite acceleration or retardation for each azimuth, the equations expressing this effect being similar to those representing the action of gravitation upon an imperfectly balanced wheel. The practical importance of these researches lies in their bearing upon ships' chronometers. The magnetism of their balance-wheels should be carefully determined, as well as the corrections necessary for various magnetic azimuths. The amplitute of the oscillation should be made as great as 440deg., as pointed out by Phillips. Unfortunately, that is difficult of attainment.

[A. Cornu, *Comptes Rendus*, November 26, 1900.]

## ROAD TRACTION.*

BY PROF. H. S. HELE-SHAW, LL.D., F.R.S.

The development and progress of any nation depends largely upon the improvement in its internal and external means of communication. This has probably been the most important material factor in the growth and the increasing prosperity of this country during the past century. Now, of the three means of communication—by road, by rail, and by sea—the two latter have, during the past century, grown in such a way as to quite eclipse the increased importance of communication by road, and yet it is probable that the latter remains still much the most important of all three. The fact is, that the introduction of mechanical power in the form of steam, both as applied to the locomotive and the marine engine, has not only effected changes so as to absorb popular attention and command the application of the

* Abstract of Paper read before the Society of Arts.

material resources of the world, but has required the application of scientific research and afforded scope for the investigation of innumerable scientific problems. Amongst these problems, and not by any means the least important, have been researches into the laws of resistance of ships and upon railways, and it is not too much to say that the experimental discoveries of such laws by men like Froude have had no little influence upon the practical results achieved in recent years by the engineer and the naval architect.

When we turn to the subject of common roads, we find that up to at any rate the last few years there have been no changes during the past century to attract general attention in the construction of the roads themselves or in the means of vehicular propulsion upon them. We must of course except the introduction of steam-propelled vehicles about 50 or 60 years ago; and, reading the literature of that time, it is clear that when this occurred it was a matter of great interest throughout the whole country. The absolute and complete failure, from a financial point of view, of the steam carriage at that time, and the imposition of laws which made their use on common roads impossible, naturally caused this interest to entirely disappear, and is even responsible for the incredulity with which their possible success is regarded to-day by a good many people.

Within the last few years, however, there has been a remarkable revival of interest in the question of the roads in this country, and, indeed, in the roads of every country, and for this there are several important causes. Indirectly, it is evident that the improved facilities in conditions of transport and of travel by land and sea have steadily led up to a demand or improvements in roads and means of communication upon them. Nothing, for instance, could more strikingly illustrate this than the fact that the great railway companies, by the force of events utterly unexpected upon the introduction of railways, have become in all the large cities the greatest proprietors of horses and vehicles for the transport of goods and, in many cases, also of passengers themselves. The invention and perfection of the bicycle and, quite recently, the development of the motor car, both of which inventions have been rendered possible by the gradual progress of the mechanical arts, have caused the general public to take the keenest interest in the nature and condition of the roads of the country, while the possibility also of producing at last successful motor vehicles for the transport of goods have led to the passing of the Light Locomotives Act in 1896, which really marked the dawn of a new epoch in this country in means of communication.

It must not, however, be thought that no changes or improvements have taken place during the past century in the direction of road communication. On the contrary, we find that at the beginning of that period the roads had been allowed to fall into a deplorably bad condition, which the 530 Acts of Parliament for their improvement passed in the previous 70 years had done very little to improve. The fact was that these acts were necessary because statute labour was required, and tolls had to be imposed to pay for the expense of repair, and they had not the slightest reference to a real improvement in the nature of road construction or apparently any influence upon it. Road-making, which, centuries before, the Romans had taught the people of this country, had at that time become a lost art, and had it not been for the greater attention attracted by railways, the gradual improvements in road construction by Telford, Macadam, and others, and the comparative perfection of roads paved with stone, wood, or asphalt in all our cities to-day, not less than that of the ordinary type of highway in country districts would have been more generally regarded as one of the great triumphs of the century. With the improvement in roads the construction and design of vehicles themselves has also steadily improved, so that the best designs for horse-drawn vehicles suitable for both light and heavy traffic may be said to have now been evolved.

It is not, therefore, to be wondered at that the same kind of attempts which have been successfully made to investigate the nature of the power required for ships and locomotives have been made during the past century to investigate road traction, and these attempts are to be found recorded in various books. Probably the most important contribution to the subject is General Morin's "Experiences sur le Tirage des Voitures et sur les effets destructeurs qu'elles exercent sur les Routes," which occupied that accomplished man of science from 1837 to 1841, the first series being undertaken by order of the Minister of War and a second series by that of the Minister of Public Works of France, and in which the author was aided by numerous skilled and distinguished observers, from which it would at first be thought that little more remained to be discovered on the subject. The truth is, however, that the problem of road traction differs in a very essential manner from that of the determination of resistance of ships and railroads. The movement of a body through the water, and of the motion of a steel wheel upon a hard surface, such as steel rail, present features which have enabled definite laws of resistance to be arrived at. On the other hand, it can scarcely be said, especially with macadam roads, that the surface, even at small distances apart along the same road, or during a small interval of time in which the nature of the weather has changed, presents conditions of anything like uniformity. Thus it is very difficult to arrive at definite laws concerning road resistance, and it is not surprising to find that even the experiments of Morin, and the conclusions at which he arrived, were taken exception to by another distinguished French observer, Dupuit, who also devoted much time and labour to the subject, resulting in many different statements, either algebraical or in a more general form, representing the laws of traction upon roads which have never yet been reconciled.

There is a further practical reason for the want of general interest in such determinations from the fact that the horse has hitherto almost entirely been the tractive agency for road vehicles. Now there are two features of difference between muscular effort and mechanical propulsion, one being the relative magnitude of the powers employed, and the other the actual nature of the effort itself. As to the power employed, it is obvious that it becomes a far more important question to know something of resistances which involve a power in the case of some modern locomotives of as much as 4,000 horses, or in the case of the large modern Atlantic liner as much as even ten times this astonishing amount of power; and this is still more the case when it is remembered that the nature of the muscular effort of animals is such that it can be applied at will according to the varying resistance, and that a sudden and almost incredible effort can be exerted by a horse, as, for instance, in starting a railway waggon into motion, which makes this sort of effort peculiarly suitable to the conditions of the case. At the same time this fact naturally relegates the problem in the opinion of most people to one of simple practical experience and, indeed, one in which experience alone would seem to offer a guide. Experience has, indeed, practically solved most of the questions connected with horse traction and furnished us with an intimate knowledge of the weights suitable for vehicles and of the loads which can be drawn upon them by horses as well as by other animals.

The foregoing reasons, which show that investigations of traction resistance in the case of horse-drawn vehicles are of little value, do not, however, hold when we come to the subject of self-propelled vehicles. Motors for such vehicles have now been constructed with a power of as much as 50 horses, but there are strict limitations to possible power of such motors, and it is important that knowledge should be available in what is comparatively a new subject as to the conditions by which the greatest economy may be effected. For the problem differs in a remarkable way from that of the railway locomotive, which, running on a hard steel track, has enabled the power to be increased in such a way that while the "Rocket" weighed with its tender 6 tons, a modern engine and tender frequently weighs more than 100 tons, with a more than proportionally greater increase of power. Thus, whereas in a railway locomotive it may be desirable to obtain the greatest efficiency on simple grounds of economy, the very existence of the motor vehicle from a commercial point of view depends upon the relation of the weight of motor required for tractive effort to the useful load which it can convey, since the load which can be carried upon wheels upon the comparatively yielding surface of a road not less than the possible speed of transit are narrowed down within a very small compass.

But this is not all. Indeed it is only one side of the question, since whereas the railroads or tramways are the property of the railway company or the corporation which has to maintain them in working condition, the roads over which motor vehicles run belong to the public at large. And whereas there is even upon the hard steel track of a railway a considerable amount of wear, which reduces the life of a steel rail in a very definite manner, and is a factor of considerable importance in the working expenses of a railway, the proportionate expense to other items of working expenses is comparatively as nothing to the cost in maintenance and repair of an ordinary highway. M. Forestier, whom we are proud to have amongst us to-night, and whose visit to England to read a most valuable Paper on "Heavy Motor Traffic in France," is a compliment which we all highly appreciate, who is the Inspector-General of Roads and Bridges in France, and therefore keenly interested in the proper maintenance of roads, and is at the same time one of the most distinguished representatives of the automobile movement, has dealt with this subject in the Paper in question. He speaks, as it were, in a sort of dual capacity, with the official knowledge which no one else could possibly have of the actual effect of heavy motor traffic on roads in France, while at the same time we are assured that his attitude towards the automobile movement is entirely a sympathetic one. I am not able here to quote his extended and valuable remarks on this subject, but I may point out that he gives instances of the running of heavy motor vehicles in connection with the "Poids Lourds" service in the Department de la Meuse in which the wear of the roads has been largely increased—in one case, for instance, a wear of 163 cubic yds. per year per mile, which involves an increased cost of £50 per mile, while in another it has been necessary to spend £80 per mile in widening and drainage, and to increase the annual expenses in repair by £28 per mile. This, it is true, has been caused by vehicles weighing when loaded 8 tons travelling at the rate of 8 miles per hour, which are conditions not yet allowed in this country; but it indicates that the subject of the effect upon the roads is one which should be taken up and studied before heavy

motor vehicle traffic has become general. Even at present, when the most conservative of the county councils have not had the hardihood to charge the light motor vehicles with doing any damage to the roads, some of these councils are combining upon another question, viz., to obtain an Act of Parliament to reduce the speed from the present low limit of 12 miles per hour to the still lower one of 10.

In the interests of a matter of great national importance such as that of heavy motor vehicles, it is desirable that no unnecessary opposition should be aroused. The imposition of tolls, for instance, such as were enforced upon the previous attempts to introduce steam carriages would almost certainly bring failure upon the present attempts to meet what is so urgently demanded by the general growth of trade. As we are reminded by a recent circular of the Automobile Club, setting forth reasons why the proposed action of the particular county councils mentioned should be opposed, the charge in those days on the Liverpool and Prescot roads for a coach was 4s., whilst Mr. Gurney's steam carriage was charged £2. 8s., and in some cases £3. 8s. at every turnpike gate.

The problem of the road locomotive is in itself sufficiently difficult and costly to bring to success without raising an opposition such as would certainly be caused by any destructive action of the wheels upon the road surface. The sooner this subject is made the matter of careful and thorough investigation, the sooner will such data be forthcoming as may obtain the best results with the least possible amount of wear and injury to the roads. Nor, indeed, can the effect upon the road surface be separated from the question of traction itself, for as M. Forestier says, after describing the exact action of the wheels upon the road in wet weather: "When this is the case, the road continually presents an inclined plane in front of the driving wheels, and this largely increases the rolling resistance, and, at the same time, adds considerable friction between the sides of the felloes and the depressions that are made. All engineers responsible for roads have agreed that during the rainy season the rolling resistance may be treble what it is during fine weather. This is one of the most unfavourable conditions for mechanical propulsion, for it necessitates the motors not only being capable of a single maximum effort but of a continual one, which may be three times greater in wet weather than in fine, unless one is content to diminish the speed of going."

It was from such considerations that I proposed at the recent meeting of the British Association the formation of a committee for investigating the different causes of resistance for self controlled vehicles on the common roads. That committee has for its chairman Sir Alexander Binnie, and the names of its members are Mr. T. C. Aveling, Mr. W. Aitken, Mr. Worby Beaumont, Mr. J. Brown, Prof. T. Hudson Beare, Colonel R. E. Crompton, Mr. A. Malloch, Sir David Salomons, Mr. A. R. Sennett, Mr. Shrapnell Smith, Mr. J. I. Thornycroft, Mr. W. H. Wheeler, with myself as secretary. It will be seen, therefore, that we shall not only have the benefit of the experience of those who are authorities on light and heavy motor vehicles, but that we have representatives who have particular experience in traction engines, and also several members whose names are already well known in connection with important experiments upon traction, as well as others who are authorities upon the nature and construction of the roads themselves. It was the idea of the Secretary of the Society of Arts in suggesting the desirability of this Paper, that the matter could be discussed at fuller length to-night than is usually possible at sectional meetings of the British Association, and with this object in view, in addition to members of the Society of Arts, the Secretary has kindly issued invitations to members of the Automobile Club, and also to many engineers who are interested in the question of road traction. In order to leave as much time as possible for discussion, I will only briefly state a few points which must be considered without attempting to suggest any definite plan of procedure by committee. The actual line of investigation, together with the design and arrangement of suitable apparatus, will no doubt occupy much time and carful deliberation hereafter.

Naturally the first thing to be done is to study the literature and experimental researches which have been published on this subject, and I have prepared a summary of such researches so far as they are of practical interest, and may furnish information for the work of the committee. This summary I will not attempt to read now, but proceed to indicate certain important points in which the work of the committee will break entirely new ground. The chief point to be noted is that while a few experiments have been made upon separate wheels drawn by mechanical means, the bulk of the observations which have been obtained by Morin and by all other investigators of the subject were effected by employing the tractive agency of the horse, and with the exception of a few of the experiments on traction engines, the muscular effort of animals has hitherto been the sole means of investigating road resistance. Now, for the following reasons, data so obtained are practically useless for application to self-propelled vehicles :—

1. The speed of a horse is not capable of being regulated in any very accurate way; indeed, many series of observations have been limited to the discussion of the two paces—walking and trotting. Thus there have been no very accurate means of determining the laws which connect the speed of a vehicle with its velocity, although Morin has attempted to obtain such relations, and numerous algebraic expressions have been suggested by various experimenters.

2. With the horse, even if the velocity is a known one, it is almost impossible to obtain a uniform tractive effort, and hence, although numerous self-recording dynamometers have been designed, nothing more than the average resistance of the various kinds of roads has been determined.

3. The increased speeds, which are not only possible for light and heavy traffic but are now permitted by law, render the previous observations of resistance at lower speeds of little use. This has a most important bearing on that part of the resistance due to shocks and vibrations, which has never yet been separated from that due to frictional resistance.

Now, the employment of a motor vehicle will enable laws of road resistance in respect of the three principles mentioned in the foregoing paragraphs to be completely dealt with, and it may not be out of place to refer to the experiments which were carried out during the past summer in Liverpool, in which one motor-car was made to tow another over roads of (a) macadam, (b) stone setts, (c) wood pavement, (d) asphalt. In the three matters of regulation of speed, uniformity of tractive effort, and ability to maintain considerable speed, a few days' experiments sufficed to show that it was possible to secure accurate and scientific results by replacing the traction of the horse by that of a powerful motor car. One observer is reading the speed indicator (shown in detail in Fig. 1) which was pressed upon the tyre of the wheel, while another observer at the back of the car simultaneously reads the indication of a dynamometer, writing down together the speed and corresponding tractive effort. The dynamometer (which was constructed for the occasion) by which the observations were made is shown in Fig. 2, and consists of an ordinary spring balance used in conjunction with a dash-pot, and could be regulated so as to reduce the irregularities of tractive effort. Fig. 3 shows the way in which it was carried upon a temporary wooden frame attached to the back of the 12 H.P. tractor-car of Mr. Holder. These experiments were only of a preliminary charater, and demonstrated conclusively that whilst it was evident satisfactory results could be obtained which would enable the relation between resistance and velocity for various kinds of roads to be accurately exhibited by graphical methods, and possibly the laws under these conditions determined, it would be necessary to design and make very much more refined apparatus than that then used, or, indeed, any apparatus of the kind which I have been able to hear of.

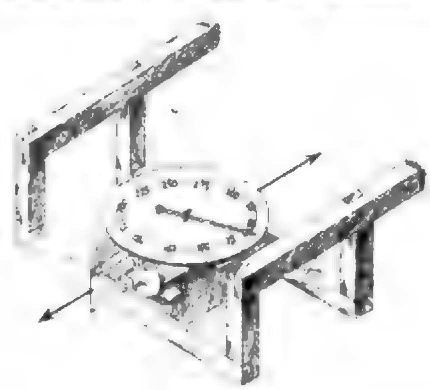


FIG. 1.

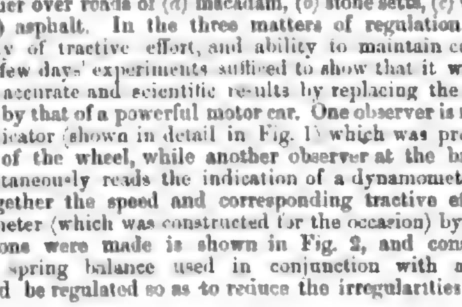


FIG. 2

The foregoing experiments and remarks relate to the possibilities of experimenting on the tractive effort of one vehicle upon another. It should be noted that the resistance of a vehicle has been investigated by allowing it to descend a slope under the force of gravity, and Fig. 4 shows a slope which was used in some trials of motors. This slope, when carefully examined and its angles measured, gave the profile shown. It is clear that there are very few hills having a

sufficiently uniform inclination for this purpose, although an artificial slope of uniform inclination might be found or actually made for the investigation.

It is clear that there are two further ways in which the experiments obtained by means of horse traction, or indeed of traction at all, are entirely inapplicable to modern requirements and are as follows :—

4. The propulsion of a vehicle by means of the effort exerted at the rim of its own wheels introduces entirely fresh considerations as to the power required to propel it compared with that by ordinary traction, and into the question of shocks and vibrations, which form an important factor in the resistance. There are also questions concerning which very little is known at present as to the relative merits of front and back steering respectively ; that is to say, as to whether the vehicle is more effectively dragged along by the action of its own front wheels or pushed along by the action of its hind wheels. Definite results concerning these matters can only be arrived at by specially constructed appliances, and the use of motor vehicles themselves for the purpose.

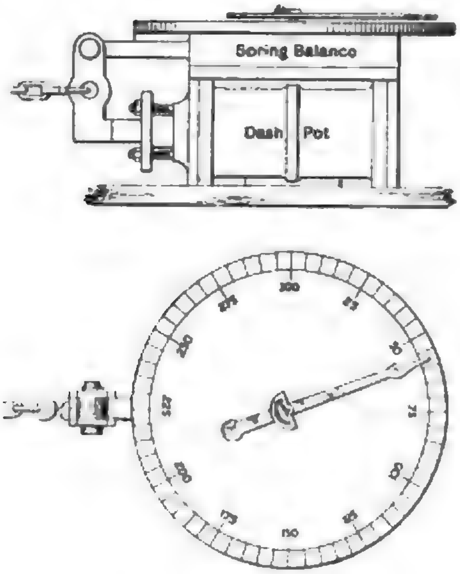


Fig. 3.

5. There is the important question of the effect upon the road itself. This constituted an important portion of the researches of Gen. Morin 60 years ago ; but his results obtained by horse traction, valuable as they were for the purpose, do not tell us much as to the effect produced upon roads when the wheel itself not only has to sustain the weight of the vehicle, but also has to exert a tangential effect upon the road. In connection with action upon road surface, it is also important to ascertain by experiment the best form of wheels, dimensions of tyre, the effect (so little understood, although of time-honoured interest) of the coning or canting of wheels, and of the results for loads of varying magnitude upon roads in all states and conditions of the weather. In all the five directions above specified, there is plenty of scope for useful work, and the application of new instruments such as the viagraph, which will accurately indicate the nature of the surface of the road over which each set of experiments is conducted ; the seismometer, which will enable us to investigate practical questions as to the effect of springs and the behaviour of tyres ; and instruments such as those Mr. Malloch has employed for investigating railway traction. There can, at any rate, be little doubt that the formation of a committee for the purposes which I have brought before you is abundantly justified. It remains to be seen what the results of their labours will be, but one may be allowed to express a pious hope that they will be sufficiently valuable, not only to be of practical use in aiding the progress of road locomotion, but to be worth laying before this Society at some future date.

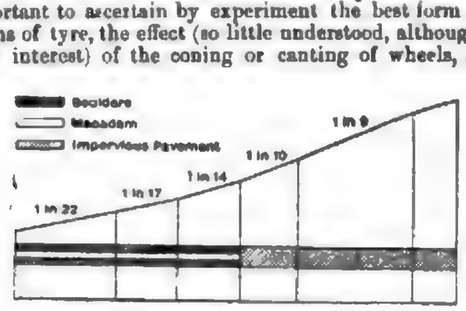


Fig. 4.

## DISCUSSION.

Mr. J. I. THORNYCROFT thought the reader of the Paper was right regarding road transit as the most important of all modes of transit, for certainly what concerned people were the means of conveyance in their own locality. Prof. Hele-Shaw had pointed out the marvellous improvement which had taken place in transit by sea and rail, but road transit had remained almost stationary. The general admiration for the horse was well earned by that useful animal, but liberty to improve our road transit was placed in jeopardy by the action of people who, out of false love for the horse strove to make legislation adverse to the automobile industry, such as charging £3 toll for a vehicle propelled artificially, when the proper amount for the same vehicle, if propelled by an animal, was 4s. He believed, however, that we were on the eve of a great improvement. London was beginning to appreciate the fact that its tramcars must be propelled artificially, and in Liverpool, where the system had been lately perfected, the improvement was wonderful. As to the material used for making roads, he looked upon steel as that to be ultimately used, but that in the meantime a material such as asphalt would resist the action of traffic for a long time. He believed some asphalt roads in London had lasted 20 years.

Col. R. E. B. CROMPTON emphasised the desirability of the investigation which had been so ably introduced by the reader of the Paper. As he had said, a committee of the British Association had been formed to go into the matter, which was of the highest interest from his side of the question—viz., the military side. The problem which presented itself in any new country which it was desired to civilise was the means of intercommunication. The surface of the country was composed of varying materials, from those sufficiently hard to form a good roadway at once to those of a softer nature. He understood the object of the investigation was to ascertain the laws which governed the passage of a wheeled vehicle over such varying surfaces. That investigation, although not complicated, must necessarily be protracted, as the whole subject was so influenced in this country by the effect of the weather on the surface of the roads. In the Transvaal the country in wet weather was very soft, and transit across it was almost impossible. But when the rainy season was over the sun hardened it, and transformed it into a ready-made roadway, across which, although many rocks, &c., were strewn over it, it was perfectly possible to drive wheeled vehicles. In the Transvaal, for the first time in warfare, the experiment had been made on a large scale of supplementing the railways by carrying military stores and supplies by traction engines. That had been attended with very great success in dry weather, though, of course, with diminished success when bad surfaces had to be contended with. By watching the results one found how much there was to learn with regard to wheel resistances. He believed the veldt, when as hard as it was in the months of July, August, and September, offered less average rolling resistance than the best English road at this time of year. That day he had been to Aldershot, testing engines under conditions of actual warfare—in very wet weather—and had been profoundly impressed by the extent to which the surface was deformed under the wheels. The committee had set itself to solve a very difficult problem ; they wished to ascertain what width and diameter of wheel were best calculated to carry a certain weight. Prof. Hele-Shaw had shown that any point of the wheel moved in a curve, and argued that there would be very severe cutting action in the road, there being a tendency to move that point longitudinally along the road. That was no doubt true to some extent, but it was greatly modified by certain facts. If the wheel were rolling over, say, an asphalted surface, the particles of road immediately under the wheel would not move to any extent. Supposing the roadway were of tesselated pavement, as long as those small prisms were prevented from moving sideways they would remain in a parallel position. But taking a roadway under the influence of wet weather—a flint road, for example—if the particles of flint were similar prisms to those above-mentioned, a few at the centre of the tyre of the wheel would not be moved, but as they passed away from the centre of the wheel they would be thrust sideways, and to a point far outside the wheel the top of the roadway would be moved. He particularly called attention to the fact that there was a piece in the centre of the wheel where the roadway was not disturbed, or so little that it had hardly any effect. This showed the enormous importance of the width of the tyre of the wheel. Taking, as an extreme case, mobile sand, a narrow wheel would hardly run in it at all, the whole of the sand moved under the wheel sideways, and the wheel sank in ; whereas a broad wheel, owing to the large number of unmoved particles underneath it, hardly sank in at all. Where were they to stop? Were they to make very big and consequently heavy wheels, or to stop at some half-way house which combined the greatest number of advantages? In South Africa, where very broad wheels were introduced for the first time (in absolute opposition to the time-honoured usages of the Boer farmers who used narrow wheels) they were able take enormous loads over the very thin crust of the veldt, going over the same ground for weeks and almost months without hurting the surface at all, whereas two or three passages of the narrow-wheeled Boer waggons destroyed the surface to such an extent that it could not be travelled over again. With regard to gravity experiments, he thought there were a good many slopes in this country sufficiently regular to allow of experiments being made in the way of observing the acceleration of a vehicle steered down them.

Mons. FORESTIER, Inspecteur-Général des Ponts et Chaussées (speaking in French), said that since the work of Morin and Dupuit there had not been any exhaustive experiments made with a view of obtaining the coefficient of traction on the different surfaces used in the main roads of the French departments. In Paris, M. Lavalard, on behalf of the Compagnie des Omnibus, and M. Bixio, on behalf of the Compagnie des Voitures de Place, had made a complete series of experiments with registering dynamometers founded on that of Morin. M. Michelin, in order to demonstrate the advantages of pneumatic tyres, had also made a number of comparative experiments on the different roadways of Paris with the same vehicles fitted with metal tyres, with tyres of solid rubber,

and with pneumatic tyres. The great drawback to the use of Morin's dynamometer was that it required a knowledge of the slope of the road traversed, or it was impossible to separate the effect of gravity from that of the traction. He had himself, in some experiments which he had carried out to ascertain the varying tractive forces required by different roadways (wood, stone, asphalt, or macadam), adopted a modification of Morin's dynamometer with the pendulum apparatus devised by the eminent French engineer, M. Desdouits. In this apparatus the effect of gravity was eliminated, and it was possible in a single journey, without any knowledge of the inclination of the road traversed, to obtain an accurate record of the force exerted upon the different surfaces. This apparatus he had used successfully in a journey he had made in 1896 from Paris to Marseilles, and he recommended it to the attention of those interested in similar researches. He could also speak favourably of certain modifications made by M. Richard, and with these modifications he could speak well of self-registering dynamometers. They eliminated personal error, and had certain other advantages.

Mr. W. WORBY BEAUMONT said with regard to Col. Crompton's remarks on the width of the wheel, instead of insisting upon a width for the heavier vehicles of 1in. per ton, or ¾in. per ton, they should have, for any size or weight of vehicle, a minimum width of wheel, and beyond that a gradually decreasing extra width per unit of load. The Paper was of great importance because it drew attention to the real automobile difficulty viz., the road question. Three years ago, in his Cantor lectures on motors, he had drawn attention to the road question, and pointed out that it was a greater difficulty than the production of the vehicles themselves. The improvement of the roads should have for its first object the improvement of transport and the reduction of its cost, to say nothing of health-giving pleasure. The proposed restriction of the speed of motor vehicles, if carried into effect, would crush one of the most useful industries in this country. That industry was already large in France, and in America was growing to such an extent that one big firm alone turned out 20 vehicles per day. If it had not been for restrictive acts and measures England would have been the first in the field, but as matters stood she had a great deal to do to attain the position of her competitors. The important point to determine upon now was that they should not be led by the nose by people who knew nothing of the matter, but should be free to use the roads in a legitimate manner.

Mr. J. BROWN said that as nowadays it was necessary to define everything in a very accurate way, it was perhaps fortunate that his instrument, the viagraph, which was for the purpose of showing inequalities of roads, should have been invented at this particular time. He would not dwell upon the actual details of the instrument, as it had been described before the British Association. He exhibited a diagram made by the instrument, showing the irregularities of certain roads, in order to show the way in which it worked, and afterwards briefly explained his invention by means of a lantern illustration thrown on the screen.

Mr. A. R. SENNETT wished to correct a wrong impression which might be created by the Paper. As a matter of fact, English engineers had really led the world in the matter of road traction, although they were now so very backward in it. About the year 1832, for two or three years, omnibuses were running regularly between Paddington and the Bank, and carried many thousands of persons over Pentonville Hill without a single accident. That would show what a scandalous thing it was to pass an act subsequently to prevent the progress of such an industry. When Prof. Hele Shaw spoke of the tearing of roads, he wished to impress upon the members that he was speaking scientifically and not practically. The idea of the committee was to find the proper way of applying motor vehicles to the roads, and whatever it might do it would have the effect of improving the roads, so that all horse owners would have reason to be grateful to it. He need hardly say that the committee, having to deal with a scientific subject, and not with an art, was very poor. The present Act of Parliament could only be looked upon as a kind of compromise between prohibition and permission. He hoped one of the results of the labours of the committee would be to show how little damage was done to the roads by heavy traffic, even if it did not do real good. Every cyclist knew that the Ripley road, being a very favourite one for bicycles, was most beautifully swept and laid out, like a carpet; yet there were still small minded people to be found who declare that bicycles destroyed the roads. Although poor, the committee had an enormous amount of work to do. Prof. Hele Shaw had said there was a great difference of opinion among automobilists as to the proper method of applying the power of the motor to the vehicle. Some experiments which he had made showed the enormous influence which the point at which the motive power was applied had upon the propulsion of a vehicle, it being conclusively proved that there was a great advantage in driving by the fore-wheels. He had experimented with every kind of vehicle, from a very light phaeton to a four-horse brake. Fore-carriage driving, however, involved a very difficult mechanical problem, and had, therefore, only been tackled within the last few months. M. Jeanteaud had informed him of an experiment he had made with two exactly similar cabs, heavily loaded, one rear driven and the other fore-driven; they had both been run continuously, and the accumulator of the former had been exhausted on the first night of the trial, whereas the latter had continued running till one o'clock the next day. Twenty years ago a compressed air tramcar was tried; it ran for a long time and very reliable figures were obtained. But it came in one evening with 20% more air in the reservoir than was usual, and the next day it behaved equally well. The reason was after a time discovered. The whole of the four wheels were driven by the motor, and the two sprocket pinions were attached to the motor shaft by feathers or keys. One of the keys had fallen out, and the consequence was the vehicle was fore-driven on those days. One of the principal advantages of the viagraph was that it showed the enormous loss of power resulting from the inequalities in the roads. When bicycles were introduced it was said they would never be labour-saving because their riders had to transport their machines from place to place as well as themselves. It was now known they were labour-saving, and the reason was that they furnished a means by which a man's body was transported on a line which approximated to horizontality. In walking, the hips continually described the portion of a circle, and thus a great deal of energy was thrown away.

Mr. MARK MAYHEW, L.C.C., pointed out how badly the action of the English administration contrasted with that of France in the matter of motors. The latter country had given every possible encouragement to the industry. During the past few weeks local administrative bodies all over the country had threatened the motor industries and the users of motor cars with very serious action in the Houses of Parliament. Why that was so it was impossible to say. It was difficult to understand how, in the face of all the evidence, local administrative bodies, supposed to represent the population, could take such action. The suggestion that motor cars should be forced to carry a large placard bearing a number back and front was a stigma upon the character of their owners, which no other men in the country would be called upon to endure. He thought he might appeal to the Chairman to place before the Society some suggestion that they should in their turn approach the Local Government Board, the Houses of Parliament, and other important administrative bodies, and lay before them arguments which were bound to dispose at once of such measures as the local county councils were now endeavouring to bring before them.

Mr. J. W. BENN (L.C.C.) said he had come to hear the Paper and discussion in order to discover if anything could be done to solve the great question of the congestion of London. Mr. Balfour, in the House of Commons a few months ago, had suggested that the solution of the housing problem was to be found in the motor car, and he thought the Professor might show how that was to be done. It was now proposed to spend vast sums of money in installing electric traction in London; he had more than once desired that something could be done on the surface of the road rather than a method which involved considerable excavation and engineering expense in structures beneath the surface. He was led to hope that the time was near when they might run omnibuses in connection with their tramways on the principle which now governed motor cars. An expert recently appealed to had stated that there was no such invention at present which would satisfy the requirements of the London County Council. He hoped the researches of the committee would lead to a more satisfactory answer to a similar question in the near future.

The CHAIRMAN moved a hearty vote of thanks to Prof. Hele Shaw for his Paper, which was carried unanimously.

Prof. HELE SHAW, in reply, said that the subject matter of the Paper had been presented under such a number of aspects by the different speakers that its vastness had been amply demonstrated. He was sure the Society of Arts, which had done so much for many years towards the improvement of so many things, could most profitably devote further time to the discussion of the question. He was greatly encouraged by the remarks which had been made.

## SIGNALLING ON SOME BRITISH ELECTRIC RAILWAYS.

At the meeting of the Institution of Civil Engineers on the 11th inst., three Papers were read, entitled "The Signalling on the Waterloo and City Railway" and "Note on Signalling Outlying Siding Connections, by Mr. A. W. Szlumper, M.Inst.C.E., and "Signalling on the Liverpool Overhead Railway," by Mr. S. B. Cottrell, M.Inst.C.E.

The Waterloo and City Railway, as previously described in the *Minutes of Proceedings* of the Institution (Vol. CXXXIX.), was an electrically-worked underground railway 1½ miles in length. It was a double line, in separate tunnels, with a station and accommodation for shunting the trains at each end. Trains ran every 6min., the journey occupying about 6min. There were two signal-cabins, one at Waterloo and one at the City, the former containing 16 levers and the latter 18 levers. The line, however, was practically divided into two block sections by the provision of signals about half-way between the stations, such signals consisting of an electric lamp fixed to the wall of the tunnel, electrically controlled from both boxes and by clearance bars or treadles. In addition to the ordinary mechanical interlocking, the Sykes electric lock-and-block system had been largely introduced, and as a further safeguard "slipper bars" were fixed a short distance in front of the more important signals, by means of which the current to the electric motors was automatically cut off should a train pass the "slipper bar" when the signal was at danger. The "starting" signals at the stations had double arms, the upper one being a "right away" signal, the lower one being a "draw ahead" signal. Both these arms were worked by the same lever by means of a Sykes "electrical selector." The "stop" signals at the stations consisted of ordinary ground discs, which were also provided for shunting movements. Treadles or fouling-bars were extensively used; they consisted of an angle-bar about 35ft. in length, balanced on pivots and connected to a contact making switch. In lieu of the ordinary repeaters, bells were fitted in the signal boxes which rang when any signal failed.

This was effected by passing a wire through a series of signals by means of contact-makers on each signal and upon their corresponding lever in the signal box, terminating in a bell which started ringing should any contact be broken. Facing points were fitted with ordinary facing-point bolts, also Sykes electrical point detectors, one being fixed to each stock rail on a pair of points and connected to and working with the tongues. Both tongues had to be dead home before the selector was operative, and until then the point lever was locked by an electric lock. The block instruments used were Sykes lock-and-block instruments, which were electrically interlocked with the levers and signals. All the lights in the signals and discs consisted of 8 c.p. glow lamps in duplicate, and were repeated in the signal boxes by pilot lights.

The second Paper described some modern methods of electrically controlling outlying siding connections. One system described was applicable to a railway where an electric lock-and-block system was installed. The siding connection was controlled by a key, the removal of which, from an instrument, locked up all conflicting signals and broke down the block instruments until the key was returned; no outdoor signals at the siding were necessary. Another system described consisted of the provision of a ground-box and outdoor signals at the siding, locking instruments being provided at both the section and siding boxes. When the siding was to be used, the switching in of the siding-box locked up the starting-signal at the section-box by means of an electric lock, and released an electric lock on the siding-signal, the switching out of the siding-box restoring the section-box signals and instrument to their normal condition. A special feature of this scheme was electrically locking up the entrance to the siding-box from the section-box. Another system described consisted of the provision of a ground-box and of outdoor signals at the siding-connection. When operations were to be carried out at the siding, the box was switched in as a section-box, and electric locks on the signals were released; during shunting operations, the siding-box was treated as a section-box, and when completed, the box was switched out, and the signals again became electrically locked from the section-box.

The third Paper described the system of automatic electric signalling in use on the Liverpool Overhead Railway, which, originally promoted to facilitate passenger transit to and from the docks, had developed into a line nearly 7 miles in length, and, in addition to fulfilling its original purpose, provided rapid access to Liverpool from two important suburbs, and by means of an electric tramcar system owned by the company from other suburbs. When the line had been originally constructed as a dock-railway with many stations, automatic electric signals had been introduced, in order to avoid the expense of men and maintenance, but with the extensions in the suburbs the automatic system had had to be supplemented at termini and junctions by ordinary mechanical signals. The intermediate stations were divided into 14 block sections; each block had a station at its commencement, and since the length of the blocks was short, each station was equipped with only four signals—viz., one home signal and one starting signal for each road, the starting signal being practically the distant signal for the station in advance. A train leaving a station passed the "breaking" contact, putting the starting signal to "danger"; it then passed the "making" contact, which pulled off the home signal of the station it had just left, and the starting signal of the station in the rear. The circuit between the making contact and the other signals was made through a switch fixed on the arm of the starting signal, so that should the latter fail to go to "danger," the circuit could not be completed and the line behind would be blocked. The making and breaking contacts were actuated by a striking-board fixed on the last coach, so that should a train break in two, the signals would not be operated. This automatic arrangement applied to all intermediate stations, and where the automatic system merged into mechanical, the alteration took place at the home signal in one direction, and at the advance starting signal in the other—that was, on the up road the advance starting signal was the first automatic signal, and on approaching the termini the distant signal was the first mechanical one. The current for working the signals was supplied from accumulators at 50 volts pressure; two sets of 27 cells were situated at each station, and these were charged in series from the generating station. These accumulators also provided light to the stations. The expenditure of electric energy in current was very small. Each station comprised four signals, each worked with a lowering current of 5 amperes at 40 volts, and with a holding current of 0.25 ampere at 40 volts. With a 3-minute service for 20 hours a day each signal would be lowered 400 times, requiring, therefore, 2,000 ampere-seconds, or, say, 0.5 ampere-hour, per signal per day. The entire station would require 80 watt-hours per day, and the total system 1,040 watt hours. This, however, did not include the holding-off currents. Assuming each signal to be held down 1½ minutes, it would be down 600 minutes per day, requiring 150 ampere-minutes, or 2.5 ampere-hours, or five times as much as for lowering. In the first few months there had been occasions of signals failing to go to "danger," but experience enabled such failures to be eliminated, and reduced the number of other failures, which now amounted to an average of only 1 in 11,156,857 operations.

# CORRESPONDENCE.

## SUN-SPOTS, MAGNETIC STORMS, COMETS' TAILS, ATMOSPHERIC ELECTRICITY, AND AURORÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Principal Lodge's interesting letter, I would remark that at the time I suggested that the magnetic disturbances on the earth might be due to electrified particles emitted by the sun, the distinction between ions and free electrons had hardly claimed any attention. What I suggested, as well as I recollect, was that the magnetic storms were due to something of the same kind as cathode rays, and I recollect that I made a calculation as to the density of the electrification—*i.e.*, of the projected particles required in order to produce magnetic forces of the amount observed in magnetic storms, and that I was convinced that, with velocities such as had at the time been observed or calculated as existing in cathode rays, quite a feasible density of emanation from the sun would suffice.

In connection with this it may be worth while recalling attention to the way in which there seems to be some evidence from auroræ and magnetic storms that the earth has a minute tail like that of a comet directed away from the sun, the time of day of maximum magnetic disturbance being about 11 p.m. and this also being about the time of maximum auroral activity in each longitude. There are many things which seem to show that comets' tails, auroræ, the solar corona, and cathode rays are closely allied phenomena. Those who are interested in the solar effect on terrestrial magnetism should consult the elaborate study of these effects that have been made by Prof. Bigelow, of Washington.

In connection with the theory of comets' tails I would call attention to the difficulty of explaining their repulsion by the sun to the Maxwell pressure of radiation in that there is no evidence that the molecules of any gas absorb more than a *very* minute proportion of the radiations that fall upon them. For example, the area of the molecules in 1 cubic cm. of hydrogen is about 10,000 sq. cm., so that there are no gaps in a layer of hydrogen one ten-thousandth of a centimetre thick. Now we know that this thickness of any gas would absorb only a *very* small proportion of the sun's radiation falling on it, and consequently we may safely conclude that the effect of solar radiation in reducing the gravitation to the sun is quite insensible. The effect at all distances from the sun is the same proportion of solar gravitation, so that if any effect of the kind were observable close to the sun it would be equally observable as a correction on gravitation at all distances.

Dr. Lodge has called attention to M. Crémieu's experiments and fears that they may upset all the foundations of modern electrodynamic theory. I would suggest a possible way of reconciling these experiments with a great deal of our existing observations and theories. Suppose that when an atom moves through the ether with an attached electron, the moving atom is so affected that its motion disturbs the surrounding ether in such a way as to produce a magnetic force equal and opposite to that of the electron. This will entirely explain M. Crémieu's experiments, and all ordinary conduction due to the motion of electrons through matter and cathode rays due to free electrons. We require, however, a subsidiary hypothesis to explain the magnetic effects of electrolytic currents. This would take the form of a suggested difference between an ion and an atom. An ion on this hypothesis would so differ from an atom that its motion does *not* neutralise the magnetic effect of the electron. I acknowledge that there are most serious difficulties in the way of this hypothesis. It would certainly require us to suppose that the electric charges on the surface of a conductor are *not* ions. If they are so on the surface of a charged electrolyte, then Crémieu's experiments should produce magnetic force if he had used a moving liquid instead of a moving metallic conductor—a very difficult form in which to make the experiment. May be an electrified squirt of liquid, as from an Armstrong's electrical machine, could be used to see if there is any magnetic force near the squirting jet. Another serious

difficulty is in deciding what happens at the terminals of an electrical machine, such as a Holtz or Wimshurst, when the conduction current with magnetic force turns into a convection current without. These difficulties are so great that, until M. Crémieu's experiments have been repeated by others, and no doubt can be thrown on their methods or calculations, I would certainly advise at least a suspension of judgment before we seek for new foundations for our electromagnetism. —Yours, &c. GEO. FRAS. FITZGERALD.

Trinity College, Dublin, Dec. 10.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I perceive from your Editorial Notes that my recent letter setting forth what I believe to be an important factor in cosmical electromagnetism has laid me open to some misapprehension, because in the introduction thereto I happen to refer (unnecessarily) to a casually-seen epistle of Prof. Rücker's, which it now appears was part of a current controversy; and I have thereby unwittingly stepped into a magnetic storm of a totally different kind from any that I was contemplating. Permit me, therefore, to assure you that I wrote with not a thought of that controversy in my mind. So far as waste tram-electricity disturbs magnetic observatories I am with the observatories. It is an unfilial act for scientific applications to damage the parent science. The experience of mankind has consistently shown that whereas waste products or other rubbish may be freely shot in small quantities, or in uncivilised districts, yet that a nuisance soon arises as they increase in quantity; and now that so many things are laid in the earth of towns I do not suppose that urban communities will long permit the random casting away of a large quantity of electricity, with sufficient voltage left in it to enable it to crawl home unguided. Telegraphic waste can be tolerated, but the waste electricity of electric railways must one day be taken home in proper conduits.

And then as to the value of the work of magnetic observatories. Surely it were madness to discontinue or spoil the record of a long series of continuous observations, except in case of dire necessity. The destruction or removal of Kew, for instance, the pioneer magnetic observatory of the world, would be a national misfortune.

If a critic were to urge that observations should be reduced and compared and not merely accumulated, if he were to plead for careful attention to individual and noteworthy features, as well as to an averaged result with eccentricities smoothed out, he might be listened to with attention and profit. But I cannot conceive any wise and responsible critic urging that the careful and strenuous process of accurate observation, on which so much of science has been built, was a mistake; nor can I imagine such a critic advocating the abandonment of continual systematic inquiry and record as useless to science.

The other matters on which I have been partially misunderstood are of minor consequence. Suffice it to say that my guess that electrons might perhaps in the future be pressed too hardly into the service of science, did not in the least apply to them here and now. On the contrary, the conditions of the vacuum tube seem to me closely to correspond with the conditions which must obtain in inter-planetary space. If the sun or other body is negatively electrified, cathode rays can hardly help streaming from it through the great dark space. When they impinge on an atmosphere they should give rise to ordinary vacuum tube appearances, with striæ, &c.; and when they impinge on an airless target, like the moon or a meteorite, they would give rise to X-rays. In any case they must in their flight constitute electric currents, and as such must have their due magnetic influence; and, if they are numerous, that magnetic influence must be very considerable by reason of their immense speed. —Yours, &c.,

University of Birmingham, Dec. 8. OLIVER LODGE.

## BOOKS RECEIVED.

"Ueber Mehrphasige Stromsysteme bei ungleichmassiger Belastung," by Wlad. Karapetoff. (Stuttgart: Ferdinand Enke.) 2·40m.

"Whitaker's Almanac for 1901." (London: 12, Warwick-lane.) 5s.

"Home-Made Jewellery and Trinkets." Useful Arts and Handicrafts Series. No. 28. (London: Dawbarn and Ward). 6d. net.

## COURT OF COMMON COUNCIL (CITY OF LONDON).

At its meeting yesterday (Thursday) the Streets committee again submitted their report on the question of the practicability of generating electricity from steam raised by burning the City's refuse. After inspecting the combined destructor and electricity generating works at Shoreditch, visiting the Leyton refuse and sludge destructor, and having reports from the engineer and the electrical engineer to the Corporation with regard to the disposal of refuse by cremation and the disposal of refuse and the generation of electricity, the committee came to the opinion that, in view of the shortness of their lease of Lett's Wharf, it would be inexpedient to sink further capital in erecting the necessary machinery for the generation of electricity, and they recommended the adoption of the system of barging dust and refuse into the country.

The Engineer, Mr. D. J. ROSS, in his report on the subject, pointed out that the Corporation, having permitted two electric lighting companies to obtain powers to supply electricity for lighting and other purposes, could only generate electricity for their own purposes or for street lighting. The Corporation was, therefore, in a totally different position to other local authorities who were supplying electricity in their districts, cremating their refuse, and utilising the power generated therefrom in connection with their electricity works. It was also extremely doubtful whether the house and trade refuse removed from the City was of such a nature as to be dealt with profitably by cremation, as it differed essentially from the refuse removed from other cities and from suburban districts, inasmuch as it consisted principally of paper, straw, and packing materials of very little calorific value, exceedingly bulky and difficult to manipulate.

The electrical engineer (Mr. A. A. VOYSEY), in the course of his report, says:—

"Before entering into the question of generating electricity, it is necessary to consider what can be done with it when generated, and whether it can be generated more cheaply in connection with destructors than it can be bought. In 1897 I went into this matter rather carefully, and came to the conclusion that considerable economy might be effected in the removal and disposal of the City refuse by raising steam from the heat generated in the destruction of refuse, and by using that steam to produce electricity with which to charge batteries for running motor dust carts or other apparatus for which horses are now required, and possibly also for propelling barges to take away the street sweepings and slop, and the clinker from the destructors. Further consideration of the matter has confirmed the views at which I arrived. There is, however, a serious objection to any immediate and wide application of the system in the fact that it is novel, and for this reason I have advised that an experiment be made with an electric motor dust cart. Such a vehicle in the City would offer great advantages for the use of electricity, for the reason that the conditions of its service would be well known and regular; it would not travel at a high rate of speed, and its journeys, when loaded, could be performed chiefly on the level or on a down gradient. Indeed, with the exception of the frequent stopping and starting, for which special provisions could be made, it offers altogether excellent conditions for the use of electricity.

With regard to electric barges, I am of opinion that they could take away the sweepings and slop and the clinker from the furnaces at a lower price than is at present paid for this service.

In addition to the running of dust carts and barges, electricity could be used for lighting the works and for street lighting, and I think sufficient electricity might be generated for all these purposes, if required.

With regard to public lighting, the relations existing between the Corporation and the City of London Electric Lighting Co. are of an uncertain nature, but it should be borne in mind that the agreements under which the public lighting has been carried out, supposing they be held good at law, are determinable, at the pleasure of the Corporation, seven years after the completion of the whole of the lighting.

I am therefore of opinion that great advantage might be obtained by using the heat generated in the cremation of the house and trade refuse for the purpose of generating electricity to propel the dust carts for collecting the refuse, and possibly the barges for removing the street sweepings and slop, and also for lighting public lamps.

As regards the electrical part of the scheme, it should, in my opinion, be carried out in the most gradual and tentative way, though always with due consideration for the ultimate end in view. First should come the trial of the electrically propelled dust cart; then, if it proved successful, an electrically-propelled barge might be tried. These experiments would take some time to carry to a conclusion, and in the meantime the question of public lighting should develop to a point at which it would be possible to determine definitely when and under what circumstances the public lighting could be taken over, and the saving to be effected thereby. These points having been settled, it will be possible to determine the question of a site for the works."

Mr. Voysey further deals with what, in his opinion, was the cause of the failure of electric cabs in London, in relation to the question of the success or failure of the suggested dust carts and barges. He also deals fully with the special requirements of the City of London and to the necessity of utilising as far as possible the Corporation wharf on the river side, of which there is an unexpired tenure of eight years. The report concludes by emphasising that it would be necessary to establish a regular long hour demand before success for the scheme could be assured, and that unless such a demand is created the generation of electric current by the Corporation should be left alone, as "it is only by superiority of the load factor that a small generating station can expect to rival the larger stations in the cost of generation."

After protests from Mr. A. C. Morton and Mr. Deputy Malthouse, the consideration of the report was again adjourned.

THE CITY STREETS.

In reply to Ald. Sir Henry Knight,

Mr. HUDSON (chairman of the Streets committee) said they had written to the Postmaster General and all the companies having statutory rights to open the public ways, informing them of the decision of the Corporation with reference to working day and night. It was not the fact that under existing arrangements trenches had been opened and left for days and weeks without any work being done. In cases where trial trenches had been opened they had been planked in or covered over. As to responsibility, the Post Office were working to a settled plan, and were responsible for and directed the work. As to whether the close proximity of the electric mains was likely to have any effect on the gas and water mains whereby the public safety would be endangered, that was a question for an electrician. Looking at the facts that all the cables were of the best possible description, and the insulation as perfect as possible, the engineer did not see how there could be any effect upon the gas or water mains. The gas and water companies were fully aware of the existence of the electric mains and they would take any steps necessary for their own protection.

Mr. BROOKE HITCHING: The hon. member asked what steps the committee was taking to induce the Charing Cross and Strand Company, which had statutory power to open the streets again, to lay the cables at the same time as the Government department laid its telephone wires.

Mr. HUDSON said the company had been written to, but no further steps had been or could be taken.

Mr. BROOKE HITCHING thereupon moved "That it be an instruction to the Streets committee to approach the Charing Cross and Strand Co. with a view to inducing them to lay their cables while the trenches are open for the reception of the telephone cables of the Post Office Department." There were 50 miles of streets in the City, and nearly the whole of those were being taken up by the Post Office authorities. The Charing Cross Company could, under its statutory powers, open the whole of those streets again.

Mr. HUDSON said that all they could do had been done, and nothing further could be done under such a resolution.

The instruction, however, after further discussion, was agreed to.

VIBRATION OF THE TUBE RAILWAYS.

Mr. Deputy JOHNSON called attention to the damage alleged to be caused by the vibration created by the underground electric railways, and moved that each member of the Court have copies of the bills in Parliament for the promotion of the Central London Railway, North-East London Railway, and City and North-East Suburban Electric Railway, together with plans and diagrams marking the depth below the surface, the location of shafts, openings, stations, &c. He knew these schemes could not be opposed, as the public must be carried from one place to another, but they could insist upon all available appliances being used by which the vibration could be decreased.

The motion was unanimously agreed to.

## LEGAL INTELLIGENCE.

### F. W. Smith & Co. v. Leigh Savings Bank.

At the Leigh County Court last week before Judge Bowen Rowlands, Q.C., the plaintiffs sued the trustees of the Leigh Savings Bank on a contract for the electric lighting of new bank premises. Plaintiffs tendered to do the work for £17. 10s., but in the course of the work certain alterations had to be made arising from instructions to plaintiffs by Mr. Stephens, architect for the bank. Defendants claimed a set-off of £6. 15s. 8d. against the amount claimed by plaintiffs. The extras which plaintiffs claimed for amounted to about £18, and defendants disputed their liability. Part of the extras were alleged to have been caused by the negligence of the defendants' builder, and defendants' contention was that the builder only was chargeable with the sums arising out of this work.

After hearing evidence judgment was given for plaintiffs for £18. 13s. 4d. and costs on the higher scale.

### Re Cork Electric Tramways and Lighting Co.

In the Chancery Division, Dublin, last week, the Vice-Chancellor granted the application of the company and Messrs. A. R. Monk and E. A. Lazarus for an order directing the Accountant General to pay out to the company £421. 5s. 11d. new Consols and £2. 15s. 1d. cash lodged as a parliamentary deposit in respect of the Cork Tramways (Blackrock Extension) Act, 1900.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Perth Corporation require a resident electrical engineer. Further particulars are set out in an advertisement, and applications must be addressed to the clerk to the Commissioners (Mr. John Begg), City Chambers, Perth, by 22nd inst.

York Corporation require a mains superintendent and a cable jointer for their electricity department. Further particulars are set out in advertisements, and applications must be sent to the city electrical engineer (Mr. C. A. Midgley) by 15th inst.

Edinburgh Corporation require an inspector to superintend the installation of electric lighting at a large public building. An advertisement gives further particulars, and applications must be sent to the resident electrical engineer (Mr. F. A. Newington), electricity supply station, Dewar-place, Edinburgh, by 29th inst.

Wimbledon District Council require a junior assistant engineer at their electricity works. Applications to chief electrical engineer (Mr. F. Barnes Spencer), the Broadway, Wimbledon, London, S.W., by 19th inst. See advertisement.

The Engine, Boiler and Employers' Liability Insurance Co. (Ltd.) require additional inspectors for their electrical department. Applications to managing director, 12, King-street, Manchester. See advertisement.

A switchboard attendant is required for the Plymouth Corporation electricity works; also a cable jointer. Applications to borough electrical engineer (Mr. John H. Ryder) by 22nd inst. See advertisement.

A technical assistant is required in a works laboratory. For further particulars see advertisement.

An old-established firm manufacturing electric accumulators requires agents in the provinces. See advertisement.

An engineer-in-charge is required for a continuous-current 500-volt plant. See advertisement.

An assistant lecturer in physics is required for the Technical College, Huddersfield. An advertisement gives further particulars.

Perth Corporation require a resident electrical engineer. Applications to clerk to commissioners by 22nd inst.

Manchester Tramways committee require a foreman platelayer for permanent-way department. Applications to chairman by 14th inst.

Battersea Borough Council require a resident electrical engineer. Applications on official forms to town clerk by Jan. 1.

Lancaster Corporation require an electric tramways engineer. Applications by 17th inst.

---

Mr. A. H. Seabrook, assistant engineer at Hampstead, has been appointed electrical engineer to the Barking District Council.

Mr. E. Cardin has been appointed mains superintendent at Newport at £150 per annum.

Mr. Austin T. Smith, of Morecambe, has been appointed assistant engineer at the Bury (Lancs.) electricity works.

Mr. C. E. L. Stewart has been appointed assistant engineer at Rochdale Corporation electricity works.

---

**Aosta-Martigny Railway.**—Public attention in northern Italy has lately been directed to the extension of the Aosta railway, either to Chamonix or to Martigny, and the president of the Provincial Council has sent for one of the engineers who have studied the line (Signor Cedali), and informed him that it is the intention to apply for a Government concession granting a subsidy of 500,000 lire from the Provincial Government. The subsidy to be asked from the national Government is 5,000 lire per kilometre for a term of 70 years. The estimated total expenditure is 56,000,000 lire for the 75 kilometres of line. Mr. J. Cook, of London, is interested with Signor Cedali in this undertaking.

**Aylesbury.**—A supplementary report on electric lighting, which was presented to the Council last week by the Lighting committee, stated that the proposals of the Wycombe Borough Electric Light and Power Co. were to take a transfer of the Aylesbury provisional order on the basis of repaying to the Council the cost of obtaining the order, with option of purchase at the end of seven or 14 years, but they could not recommend their acceptance. The committee had had several interviews with the resident engineer at Wycombe and it had been represented to them that a combined scheme for Aylesbury and Wycombe could be worked more economically than separate undertakings for the two towns. The company's success at Wycombe was in no small measure due to three large consumers and to the number of motors in use, which could not be looked for in Aylesbury. Taking the private consumers at Wycombe, the success there were only an equivalent of 850 8 c.p. lamps connected at the end of last year, and therefore the local authority would be running great risk in undertaking the supply at Aylesbury, relying on the results obtained at Wycombe. Substantial guarantees for the efficient carrying out of the contract by the company would be furnished. The committee had obtained an amended report from Mr. F. H. Medhurst on the question of municipal works, from which it would be seen that the total estimated capital expenditure had been increased from £19,170 to £23,211 owing to the increased cost of materials, labour and plant. The committee had carefully considered those figures, which were based upon an increased consumption for private lighting from 3,000 to 4,000 8 c.p. lamps and they considered it would be safer to be guided by the 1898 report, and to take the estimated demand as 3,000, when the estimated revenue from private lighting was put at £1,462, and from public lighting at £835, a total of £2,297. The

estimated expenditure was £2,343, leaving a loss of £36. The committee were of opinion that it was not to be expected that any appreciable profit would accrue for some years, but that the Council's endeavours should be directed to ensuring with reasonable certainty that there should be no loss to the ratepayers. They consider that as regards private consumers electricity will be in a position to compete with gas in Aylesbury, even at a considerable reduction on the present price, and in view of the area of supply being a compact one and to the fact that electrical undertakings of the present day, if properly conducted, appear invariably to have been carried on without loss, they consider that it would not be desirable for the Council to part with their powers to a private company on terms which could hardly fail to prove onerous when the period of re-purchase arrived. The consideration of the matter was adjourned.

**Birkenhead** —A sub-committee has been appointed to report upon the practicability of framing a scheme of "assisted wiring" in the district.

**Bloemfontein (South Africa).**—The electricity works were formally opened on the 9th ult. The contractors for the equipment of the station were Messrs. Reunert and Lenz.

**Brighton.**—An inquiry was held here on Wednesday into the application of the Corporation to borrow £56,000 for electric lighting extensions. The town clerk (Mr. F. J. Tillstone) appeared in support of the application, which was unopposed. Mr. Tillstone stated that the money was required for the expenses in respect of the electricity undertaking for the years 1901 and 1902, and it was proposed to extend the repayment over 25 years. Mr. J. Christie, the resident electrical engineer, stated that the present capacity of the works was 4,710kw., equivalent to 147,000 8 c.p. lamps, and they at present had 150,000 lamps connected. They had a prospect of also lighting the new pier that was being built, and the local tramways would be run with power from the works. The pier would probably require an additional 2,500 and the tramways 11,000 equivalent 8 c.p. New consumers were coming on to the mains at the rate of from 400 to 500 per annum and the increase of business might be taken at about 16 per cent. on the previous year's output, both as regards output of energy and new connections. He gave technical particulars of the additional plant it was proposed to lay down to meet the growing demand, and stated that the tenders which had been accepted had proved somewhat below the estimate, and therefore the Corporation would only require some £54,798, and the amount asked for would be reduced to this figure.

**Bristol.**—At the Corporation meeting on Tuesday Alderman Pearson submitted the report of the Electrical committee, which dealt with the new works at Avonbank, for which a tender amounting to £22,133 had been accepted. The time had, he said, arrived when the preparation of plans and specifications for the superstructure should be in hand, and, if an architect were to be employed, now was the time to appoint him. But they felt it was more of an engineer's than an architect's question. After discussion the committee's report was rejected by 33 votes to 32, and an architect, therefore, will be employed.

The electrical equipment of the new electric tramways was officially inspected by Mr. A. P. Trotter on behalf of the Board of Trade last week.

**Burton-on-Trent.**—A contract for a 400kw. steam alternator and condensing plant for the electricity works was let by the Council on Wednesday. It was reported that the demand for electricity was on the increase and justified the additions to the plant. The committee also resolved to undertake the letting out of gas engines and electric motors, the chairman pointing out that the business had proved a great success in Birmingham and elsewhere.

**Bury St Edmunds.**—Application is to be made for sanction to borrow about £6,000 further for public electric lighting.

**Cardiff.**—Work in connection with the laying of new track for the electric tramway system will be commenced on Monday. The work of reconstruction will be under the direction of the borough engineer (Mr. Harpur). While this work is being executed the Tramways committee will be laying conduits for cables from the site of the station at Roath. In this case the work, which will be started in several places at once, as well as the bonding of the new track, will be carried out under the supervision of the borough electric tramways and lighting engineer (Mr. Arthur Ellis).

**Conway.**—Owing to a suggestion to extend and improve the gasworks, the Council decided last week not to let tenders for the present, and a committee is to be appointed to consider and report upon the question of erecting electricity works for public and private supply.

**Crete.**—We learn that the Cretan Government is contracting for the establishment of telephonic communication with the interior of the island.

**Dalkeith.**—Messrs. Crompton & Co., who are applying for a provisional order for this burgh, have submitted terms for the supply of current, &c., and the Commissioners have decided to call in Mr. A. A. Campbell Swinton to advise them.

**Dorking.**—The Council have decided to transfer their provisional order to the West London and Provincial Electric Supply Co. The conditions of the transfer deed include the supply of current for street lighting at 2½d. per unit. The Council retain the right to purchase at the end of the first ten or any subsequent period of seven years. The Council have engaged Mr. W. H. Trentham to advise them upon the transfer and also in regard to the electric lighting scheme of the company.

**East Ham.**—A report was submitted to the District Council last week by the accountant (Mr. A. Plant) upon the question of supplying electric current to artisans' dwellings. The capital outlay for wiring and fitting, as shown by the electrical engineer's report, was £6. 10s. per double tenement house, to which must be added 2s. per house covering loan charges, or a total estimated capital outlay of £6. 12s. On the question of the public lighting, the Electric Light committee recommended that High-street South and the Manor Way to the Ferndale Tavern, North Woolwich, be lighted with arc lamps, placed 80 yards apart; that the portion of the highway to Beckton-road be proceeded with forthwith; and the remainder of the work be carried out as the tramway track is constructed. The report was adopted.

**Edinburgh.**—The Cleaning and Lighting committee have instructed the lighting inspector to report upon a proposal to light Thistle and Rose streets by means of lamps suspended from the middle of span wires across the streets.

**Exhibition.**—The German Ministry of the Interior has voted a sum of 25,000m. (£1,200) in connection with the exhibition of fire protection and extinguishing appliances to be held in Berlin next year.

**Fulham (London).**—Application is to be made to the London County Council for sanction to a loan of £15,000 for extensions of the electric lighting mains. A discussion took place at the Council meeting last week as to the supply of current to the workhouse premises. The report of the Electric Light committee recommended that application be made to the Board of Trade for sanction to supply current to the Guardians at a reduced rate. Ald. Thomas, a guardian, thought the Council could not refuse a private consumer the same facilities as they proposed to grant to the guardians. As a matter of fact, a private consumer could demand to be charged at the same rate. There were, he said, legal difficulties, and as the vote at the committee was taken hurriedly he moved a reference back to the committee. After discussion the committee's recommendation was adopted.

**Glasgow.**—At last week's meeting of the Electrical committee it was announced that Mr. W. A. Chamen, chief engineer to the Corporation electricity department, had received the offer of an appointment as chief engineer to a large electricity supply company, but would prefer to remain identified with the Glasgow undertaking if his salary were increased from £800 to £1,000 per annum from Jan. 1st next. In a communication from Mr. Chamen it was pointed out that at the time of his appointment at the beginning of 1898 he asked for a salary of £1,000 per annum but accepted £800 on the implied understanding that an increase would follow as soon as he had made a name for himself in Glasgow. The committee, having carefully considered Mr. Chamen's letter, unanimously agreed to recommend that the increased salary be approved. Bailie Maclay, who moved the approval of the minute, said the committee would certainly have themselves come forward with a proposal to increase Mr. Chamen's salary if the present application had not been made. The minute was, after only brief discussion, approved unanimously, except for the dissent of Mr. Buchanan, who withdrew from the committee.

**Halifax.**—An accident occurred at the electricity works on Monday evening, when a 10in. steam pipe in the boiler-house burst, and three workmen who were near were scalded. One of these, named Drew, was so seriously injured that he succumbed to his injuries on Wednesday. The other two men were not badly hurt. The accident caused a stoppage in the supply for about half an hour, but no damage was done to the plant at the station.

**Hampstead (London).**—Having been appointed resident engineer at the electricity works of the Barking District Council, Mr. A. Hugh Seabrook will relinquish his appointment as assistant at Hampstead in January.

**Hanley.**—The Board of Trade have authorised the alteration of the standard pressure from 100 volts to 200 volts, provided that no change should be made except with the consent of the consumer in the pressure of supply to any premises which on March 4, 1896, were supplied with energy by the undertakers.

**Hull.**—The Beverley-road electric tramway route was opened for traffic on Saturday.

**Hyde.**—The Council, on Monday, passed a resolution authorising application for parliamentary powers, in conjunction with the Corporations of Stalybridge, Mossley, and Dukinfield, for constituting

and incorporating a joint board, consisting of representatives of the four corporations, to construct and work tramways, and to supply electric energy in these boroughs, and for other purposes. Mr. Tinker said all the financial provisions of the scheme had been gone into, and he felt satisfied it would prove a great success, and would be found to be a great relief to the rates after two or three years' working. There would be car sheds built at Hyde, Mossley, and Stalybridge, and sub-stations at Hyde, Dukinfield, and Mossley. The total expenditure would not be less than £400,000. The town clerk was instructed to oppose the application of the Oldham, Ashton, and Hyde Electric Tramway for further tramway powers within the borough.

**Inquest**.—An unfortunate accident occurred on Saturday at the extensive works of the Telegraph Construction and Maintenance Co. at East Greenwich. It appears that a man named Carr entered a cable tank with a view to removing the valve to allow water to drain out of the tank, but not returning, a workman named Thornton went to look for him. It was observed that he, too, was away some time. Another man, Smoker, then followed, and he not returning, Rice entered the tank and found it foul with gas, but succeeded in recovering the lifeless bodies of Thornton and Carr. Then he rescued Smoker, who was in a very bad state, and was conveyed to the Seamen's Hospital. Rice, although prostrated at the time by the fumes, was, fortunately, not seriously inconvenienced.

At the inquest, opened on Wednesday at St. Alphege Mission Hall, Greenwich, the evidence showed that Carr descended into the tank and was at once overcome by the gas which had been generated. Thornton was also overcome. Carr and Thornton were both got out of the tank by Rice, but all attempts at resuscitation failed.

Mr. F. R. Lucas, engineer-in-chief to the T. C. & M. Co., eulogised the bravery of the men who had attempted the rescue, and said the firm were proud of them. It was the duty of the deceased to adjust the rope bands of the machinery for hauling the cable. The tanks were drained by the drawing of a plug, but it was no one's duty to touch the plug except when ordered to do so by the foreman. The cables were kept in water in the tanks, and the action of the water on the cable would generate sulphuretted hydrogen gas. The men were not required in the tank at the time.

Walter J. Sutton, foreman at the works, said he was in charge when the accident occurred. He gave orders to Thornton to get some spun yarn ready for the working tanks, but No. 6 tank was not required. Just before seven o'clock he was informed that there were men down the tank eye, and he at once gave orders to have the men got out, and eventually Smoker was brought up unconscious. He was at once taken to the Seamen's Hospital, and was now recovering. About 10 minutes later Thornton and Carr were brought up, but were both dead. A number of men went to their assistance and nearly lost their lives.

Dr. S. Thomas said death was due to suffocation by carbonic acid gas.

The inquiry was adjourned to Dec. 31.

**Kirkcaldy**.—The thoroughfares leading to the railway station as well as Link-street are to be lighted electrically.

**Knutsford**.—The Council have arranged terms for the transfer of their provisional order to the Alderley and Wilmslow Electric Supply (Ltd.).

**Leamington**.—The Midland Electric Light Co. last year obtained a provisional order, but the Council had the option of purchasing the undertaking of the company on certain conditions. Some correspondence has recently passed between the company and the Board of Trade, and the latter have now been asked to fix a date when the order is to come into force, as the Corporation's offer for the electricity works has been refused.

**Lecture**.—Mr. Robert O. Ritchie (of Greenwood and Batley, Leeds) delivered a lecture on "Electric Driving," at Yorkshire College, Leeds, on Tuesday. The lecturer showed numerous slides illustrating the various processes he described of generating and utilising electric energy, pointing out that the use of water power was vastly more costly than was usually supposed. He stated that in the future the alternating-current machinery would be very largely used in England, and engineers would have to face this fact unless they wished our machinery to come from abroad. He concluded by stating that in this country electric driving for textile factories was not of any value at the present moment unless the electricity was brought from a considerable distance, and the nearer machinery approached the class of that used in textile factories the less was the economy obtained from using electric power. In many works the loss on steam power was 60 or 70 per cent., and in most it was 50 per cent. That was where the value of electricity came in, whereas in textile machinery there was exceedingly little waste of energy, and consequently very little scope for the introduction of electric machinery at the present time.

**Liège (Belgium)**.—A New York contemporary states that it is proposed to make Liège a seaport, and to build a canal, 200ft. wide and 23ft. deep, from Liège to Antwerp, a distance of 84 miles. The tugboats, locks, bridges, elevators, &c., are to be equipped for electrical working, and the entire route of the canal to be lighted electrically at night. The total cost of the works is estimated at about £5,000,000.

**Light Railways**.—Longton Council have approved the application of the Potteries Electric Traction Co. for an order for the extension of their line to Sandford Hill.

The Blackpool and Garstang Light Railway Order will shortly be submitted to the Board of Trade for confirmation.

**Liverpool**.—On Wednesday the chairman of the Tramways committee (Ald. Petrie) moved that the Council approve a supplementary estimate of £15,000 for tramways. He said that at the beginning of the present year the committee estimated their expenditure for the 12 months at £320,000, but owing to the rapid development of the system a supplementary estimate was required. The receipts had increased by 15 per cent., the mileage by 19 per cent., and the passengers by 27 per cent. At the end of the year the committee anticipated a surplus of £5,000 to £6,000. The committee had been trammelled this year with horse cars and omnibuses, but Saturday saw the last horse car in Liverpool, and by the end of the year the omnibuses would have disappeared. With the whole system running by electricity the committee anticipated a large profit next year. The motion was agreed to.

The electric tramway service between Liverpool and Seaforth was inaugurated last week.

**Ludlow**.—Mr. J. S. Enright is to prepare a supplementary report on the proposal to establish municipal electricity works.

**Manchester**.—A report on the present condition of the plans of the Stewart-street generating station has been prepared by the city electrical engineer (Mr. C. H. Wordingham) for the Electricity committee. Mr. Wordingham states that the actual development of events in the demand for and supply of electricity has been enormously greater than was anticipated when he entered into his agreement with the Corporation four years ago to act as their resident engineer at Dickenson-street chief station, and to advise them on all electrical matters. Instead of being resident engineer for a station with 5,000 H.P. of plant, supplying about 1,500 consumers, with some 143,000 lamps, he was now resident engineer for a station developing over 10,000 H.P., and supplying energy to 3,000 consumers with 360,000 lamps, and the whole of the management of the station had fallen upon him. The work that had devolved upon him included the lighting of the whole of the city, supplying energy to an enormous outlying area, the responsibility of providing electrical equipment for the tramway system, this comprising the cars, overhead lines, and bonding of the rails, advising on a large fire alarm system, and the lighting of many public and semi-public institutions. He did not complain of those things, but during the last two years a great change had come over the policy of the committee. They had multiplied sub-committees, had required him to attend endless meetings of such sub committees, not only in the electricity department, but in the tramways department, and he had been called upon to present voluminous reports upon the most trivial matters—matters which had no concern whatever with the development of the undertaking, and which could have been disposed of without any report from him. Notwithstanding that, he had found time to design and to superintend everything in connection with the plant for an entirely new generating station of substantially greater capacity than the existing one, which had taken seven years to attain its present size. He had designed and superintended the laying of an immense system of high-pressure mains, a system with which there was nothing comparable in this country. The whole of the work had been carried out by the Corporation's own staff, and only within the last 12 months had he had any assistance in the matter, and then only with the actual superintendence of the execution of the work. With all that work on his hands, he had been expected to personally interview ordinary labourers, and it had been no uncommon thing for him to have to expend half-an-hour or more explaining his reasons for discharging a workman who had made groundless representations respecting his discharge. Mr. Wordingham concludes his report: "I say that the work, as regards Stewart-street, is as forward as it is possible for it to be in view of the enormous amount of work which I have had to do. The scheme is worked out, the general arrangement of the station is settled, many of the details are complete, and a considerable proportion of the specifications are prepared, and everything would have been ready in time had I not been hampered and fettered in the way I have described."

A special meeting of the Corporation will be held on Jan. 9 to consider whether the Council shall exercise its powers to acquire that portion of the undertaking of the Manchester Tramways and Carriage Co. authorised by the Company's Act of 1879.

**Marriage**.—Mr. Thomas Blackwood Murray, B.Sc., M.I.E.E., of Heavyside, Biggar, N.B., and Glasgow, was married on the 5th inst. to Hetty, daughter of Mr. W. Rusack, St. Andrews, N.B.

**Midsomer Norton**.—The Council of this district, in conjunction with the District Council of Radstock, have decided to obtain a report on a joint electric lighting scheme.

**Municipal Finance**.—Pemberton District Council invite offers for a loan of £20,000 for electric lighting. Offers to clerk by 31st inst.

Middleton Corporation are applying for a further loan of £12,442 for extensions of the electricity works. The additional plant is required to provide electric energy for the tramways.

**Municipal Telephony.**—The Corporation Telephone committee of Tunbridge Wells notifies intending subscribers that a large proportion of the municipal telephone system will probably be in operation about June next, while a limited service will be available early in 1901. The "unlimited" service has been fixed at £5. 17s. 6d. per annum, the "limited" or toll service at £3. 10s. and ½d. for each outward call, or £2. 10s. and 1d. for each outward call, subscribers under the limited system being entitled to any number of inward calls free. A list of towns and villages embraced within the Tunbridge Wells municipal exchange area is set out. An annual charge of 10s. per quarter-mile is made for installations over 1 mile from the nearest switch-room, the toll charges remaining unaltered. All the lines are to be metallic circuits, and day and night and Sunday service will be provided.

A sub-committee has been appointed by Lincoln Corporation to report upon the question of equipping a municipal telephone exchange.

The Sunderland Corporation have decided to engage Mr. A. R. Bennett, at a fee of 25 guineas and out-of-pocket expenses, to prepare a report on the muncipial telephone question.

**Paris Exhibition Awards.**—At the close of the Paris Exhibition Messrs. Robey & Co., Lincoln, have been awarded a gold medal for the good work done by the 550 H.P. engine exhibited by the firm for driving a large portion of the electric light and power generating machinery in the exhibition. During the daily runs at the exhibition there was no stoppage of this engine from any cause. The gold medal presented for this exhibit is, we understand, a distinction only shared by one other engine.

**Pearson Fire Alarm Co.**—The latest report concerning this company is that arrangements have been completed for the formation of sub-companies for Leicester and Manchester, and that the parent company receives from its offspring substantial sums in cash and shares. What is given in consideration is not quite so clear.

**Piacenza (Italy).**—An application for a concession to construct and work an electric tramway from San Niccolo to Agozzano has been made in the names of Mr. A. J. Lawson, of London, and Signor Ingegnere Torquato Perdoni, of Ponte dell'Olio, who also seek powers to construct a canal and obtain power from the River Trebbia for generating electricity for the working of the tramway and for the lighting of the towns and villages through which the lines will pass. The application has the support of the local authorities of these districts.

**Port Elizabeth (South Africa).**—The *British and South African Export Gazette* states that under the act recently passed for improving the harbour facilities at Port Elizabeth, provision has been made for erecting additional electric lighting and power plant, estimated to cost £16,662.

**Presentations.**—On Dec. 7 at the Falcon Works, Loughborough, Mr. E. W. Jones on retiring from the Brush Company's staff to take up the post of head draughtsman to Messrs. Reavell & Co., Ipswich, was presented by the staff with a planimeter.

Last week a number of leading residents of Bray presented an illuminated address and a purse of sovereigns to the late electrical engineer (Mr. G. M. Harris) and a gold brooch to Mrs. Harris on Mr. Harris's departure to assume the duties of representative in Ireland of Prof. George Forbes and also the position of resident electrical engineer at Carlow.

**St. Austell.**—The Council have formally consented to the application of the St. Austell and District Electric Light and Power Co. for a provisional order.

**Smithfield Club Show.**—"Nothing particularly electrical" may be again written in regard to the Smithfield Club Show, 1900, at the Agricultural Hall, London, which closes to-day (Friday). This notwithstanding, there are many exhibits of engineering specialities of an attractive character. Messrs. Robey & Co., at Stand No. 20, show some highly-finished specimens of the well-known Robey undertype, portable, high-speed vertical, horizontal fixed, medium-stroke steam engines, oil engines, &c., but the fact that Messrs. Robey & Co. are so full of orders for engines for electric light and other industrial work and for mining machinery has prevented their devoting time to the production of any special novelty for the Smithfield Show. Messrs. Ruston, Proctor & Co. have, as usual, a fine exhibit of steam and oil engines for all industrial purposes, and an especially strong exhibit of steam traction engines. At Stand No. 29 Messrs. W. Foster & Co. exhibit a new design of high-speed vertical engine for a speed of 250, 300, or 350 revolutions per minute claimed to be specially suitable for coupling direct to a dynamo or for belt driving. The exhibits at this company's stand include several excellent engines for general industrial work manufactured at the new works at Lincoln. Other exhibitors who make an excellent display are Messrs. Crossley Bros. (Ltd.), whose stand is always attractive; and Messrs. John Fowler & Co. (Leeds) (Ltd.), who display a number of engines which are the delight of the farmer element, to whom the Smithfield Shows are so dear. Messrs. Richard Hornsby & Sons' exhibit, as usual, formed a centre of attraction for crowds of visitors, as did also the displays made by Messrs. Ransomes, Sims and Jefferies, at whose stand on this occasion a more than usually large number of useful farm implements, engines, &c., for contractors' and general work was on view. Messrs. Shelby & Co. exhibit oil filters, tool grinders, &c.; Messrs. John Bellamy (Ltd.) have a good show of their special class of manufactures; and Messrs. W. H. Willcox & Co. have as usual a well-assorted group of engineers' stores, belting and general fittings and sundries.

**Smoke Nuisance.**—At West London police court on Saturday the Central London Railway Co. appeared to seven summonses brought by the Hammersmith Borough Council for failing to abate a nuisance arising from the emission of black smoke from their two shafts at the generating station in Wood-lane, Shepherd's Bush. After evidence for the prosecution had been given, Mr. Maurice Hill, for the company, did not dispute there was black smoke occasionally for a few minutes, but special precautions were taken to obviate it. He pointed out that the company were, under their act, bound to have their trains and generating station going, and so were not in a position to deal with the matter so completely as those who conducted private establishments. Certain deliveries of coal had been stopped because the quality was unsatisfactory. The magistrate (Mr. Rose) imposed a penalty of £3 in each case, with £2. 2s. costs.

At Lambeth (London) police court, on Wednesday, the South London Electric Supply Corporation appeared in answer to 10 summonses taken out by the Lambeth Borough Council, charging them with causing a nuisance by the issue of black smoke from the shaft of the company's works in Bengeworth-road, Loughborough Junction. The defence was that no nuisance had been caused, and that the corporation had done all they could to make their works perfect. They had gone to enormous expense, but if these prosecutions were to go on they would have to stop the works, and half-a-million of money would be lost. The magistrate (Mr. Hopkins) said the point was, Did black smoke issue from defendants' shaft in such quantities as to be a nuisance? There were 10 summonses for 10 different days, and witnesses swore that on each of those days black smoke did so issue. Defendants' case was that the furnaces were so constructed that black smoke could not be made. But that assertion was absolutely no answer to the evidence of credible witnesses. He ordered defendants to pay a fine of £10 upon each of the 10 summonses, together with £10. 10s. costs upon the first. He hoped the Borough Council and the company would now put their heads together in order that their united experience might enable them to come to some arrangement by which the nuisance might be obviated.

**South Shields.**—The revenue account of the electricity department for the six months ended Sept. 30 shows a gross profit of £1,331. 14s. 4d. The expenditure was £2,467. 7s. 5d. and the receipts £3,799. 1s. 9d., including £2,803. 3s. 1d. for the sale of current to private consumers and £864. 12s. 6d. for public lighting, &c. Of the net revenue, £1,123. 14s. 4d. is carried forward.

In a recent report on the existing system of charging for electric current the borough electrical engineer (Mr. J. A. Jeckell) states that should the Electric Lighting committee adopt a discount system they would be reversing the policy which has been so successful in the past. It would be practically no advantage to shopkeepers, and would be extremely detrimental to the consumers who are now profitable. Owing to the fact that the maximum demand system is not easily understood, and that the present system of charging does not meet all requirements, he proposed to substitute for it the following rate of charging: A fixed charge of 8s. per 8 c.p. lamp per annum; and ½d. per unit for all current consumed. This system would meet all cases, and as the works increased, the standing charges would probably be reduced. The time would, he thought, doubtless come when a "flat" rate would be universal, but that would only be when, owing to the encouragement given under some demand system to long consumers, the load factors on the stations are vastly improved. Under a properly arranged demand system, the load factors of stations will continually improve, and the average price to the consumer will, therefore, be able to be reduced; whereas, under a discount system the tendency will be to make the load factor worse, thus causing the average price to consumers to be raised, except in those places which can afford to charge such a low price as to encourage the long hour consumer.

**Southampton.**—An inquiry was held here yesterday into the application of the Council to borrow £12,000 for electric lighting.

**Southport.**—The Corporation give notice of intention to lease a portion of their tramways, when electrically equipped, to the Southport Tramways Co. (Ltd.) for 21 years, at a rental amounting to 7 per cent. per annum on the purchase money (£17,000), less £4,000 paid as sinking fund on this £17,000, on the capital to be expended by the Corporation in reconstructing and electrically equipping the lines, and on an allowance of 3 per cent. on the cost of reconstruction. The company will take electric energy from the Corporation at 4½d. per tramcar per mile. The lease contains (inter

alia) covenants not to use other than electric power on the overhead trolley system; to take electrical energy from the Corporation; to pay an annual sum per mile for the repair of the lines, &c.

**Spain.**—Application has been made for a concession to utilise the water power of the river Nalon for the generation of electric energy to supply electric energy at Oviedo, Gijon, and Aviles.

**Stafford.**—The salary of the engineer of the electricity works (Mr. J. H. Clothier) has been increased from £175 to £200 per annum.

**Stirling.**—Thirty additional arc lamps are to be erected in the Craigs and Cowane-street district at an estimated cost of £915. Additional plant is to be put down at the electricity station, including two Lancashire boilers, two dynamos, feed pump and heater, &c., at a cost of about £10,000. The consulting engineer (Prof. Kennedy) advised that this extension is absolutely necessary if the station is to be capable of meeting the demands of next winter. In view of the delay in getting electrical plant at the present time the Commissioners have resolved to obtain estimates at once.

The Police Commissioners have notified the Stirling and Bridge of Allan Tramways Co. (Ltd.) requiring them to sell to the Commissioners that portion of the tramway undertaking which lies between the centre of the bridge over the river Forth and the foot of King-street. The Commissioners are negotiating with the British Electric Traction Co. and the local tramways company for the acquisition of their rights.

**Stockton-on-Tees.**—The official inauguration of the electricity works will take place on 17th inst.

**Straits Settlements.**—The Government of the Straits Settlements owns nearly 85 miles of telegraph lines in the Penang Settlement and 36 miles in Malacca. These lines are all connected with the Government lines in the federated Malay States. The Government telephone lines in Singapore are maintained and worked by a company (the Penang Telephone Co.). In Penang, Province Wellesley, and Malacca they are worked by the Government. There are 309 miles of line open, all government-owned.

**Strike of U.S.A. Telegraphists.**—Reuter states that a strike of telegraphists on the Gulf of Colorado and Santa Fé division of the Atchison Railway led to a sympathetic strike of telegraphists on the entire Atchison system, involving 1,200 men.

**Telegraph and Telephone Extension in Cape Colony.**—£40,833 has been voted by the Cape Government for the extension of the telegraphic and telephonic services of the colony.

**Telegraph and Telephone in the Field.**—According to the Paris correspondent of the *Daily Mail* the French Minister of War has instructed that all cavalry officers are to be trained in the practical use of the telegraph and telephone.

**Tonbridge.**—The Council have decided, on the advice of their consulting engineer (Mr. Robert Hammond), to proceed with their electric lighting scheme, estimated to cost about £20,000.

**Trunk Telephone Communication.**—A deputation waited upon the Postmaster-General on Friday to protest against a proposal of the Post Office to cut off their special wires to Glasgow. It appeared that certain firms arranged with the National Telephone Co. to have special wires communicating with the company's exchange in Glasgow, as there were many delays by going on the public trunk wires. The Government took over the trunk wires from the National Company in 1896, and contends that by the agreement with the company all the business referred to should come on to the trunk lines. The deputation pointed out that their agreements with the company were made prior to the trunk wires being acquired by the Government, that the facilities given on the trunk lines were not such as would meet the demands of their businesses, and that the royalty paid by the deputation to the company would equal, if not exceed, any charges payable to the Government for the use of the trunk wires. Lord Londonderry promised to consider the matter and see whether any arrangement could be made to meet the difficulty.

**Vibration from the Tube Railways.**—In the House of Commons last evening Sir G. Fardell asked the President of the Board of Trade if his attention had been drawn to the inconvenience experienced day and night by the occupiers and owners of houses in Bayswater in consequence of the vibration caused by the running of trains on the Central London Railway; and, if so, whether the Department would at once institute an inquiry into the cause of the vibration, so that, if possible, some means may be devised for remedying the evil. Mr. G. Balfour said the matter was receiving his most careful consideration. There were many difficulties, and he was not prepared at the present moment to make any pronouncement on the subject.

**Wakefield.**—A proposal to adopt incandescent gas lighting for the streets led to a lively discussion at the Council meeting on Tuesday, and after discussion the proposal was referred back.

**Warwick.**—The Council have rescinded the recent resolution approving the British Electric Traction Co.'s application for a provisional electric lighting order on the ground that the generating works would not be situated in Warwick.

**West Bromwich.**—The Council have accepted tenders for the supply of materials for wiring premises on the easy payment system. The Council also propose to hire out motors for power at an annual rent of 10 per cent. on the cost of the motor and installation.

**Whitehaven.**—The Council decided on Tuesday to apply for sanction to borrow £10,000 for electric lighting, including extensions of the mains.

**Willesden.**—An error occurred in our note on electrical matters at Willesden last week. The ratepayers' meeting had been called to consider the District Council's electric tramways proposals. The Council already possess full powers for their electric lighting undertaking.

**Wimbledon.**—Owing to opposition to the proposal to construct an electric tramway from Tooting to Wimbledon Station the District Council have decided not to proceed with their Improvements Bill.

**Workhouse Lighting.**—A supplementary report on the electric lighting of the Christchurch workhouse, has been prepared by the consulting engineer (Mr. G. R. Peers). The Local Government Board suggested that the guardians should obtain electric current from some public supply, but Mr. Peers points out that the nearest source of supply is Bournemouth, where 7d. per unit is charged. Even if a public supply were established in Christchurch, considering the small demand there would be, he did not think it possible for the guardians to be supplied at less than this rate. He is, therefore, convinced the guardians could generate electricity at 50 per cent. less than they could obtain it from a company. He estimated that the total charges should not exceed 3d. per unit, by using their own plant. The price they were now paying for gas was 5s. 6d. per 1,000, and electric light was, therefore, considerably cheaper, light for light. The total number of lights allowed for in his scheme was 337, made up of 16 c. p. 8 c. p. and 5 c. p. each, or equivalent to approximately 180 16 c. p. lamps. The report is to be considered at the next meeting.

**Yeadon.**—After many delays the Council have been informed that the Board of Trade are of opinion that the Council's electric lighting order should not be allowed to remain in force any longer, and the Board therefore propose to revoke it. At the sitting of the Council last week a circular was received from the Yorkshire Electric Power Syndicate (Ltd), who are seeking powers for electricity supply in the district, and it was decided to write to the various councils affected asking them whether they were disposed to attend a joint meeting to consider the syndicate's circular and decide what attitude to take thereon.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

The *Leeds* Lighting committee will receive tenders for two sets of electricity generating plant, comprising two 2,000 B.H.P. engines, two two-phase 1,400kw. alternators and exciters, and two sets of surface condensing plant. Further particulars are given in an advertisement, and conditions may be obtained from the manager of the department (Mr. Harold Dickinson), 1, Whitehall-road, Leeds. Tenders to town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Dec. 31.

*Partick* Burgh Commissioners require tenders for the supply and erection of steam dynamos, battery-charging motor, booster and balancer. Specifications can be obtained at 97, West Regent-street, Glasgow, or they may be inspected at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, S.W. Tenders must be sent to the town clerk (Mr. Jas. Donaldson), 97, West Regent-street, Glasgow, by noon of Jan. 7. See advertisement.

*Manchester* Tramways committee require tenders for rail bonds. Specifications may be obtained from the general manager (Mr. J. M. McElroy), Town Hall, Manchester, and tenders (addressed to chairman) must be in by Saturday, 22nd inst. See advertisement.

*Rathmines* District Council require tenders for boiler-house and engine-house plant, condensing apparatus and pipework, switchboard extension, mains, and public incandescent lighting. Tenders to clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, Co. Dublin, by 4 p.m., Jan. 10.

*Middleton* Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves and accessories for their electricity works. Tenders to Town Clerk, Town Hall, Middleton, by Jan. 2.

The directors of the *Caledonian Railway Co.* invite tenders for various stores for six or 12 months from Feb. 1, 1901, including telegraph and electrical appliances, &c. Tenders to secretary (Mr. J. Blackburn), 302, Buchanan-street, Glasgow, by Dec. 17.

*Ilford* School Board invite tenders for wiring and fitting (for about 200 16 c.p. lamps) their Melbourne-road Higher Grade School. Tenders to clerk (Mr. W. J. Rendall Moore), Cleveland-road, Ilford, by 4 p.m., Dec. 17.

*Brighton* Corporation require unarmoured and armoured lead-covered electric cables for year ended Dec. 31, 1901. Tenders to Town Clerk, Town Hall, Brighton, by 24th inst.

*St. Pancras* (London) Guardians require tenders for wiring Cook's-terrace Infirmary. Tenders to Clerk, Town Hall, Pancras-road, London, N.W., before 3 p.m., Dec. 20.

*Oldham* Electricity committee require an ejector-condenser and two motor-driven circulating pumps. Tenders to Mr. A. Andrew, Gas and Water Offices, by Dec. 29.

Visitors' committee for County Asylum, *Winwick*, near Warrington, require tenders for wiring, &c. Tenders to Clerk, County Offices, Preston, by Dec. 29.

*Thetford* Town Council require tenders for wiring the new Town Hall. Tenders by Jan. 1.

*Aberdeen* Electric Lighting committee invite tenders for storage batteries. Tenders to city electrical engineer (Mr. J. Alex. Bell) by Dec. 22.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal-buildings, Lavender-hill, S.W., before noon Feb. 1 next.

*Bristol* electrical commiteee require tenders for induced draught plant, steam, electric, feed and general service pumps and water-softening plant. Tenders by noon of Dec. 20.

*Swindon* Corporation invite tenders for three steam dynamos, balancer, and motor generator. Tenders to acting town clerk by Dec. 24.

*Hendon* District Council invite tenders for electricity generating plant and apparatus. Tenders to Clerk, Public Offices, The Burroughs, Hendon, by 4 p.m. Dec. 31.

*Blackpool* Corporation require arc lamp carbons and oils for one year. Tenders to Borough Electrical and Tramways Engineer by Dec. 17.

*Worthing* Corporation require tenders for a main switchboard. Tenders to Town Clerk by noon Dec. 31.

*Fulham* (London) Guardians require tenders for wiring the Children's Home. Tenders to clerk by 10 a.m. Dec. 20.

The *Metropolitan Asylums Board* require tenders for wiring the new asylum at Tooting Bec. Tenders by Jan. 2.

*Reigate* Corporation require electricity meters. Tenders by Dec. 19.

*Leigh* Corporation require mains, motors and starting switches, and about 1,000 220-volt incandescent lamps. Tenders by Dec. 17.

*Harrogate* Corporation require two boilers, with fittings and economiser. Tenders by 25th inst.

*Manchester Ship Canal Warehousing Co.* require 22 electric jib cranes. Tenders by Jan. 4.

*Swansea* Public Library committee require tenders for wiring the public library, &c. Tenders by 17th inst.

## TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Cardiff Corporation for additional electric tramway plant :—

*Contract No. 4 Motor Generator and Tudor Storage Battery.*

*Motor.*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| *D. Bruce Peebles & Co. | £1,041 | 0 | 0 | British Schuckert Co. | £1,032 | 0 | 0 |
| Elec. Construction Co. | 1,408 | 0 | 0 | Brush Co. ... | 1,006 | 2 | 6 |
| Geipel and Lange ..... | 1,291 | 0 | 0 | Crompton & Co ...... | 990 | 0 | 0 |
| Thos. Parker (Ltd.)... | 1,142 | 0 | 0 | India Rubber Co....... | 949 | 15 | 0 |
| Johnston - Lundell Elec. Traction Co... | 1,131 | 11 | 0 | H. M. Salmony & Co. | 946 | 0 | 0 |
| Ashton, Frost & Co. . | 1,114 | 0 | 0 | Bergtheil and Young | 805 | 10 | 0 |
| Rosling and Appleby | 1,055 | 0 | 0 | Lancashire Dynamo Co. ... | 795 | 10 | 0 |

*Battery.*

| | £ | s. | | £ | s. |
|---|---|---|---|---|---|
| *D. Bruce Peebles & Co. | £1,260 | 10 | Tudor Accumulator Co. | £1,365 | 10 |
| British Schuckert Co. ... | 1,335 | 18 | Accumulator Co. ......... | 938 | 18 |

*Contract No. 5 (Cables).*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| *British Ins. Wire Co. | £22,166 | 16 | 3 | Telegraph Mfg. Co.... | £23,702 | 5 | 4 |
| Union Cable Co....... | 24,702 | 19 | 5 | Callender's Co. ..... | 23,614 | 17 | 4 |
| St. Helen's Cable Co. | 24,065 | 7 | 3 | W. T. Glover & Co. | 23,458 | 5 | 0 |
| Johnson & Phillips... | 24,007 | 0 | 0 | Western Electric Co. | 22,667 | 12 | 1 |
| W. T. Henley's Co... | 23,828 | 15 | 0 | Siemens Bros. & Co. | 22,656 | 15 | 7 |

*Contract No. 6 (Cranes).*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| *Joseph Booth & Bros. | £685 | 0 | 0 | Thos. Smith............... | £785 | 0 | 0 |
| Musgrave & Sons........ | 815 | 17 | 6 | Higginbottom & Mannock | 727 | 10 | 0 |
| J. Spencer & Co. ........ | 795 | 0 | 0 | J. Carrick.................. | 724 | 0 | 0 |
| Carrick and Ritchie ... | 787 | 10 | 0 | Chatteris Eng. Works... | 712 | 10 | 0 |

* Accepted.

The following tenders have been received by the Southwark Borough Council for the supply and erection of back E M F. cells at the Corporation electricity works, Penrose street :—

| | | | |
|---|---|---|---|
| Tudor Accumulator Co. ..... | £588 | British Power, Traction and Lighting Co. ............... | £390 |
| Hart Accumulator Co. ......... | 565 | Pritchetts and Gold ......... | 349 |
| Electrical Power Storage Co. | 509 | | |

As the tenders have not yet been before the Council no tender has been accepted.

The following tenders have been accepted by the Lowestoft Town Council :—Babcock and Wilcox (two boilers, pipe work, &c.), £2,118. 12s. ; Lancashire Dynamo and Motor Co. (250kw. dynamo, with Browett-Lindley engine), £2,200. The tenders of Bush and Dryburgh have also been accepted for wiring the town hall at £180, and that of G. N. C. Mann & Co. for wiring the dust-destructor works. The tender of J. W. Brooke & Co. has been accepted for a storage tank at £217. 12s.

Bradford Corporation have accepted the tender of C. Murgatroyd & Sons for the erection of a brick chimney at the new Valley-road electricity works for £2,935. The tenders of T. Broadbent & Son has been accepted for the supply of a 30 ton electric travelling crane, to operate on a 500 volt direct-current circuit, for £1,125, and the tender of W. T. Glover & Co. for 2 miles of underground armoured paper-insulated cable at £359. 6s. 8d.

Maidstone Corporation have received the following tenders for the supply of surface condenser for their electricity works :—

| | £ | s. | | £ |
|---|---|---|---|---|
| Cole, Marchent, and Morley *accepted* ...... | £1,209 | 10 | British Power, Traction and Lighting Co.................... | £1,164 |
| Davey, Paxman & Co. ... | 1,595 | 0 | Wheeler Condenser and Engineering Co......... ... | 1,010 |
| Edwards and Barnes .... | 1,398 | 0 | | |
| W. H. Allen, Son & Co. | 1,307 | 0 | | |

Lincoln Corporation have accepted the tender of Tinkers Limited for a dry-back marine-type boiler. Messrs. Ruston, Proctor & Co. and John Fraser & Son also tendered. The tender of Messrs. Laurence, Scott & Co. has been accepted for a 200kw. steam dynamo, pump, &c. Messrs. Mather and Platt, the Electric Construction Co., J. H. Holmes & Co., Crompton & Co., Thomas Parker (Ltd.), and Siemens Bros. & Co. also submitted tenders.

West Bromwich Corporation have accepted the following tenders for the supply of materials for wiring houses in the district :—

Union Cable Co. (cables) ; S. Jones (steel conduits, walnut pattern, wood casing (double groove), ceiling roses, lampholders, and counter-weight fittings) ; Connolly Bros. (Buckley tape) ; Whittaker & Co. (solder metal pattern, wood casing (single groove), and labour in wiring) ; Handley and Shanks (switches and fuses) ; A. P. Lundberg (wall plugs) ; Hands Limited (bad fittings, shades, and incandescent lamps) ; and Alliance Electrical Co. (motors and switch gear).

Hereford Town Council have accepted the tender of the India Rubber Co. for the supply of a 250kw. steam dynamo, at £3,185, subject to a loan being obtained.

Partick Burgh Commissioners have accepted the tender of the British Thomson-Houston Co. for two-wire meters ($2\frac{1}{2}$ to 50 amperes) at £5. 18s. 10d. to £11. 16s., and for three-wire meters (25 to 100 amperes) at £15. 4s. to £18. 9s. 6d.

Brighton Corporation have accepted the offer of Messrs. Willans and Robinson (Ltd.) to supply two 3T triple expansion engines, coupled to 440kw. dynamos, similar to the last two sets supplied by the same firm to the Corporation, for £9,698.

Burton-on-Trent Town Council have accepted the tender of Messrs. Geipel and Lange for a 100kw. steam alternator and condensing plant for their electricity works at £3,335.

Watford District Council have accepted the tenders of Messrs. Babcock and Wilcox for a superheater at £150, and steam pipes, connections, &c., at £452 ; that of Mr. W. Boby for a water tank at £38, and that of Messrs. H. Windsor & Co. for boiler settings at £149.

Sheffield Electric Light committee have ordered a 500kw. turbo-generator from Messrs. C. A. Parsons & Co. at £3,500. The plant is to be fixed at the electricity works within three weeks from Nov. 26.

Darwen Corporation has placed an order with Messrs. D. Bruce Peebles & Co. for a 600 H.P. traction generator, to be coupled direct to a Belliss high-speed vertical engine.

Chesterfield Corporation have accepted the tender of Mr. John Wright for the erection of electricity station buildings, at £1,816.

In connection with the tenders for meters at Swansea, we were in error in the particulars given in our last issue. The contract was divided between the General Electric Co. and Messrs. Chamberlain and Hookham for Aron and Hookham meters respectively.

## BUSINESS NOTICES.

The Electrical Company, 122-124, Charing Cross-road, have established a special department for cables, wires and insulating materials, and Mr. A. Holborn has been appointed manager of the cable department.

## BANKRUPTCIES, LIQUIDATIONS, &c.

The discharge of W. J. Stanley Green, electrician, &c., 45, Birchfield, Aston, has been suspended for two years.

In the bankruptcy of B. Wild and J. H. Clarke (trading as Wild, Rothwell & Co.) electrical and general engineers, Virginia-street, Southport, the trustee (Mr. Nathan Yates, 4, Wood-street, Bolton) has been released.

The Giffre Electro Chemical and Power Co. (Ltd.) is to be wound-up voluntarily for reconstruction, and Mr. F. H. Haviland, 11, Queen Victoria-street, London, E.C., has been appointed liquidator.

Claims against the Nuneaton Electric Co. (Ltd.) must be sent to the liquidator, Mr. H. B. Harris, 1, New Bridge-street, Nuneaton, by Feb. 1.

**Winding-up Petition.**—A petition for the winding up of the Carbon (New) Syndicate (Ltd.), will be heard in the High Court on 19th inst.

**Plant Wanted.**—An advertiser requires a good new or second-hand combined engine and dynamo for about 130kw.

**Plant for Sale.**—Some electric lighting plant is advertised for sale in another column, by "Engines," care of Messrs. Pryce Jones (Ltd.), Newtown, Montgomeryshire.

Messrs. Wake and Carr, 123, Victoria-road, Darlington, have a quantity of electrical engineering plant and machinery for sale, particulars of which are set out in an advertisement.

A 120kw. steam dynamo is advertised for sale in another column and can be seen at Messrs. Paterson, Cooper & Co.'s, Patella Works, Paisley.

Messrs. A. Verey & Co., Dover, advertise in another column some direct-current electric motors for sale.

**For Sale.**—The buildings known as the Soho Foundry, Blackburn (Lancs.), suitable for electricity or other engineering works, are for sale. See advertisement.

**Fuel for Sale.**—An advertiser announces in another column that he has large quantities of first-class fuel of high calorific value for utilisation in connection with the generation of power for electro-chemical or other work.

**Fire.**—A serious fire, but one which will not, we are informed, in any way interfere with the completion and delivery of contracts in hand, occurred at the extensive works of the Société Industrielle des Téléphones, at Calais, France, on Saturday last. The cable in hand included a small portion of a contract for the National Telephone Co., and this small portion, with the remainder of the contract, was immediately put in hand at the Société's factory at Bezons, and the whole will be delivered to time. There was also in hand at the time at Calais several contracts for submarine telegraph cables, as it is at the Calais works that the company's business in this branch of electrical work is mainly conducted. A large quantity of stock rubber and other inflammable material was ignited by the overturning of a spirit lamp, and the damage done was considerable. A large number of workpeople are temporarily thrown out of employment, but it is anticipated that the works will be in full going order again in a few weeks.

**"Electro-Chemist and Metallurgist."**—This is the title of a new monthly journal, the first number of which will be issued in January. The paper is being published by Messrs. Sherard Cowper Coles & Co. (Ltd.).

**Wall and Floor Sockets.**—Messrs. Davies, Kent and Stewart, 17, Berners-street, London, W., issue a circular relating to their patent china "flush" wall or floor socket. Copies of the circular can be had on application.

**Art Fittings.**—Mr. W. Höfler has on show at his newly-decorated premises, 26A, Soho-square, London, W., a variety of high-class fittings in hammered iron, brass, and copper, French art bronzes and fittings, art castings, &c., to which he invites inspection.

**Calendars, Diaries, &c.**—A useful diary and scientific handbook is issued (price 3s.), by the publishers of *Knowledge*, 326, High Holborn, London, and is intended for scientific workers in general and astronomical students in particular. A calendar of notable scientific events is included, and the volume is frontispieced by a portrait of Prof. Huxley. Other portraits and illustrations are given, and the diary is conveniently arranged.

A useful hanging day-by-day tear-off pad calendar for 1901 is to hand from the Direct United States Cable Co.

We have also to acknowledge an attractive week-by-week tear-off pad calendar from the Commercial Cable Co.

**Railway Officials' Directory and Diary, 1901.** (London McCorquodale & Co., price 1s.). This useful directory of railway officials of the United Kingdom has been again carefully revised and brought up to date, and forms a most useful work of reference for traders and others having relations with the railway companies. Financial particulars are given in a compact and useful form.

**Tariff Changes.**—Under the new classification of articles under the tariff of Western Australia telephone cord for "telephonettes" is admitted as telephone material free of charge.

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods and apparatus imported into this country during November was £149,537, against £174,524 in the preceding month. The total for the 11 months ended Nov. 30 was £1,118,760.

**Argentina.**—According to the *Review of the River Plate*, the imports of electrical apparatus and materials during the first nine months of the year were as follows:—

| | |
|---|---|
| Telephones (462) | $3,168 gold. |
| Telephone material (381 cases) | 19,347 |
| Telegraph do. (298 do.) | 20,913 |
| Galvanised iron wire (18,054 tons) | 1,239,446 |
| Dynamos (507) | 68,308 |
| Various materials (3,851 cases) | 205,495 |
| Cables and wires (720 tons) | 339,046 |
| Chandeliers (67 tons, electric and gas) | 99,260 |
| Electric bells (5,080) | 2,540 |
| Meters (1,126) | 13,512 |
| Porcelain insulators (112 tons) | 13,960 |
| Glass insulators (7 tons) | 401 |
| Arc light carbons (112 tons) | 16,587 |
| Arc lamps (166) | 1,992 |
| Incandescent lamps (27,238 dozen) | 77,175 |

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 5 to Dec. 11, with the ports of destination:—

*Africa*—Alexandria, £162; Beira, £311 (telegraph material); Cape Town, £2,235 (including £1,967 telegraph material); Durban, £859; East London, £555 (telegraph material); Port Elizabeth, £38; Port Said, £21. *Argentina*—Buenos Ayres, £1,586 (including £644 telegraph wire); Rosario, £898 (including £309 telegraph material). *Australasia*—Fremantle, £375; Otago, £46; Sydney, £1,028 (including £469 telegraph material); Wellington, £4,887 (including £4,836 submarine cable). *Belgium*—Antwerp, £242; Ostend, £421. *Brazil*—Rio Janeiro, £36. *Burma*—Rangoon, £475. *Canada*—Halifax, £38. *Ceylon*—Colombo, £190. *China*—Shanghai, £183. *Denmark*—Copenhagen, £299 (telegraph material). *Germany*—Hamburg, £200 (telegraph material). *Gibraltar*—£59 (including £50 telegraph material). *Holland*—Amsterdam, £85. *Hong Kong*, £115. *India*—Calcutta, £656. *Japan*—Hiogo, £136; Nagasaki, £103; Yokohama, £30. *Malta*, £55 (telegraph material). *Portugal*—Lisbon, £1,100. *Russia*—Odessa, £200 (telegraph material). *Siam*—Bangkok, £53. *Straits Settlements*—Penang, £147 (telegraph material); Singapore, £107. *Sweden*—Stockholm, £311 (telegraph material). Total £18,222, against £10,694 in the corresponding week last year (Dec. 6 to Dec. 12).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

September 26, 1900.

17,110. SIEMENS BROS. & CO. (LTD.). London. An arrangement of connections for sets of electric glow lamps in series so as to maintain the circuit in case of the extinction of one or more of the lamps. (Siemens and Halske Aktien Gesellschaft, Germany.)*

17,125. H. V. WEYDE. London. Electric generators for military and other cycles.

17,128. H. E. NEWTON. London. Improvements in magneto-telephones. (P. Rabbidge, New South Wales.)

17,131. C. A. HENRY. London. Improvements in and relating to incandescence electric lamps.

17,135. H. J. HADDAN. London. Improvements in electrodes for accumulators. (R. Goldstein, Germany.)

September 27, 1900.

17,154. J. A. ELLIS. Liverpool. Improved mode of attaching glass shades to electric light and the like fittings.

17,160. A. D. SMITH. Bradford. Improvements in electrical fuse boxes.

17,172. V. G. LIBONI. Manchester. Improvements in electric switches.

17,174. SIEMENS BROS. & CO. (LTD.). London. Improvements in carbon brush holders for dynamos. (Siemens and Halske Aktien Gesellschaft, Germany.)*

17,184. J. M. HEWITT and W. G. RHODES. London. Improvements in electric switches.*

17,194. R. PEARSON. London. A fusible alloy especially adapted for use as an electrical circuit-breaker.

September 28, 1900.

17,211. I. MARSH. Liverpool. Improvements in electric conductor casings or conduits.

17,234. J. F. MILLER. London. Improved means for generating variable electromotive force. (Date applied for under Patents, &c., Act, 1883, sec. 103, March 1, 1900, being date of application in United States.)

17,246. B. Avena. London. Improved prepayment of electricity meter with coin-freed control mechanism.*

17,262. A. Wright and The Reason Manufacturing Co. (Ltd.). London. Improvements in electricity meters of the electrolytic type.

September 29, 1900.

17,289. A. H. Adams. Liverpool. Improvements relating to automatic electric switches.

17,294. A. J. Boult. London. Improvements in or relating to electric telegraph or telephone instruments. (A. Bannerman, South Africa.)

17,310. F. E. Elmore. London. Improvements in apparatus for the generation and electrolytic application of electric currents. (Partly by J. O. S. Elmore, India.)

October 1 1900.

17,379. H. H. Lake. London. Improvements relating to electric meters. (Société pour l'Exploitation des Compteurs Electriques Rettener & Cie, Switzerland.)

17,399. C. Oliver. London. Improvements in or relating to electric arc lamps.

October 2, 1900.

17,437. E. C. Paramore. London. Improvements in telegraphones.*

17,453. G. H. Davis. London. Improvements in and relating to electric perforating and recording machines.*

17,457. H. T. Cedergren and A. Karr. London. Improvements relating to telephone switch boards.*

17,479. J. Wall. Liverpool. Improvements in automatic releasing mechanisms for phonographs and the like.

17,487. L. B. Atkinson. London. Improvements in dynamo-electric machines and motors and in means for regulating the same.

17,489. A. D. Douglass and N. Collins. London. Improved electrical apparatus for automatically playing violins and the like instruments.

17,490. B. Kuettner. London. Improvements in the manufacture of secondary battery plates.

17,496. H. Hirst and H. Bevis. London. Improvements in and relating to ceiling roses and terminals for electrical lamps and power installations.

October 3, 1900.

17,509. H. F. Proctor. Bristol. Improvements relating to electric lanterns to be fixed on the top of posts.

17,514. E. W. Cowan and W. P. Hamlyn. Manchester. Improvements in electric switches.

17,549. P. M. Jerrard. London. Improvements in electrically operating signal bells, and apparatus for that purpose.*

17,567. T. H. Minshall. London. Improvements in or relating to prepayment mechanism for electric meters.

17,575. F. de Mare. London. Improvements in electric converters.

October 4, 1900.

17,635. G. Calvert and R. Morrell. London. Apparatus for automatically turning on gas should the current fail in a place electrically illuminated.

17,642. W. Du Bois Duddell. London. A new or improved instrument for measuring direct or alternating electric currents and potential differences.

October 5, 1900.

17,763. E. J. Silkman, C. Selden, and E. W. Day. Stockton-on-Tees. Improvements in methods of and apparatus for signalling between stations having no electrical or mechanical connection.*

17,670. H. Alexander and A. D. Hunter. London. An improved method of combining a telephone with a system of electric bells.*

17,675. C. J. Young. London. Improvements in systems of electrical distribution. (Date applied for under Patents, &c., Act., 1883, Sec. 103, March 6, 1900, being date of application in United States.)

17,694. C. Oliver. London. Improvements in or relating to the attachment of arc lamps in their weatherhoods or supports.

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

23,413. Robinson and Sankey. Construction of dynamo-electric machines.

23,960. Cros. Electric switch or governor.

22,291. Lorrain (Bedell). System of telegraphy.

22,609. Hill. Electric lighting of railway vehicles. (Date applied for under International Convention, April 14, 1899.)

24,791. Kingsland. Boxes or cases for containing switches and mechanism connected therewith for electrical traction.

24,792. Kingsland. Method of and means for carrying and connecting strikers to motor vehicles for mechanically operating electric switches.

1900.

622. Bonhivers. Incandescent arc and other lamps.

1,617. Reichwald. (Firm of Fried. Krupp.) Carbon contacts for electrical switches and the like.

6,540. Stein and Freund. Electric railways on the conduit system.

6,974. Thompson (Coerper). System or means for controlling or regulating electrical installations.

10,134. Duncan. Alternating-current watt meters.

10,319. Fell. (Wiegand.) Electric storage batteries.

10,444. Pathouilleau. Electric incandescent lamps of the refractory conductor type.

10,602. Ritter. Telephone systems.

10,579. Siemens Bros. & Co., Ltd. (Siemens and Halske Aktiengesellschaft). Electrically controlled apparatus for shifting and locking railway points and signals.

10,688. Wells and Brown. Telephonic fire alarms and other similar call systems.

10,711. de Pitter. Electric signalling apparatus for railways and the like.

10,974. Ricks. Electric accumulator electrodes or plates.

11,006. Lake (Reuterdahl). Secondary electric batteries.

11,022. Macaulay. Electrical apparatus for adjusting tram-rail points.

11,026. Lundberg and Lundberg. Cord grips for electric light fittings.

11,120. Gottsberger. Ploughs for conduit electric railway cars. (Date applied for under International Convention, Jan. 4, 1900.)

11,190. Siemens Bros. & Co., Ltd. (Siemens and Halske Aktiengesellschaft). Switches for high tension electrical currents.

11,272. Hofbauer. Means of and apparatus for preventing the premature starting of electric motors or the like used in connection with electric lifts.

# COMPANIES' MEETINGS AND REPORTS.

## India Rubber, Gutta Percha, and Telegraph Works Co. (Ltd.)

A general meeting of this company was held yesterday (Thursday), under the presidency of the Hon. Henry Marsham (chairman of the company).

Mr. T. J. LLOYD (the secretary) read the notice convening the meeting and the report and accounts were taken as read.

The CHAIRMAN said: Last year we laid before you a nine months report, on the present occasion the accounts are for a full period of 12 calendar months, and will I think be considered satisfactory by the proprietors. We could certainly not have come before you under such favourable conditions had we not, to meet the high price of raw material, taken the unpopular step of raising the selling price of our goods. Our customers have tacitly acknowledged the necessity of our doing so by the continued support they have given us. We intend returning to more reasonable selling prices at the earliest opportunity, and from the appearance of the markets it is just possible that we may be able to make reductions before I again address you. The price of india-rubber shows signs of falling; the price of gutta percha, however, maintains its high standard, and in view of the probably large consumption during the next year or two, we do not anticipate lower values in this product. As you are aware, we own three cable steamers, the "Silvertown, the "Dacia" and the "Buccaneer." All three vessels are at present employed, the "Dacia" having been chartered by the Spanish Government for cable repairs since the end of our financial year. At the works at Silvertown we have almost completed a large central station for the generation of electricity to be employed in the transmission of power. It will be pleasing to the shareholders to know that the machinery necessary for equipping this station is designed and built by our own employees at our own works. The construction and erection of this plant under the circumstances occupies a longer time and costs more than it would otherwise do because your board do not wish work which we carry out for ourselves to seriously interfere with orders which are placed with us by customers. It is anticipated that when the station is completed a saving will be effected in our consumption of coal, and you will agree this is highly desirable when the price of this commodity is at such a high level. With the view of enlarging our selling power we have sent to South Africa a representative who was for a long period in charge of our Newcastle-on-Tyne agency, and when South African matters settle down it is anticipated that we shall do a fair if not a large business there. Our colleague, Mr. Jarvis, who has been detained in South Africa for some considerable time sailed from Cape Town on the 28th ult. and will be able to give us his valuable advice on the prospects of our venture. You will doubtless expect me to say something about the Pacific cable. Although we have not yet received any official reply to our tender, we must consider the matter closed so far as we are concerned. From the figures mentioned in the daily press (£1,795,000) as the price at which the work has been allotted, we judge that your board have been, perhaps, too timid in approaching the subject, but we feel, as managers of your interests, that with a work of such magnitude we could not be too careful, and we hope you will approve of our caution even though we have missed a contract which was desirable from many other points of view. We must not, however, be despondent; the laying of the Pacific cable will supply an important Imperial want, and as especially affecting this company, will widen the market of British cable manufacturers. I may remark before putting the usual resolution that we have entered this financial year with a fair prospect, and that we have now in hand a considerable order from a foreign Government. I now move—

*"That the report and accounts to September 30 be adopted, and that a dividend of 15s. per share, free of tax, payable on 17th inst., be declared."*

Mr. ABRAHAM SCOTT seconded.

There were no questions asked, and the resolution was carried unanimously.

The retiring directors (Major Leonard Darwin and Mr. Robert Kaye Gray) were then unanimously re-elected.

On a motion for the re-appointment of Messrs. Turquand, Youngs, Bishop and Clarke as auditors of the company for the current year,

Mr. LAMONT said he had to draw attention to the matter of the form of the auditors' certificate as printed in the accounts. He was sorry no change had taken place since last year in this form. It seemed to him that that certificate threw some doubt on certain matters. The auditors seemed satisfied as to the stock-in-trade at Silvertown, of which the inven

tories had been produced to them by the works manager, and he did not know why in a similar way they could not have recorded a statement from the bookkeeper in regard to the debts mentioned in the certificate. The certificate seemed to throw some doubt on the correctness of some of the debts. He hoped some change in the form of the accounts might be made in respect to this.

The CHAIRMAN said he had mentioned before that the debts owing to the company included sums of money for uncompleted submarine cable work, and speaking generally all that money had been collected, and he therefore saw no special reason why the auditors should question the correctness of that particular item. As to the item of "debentures and shares in other companies," he did not see that they could do better than they had done. The question was one where the board took the responsibility for the valuation, and their view of the matter was that the valuation was a careful one, and that it was a right and proper one. As to suggesting to the auditors any alteration in the form or wording of the certificate, he felt that that was a matter outside the province of the board. The auditors were the servants of the shareholders, and were elected by them, and he did not think that it would be right or proper for the board to attempt to dictate the terms of the certificate to the auditors.

The auditors were then unanimously re-appointed.

At an extraordinary meeting which followed,

The CHAIRMAN said: The directors have thought it advisable to ask you to adopt certain resolutions, as they will enable the directors to provide for eventualities. Your business continues to increase from year to year, and the duties and responsibilities of your directors augment with this increase. Some members have expressed a desire to retire from the board, but their colleagues do not wish to lose their valued advice, which has been of such profit to the company during a long series of years. They recognise, however, that that they are asking too much in requiring these gentlemen to attend the necessarily frequent board meetings which your business demands. The resolutions have been framed with a view of meeting the situation.

Resolutions were then submitted to the meeting empowering the directors to appoint and to revoke the appointment of extraordinary directors (not to exceed four in number), who are to be additional to the directors and not to be considered to be directors of the company within the meaning of the articles of association, or the regulations of the company. Any person may be appointed an extraordinary director who shall formerly have been a director of the company, or shall be an officer of the company for the time being in its employment; and no person other than a former director, or an officer of the company as aforesaid, shall be so appointed. An extraordinary director must hold not less than 100 shares of the company in his own sole right. No person shall be appointed an extraordinary director for a longer period than three years at any one time, but the appointment may from time to time be renewed. The extraordinary directors may attend board meetings and act as advisers to the board, but will not be entitled to vote or exercise any of the powers, or be under any responsibility for the acts of the directors. The remuneration of an extraordinary director for acting as such shall from time to time be determined by the board, and shall not exceed £200 per annum.

These proposals were carried unanimously, and a vote of thanks to the chairman closed the meeting.

## Aron Electricity Meter (Ltd.).

The third ordinary general meeting of this company was held yesterday (Thursday), under the presidency of Sir JAMES PENDER, Bart. (chairman of the company).

Mr. MAURICE ARON (general manager and secretary) read the notice calling the meeting, and the report of the directors and statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, we have put before you the directors' report and the balance-sheet of our second year's working, and were it not for the traditional chairman's speech at such a meeting I would have little to say, but would simply ask you to pass the report and call for any further information if you so desire. We have had a most successful year. Thanks to the efforts of Dr. Aron and his technical staff we have overcome all difficulties, and thanks to our commercial department we have been able to show a good increase of business. The sales of the instruments have gone up for this year by 40 per cent. compared with last year, and the profits, which in our prospectus showed a course of uninterrupted progress from £11,000 in 1892 to £18,000 in 1897, have reached in the last two years £23,000 and £30,000 respectively. The increase in trade has been noticeable in every one of the branches, but more particularly in England, though the profit in the United Kingdom this year does not show as favourably in proportion to the turnover as in the other countries. The reason for this is that we have arranged larger workshops, which will enable us in future to manufacture in England entirely with the exception of the counting gears, which are manufactured for all our branches in our central factory in Schweidnitz. Thus the promise of making the meter in this country has been fulfilled very quickly; and now that the expenses of erection and organisation have been principally defrayed, we can look hopefully to a very much larger percentage of profit from the London business in the future. This is irrespective of the increase in sales that we have every right to expect. The orders for meters during the two months since the end of the financial year (October and November) exceed in England by 40 per cent. the sales of the corresponding months of last year, and in the other branches an increase has also been made. Every one of the branches during the last year has worked at a profit, the most satisfactory result being that the factory in Schweidnitz, which was in an embryo state last year, showing even a small loss at that time, has shown this year a very handsome profit after paying all expenses, and the directors have made arrangements for considerably increasing this factory, which would be the most remunerative department when the prices of raw material have again assumed a more normal aspect. The sale of our American patents is now so far effected that all but £4,000 in cash has been paid, and the stock to the face value of £33,000 has been handed to us and deposited with our bankers. By utilising the sum of £9,400 for writing off part of the original purchase money and putting the whole of the American stock, which a few years hence will be very valuable, towards reserve, the directors think ample provision has been made for satisfying the best interests of the shareholders and the company. Dr. Aron, during the past year, has succeeded in introducing further important improvements to suit the requirements of supply station engineers. Another distinct improvement has been the design of a small meter which we call the "Cottage" type, now in the hands of the Board of Trade for official approval. This is a meter that can be made and sold at a considerably lower price, and will be used in small houses and shops in the poorer districts in town and country where the electric light is now making its advent, where only two or three lights are probably burning at a time, and where a small and accurate, but particularly a cheap meter is a necessity. It is unwise to predict unless you know, but we believe that this meter as constructed at present will meet completely the most stringent regulations of Government and municipal authorities, and be a large additional source of revenue in the future. I now move the adoption of the report and accounts.

Mr. R. W. WALLACE, Q.C., in seconding the motion said he desired to pay a tribute to the great energy which was displayed by the managing directors in Berlin, Prof. Hermann Aron and Dr. Julius Juttke. He expressed the confident belief that they would be able to show still larger profits in the future. They possessed a most excellent staff who had done their duty exceedingly well during the year.

Mr. GEORGE KITCHEN said he had heard a rumour that this company was likely to be involved in legal proceedings in regard to their patents, and he thought it would be well if an authoritative statement could be made by the chairman with a view to putting an end to rumours of that kind. He had raised the point in the interests of the shareholders.

Mr. HIRST (a director) said they had heard no such rumour, and they knew nothing about it.

Mr. HYAMS asked whether their meters could be made to meet the requirements of the London County Council.

The CHAIRMAN said he believed they already did so.

Mr. HIRST said that they had passed the test of the Board of Trade and he did not see that the London County Council could object to what the Board of Trade had passed.

Mr. CHALMERS said that he understood that the London County Council refused to allow the meters although the Board of Trade had passed them.

Mr. HIRST said that there seemed to be a little misunderstanding. The Board of Trade had approved the type of meter, and the London County Council had no right to object to any type of meter which the Board of Trade had passed; but what the London County Council could do was to insist upon the testing of each single meter, and if it were found to be wrong they could reject it, but they had no right to object to any type of meter which had been approved by the Board of Trade.

In reply to a further question from Mr. Hyams as to whether the company could in any way have legal proceedings taken against it for infringement, Mr. HIRST said in the event of any legal proceedings being taken this company would be the prosecuting parties, because undoubtedly Prof. Aron held the master patent, dating back to 1883-4.

The resolution was then carried unanimously.

Messrs. R. E. B. Crompton and Hugo Hirst (the retiring directors) were re-elected, and dividends at the rate of 6 per cent. per annum on the preference shares for the year, together with an additional half per cent. on the same shares for the same period, and on the ordinary shares at the rate of 12 per cent. per annum were approved.

Messrs. Price, Waterhouse & Co. having been re-appointed as auditors, a cordial vote of thanks to the chairman and directors closed the proceedings.

## Marconi's Wireless Telegraph Co. (Ltd.).

The directors' report for the 13 months ended Sept. 30, just issued, states that the period under review must be considered mainly as a further time of scientific and technical development; yet remunerative work has been carried out, the foundation of commercial business has been laid, and there is good promise of increased business in the immediate future: a profit and loss account is presented for the first time. The International Marine Communication Co. was registered this year, and has allotted 100,000 fully-paid shares to this company, and 5,000 fully-paid shares to its nominees. The International Company has commenced work. Their first installations have been erected on the Belgian coast at La Panne, and on one of the Belgian Government steamers. These have been quite successful and have attracted a great deal of public attention. The International Company has given orders for the erection of several stations on the coasts of the United Kingdom, and is engaged in negotiations with several Continental Governments. In August last, when the directors resolved to issue fresh capital, the offer of 25,000 shares at a premium of £2 was made to the shareholders, and an arrangement was made with a firm of brokers who undertook to take any number of shares up to 12,500 at £2 premium, for which the shareholders did not apply. 12,500 of the above shares have been subscribed and paid for by the shareholders and the brokers, subject to the brokers having a call on the remaining 12,500 at a premium of £2. 10s. per share. The transaction with the brokers was completed on Oct. 31, and £34,375 has been paid, of which only £1,076 comes into the present accounts.

The chief business event has been the obtaining of a contract with the Admiralty for the supply and equipment of 32 sets of apparatus on payment of an annual royalty on each set. This is in addition to the five sets of apparatus which were transferred by the War Office to the Naval authorities in South Africa. Only a small portion of the payment falls within the time embraced by these accounts; therefore the benefit of this contract will be realised during the current year. The captain of H.M.S. "Vernon," under whom the work has been carried out, has expressed himself as satisfied therewith, and with the rapidity with which it was completed.

Mr. Marconi has made great advances recently, some of which are of most undoubted value. The Directors will shortly be able to commence bringing them into use, and the Company may expect to derive much advantage from them. The works at Chelmsford have been improved and the plant and machinery increased, so that they can now turn out all the apparatus required, or likely to be required during the next twelve months.

**KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.).**—A general meeting of this company was held on Monday, under the presidency of Mr. Roger W. Wallace, Q.C., who regretted he had not much to say as to the successful progress of the operations of the company, and thought the directors had adopted a wise course in proceeding so slowly. The difficulties that arose were perhaps unavoidable in works like those of the company. It was apparent to him by a perusal of the engineers' reports, and inquiries which he had made about the natural resources of Western Australia, that they had not a smooth course before them in choosing the plant they had to put up, and the greatest difficulty had been the water supply on the site which was chosen. At their last meeting he pointed out that difficulty, and suggested that they might possibly be able to use gas engines instead of steam boilers to produce their power. He was sorry, however, to say that those who had been working at that matter had not been able to produce a satisfactory engine for the purpose, and they had to go back and study the water question. That question had never been properly studied for work of the magnitude of Kalgoorlie, so that it had taken a considerable time to come to a satisfactory conclusion. Even if the water question had been settled, there would have been another difficulty in the way, as the mining lease granted to them did not allow of their erecting, with security, buildings of the nature they proposed to put up. They had only been offered a lease of 21 years, and he did not think the shareholders would be justified in erecting their plant on the site available for so short a period. The directors did not intend to put down the plant until they had a satisfactory lease. The plant ordered had been only such as was necessary to secure the company being able to go ahead the moment those matters were settled, so that they might not be delayed in their operations. The vast expense would be in the boilers and evaporating condensing plant, the orders for which they had not yet given, so that the only money spent had been on such plant as could be kept in hand and dealt with on any other site. The shareholders would not be paid dividends during construction. They could not expect the company to be remunerative in the first year or so of its existence, but he believed they would eventually earn large dividends. In new countries, such as Western Australia, where they had to educate the people to the use of electricity, he thought they adopted the best course in sending over a competent engineer to feel his way, and to talk to the managers and people on the mines as to the use of electricity before introducing it. It was not only necessary to supply people with the power, but to see that they had their plant adapted for its use, a matter which required considerable study. So that for these reasons the delay had been favourable to the shareholders, because if they did not obtain the freehold site on the mining property they now had, they would get one elsewhere. Their engineers estimated the net earnings on the electrical plant would be about 16 per cent. on a sum of £200,000. That was the engineers' estimate, and they must not be too hopeful about it. It might take a year or two to arrive at that point, but he believed that if they commenced working they would be able to increase the plant to a very large extent at a comparatively small cost in the future, and when the Government water scheme was carried out, there would be sufficient water for that purpose. Their plant in the future would be much larger at a very moderately increased cost, so that they would be able to supply far more electricity in proportion to the capital than was the case as compared with the money they were now putting down for the present plant.

**NERNST ELECTRIC LIGHT (LTD.).**—The directors' report from Feb. 23, 1899, to Sept. 30 last, states that the expenditure on capital account was £9,696, disbursements £6,757. Acting on the advice of the auditors, the directors, after deducting from the latter amount £846, received on account of interest and transfer fees, have placed the balance (£5,911) to a development suspense account, to be dealt with in future years. Apart from the purchase consideration for the patent rights, the only prominent item of expenditure on capital account is £5,000 contributed towards the purchase for this company of Prof. Nernst's British royalties, the balance of the consideration having been provided by the vendors. As the owners of the British rights have not commenced business in England, this investment is still unproductive. Since the formation of the company the directors have been engaged in further developing the Automatic Nernst lamp, so as to render it more capable of being manufactured and sold in quantities on a profitable commercial scale, and with a uniform degree of quality and efficiency for various sizes; they have also taken out subsidiary patents, which, it is hoped, will prove of considerable value. The fire which occurred on the company's premises on May 31 unfortunately destroyed the patterns, instruments and apparatus collected during the previous twelve months, and, notwithstanding the strenuous efforts of the staff, progress was practically arrested for more than three months. The directors have found that the practical difficulties to be overcome in the wholesale reproduction of the Nernst lamp to the best advantage have been greater than they anticipated. The variations which occurred in endeavouring to repeat on a more extensive scale results already obtained have involved lengthy experiments and chemical research in directions where no precedent was available. It is now, however, confidently hoped that the main causes of such variations have been traced to their origin, and means devised for their elimination. It should be considered that, although all the licensees possessing rights for other parts of the world commenced work many months before the formation of this company, and had, in most cases, the advantage of an organisation already equipped, the company has, in the opinion of the directors, made at least as rapid progress in the practical development of the lamp as other concessionnaires.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BRITISH ELECTRIC RAILWAYS (LTD.).**—Registered Dec. 4, with a capital of £100 in £1 shares, to construct and maintain electric and other railways and tramways and their accessories.

**CUMBERLAND CONSTRUCTION CO. (LTD.).**—Registered Nov. 30, with a capital of £10,000, in £100 shares, to further the construction, equipment and development of tramways, tramroads and light railways, to acquire powers or concessions, and to carry on the business of tramway and light railway contractors and proprietors, &c. The first directors are G. Flett, T. D. Lingard, A. L. Ormrod and T. S. Turnbull.

**HILLGROVE AND ARMIDALE ELECTRICAL CORPORATION (LTD.).**—Registered Dec. 6, with a capital of £70,000 in £1 shares, to acquire the undertaking of the Hillgrove and Armidale Water Power Electric Co., and also the benefit of certain powers granted by the New South Wales Legislature, to carry on in the County of Sandon and elsewhere in Australia the business of an electric light and power company, and to carry on the business of electricians, mechanical and electrical engineers, &c.

**HOLDEN MOTOR PATENTS SYNDICATE (LTD.).**—Registered Nov. 30, with a capital of £10,000, in £1 shares, to carry on the business of motor car, omnibus, &c., manufacturers, electricians, electrical and general engineers, &c. The first directors are Lieut.-Col. C. M. Davidson, E. P. Favarger, and G. L. Hillier. The Motor Traction Co. (Ltd.) and Major H. C. L. Holden have certain rights of nominating directors.

**MILLER AND SONS (LTD.).**—Registered Dec. 7, with a capital of £30,000 in £1 shares (15,000 6 per cent. cumulative preference), to acquire and carry on the business of electricians, gas and electric light fitters, manufacturers of and dealers in electroliers, electric light fittings, &c., now conducted under the style of Miller & Sons. The first directors are A. T. Miller, M. Miley and W. Brooman (managing director).

**RAILWAY EQUIPMENT AND CONSTRUCTION CO. (LTD.).**—Registered Dec. 1, with a capital of £1,000,000 in £10 shares, to construct, acquire, equip, maintain, and control railways and tramways, and to carry on the business of civil, electrical, and mechanical engineers, &c. The subscribers are Dr. L. H. Louderback, railway manager, (with 99,994 shares), and H. H. Dalrymple Hay, civil engineer, W. T. Potts, traffic manager, J. Barlow, J. M. Caig, S. Peck, and R. H. Howe (with one share each).

**SIMMS MANUFACTURING CO. (LTD.).**—Registered Nov. 25, with a capital of £25,000, in £1 shares, to carry on the business of motor, cycle, &c., manufacturers, electricians, electrical and mechanical engineers, machinists, &c. The first directors are F. R. Simms (chairman), and E. B. Donkin, or other nominee of Bryan Donkin and Clench (Ltd.).

**WALTER SCOTT (LTD.).**—Registered Dec. 4, with a capital of £575,000 in £1 shares (300,000 preference), to adopt agreements with Walter Scott (Ltd.) and with the Leeds Steel Works (Ltd.), and to carry on the business of steel manufacturers, engineers, electricians, &c.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation | Dec. 8 | 589 | + 112 | 27 | 19,297 | + 2,769 |
| *Birmingham Tramways | " 8 | 4,569 | + 430 | 22 | 99,949 | + 2,862 |
| Blackpool Corporation | " 6 | 179 | + 41 | 36 | 27,552 | + 7,213 |
| Blackpool and Fleetwood | " 8 | 139 | + 12 | 23 | 19,852 | − 12 |
| Bolton Corporation | ... | ... | ... | ... | ... | ... |
| Bradford Corporation | " 9 | 767 | + 431 | 36 | 19,858 | + 5,634 |
| Brisbane Trams | Oct. 24 | 4,863 | + 371 | 16 | 29,776 | + 5,818 |
| *Bristol Trams & Carriage | " 7 | 3,066 | + 435 | 23 | 76,327 | − 814 |
| *Buenos Ayres & Belgrano | Nov. 11 | 2,785 | + 292 | 19 | 46,527 | + 3,846 |
| Central London Railway | Dec. 8 | 5,765 | ... | 19 | 99,427 | ... |
| City & South London Ry. | " 9 | 1,915 | + 605 | 23 | 37,775 | + 15,104 |
| Cork Elec. Trams | " 6 | 348 | − 10 | 49 | 19,995 | + 1,420 |
| Dover Corporation | " 8 | 167 | + 21 | 36 | 8,218 | + 456 |
| Dublin & Lucan Rly. | ... | ... | ... | ... | ... | ... |
| Dublin United | " 7 | 3,351 | + 407 | 23 | 95,027 | + 11,089 |
| Dublin Southern Dist. | " 7 | 691 | + 19 | 23 | 22,933 | |
| *Dundee Corporation | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation | " 8 | 9,027 | + 380 | ... | ... | ... |
| Hull Corporation | " 8 | 1,401 | + 735 | 23 | 31,710 | + 16,807 |
| *Liverpool Corporation | " 1 | 8,054 | + 1,072 | 48 | 380,550 | + 49,451 |
| Liverpool Overhead Rly. | " 9 | 1,483 | + 35 | 23 | 38,131 | + 655 |
| *Sheffield Tramways | " 9 | 2,780 | + 1,035 | 49 | 112,144 | + 38,765 |

* Partly electrical

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29⅛d. per oz. (Dec. 13). Consols (2¾ per cent.) 97⅞—97⅞ for money, 97⅝—97⅞ for account; 2½ per cent. 97½—97¾ (Dec. 13). Stocks and Shares Continuation Days, Dec. 24 and Jan. 14; Ticket Days, Dec. 27 and Jan. 15; Pay Day, Dec. 28; Mining Share Carry-over Days, Dec. 21 and Jan. 13.

**ALLGEMEINE ELECTRICITATS GESELLSCHAFT, BERLIN.**—The annual general meeting of this company was held at Berlin last week, when the directors' report was adopted, and a dividend of 15 per cent. declared, as set out in our issue of the 30th ult. In regard to the Nernst lamp, the general director (Herr Rathenau) referred to the criticism that had been passed on this lamp, and particularly in regard to the alleged delay in putting it on the market. He said that, after thousands of the lamps had been successfully tested under the most various conditions of daily use and had received general approval, they extended their works so as to be in a position to turn out about 1,000 lamps per day as the demand grew. They intended to do their utmost to popularise and extend the use of the lamp.

**GENERAL ELECTRIC CO. (NEW YORK).**—A quarterly dividend of 2 per cent. and an extra dividend of 1 per cent. has been declared.

**RICHARD HORNSBY AND SONS (LTD.)**—At a meeting held on Monday the chairman (Mr. H. Simpson Gee) said that including the balance brought forward, the net profit amounted to £33,899, compared with £50,060 in the previous year. The reduction was owing to the enhanced value of iron, steel, and coal, which had cost the company £20,000 more than in the previous year without their securing any adequate increase in the price of machinery sold. The turnover had not been quite so large, the sales having fallen off to the extent of £30,000, entirely due to the decline in their trade with the colonies. A half-year's dividend, 6 per cent. on the preference shares, and 8s. per share (5 per cent.) on the ordinary shares (together absorbing £15,000) were approved. £10,000 was placed to reserve, and £5,899 carried forward.

**ROSS ELECTRIC LIGHT AND POWER CO. (LTD.)**—A prospectus of this company, which has been formed to establish electricity works in Ross, has been issued locally. Current is to be supplied on continuous-current system. It is proposed to erect plant capable of supplying the equivalent of 4,210 8 c.p. lamps, the maximum charge for current being fixed at 8d. per unit for lighting and 5d. for power. The total cost of the scheme is estimated at £7,800.

**WESTERN UNION TELEGRAPH CO.**—The regular quarterly dividend of 1¼ per cent. has been declared. The net earnings for the quarter ending 31st Dec. (partly estimated) amount to $1,700,000, an increase of $121,000.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 5. | | Price Wednesday, Dec. 12. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Dec. 12. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | | | | |
| 100,000 | 1 | ... | Bl'kh'th & Gr'nw'ch Dist'ct Elec. Lt. Ord. (fully pd.) | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 19/9 | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,561 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | 7½ | 7⅛ |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | 10 | 9[illegible] |
| 20,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | [illegible] | [illegible] |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6¾ | 6[illegible] |
| £[illegible]52,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 111 | 4 0 11 | June and December | 111½ | ... |
| $1,[illegible],000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,670 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 | 10 | 9 | 10 | 4 0 0 | February and August | 9½ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 13½ | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11 | 12 | 11 | 12 | 4 16 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | 109 | ... |
| 10,[illegible] | 5 | ... | Folkestone Electric Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 1[illegible],000 | [illegible] | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ | 12½ | 11½ | 12½ | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 [illegible] 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1¾ | 2¼ | 1¾ | 2¼ | ... | ... | ... | ... |
| 40,500 | 5 | 3/0 | Do. 6 per Cent. Preference | 4½ | 5½ | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 100 | 102 | 100 | 102 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 55,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 4 4 0 | April and October | 12[illegible] | 12½ |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 7 | June and December | 114 | ... |
| £[illegible] | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 101 | 98 | 101 | 3 10 3 | ... | 99[illegible] | 99½ |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6¾ | 6½ | 6¾ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/0 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 12 15 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Traction, Ltd., 5% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 5 15 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 180 | 4 [illegible] 11 | April and October | ... | ... |
| $115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 41,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 5 | February and August | ... | ... |
| 2[illegible],000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 8 | " " | ... | ... |
| £1[illegible] | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | ... | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £[illegible] | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | ... | ... | ... |
| 60,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 3¼ | 3 |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12⅝ | 12[illegible] |
| 20,[illegible] | 5 | ... | Do. Do. | 11½ | 12½ | 11½ | 12½ | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | 15 | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24½ | 25½ | 24 | 25 | 3 6 3 | February and August | ... | ... |
| 2[illegible] | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £100,[illegible] | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 1[illegible] | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 6[illegible] | 10 | 11/0 | British Elec. Trac. Ord. | 14 | 15 | 14 | 15 | 5 13 4 | ... | 14½ | ... |
| 6[illegible] | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 5 9 | February and August | [illegible] | [illegible] |
| £[illegible] | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | [illegible] | [illegible] |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4¾ | 5½ | 4¾ | 5½ | 5 14 3 | ... | [illegible] | [illegible] |
| 37,[illegible] | 5 | ... | Do. "B" | 4½ | 5 | 4½ | [illegible] | ... | ... | [illegible] | [illegible] |
| £1[illegible] | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 15 5 | ... | ... | ... |
| £[illegible] | Stock | 13/9 | Do. 5% 2nd Deb. Stock Perm. Certs. (all pd.) | 98 | 99 | 98 | 99 | 5 1 0 | ... | ... | ... |
| [illegible],247 | 10 | 3/0 | Central London Ordinary | 9½ | 9¾ | 9½ | 9¾ | 3 1 6 | June and December | 9½ | 9[illegible] |
| £466,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 53 | 56 | 53 | 56 | 2 9 7 | February and August | 53 | [illegible] |
| 37,500 | 10 | [illegible] | Do. Ordinary (Nos. 23,601 to 61,000) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | ... | ... |
| £[illegible] | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £[illegible] | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £241,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 118 | 121 | 118 | 121 | 3 5 1 | May and November | ... | ... |
| 6[illegible] | 10 | ... | Dublin United Trams. (1896) Ltd., Ordinary | 17 | 18 | 17 | 18 | ... | ... | ... | ... |
| 5[illegible] | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £[illegible] | 100 | ... | Do. 5½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,[illegible] | 10 | 7½% | Imperial Tramways Ordinary | 22 | 23 | 22½ | 23½ | 3 12 0 | March and September | ... | ... |
| 10,[illegible] | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 8 | " " | ... | ... |
| £3[illegible] | Stock | 4½% | Do. 4½ per Cent. Debenture | 113 | 116 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 3[illegible] | 10 | [illegible] | Kidderminster & District E. L. & Traction 6% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,[illegible] | 10 | [illegible] | Liverpool Overhead Railway Ordinary | 8¾ | 9¼ | 8¾ | 9¼ | 4 9 6 | February and August | ... | ... |
| 10,[illegible] | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 11 1 | " " | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture | 104 | 105 | 104 | 105 | 3 17 0 | January and July | ... | ... |
| $[illegible] | $1,000 | ... | London Street Ry. (Canada) 1st Mort. 5% Debs. (red.) | | | 102 | 104 | 4 17 7 | ... | ... | ... |
| $[illegible] | 100 | 5% | Montreal Street Railway 5% Sterling Mort. Debs. (1908) | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| £140,[illegible] | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 6[illegible],000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5 | 4¾ | 5½ | 6 0 0 | May | 5 | ... |
| [illegible],000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| [illegible],000 | 10 | 6/0 | Do. 5 per Cent. Preference | ... | | ... | | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 10½ | 11½ | 10½ | 11½ | ... | ... | 11[illegible] | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,[illegible] | Stock | [illegible] | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | ... | ... |
| £40,000 | Stock | 3% | Waterloo and City Ordinary | [illegible] | [illegible] | 94 | 97 | 3 2 6 | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 5. | | Price Wednesday, Dec. 12. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Dec. 12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | Highest | Lowest |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 103 | 3 17 8 | January and July | ... | — |
| 35,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | — | — |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 86 | 87 | 85 | 90 | 5 11 1 | ... | — | — |
| £433,720 | Stock | 15/0 | Anglo-American | 51 | 55 | 52 | 55 | 6 11 10 | Feb., May, Aug., Nov. | 53 | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 97 | 99 | 97 | 99 | 6 2 5 | " " | 99 | 97½ |
| £3,088,640 | Stock | 27/0 | Do. Deferred | 10½ | 10¾ | 9¾ | 10½ | 13 3 5 | " " | 10½ | 10 |
| 13,333,200 | $100 | $1½ | Commercial Cable Capital Stock | 165 | 175 | 171 | 180 | 4 9 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,563,073 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 17 4 | " " | 103 | 102 |
| 16,000 | 10 | 8/0 | Cuba Submarine Ordinary | 6 | 7 | 6½ | 7½ | 7 4 8 | February and August | ... | — |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 | 16 | 15 | 16 | 6 5 0 | " " | — | — |
| 11,961 | 5 | 3/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | — | — |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | — |
| £60,900 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 101% | 103% | 101% | 4 6 7 | January and July | ... | — |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10½ | 10¾ | 10 | 11½ | 6 13 1 | Jan., Apr., July, Oct. | ... | ... |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 102 | 99 | 102 | 4 8 6 | June and December | — | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary | 131 | 143 | 132 | 143 | 4 16 7 | Jan., Apr., July, Oct. | 141 | 131 |
| £1,626,683 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 93 | 96 | 99 | 3 11 1 | " " | 97½ | — |
| £1,431,388 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 114 | 110 | 114 | 3 10 4 | May and November | 111½ | 110 |
| 380,000 | 10 | 2/6 | Eastern Extension | 13½ | 14½ | 13½ | 14½ | 4 18 3 | Jan., Apr., July, Oct. | 14 | 13½ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £5pd., is'd at 65pm, all p.i. | 9½ | 9½ | 9½ | 9½ | ... | ... | ... | — |
| £330,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 | 115 | 113 | 115 | 3 9 7 | February and August | ... | — |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 100 | 103 | 3 17 9 | February and August | — | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 101% | 99% | 101% | 3 19 5 | May and November | ... | — |
| 183,337 | 10 | 1/0 | Globe Telegraph and Trust | 10½ | 10½ | 10½ | 10½ | 4 17 8 | Jan., Apr., July, Oct. | 10½ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | " " | 15 | 15 |
| 180,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 33 | 31 | 33 | 3 15 7 | January and July | ... | — |
| £84,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 4 10 0 | June and December | ... | — |
| 17,000 | 25 | 12/6 | Indo-European | 43 | 62 | 44 | 54 | 4 16 2 | May and November | 43 | — |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 12 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 101 | 104 | 101 | 104 | 3 15 3 | June and December | — | — |
| 11,830 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 123 | 128 | 4 14 0 | " " | 126½ | 125 |
| 16,609 | 10 | ... | West African Telegraph | 3½ | 3½ | 3½ | 3½ | 4 9 3 | December and July | ... | — |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 102 | 99 | 103 | 4 19 5 | March and September | 99½ | — |
| 180,000 | 2½ | ... | West Coast of America | ½ | ¾ | ½ | ¾ | ... | ... | ... | — |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 14 4 | January and July | 100½ | — |
| 88,321 | 10 | 6d. | West India and Panama | ½ | ¾ | ½ | ¾ | ... | May and November | ... | — |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | 6 | 6 |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | — |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 12 6 | January and July | ... | — |
| 307,980 | 10 | 5/0 | Western Telegraph (late Brazilian S'bm'rine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14 | 14 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 103 | 106 | 103 | 106 | 4 14 4 | June and December | ... | ... |
| £345,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | — |
| 334,850 | 10/0 | 1½d. | Consolidated Telephone Con. and Manfg. | 3/6 | 4/3 | 3/6 | 4/3 | ... | July | — | — |
| 72,000 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | 1 | ½ | 1 | 5 0 0 | November | — | — |
| 66,493 | 1 | 1/0 | Do. 5 per Cent. Preference | 1 | 1 | 1 | 1 | 5 0 0 | " | — | — |
| 580,000 | 5 | 3/0 | National | 4 | 4½ | 4 | 4½ | 6 9 9 | February and August | 4½ | — |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 | 14 | 12 | 14 | 4 5 9 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 | 14 | 12 | 14 | 4 5 9 | " " | ... | ... |
| 240,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | " " | ... | — |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 91 | 90 | 90 | 91 | 3 11 5 | June and December | 91 | — |
| £500,000 | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 106 | ... | ... | 10½ | — |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1½ | ¾ | 1½ | 6 2 9 | April and October | ... | — |
| 88,000 | 5 | 4/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | — |
| 16,580 | 5 | 2/6 | Do. 5% Cumulative Preference (fully paid) | 5 | 5½ | 5 | 5½ | 4 10 11 | June and December | ... | — |
| 73,361 | 5 | ... | Do. do. (£3. 10s. paid) | 3½ | 3¾ | 3½ | 3¾ | ... | ... | ... | — |
| £79,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | June and December | ... | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 8d. | Alliance Electrical Co. 5% Cum. Pref. | ¾ | 1¼ | ¾ | 1¼ | 4 8 11 | ... | — | — |
| 136,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 7 7 6 | March and September | — | — |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ... | ... | ... | ... | ... | ... | — | — |
| 80,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ... | ... | ... | ... | ... | ... | — | — |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 99 | 97 | 99 | 4 4 2 | ... | ... | — |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10 | 11 | 11 | 12 | 8 6 8 | July and February | ... | — |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6½ | 6½ | 6½ | 6½ | 4 16 0 | January and July | ... | — |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | ... | — |
| 90,060 | 3 | 1/2½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 8 4 | September | ... | — |
| 15,731 | 3 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | " | 2 | 2 |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 106 | 111 | 108 | 111 | 4 0 11 | March and September | 107 | — |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 105 | 103 | 103 | 4 7 0 | January and July | ... | — |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 12½ | 13½ | 12½ | 13½ | 5 11 1 | " " | 12½ | 12½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5 | 6 | 5½ | 5½ | 4 6 11 | " " | 5½ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 110 | 114 | 3 18 11 | November and May | — | — |
| 300,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | ... | — |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | 98½ | — |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | — |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1½ | ¾ | 1½ | 5 6 8 | ... | ¾ | — |
| 34,000 | 3 | 2/4½ | Crompton and Co. (Nos. 1 to 32,099) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | 4 | — |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 97 | 103 | 97 | 102 | 4 13 0 | " " | ... | — |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1½ | ¾ | 1½ | 5 6 8 | ... | ... | — |
| 99,281 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | 1½ | — |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | — |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 5 | June and December | ... | — |
| £100,000 | Stock | 27/4½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 93 | 100 | 93 | 100 | ... | ... | ... | 6½ |
| 36,100 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half-yearly | 5 | — |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 104 | 103 | 105 | 4 7 3 | ... | ... | — |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 2 | 2½ | 2 | 2½ | 5 6 8 | January and July | 2 | — |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3½ | 2½ | 3½ | 4 6 2 | July | 3 | — |
| £182,300 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 16 2 | January and July | ... | — |
| 110,000 | 1 | ... | Elliott Electro Chemical and Power Co. Ord | ½ | ¾ | ½ | ¾ | ... | ... | ... | 12½ |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 14½ | 13½ | 13½ | 11½ | 5 11 1 | February and August | 11 | 5½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 3 13 3 | " " | 6½ | ... |
| £30,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 | 112 | 108 | 112 | 4 0 4 | " " | ... | ... |
| 30,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 2 9 2 | " " | 21½ | 21½ |
| £200,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 18 3 | March and September | ... | 101 |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | 41 | 42 | 41 | 42 | 4 5 9 | March and July | 41 | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 15,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 3 19 2 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5½ | 5½ | 6½ | 4 6 11 | ... | ... | ... |
| 20,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 8 1 9 | April and October | ... | 6½ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | " " | 6½ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures &d | 103 | 105 | 103 | 105 | 4 0 11 | May and November | 104 | 103½ |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,179. [No. 9. Vol. XLVI.] FRIDAY, DECEMBER 21, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Engineering science long ago invented the ether engine: last Monday, at the Society of Arts, Dr. J. A. Fleming invented the "ether engineer." But the ether is not the same in the two cases, and it is a simpler matter to build an ether engine than it is to qualify as an ether engineer. Dr. Fleming considers the advent of the latter inevitable: "In the century now so close upon us," he observed, "electrical engineers will have to become more and more *ether* engineers." If this is really to be the case, it will be a curious coincidence that ether engineering should have begun with the same problem as electrical engineering—viz., telegraphy. Will it, in the next century, attain to the heavy work of the transmission of power for motors and lighting? There are, of course, theorists who tell us that all electrical engineering is and must be ether engineering—that electrical transmission of energy, whether by electric current or by electromagnetic stress, takes place through the ether. We may grant all this, and yet perceive a fundamental distinction between the engineer, the axis of whose work and labours is a guiding copper wire, and his more modern *confrère* who requires along the axis of his work nothing but ether-filled space.

Ether engineering, if it should ever develop into a *fait accompli*, will have received as a legacy from the nineteenth century a substantial foundation of experimental theory. It is this legacy that has, in reality, served Dr. Fleming as the topic for the excellent course of Cantor lectures which he brought to a conclusion last Monday evening. Whether all the future modes of utilising the ether in engineering will be by means of electric oscillations and electric waves it is impossible now to decide: the properties of the ether may possibly be adapted in a different and as yet unsuspected manner to "the use and convenience of man." But no small attainment has been made already along the line of experimental research and practical application, the initiator of which was the immortal Heinrich Hertz.

While writing of Dr. Fleming's Cantor lectures we may refer to an interesting letter in our Correspondence columns this week, in which the lecturer comments upon a remark we made last week with regard to his third discourse. Dr. Fleming has taken our remark a little too seriously. When writing that his treatment of the subject of anomalous dielectrics "seemed to allow of the inexact impression that by suitably choosing the temperature any recalcitrant dielectric could be coerced into obedience to" Maxwell's law, we had no intention to undervalue his very important low-temperature researches. It was not the *experimental evidence* that we had in our mind, but the logical force of the criticism that a judicious selection of temperatures might conceivably—though, of course, it could not in reality—prove a contrary law. Suppose, for instance, the dielectric constant of every dielectric varied considerably with the temperature, each dielectric having its own peculiar law of variation; then, by a judicious selection of temperatures, not only Maxwell's law but any other law on the subject might be "established"—*e.g.*, a cube or $n^{th}$ power law. After all, what we have to prove is, not merely that at certain low temperatures the arithmetic works out all right, but that behind that mathematical agreement there is an essential and fundamental physical principle.

And our remarks, however playfully framed, have been abundantly justified in their having elicited from Dr. Fleming so valuable a contribution as his letter this week. Therein, starting with Dr. Larmor's conception of the electron as a strain-centre in the ether, he proceeds to show deductively how it can be that certain dielectrics behave at all temperatures according to Maxwell's law, while certain anomalous dielectrics are brought into agreement with that law only when, by means of a low temperature, or by high-frequency alterna-

tions of electric stress, their molecular and electrónic conditions are made conformable to that law. It is an excellent piece of reasoning: we have nowhere seen the electronic theory more lucidly and convincingly applied.

At the last meeting of the Physical Society, several Papers of great electrical interest were read and discussed. The two first, by Prof. Schuster, were, in effect, studies on the modifications which may prove necessary in our conceptions and calculations of that important quantity *inductance* if the most modern hypotheses of the electric current and of electricity in general become finally accepted. The alteration in the numerical value of the inductance of a solid conductor can in any case be only extremely small, and may for practical purposes—perhaps for ever—be neglected. Its possible influence in causing the slow secular variation of the magnetic elements was, however, traced by Prof. Schuster, and constitutes an attempt of great plausibility on the secret of terrestrial magnetism.

Two Papers bearing on the question of observatories and tramways followed. In the one by Prof. Rücker, a method of computing the effect of a tramway installation on the vertical force instruments at a distant observatory was developed. The method itself was of great elegance; and the formula deduced by its aid was modified and utilised by Dr. Glazebrook in another Paper. The results of the application of the formula were discussed at length by Dr. Glazebrook. From it he showed, among other things, that a tramway of any given length at a certain distance from a magnetic observatory is many times more obnoxious to the observatory than a tramway half as long at half the distance. If this indeed be so, it seems to us that the whole of the observatory-tramway question must become greatly more complicated—especially for the observatories; and that, to proceed at once to a definite case, a busy tramway, say from Kilburn to Bermondsey, would exert at Kew an effect so appalling as to necessitate a vehement protest from the observatory authorities.

**Obituary.**—We regret to announce the death, last Saturday, of Sir John Conroy, Bart., F.R.S., Bedford Lecturer in Physics at Balliol College, Oxford.

**Cable Interruptions and Repairs:**—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Tangier—Tarifa | Jan. 3, 1900 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Falmouth—Bilbao | Nov. 19, 1900 | Dec. 19, 1900 |
| Cayenne—Pinheiro | Nov. 26, 1900 | — |
| Pernambuco—Ceara | Nov. 29, 1900 | — |

**Telephones and Power Circuits in Switzerland.**—The fight between the telephone and electric traction and supply interests, settled long ago in this country, is still being waged in Switzerland, where the telephone system is mostly on the single-wire system with earth return. The matter has recently been engaging the attention of the Swiss Federal Council, who have decided that the telegraph and telephone administration must contribute towards the cost of moving the wires crossed by electric power circuits, that all the telephone lines are gradually to be converted to metallic circuits, and that no new single-wire telephone circuits are to be erected.

**Telegrams for South Australia, Western Australia, and Tasmania.**—The Eastern Extension, Australasia, and China Telegraph Co. announce that, in accordance with the agreement concluded in April last with the Governments of South Australia, Western Australia, and Tasmania, a further reduction of charges will take place on January 1st, making the tariffs for the contracting colonies 3s. 6d. per word for ordinary messages, 2s. 6d. for Government messages, and 1s. 4d. for Press messages. Should the "standard revenue" on which the reductions are based still be maintained, the tariff for ordinary telegrams will be further reduced to 3s. on January 1, 1902, and to 2s. 6d. on January 1, 1903, the tariffs for Government and Press messages being also reduced. The tariffs for the non-contracting colonies remain unchanged.

**Wireless Telegraphy for Warning Vessels.**—On Thursday of last week a trial of a new system of signalling, designed to warn vessels of their approach to danger, took place. The system is the invention of Mr. J. Gardner, and is being exploited by the Signals Syndicate (Ltd.). It consists in sending from the shore station continuously—or, perhaps, only in foggy weather—etheric signals which may be read by such vessels as are within a certain distance of the danger-point, and are provided with proper receiving apparatus. The sending and receiving apparatus used is that modification of the Popoff vertical air wire system designed by Colonel Hozier and Mr. Nevil Maskelyne, but the sending apparatus is made to give forth automatically the name of or other information concerning the danger-point. This is effected by using as contact-maker, in place of the Morse key usually employed in ordinary signalling, a revolving wheel, whose periphery is cut appropriately. For the trials, a mast 100ft. high had been erected at Shoeburyness, the danger-point, and the "Mermaid," sailing from Southend, tested the efficacy of the warning emanating from the shore station. The tests passed off successfully, and demonstrated the feasibility of the system. But such a system can, unfortunately, at its best, afford but little guidance to a straying navigator.

**Institution of Electrical Engineers (Glasgow Section).**—The two meetings that have already been held of the Glasgow Section of the Institution of Electrical Engineers have been so well attended that the committee have found it necessary to engage for future meetings the large hall of the Institution of Engineers and Shipbuilders. This hall is fortunately disengaged for all except the January date, so that after that meeting, which will have to be held in the small hall as before, the large hall will be utilised. The committee engaged the large hall for the discussion on Mr. Langdon's Paper, a report of which we give on another page. Mr. R. F. Yorke will read his Paper on "The Utilisation of Water Power for Electrical Purposes" at the January meeting. The local hon. sec. tells us that the total membership of the section now numbers 118, and that there are some 12 or 20 new candidates for election.

At the conclusion of the meeting of the section on the 12th inst., Mr. H. A. Mavor moved the following resolution:—"That Colonel R. E. Crompton and his gallant boys, who are being officially welcomed back from the front in London by our parent institution on Tuesday next, be accorded a hearty vote of congratulation by this section, and that we send them our sympathetic wishes on the conclusion of their patriotic and arduous campaign." This was duly seconded, and carried with acclamation.

**International Catalogue of Scientific Literature.**—At meetings of the council of this undertaking held on the 12th and 13th inst., the object, scope, and organisation, as defined by successive conferences held during the last four years, were brought into their final form, and all arrangements were completed for the definitive commencement of the work on January 1. One or all of these conferences have been attended by representatives of the following countries:—the United Kingdom, Austria, Canada, Cape Colony, Denmark, France, Germany, Greece, Holland, Hungary, India, Italy, Japan, Mexico, Natal, New Zealand, New South Wales, Norway, Portugal, Queensland, Sweden, Switzerland, the United States, Western Australia, South Australia and Victoria, whose adhesion to and co-operation in the work may be regarded as assured. The catalogue will at first be issued in annual volumes, but its form and rate of production will necessarily be governed to a great extent by financial con-

siderations. The responsibility for publication and for the initial expenditure is undertaken by the Royal Society, and the central bureau will be in London, while bureaus in correspondence therewith will, of course, be established in all the countries taking part in the undertaking. A comprehensive and elaborate system of classification has been devised with the assent of all the countries interested.

**The Tercentenary of Electricity.**—At the London Institution on Monday last Prof. Silvanus P. Thompson gave a lecture on the "Tercentenary of the Science of Electricity." This tercententary, he said, was to be dated from 1600, because in that year appeared Gilbert's treatise "De Magnete," in which it was shown that the attraction of the loadstone for iron was not the same as that exerted by amber for small particles of chaff, feathers, &c., and that this property of amber was shared by many other substances. In the century 1601-1700 Guericke constructed the first electrical machine, using a ball of sulphur, but very little more was discovered. In the next century there was a galaxy of names illustrious as contributors to the progress of the science of electricity. Still the real beginning of its useful applications dated only from the earliest part of the nineteenth century. Volta, in 1800, gave an account of the voltaic cell, and in 1802 Sir Humphry Davy, experimenting at the Royal Institution with a large battery of cells, produced the electric arc for the first time. About 1836 Daniell constructed a cell whose current was constant, though not very strong, and a few years later Grove invented his more powerful zinc-platinum cell, showing in 1841, in the theatre of the London Institution, that a battery of 100 of these cells could yield an electric arc 4in. long. So impressed were the managers with this achievement that they made Grove a professor of the Institution, where for some years he carried on researches on his cell and also on the gas battery. On the occasion of one of his lectures he illuminated the theatre with electric light produced by incandescent lamps with platinum filaments. In 1820 Oersted discovered the connection between electricity and magnetism, and in 1825 William Sturgeon, to whose name sufficient honour was not paid, described what was literally the foundation of electrical engineering—the electromagnet. This was applied to the purposes of telegraphy—in America by Morse and in England by Wheatstone and Cooke. Finally, Faraday, arguing that, if electricity could produce magnetism, the converse should be true and magnetism should produce electricity, invented the first mechanical method of generating electrical currents by rotating a coil of wire in such a way that it cut the lines of force proceeding from a magnet. The magneto-machine thus made was improved by Wilde, Gramme, and others into the dynamo of to-day. The lecture was illustrated with experiments and with a number of lantern pictures both of men and apparatus.

**Reception of the Electrical Engineers (R.E.) Volunteers.**—On Tuesday last, at the Covent Garden Opera House, the officers and men of the Active Service contingent of the Electrical Engineers (R.E.) Volunteers were welcomed home by the members of the Institution of Electrical Engineers. The parade comprised eight officers and 48 non-commissioned officers and men, the remainder of the two detachments that originally left England being accounted for as follows: Four have died, two (Lieut. Stubbs and Lance-Corporal Thorn) are left in hospital in South Africa, seven remain behind on duty, and two have accepted commissions in the Royal Field Artillery. The floor space set apart for the reception was kept by a guard of honour provided by the corps, and punctually to time (9 p.m.) Lieut.-Col. R. E. Crompton and his men were received by the President (Prof. Perry) and Council of the Institution.

Lord Kelvin, the honorary colonel of the corps, sent the following letter to the secretary:—

I am exceedingly sorry that I cannot be present with the President and Institution of Electrical Engineers on the occasion of the reception of the South African detachment of Electrical Engineer Volunteers, as I must be in Edinburgh on Monday, the 17th, on account of business undertaken six weeks ago. Will you make my apologies to Prof. Perry, and ask him to give my congratulations to the corps and best wishes to everyone of them on their safe return from the arduous work which they have so patriotically undertaken for our country, and tell him it is a very great honour to me to be their honorary colonel.

Prof. Perry, as President, then delivered the Institution's welcome as follows:—

Col. Crompton, Capt. Lloyd, officers and men of the electrical engineer unit of the South African army, in the name of the Institution of Electrical Engineers, I welcome you home. When Dr. John Hopkinson suggested that all British professional men, and particularly engineers, should prepare themselves in time of peace for giving their professional services to their country in time of war, he created the germ of what may become the greatest and best line of defence of the empire. You have carried out successfully the very first experiment. We of the Institution know how much you have sacrificed. I speak neither of social pleasures nor home comforts. I do not speak of the dangers you have risked either from the chances of war or from that more dreadful enemy, disease. These were common to you and all other volunteers. But you gave up positions and chances of promotion in your profession, a sacrifice which we of the Institution are particularly well able to appreciate. For those who have died we mourn not "as those without hope." Hope that a life laid down by a man for men is not a life thrown away. Hope for a country that can still breed sons who for her sake are not afraid to die. We are assured that, in the opinions of the generals your small force was of very great service. In particular, with the aid of your electric lights, the work of mending the broken bridges went on by night as well as by day, thus saving this country millions of money and who knows how many lives. You did any kind of engineering work that had to be done, and showed yourselves the handiest of "handy men." Officers and sappers alike took their full share of actual physical toil; but to us civilians, members of the Institution, the distinction between officers and sappers is merged in the fact that all alike were worthy representatives of the electrical engineering profession. We stand higher in our own opinion and, as we believe, in that of the world in that our common profession has developed in you that common-sense, that resourcefulness in time of trouble, that reserved power and moral courage which have distinguished you particularly in an army of distinguished men.

Major Gen. Salmond (R.E.) said that, with the assistance of such scientific men as electrical engineers, the Army would have a stand-by to which they could look for the greatest help in the time of need. He then reviewed the progress of the Electrical Engineer Corps from the time of its inception in 1896, by the late Dr. John Hopkinson, down to Lieut.-Col. Crompton's suggestion that a detachment should go to South Africa, and spoke highly of the latter's work in connection with the corps, which was so recognised in official quarters now that anything he asked for he got.

Lieut.-Col. Crompton replied that the responsibility thrust upon him since the death of Dr. John Hopkinson was great. Dr. Hopkinson was such a difficult man to follow, but he had tried to follow him. The fact that Lord Roberts was so far ahead and that De Wet was so troublesome, had made their position on the lines of communication very interesting, but it had made them feel like real soldiers. The electric lighting of the camps and tent hospitals had added much comfort to these places, and doctors and nurses had given their thanks; whilst a source of self-satisfaction was the fact that by means of their traction engines they had been able to haul a 12-ton gun up 1 in 6, and, generally, they had moved guns twice as heavy as had ever been moved before. He gave some particulars of how Lieut. Stubbs had been fired on whilst examining what he thought was a charge of gunpowder on the railway line, and then drew attention to a searchlight taken from a Boer fort, which was evidence, he said, that, "slim" as the Boer was, he was sometimes "done" by the wily contractor. It was only about one-half the size of the portable searchlight used by the electrical engineers. He then formally presented this, together with the dynamo exploder captured from Theron, to the Institution. Capt. Lloyd also spoke, and referred in flattering terms to the services rendered by some civilian electrical engineers in Pretoria and Johannesburg. He also repudiated the suggestion that there had been any class distinction in the South African field force. Later in the evening a vote of thanks to Mr. Frank Rendle and Mr. Neil Forsyth for having generously lent the Covent Garden Opera House was proposed by the President, and, of course, carried by acclamation. A programme of instrumental and vocal music concluded the evening's entertainment.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), December 21st.**

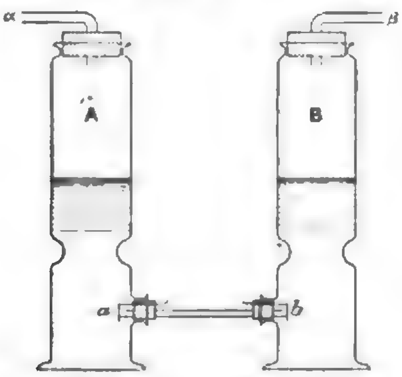
Institution of Civil Engineers.

*8 p.m.* Students' Meeting. Paper to be read: "The Use of Geometrical Methods in Investigating Mechanical Problems," by C. E. Inglis.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

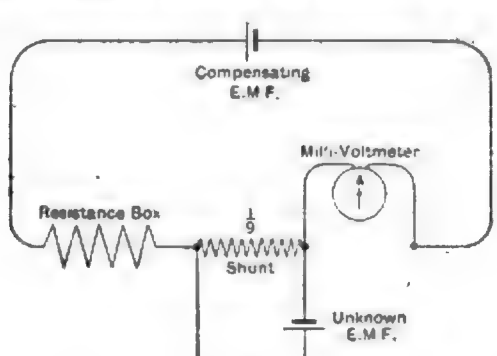
*E.M.F. produced by a Current of Water.*—C. Zakrzewski describes a curious experiment made with a current of water flowing from a vessel A to a vessel B (see diagram) or vice versa, through a glass tube, *ab*, silvered on the inside. Whenever the current of liquid is produced by pumping in air through $\alpha$ or $\beta$, a galvanometer connected with the platinum electrodes at *a* and *b* shows a deflection, which changes in direction with the direction of flow of the water, and in amount with the velocity of the water. The author regards this experiment as a confirmation of the Quincke-Helmholtz electro-capillary hypothesis, which sees the origin of the E.M.F. in the tearing of the electric



double layer at the separating surface of silver and water. The current is diminished when the electrode is pulled away from the issuing jet, since fewer electrified water particles then reach the electrode. The thicker the silvering the smaller is the E.M.F. The direction of the electric current is always opposed to that of the water current, but the two are the same in the case of a silver nitrate solution. The silvered tube shows sometimes the behaviour of a coherer, and its reduced resistance can be brought to its original value by the impact of electric waves.

[C. Zakrzewski, *Phys. Zeitschr.*, December 8, 1900.]

*Compensation Method for E.M.F.s.*—Very small E.M.F.s can now be measured with ease and rapidity by means of the



modern exact measuring instruments. E. Bose describes a method of employing Siemens and Halske's millivoltmeter for this purpose. The arrangement is immediately evident from the diagram. E.M.F.s of a few millivolts can be obtained without much calculation or interpolation, and without the use of a standard cell or even a standard resistance, since the actual value of the resistance in the box does not come into account.

[E. Bose, *Phys. Zeitschr.*, December 8, 1900.]

*Defence of the Cadmium Cell.*—W. Jaeger replies to the criticisms of the Weston cadmium cell put forward by Barnes and by Cohen. That the E.M.F. of the cadmium cell shows certain irregularities at 0°C. was already found by Wachsmuth and the author in 1896, and at that time they indicated 5°C. and 25°C. as the limits within which the new standard cell could safely be used. Similar irregularities are known to occur in the Clark cell, due to the transition point occurring at 39°C., below which the zinc sulphate may assume two different states, the normal curve being broken with respect to the portion above 39°C. Such a behaviour cannot be traced in cadmium sulphate. The metastability of the Weston cell must therefore be explained on some other ground, and this both the author and his critics now agree to find in the behaviour of the cadmium amalgam, which experiences irregular changes of structure at low temperatures. The concentration of the cadmium amalgam was originally put at 14·3 per cent. It is now admitted that elements with that amalgam should not be used below a temperature of 10°C. The cells brought out by the European Weston Electrical Instrument Co. contain an amalgam of only 12·5 per cent., and they show no metastability even at 0°C.

[W. Jaeger, *Zeitschr. Instrum.*, November, 1900.]

*Simple Wehnelt Interrupter.*—J. von Pallich describes a form of Wehnelt interrupter in which the lead plate is replaced by a copper wire, and the platinum anode by a steel wire. Both wires are enclosed in glass tubes, that containing the steel wire being strong, and tightly surrounding the steel tip. Both wires dip into dilute sulphuric acid. The steel wire is 1mm. or 2mm. thick, and its upper end is held in a cork provided with a cup for a mercury contact. The vessel containing the sulphuric acid is surrounded by cold water to keep the temperature down. The two glass tubes with their wires are inserted in a rubber stopper provided with borings to allow the acid to flow back into the bottle in case it spurts out. A curious phenomenon noticed in the working of the instrument is that the steel wears away just where the wire emerges from the glass tube, and not in the portion more immersed in the acid. A constriction is thus formed, and the effect appears to be that its formation assists rather than retards the generation of the gaseous layer, the explosions becoming stronger and more abrupt as the work of the interrupter continues. The double adjustment possible in this type of instrument makes it particularly easy to obtain the necessary current strength.

[J. von Pallich, *Ann. der Physik*, No. 11, 1900.]

*Method of Transverse Currents.*—An interesting investigation of the theory and practice of the transverse current method of determining resistances has been made by J. Stark. The main question raised is as to whether two currents traversing a conductor in two different directions between electrodes situated upon equipotential surfaces with respect to each other can be considered as simply superimposed. This is obviously only the case as long as the resistivity is independent of the current density. It is also necessary that the electrodes do not produce a polarisation. The author considers a cylindrical conductor, carrying a current along its axis, and having point electrodes applied to it at opposite ends of a diameter of a cross section. He shows that a simple superposition of currents holds good even if there are internal electric forces, provided their effect is axial. In practice, it is almost impossible to place the electrodes in an equipotential surface, especially in gases. In the latter, the resistance does not correspond with the potential gradient owing to the internal charges. There is less conductivity near the cathode owing to the greater speed of the negative ions. This is a well-known fact in connection with incandescent lamps, where transverse currents are almost inevitable.

[J. Stark, *Ann. der Physik*, No. 11, 1900.]

# ELECTRICAL EQUIPMENT OF THE SOUTH-EASTERN AND CHATHAM RAILWAY CO.'S LOCOMOTIVE SHEDS AT SLADE'S GREEN.

The locomotive shed which the South-Eastern and Chatham Railway Co. have erected at Slade's Green is one of the largest in this country, covering, with repair shops, coal staging and offices, about 2¼ acres, and affording accommodation for about 120 locomotives. It is supplied throughout with electricity both for light and power purposes, as well as with water from one generating and pumping station, and affords an interesting example of an electrical equipment of the most modern and efficient type. The convenience and economy with which the power is distributed there should act as an inducement to other works of a similar size to introduce electrical methods. The works and the whole electrical equipment were designed and carried out for the West Kent Electricity Supply Co. by Messrs. Kirkland and Capper as consulting engineers, Mr. C. F. Nursey acting as resident engineer until the appointment of Mr. W. Huskisson as chief engineer and manager and as resident during the completion of the works. They have been working now for over a year.

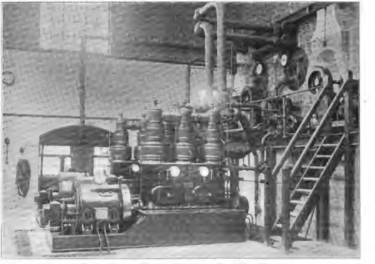


FIG. 1.—GENERATING SETS AND ELECTRICALLY-DRIVEN FEED PUMPS.

These works, which were specially designed to permit of extension, have now been taken over by the South-Eastern and Chatham Railway Co., and have been placed under the management of their chief electrical engineer, Mr. W. Leonard. A three-wire system at 460 volts between outers has been adopted. In addition to the power supply and the arc lighting, a number of 230-volt incandescent lamps are employed in the sheds and at the workmen's cottages and station at Slade's Green, and these are connected on the two sides of the three-wire system.

The power-house, of which Messrs. Humphreys, Davies & Co. were the architects, was designed to suit the requirements of the engineers with the coal store, boiler-house, engine-room, and accumulator house, running side by side separated by division walls. A railway siding runs along the outside of the coal store, which is fitted with a platform so that the coal can be delivered direct into the bunkers. In the boiler-house there are at present two Babcock-Wilcox boilers each capable of evaporating 5,000lb. of water per hour at 160lb. per square inch and provided with superheaters. They are placed with the back ends of the steam drums projecting through the division walls so that auxiliary pressure and water gauges are placed within sight of the engineer-in-charge in the engine-room. Two electric feed pumps (see Fig. 1) each capable of supplying 1,500 gallons of water per hour are placed upon a platform carried independently above the main flue which runs along the division wall in the engine room. These are three-throw pumps, of Hayward, Tyler's make, driven by Lundell motors, made by Messrs. J. H. Holmes & Co. The motors are connected so that they can be switched on to either side of the three-wire mains and thus be used to assist in balancing the load. As their full output is not yet required, one of them is being modified by double winding the armature, so that any speed between 700 and 175 revs. per min. can be obtained. It will thus be possible to give a constant feed when running on light load. The motors are fitted with raw hide pinions, and drive the pumps through double spur gearing.

The waste gases from the boilers are passed through a Green's economiser of 72 tubes, of which the scrapers are driven by a ½ H.P. Lundell motor. Provision is made for an additional economiser when required. The chimney stack, which is 110ft. high, is large enough for the addition of eight similar boilers.

The main engines, shown in Fig. 1, consist of two Willans three-crank compound sets, driving four-pole 100kw. Bruce Peebles dynamos at 450 revs. per min. These machines have the peculiarly extended pole-pieces already illustrated in our columns. The steam mains are in duplicate, and so arranged that but few valves are required, and these of small size. These pipes, together with their flanges, the steam drums of the boilers, and other exposed surfaces are covered with magnesia non-conducting material.

The dynamos, which can be regulated to generate at any voltage between 450 and 500, are connected across the outers

of the three-wire system, the middle wire being connected between the two sides of a double battery of accumulators. This battery consists of two sets of 138 Tudor cells (of which 50 are regulating), with a capacity of 324 ampere-hours at a three-hour discharge rate, and with an emergency output of 200 amperes for half an hour. The cells have 13 plates, and are arranged in two tiers on wooden stands of the usual pattern painted with anti-sulphuric paint. The stands are on oil insulators made in porcelain, and glass insulators support the individual cells. The regulating cells, which are connected at the middle of the battery, are designed to be charged by a double-wound booster balancer, which is not yet fixed, its place being temporarily supplied by a booster giving 90 amperes at 200 volts. When the balancer is in place it will be coupled so as to take the balancing load off the battery.

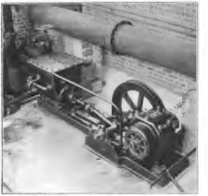


FIG. 2.—ELECTRICALLY-DRIVEN LEDWARD AIR PUMP.

The switchboard, made by Messrs. Verity, is arranged with separate enamelled slate panels for each dynamo, the battery, and outside circuits, those for the dynamos and circuits being placed at the outsides to allow for extension. The charge and discharge battery switch is of the circular concentric type, and the meters are of the Weston's dead-beat pattern. The board is placed 5ft. from the engine-house wall thus giving ample space for the recording meters and for getting at all connections. Pilot wires are brought from the shed to voltmeters on the board. A charge and discharge meter on the Aron-Miller principle is coupled to each side of the battery, and is so adjusted as to return to zero when the cells have been charged with the number of ampere-hours discharged plus 10 per cent.

Three circuits run from the switchboard underground to the locomotive shed some half a mile distant, with a branch to Slade's Green station and to the workmen's cottages on the company's property. The mains are concentric paper-insulated lead-covered and armoured cables made by the British Insulated Wire Co., and are laid directly in the ground in the 6ft. way. The branch mains to the cottages were laid by the Callender Co. on their well-known solid system.

The pumping, condensing, and softening arrangements are of special interest and afford a striking example of the advantages of concentration of plant. Water is pumped from wells over the top of a Ledward's condenser falling into a 12,000-gallon tank underneath, and being warmed in the process is freed in large part from suspended matter. Thence it passes to a Doulton's softener and is delivered into storage tanks from which a second pump delivers it through a recording meter to a 150,000-gallon tank on the roof of the locomotive shed over half a mile distant, the height of the water in this tank being continuously recorded in the engine room by an Elliott electrical step-by-step recorder. The tank underneath the condenser is also connected to an electrically-driven centri-

FIG. 3.—MAIN LOCOMOTIVE SHED, LIGHTED BY ARC LAMPS.

fugal circulating pump, so that condensing can be carried on independently of the other pumping arrangements. The wells, which are four in number, were sunk by Messrs. Le Grand and Sutcliff, one of them being 8½in. and the other three 4in. in diameter. The sinking of these wells gave a very interesting illustration of the uncertainty of the water-bearing strata. The top of the chalk is about 15ft. below ground level, and no water was found in the overlying ballast, although occurring in large quantities in the immediate neighbourhood. The depth of the 8½in. tube is 273ft. and of the others 250ft. The 8½in. well was first sunk. At 260ft. it yielded 1,560 gallons per hour, which increased to 2,500 gallons when a part of the lining tube was withdrawn. The next well, 4in. diameter, 300ft. north, yielded 1,600 gallons at 250ft. The third well, 4in. diameter, 350ft. south of the 8½in. well, yielded 2,500 gallons at 250ft., while the fourth well, intermediate between Nos. 1 and 2 in a straight line, yielded 3,000 gallons per hour at 200ft. depth, with only a 5ft. drop in level, showing a capacity largely in excess of all the other wells. The hardness of the water from these wells varied in an equally remarkable way, showing that quite different streams were tapped in the several cases. These wells are all joined to a common suction pipe so arranged that any one can be disconnected. The quantity of water actually used is at present about 1,000,000 gallons per week.

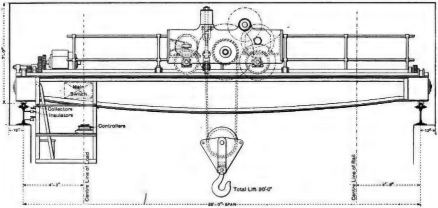


FIG. 4.—25 TON THREE-MOTOR ELECTRIC TRAVELLER.

FIG. 5.—UTILISING ELECTRIC TRAVELLING CRANES FOR REPLACING LOCOMOTIVE WHEELS.

The pumps temporarily installed are Worthington duplex steam pumps, which are arranged to be interchangeable for pumping through the condenser or direct from the well to the main storage tank. It is intended when the station is in full work to lay down specially designed electric pumps, for the sake of economy, using one of the steam pumps as stand-by. The electrically-driven Ledward air pump placed in the same house (see Fig. 2) delivers into duplicate graduated feed tanks, so that the feed water can be measured and the economy of the engine checked at regular intervals; the exhaust is provided with a drain tank ingeniously arranged to collect the oil which condenses in the vertical delivery to the condenser and an atmospheric exhaust branch is provided for use when the condenser is cut off. The softening plant was made by Messrs. Doulton & Co., and is arranged in two duplicate sets, each capable of treating 6,000 gallons per hour. The original hardness of the water varies up to a maximum of about 24deg. It is softened by lime and soda processes, the bulk of the foreign matter being precipitated in softener tanks, and

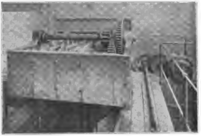


FIG. 6.—CRAB OF TRAVELLING CRANE.

after passing through sponge filters it is then delivered into four storage tanks of a total capacity of 12,000 gallons.

The locomotive shed, illustrated by Fig. 8, is under the charge of Mr. H. S. Wainwright, locomotive engineer to the South Eastern and Chatham Railway Co., and measures about 600ft. in length by 120ft. in breadth. It is very well lighted, 30 1,200 c.p. Stewart enclosed arc lamps in six rows being employed for that purpose. Every few yards in the inspection pits are connection boxes, with projecting sockets for plugging in portable lamps. Altogether there are about 60 enclosed arcs for lighting, these being connected five in series across the 460-volt mains. The wiring is done throughout in Simplex tubing, except where water is met with, where solid drawn screw tubing is employed.

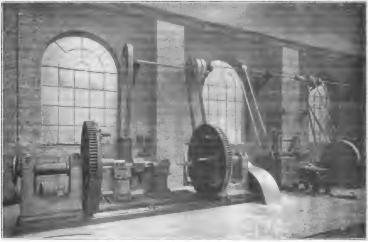


FIG. 7.—LARGE CAPSTAN LATHE AND PLANING MACHINE.

FIG. 8.—GENERAL VIEW OF REPAIRING SHOP.

In the engine-repairing shed, which measures 315ft. by 80ft., are two fine 25-ton electrically driven travelling cranes (see Figs. 4, 5 and 6). These between them lift without difficulty the largest locomotive. They were manufactured by Messrs. Jessop and Appleby and are fitted with Bruce Peebles' motors. Fig. 5 is a general view of the two cranes lifting a locomotive

in order that the wheels may be changed, and Fig. 6 shows the crab of one of the cranes and the motor and gearing for the longitudinal traverse. There are three motors on each, crane one for each motion. Current is picked up by a wiper from four trolley wires fixed on insulators below the crab on the beam, two similar trolley wires being employed on the longitudinal beam for the longitudinal traversing motor. Each crane is controlled from a cage at one end below the beam, seen to the right in Fig. 5. The motors are series wound the speed being regulated by means of controllers and resistances in series with them, the switch to each having off and on position and being arranged for reversing. An emergency switch on the main circuit is also provided in each cage. Each of the three motors is rated at 12 H.P., and, as already mentioned, the pressure is 460 volts. For lifting the speed is reduced five times between the motor and the main winding drum, the speed at full load being 8ft. per minute the motor running at 700 revs. At lighter loads the speed of lifting is correspondingly greater. The motors are carried on brackets fixed to the frame of the crab. An automatic magnetic brake is employed consisting of a wooden shoe which is pulled against a grooved steel wheel on the motor shaft by strong spiral springs when no current is flowing to the lifting motor. As soon as current is passing, an iron armature, to which the shoes are attached, is attracted by an electromagnet, so that the brake is held away from the wheel. The span of the traveller is 28ft. and the length of travel 815ft. The speeds of longitudinal travel and cross traversing are 100ft. and 40ft. per minute respectively at full load. All along the benches and inspection pits in this part of the shed are brackets with fixed lights wired and arranged so that either a lamp or flexible connection for a drill motor can be plugged into an additional socket. At the end of this repair shop are a number of machine tools all electrically driven by Bruce Peebles motors. There are four 8 H.P. four-pole shunt motors in all running at 820 revs. per min, on the 460-volt circuit. Each is controlled by a Cutler-Hammer starting rheostat with automatic release and overload preventer. One motor drives two planing machines, with tables 2ft. wide by 6ft. stroke, and a large grindstone through belts and countershafting. Two wheel lathes (Figs. 7 and 8), one 6ft. the other 7ft. in diameter, are each driven by an independent motor through a countershaft with cone pulleys, and the remaining motor drives the rest of the machinery shown on the left of Fig. 8. This consists of a screwing machine, shaping machine, drilling machine, and four small lathes, the speed of these being alike variable by means of belts with countershafts and cone pulleys. Fig. 9 is a view of the electrically-driven coal conveyor supplying coal to a locomotive. It is belt-driven from a motor placed in the casing to the right of the picture. It is made by Messrs. Waygood & Co.

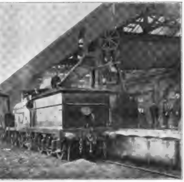


FIG. 9.—COAL CONVEYOR.

There are 146 cottages for the company's workmen, varying in size from four rooms to six rooms. Each cottage has incandescent lamps in three of the principal rooms. This forms a successful and unique installation. Lamps are also being put up for street lighting and connections provided for a large hotel and a number of shops. At Slade's Green Station the platforms are provided with 15 two-light and three single-light posts. The switching is arranged so that when no train is at the platform only a single light on each alternate post is in use. The full light is thus only on when a train is in the station. The lights in the offices, subway, &c., are all connected on an independent circuit controlled by one main and the requisite number of individual switches.

## THE DEVELOPMENT OF THE DENSITY FACTOR.*

BY C. TURNBULL.

The density factor of an electricity works may be defined as the number of 8 c.p. lamps connected per £1 worth of mains laid, or perhaps better as the number of units sold per annum per £1 worth of mains laid. Mains in this case should include transformers and the like. Owing to the great cost of every yard of cable laid it is of the utmost importance to have a good density factor; indeed, it may be said, take care of the density factor—*i.e.*, get the mains loaded up with every kind of consumer within reach—and the load factor will take care of itself.

The density factors of the following towns, taken at random from Garcke's "Manual," will serve to show the great differences that exist:—

| | 8 c.p. lamps connected per £1 worth of mains. | No. of units sold per annum per £1 worth of mains. |
|---|---|---|
| Aberdeen | 1·21 | 7·8 |
| Brighton | 1·03 | 25·4 |
| Derby | 0·89 | 17·5 |
| Edinburgh | 1·12 | 20·6 |
| Harrow | 0·64 | 6·5 |
| Manchester | 0·94 | 18·8 |

The cost of transformers is not taken into account in the above, as it is not shown separately in the "Manual." Seeing that the mains represent some 40 per cent. to 50 per cent. of the capital expenditure, I think the figures worthy of consideration.

*Rented Wiring.*—To meet those who do not wish to be at the expense of wiring their premise it has been proposed to take the mains throughout the building instead of stopping them at the meter only, and to charge a proportionately increased rate for the current consumed to cover the cost. This method is not entirely satisfactory, especially seeing that the modern tendency is to make consumers pay a fixed sum per annum to cover standing charges with a comparatively small charge for current used. I would suggest that the following points are desirable in a system of rented wiring:—

For a plain fitting, including lamp and switch complete, a fixed quarterly rental should be charged.

Additional fittings on the same switch should be charged at a second and lower rate.

Additional lamps on a fitting not having independent switches should be charged at a third and still lower rate.

The hirer should have the option of hire-purchasing the installation at rates based on the rentals; or he should be allowed to purchase outright at any time for a reasonable sum.

When the station does the wiring the rentals, &c., may be fixed by examination of the average costs of installation, but personally I prefer to have the work done by a wiring firm. Wiring needs more supervision than most of resident engineers are prepared to give, and with smaller stations at any rate there would not be a sufficient flow of work to keep an efficient staff busy, unless outside firms were discouraged—which would be foolish. When wiring is done by contract the terms must be settled by bargain. In Tynemouth we have arranged with a private firm to do the work, we to collect their rentals. A plain fitting complete costs 5d. per quarter, or without a separate switch 4d. per quarter, while an additional lamp on a fitting costs 3d. per quarter. Double these rates will pay off the cost in 4½ years, or 1½ times these rates will pay it off in 6½ years; or the hirer may buy at any time at a moderate price. Of course, these terms are not suitable for large houses, and in many towns special arrangements would have to be made to meet special cases. But it is to be observed that rented wiring is intended mainly for small consumers.

*The Two-Meter System.*—It has always been a trouble with the maximum demand system that consumers are in fear that their

---

* Paper read before the Newcastle Section of the Institution of Electrical Engineers, November 26th.

accounts will go up with a jerk if they happen to put on extra lights some night. This has been met in various ways, such as by allowing the indicator to be short-circuited on special occasions, or by having two-way switches arranged so that if one lot of lights is switched on then another lot will be switched off. In many cases people will only wire a few rooms in their houses to make sure that they will not at any time be let in for a big bill. It has been proposed to meet the difficulty by having two meters, one to register during the hours of heavy load and the other during the hours of light load, the units registered by the latter being charged at a lower rate. On examination this will be found unsatisfactory, for a shop which, say, averages two hours a day throughout the year, will be charged at the high rate, although undoubtedly a good customer, while an office which occasionally overlaps the station maximum demand, and only takes current during the winter months, will get off at far too light a rate.

I would suggest to you that houses which have a good steady load throughout the year will not appreciably increase the station maximum demand by having bedroom and other short hour lights connected up, in addition to their long hour lamps, nor will they require any heavier mains. It is therefore worth while to do something to rid their owners of the fear of a largely increased maximum demand if the occasional lamps are connected up. This can be done by allowing consumers to have two meters, one for long hour lights and the other for the remainder. The units registered by each meter are charged as if for separate consumers, so that practically the full rebate is obtained on the long hour lights and no rebate on the occasionally-used ones. A small extra rent may be charged for the second meter which may genenerally be one of the cheaper types now coming into use. It is also possible, as a rule, to omit the demand indicator, as of course the demand on each meter is the full number of lamps connected thereto. This concession has the effect of relieving people from anxiety so that they wire their houses freely, and they will, I doubt not, use their lights freely, too.

## ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.*

BY W. DUDDELL.

(*Concluded from page 273.*)

*Musical Arc.*—A direct-current arc of suitable length and current, between solid carbons will give out a musical note if it be shunted with a condenser in series with a self-induction, as in Fig. 9, even though the source of supply of the current be perfectly constant and the arc be protected as far as possible from any outside cause of disturbance. I find that the musical note is produced by oscillatory currents flowing in the circuit composed of the condenser F, the self-induction L, and the arc, Fig. 9, and its pitch is determined by the periodic time of this circuit—that is, on the relation between the capacity, self-induction, and effective resistance of the circuit. Neglecting the resistance, which it will be shown later must be small, the periodic time of the circuit $\tau=2\pi\sqrt{LF}$, and this has been found, by judging the pitch of the note by ear, to be approximately correct, so that for lecture purposes Kelvin's law can by this means be easily demonstrated.

It must be remembered that although we have an alternate current through the condenser and self-induction, the source of supply is not an alternating one, and that *it is the arc itself which is acting as a converter and transforming a part of the direct current into alternating, the frequency of which can be varied between very wide limits by altering the self-induction and capacity.* The upper limit I find to be about 10,000 ∿ per second, and the lower limit, if such exists, is well below 500 ∿ per second.

It has long been known that a train of oscillations of almost any frequency can be obtained on discharging a condenser through a suitable inductive resistance, but of course these oscillations have a rapidly decreasing amplitude; and the means of supplying energy to such a circuit so as to maintain *the amplitude of the swings constant*, other than by means of a varying source of power having the same periodic time as the circuit, has been wanting. It is, therefore, necessary to inquire under what conditions it is possible for the arc to cause the source of direct current to supply the energy necessary to maintain the oscillations in the condenser circuit when once they have been started. If the resistance in the main current in series with the arc is large, and if the $\partial V$ be a small instantaneous change in the P.D. between the terminals of the arc, $\partial A$ the corresponding small change in the current through it, and $r$ the resistance of the condenser circuit, not including the condenser; then during the time this small change lasts, sufficient energy may be supplied to the condenser circuit to make up for the energy dissipated there, in ohmic losses, if the following conditions are fulfilled (see Appendix II.):—

1. $\partial V/\partial A$, negative.
2. $\partial V/\partial A$, numerically greater than $r$.

The question is, can the arc fulfil these two conditions? Messrs. Frith and Rodgers* have experimentally determined the value of $\partial V/\partial A$, which they call the resistance of the arc, for various arcs, and they found that while $\partial V/\partial A$ was always + when *both* carbons were cored, it was, on the contrary, always − when *both* carbons were solid; and that it was as small as − 2 ohms for a 4-ampere solid arc. Now the resistance of the condenser circuit, $r$, external to the condenser, can easily be made less than 2 ohms, so that the arc can fulfil both the necessary conditions.

I will now describe some observations on the musical arc which tend to confirm the above conclusions. Arcs between solid carbons for which $\partial V/\partial A$ is always negative *work well*, while those between *cored* carbons for which $\partial V/\partial A$ is positive I find *will not work* under any conditions. The largest negative value of $\partial V/\partial A$ given by Messrs. Frith and Rodgers is 2 ohms for a 4-ampere solid arc, and it is probable that it did not exceed 2·5 ohms for the smaller currents, viz., 3 amperes to 3·5 amperes, which I used. According to the above conditions 2·5 ohms should be the limiting resistance of the condenser circuit; by experiment it was found that when the resistance of this circuit was increased to 2·4 ohms the oscillations stopped and could not be restarted. It is evident that besides the resistance there are other causes, such as hysteresis, which tend to dissipate the energy in the condenser circuit and stop the arc giving its note. The hysteresis in an iron-wire core introduced into the self-induction will instantly stop the note. Any complete circuit, such as a ring of wire placed near the self-induction, has the same effect.

On several occasions before the importance of these causes of the dissipation of the energy were realised, considerable trouble was experienced in tracing the reason of the arc failing to give its note. As examples, in one case it was traced to an ammeter and in another to the tinfoil in the condenser which were acting as short-circuited secondaries to the self-induction coil, which had been placed too near them. The relation between the self-induction, capacity, and frequency can be very easily demonstrated by playing a tune on the arc by varying either the capacity or the self-induction by means of a keyboard. Another method of varying the self-induction is by separating or bringing closer together the turns of the coil, as if playing on a concertina, the relative positions of the turns determining the self-induction and the pitch of the note. The musical arc can be used as a means of comparing self-inductions or capacities by comparing the pitch of the notes produced.

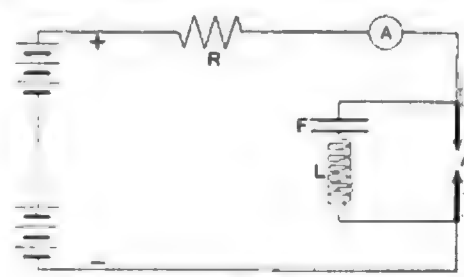


FIG. 9.

The "enclosed arc" will work equally as well as the open arc, though the note given out is not so audible owing to the globe; but it can easily be made so by taking advantage of some of the telephoning effects mentioned in Part I.

The alternating current through the condenser circuit may be as large as from 3 amperes to 5 amperes R.M.S. value, and the direct current in the main circuit also varies considerably, depending on the amount of resistance in the circuit. This condenser current is sufficient to show experiments with alternating currents which do not require much power, and is very convenient in many cases for lecture purposes, as the frequency, and any changes in it, are at once evident from the pitch of the note given out by the arc. Magnetic space telegraphy can easily be demonstrated on a small scale by using the self-induction coil as the transmitting circuit. Several arcs can be used in series when more power is required in the condenser circuit than can be obtained from one arc alone.

For the convenience of those who may wish to repeat these experiments, I append a table of good working conditions for open and enclosed arcs. The exact figures need not be strictly adhered to, as the musical arc will work over a wide range of conditions. It may perhaps be well to mention that only condensers suitable for high voltages should be used, as although the P.D. arc is only 50 volts, the P.D. condenser rises to several hundred volts.

* Paper read before the Institution of Electrical Engineers.

* *Proceedings* of the Physical Society, 1896, Vol. XIV., p. 307.

*Table of Data of Musical Arcs.*

| — | Open arc. | Enclosed arc. |
|---|---|---|
| *Carbons both solid.* | *Conradty.* | *Electra.* |
| Diameter | 9mm. | 13mm. |
| Arc length | 1·5mm. | 1·0mm. |
| Arc current | 3·5 amps. | 5 amps. |
| Resistance in series R | 42 ohms. | about 28 ohms. |
| Self-induction of L | $5{\cdot}3 \times 10^{-3}$ h. | $5{\cdot}3 \times 10^{-3}$ h. |
| Resistance of L and leads | 0·41 ohms. | 0·41 ohms. |
| Capacity of condenser F | 1·1 to 5·4mf. | 1·1 to 5·4mf. |
| R.M.S. current through condenser when capacity = 5·4 mf. | 3 amps. | 4·5 amps. |

*Metal Electrodes Switch Contacts.*—In connection with the above experiments the attempt was made to replace the carbons by metal electrodes, when I found that on trying to shunt the metal arc with a condenser it went out, no self-induction except that of the leads being used. Of course, whether the arc is extinguished or not depends on the capacity used to shunt it and on the other conditions of the circuit; thus in the present case, with a 3-ampere arc between 6mm. diameter copper electrodes and a resistance in series of from 50 ohms to 60 ohms, it was found that the arc was always extinguished when shunted with a condenser having a capacity from 0·6mf. to 5·4mf., though with the smaller condenser, 0·6mf., and longer arc lengths the extinguishing was not quite so certain. Condensers larger than 5·4mf. were not tried, though I have no doubt that they would prove even more effective.

This experiment is very instructive as showing how very soon the metal arc becomes practically non-conducting after the current through it is interrupted, for if we consider that the current through the arc is reduced to zero at the instant of first connecting the condenser, and remains zero unless the arc re-lights, then the time required for the 0·6mf. condenser to charge up to $(1 - 1/\epsilon)$, or 63 per cent. of the supply voltage—*i.e.*, 126 volts—is about $\frac{1}{5000}$th of a second. So that we may consider that if the current through the metal arc is interrupted for about $\frac{1}{5000}$th of a second, even applying about three to four times the normal voltage,* will not cause it to re-light. This is very different from the case of the arc between cored carbons, for it is well known that the current through a 10-ampere cored arc may be interrupted by opening a switch in series with it for, say, a quarter-second, and yet the arc will re-light on closing the switch again, owing to the high conductivity of the vapour left when the arc is extinguished. The comparison is, however, not quite a fair one, as it might be expected that with the larger current—viz., 10 amperes used with the cored arc—more conducting vapour would exist than with the 3 amperes used for the metal arc, and that it would therefore take longer for the vapour column of a 10-ampere arc to cool down and attain a high resistance than that of a 3-ampere arc.

In order to make a fair comparison, the metal electrodes were replaced by cored carbons, and a 3-ampere arc obtained under as nearly as possible the same conditions as the copper arc. This cored carbon arc could not be extinguished even on shunting it with the largest condenser—viz., 5·4mf., and it was found necessary, in order to make the cored arc go out on shunting, to reduce the current through it to below 1 ampere; but with such a small current the arc is rather unstable and liable to go out even when not disturbed in any way. Two solid carbons were also tried, and the effects were found to be intermediate between the cored arc and the metal arc, as a 2-ampere solid arc could just be put out by shunting with the 5·4mf. condenser, whereas the 3-ampere metal arc always went out on being shunted with a condenser of as small a capacity as 0·6mf., as already stated.

The correct method of finding out whether the arc will re-light in any given case after it has been extinguished on suddenly reducing the current through it is the following: Let A (Fig. 10) be a curve which might be drawn between the P.D. which will have to be set up between the electrodes to re-light the arc and the time that has elapsed since the arc was extinguished, and B the curve that connects the actual rise in P.D. between the electrodes—*i.e.*, between the condenser terminals—and the same time. Then the condition for the arc to re-light is that the curve B touches or cuts the curve A. Unfortunately we do not know much about the curve A between P.D. required to re-light the arc and time except that it starts from the P.D. at which the arc was burning at the instant it was extinguished, and attains a final constant value equal to the P.D. required to spark across between the electrodes. We can, however, form some idea of the steepness of the curve A at the commencement, for we know that, if the arc fails to re-light, the curve A lies between the ordinate at the time of connecting the condenser and the curve B—that is the ordinate at time nought. The shape of this latter curve, which represents the P.D. between the terminals of the condenser during charge, can be calculated from the known data of the circuit; thus with the copper arc mentioned above, which is just extinguished by shunting with a condenser of 0·5mf. capacity, E.M.F. in circuit being 200 volts, resistance 56 ohms, and self-induction of leads neglected, the curve B will start with an initial steepness of about $6 \times 10^6$ volts per second. In spite of this very rapid rise of curve B, it will generally fail to intersect the curve A for the 3-ampere copper arc, so that the apparent resistance of the copper arc seems to increase at a very high rate after the current through it is stopped. With cored carbon electrodes the arc under similar conditions could not be extinguished by shunting with 5·4mf., so that since the initial steepness of the curve B was one-ninth, or about $7 \times 10^5$ volts per second, this curve always intersected the curve A for cored carbons. Further, I think that the curves would still intersect—that is, the cored arc would re-light—if the initial steepness of B had been even many times smaller, so that the rate of increase of apparent resistance of the cored arc after interruption of the current is many times smaller than with the copper arc. In what has been said above, I have neglected the unknown self-induction of the leads, so that the figures given must be considered as only rough approximations.

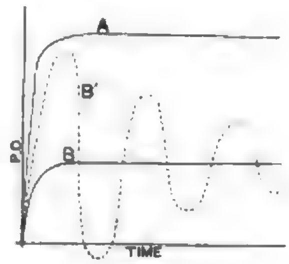
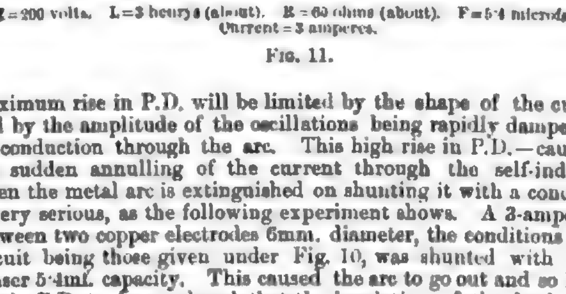


FIG. 10.

The extreme rapidity with which it is necessary to increase the P.D. between the terminals of the metal arc in order that it may re-light again after the current through it has been stopped, explains the fact that it seems impossible to maintain an *alternate* current arc between *metal* electrodes at ordinary frequencies and P.D.s of even several hundred volts; and that it requires a P.D. as high as 2,000 volts to maintain a metal arc as found by Herr Arons.† If the non-inductive resistance in series with the arc be replaced by a highly-inductive one, as shown in Fig. 11, the curve B will be altered in shape, and with the conditions inserted under Fig. 11 the charge of the condenser will be oscillatory as shown by B', Fig. 10, the maximum P.D. attained if the arc fails to re-light at all being many times as high as the E.M.F. of the source of supply. Although the arc is put out on shunting with a condenser, it does not follow that it may not have really re-lit and gone out again several times, corresponding with each swing of the condenser, before it is finally left extinguished owing to the dying away of the oscillations; and this is probably what occurs when the curve A is not very steep, as in the case of cored carbons. In this case the



E = 200 volts. L = 3 henrys (about). R = 60 ohms (about). F = 5·4 microfarads. Current = 3 amperes.

FIG. 11.

maximum rise in P.D. will be limited by the shape of the curve A and by the amplitude of the oscillations being rapidly damped, due to conduction through the arc. This high rise in P.D.—caused by the sudden annulling of the current through the self-induction when the metal arc is extinguished on shunting it with a condenser, is very serious, as the following experiment shows. A 3-ampere arc between two copper electrodes 6mm. diameter, the conditions of the circuit being those given under Fig. 10, was shunted with a condenser 5·4mf. capacity. This caused the arc to go out and so high a rise in P.D. to be produced that the insulation of the leads broke down, a spark passing from *a* to *b*, accompanied by a report. When, however, I substituted carbons for the copper electrodes, no report was heard, nor was any serious rise in P.D. noticed.

The next experiment tried was to connect the condenser permanently as a shunt to the metal electrodes, and then to attempt to

* Direct-current metal arcs as above usually require a P.D. roughly about 30 volts.

† *Wiedemann's Annalen*, Vol. LVII., p. 185.

strike the arc, the circuit being arranged as in Fig. 11. I found that it was impossible to strike an arc between metal (Cu., Fe., Al., and Brass) electrodes if the capacity of the condenser F., Fig. 11, exceeded 0·1 mf.—even although an E.M.F. of 200 volts was used—and that on separating the electrodes the sudden interruption of the current through the self-induction set up oscillations in the circuit and a high rise in P.D. between the terminals of the condenser similar to that produced when the metal arc was extinguished by shunting with a condenser, as explained above. The condition that determines the possibility of striking the arc is similar to the condition that governs the re-lighting of the arc after the current through it has been reduced to zero, as explained above. For corresponding with each position of the electrodes as they separate there is a certain P.D. required to start the arc, and if the relation between the position of the electrodes and time be known, then a curve between P.D. required to start the arc and time can be plotted similar to curve A, Fig. 10 above, and the intersection or otherwise of this curve with the curve B′ determines whether the arc will strike or not.

The practical interest in this subject of the striking of the arc lies in the fact that when the attempt is made to interrupt a steady-direct current flowing through an inductive circuit by means of a switch with metal contacts, an attempt is really made, at the first instant, to strike a metal arc between the contacts, and if these contacts be shunted by a condenser which prevents the arc from forming, a high rise in P.D. will occur. If, however, the arc was allowed to form, the time during which the break takes place would be lengthened, and no such great rise of P.D. would be produced. This rise in P.D. has been mathematically investigated by Mr. Johnson* on the assumption that the arc does not form, and putting the data given under Fig. 11 into his equation, I find that the rise in P.D. is just over 2,000 volts as compared with 200 volts—the E.M.F. in the circuit. It is, therefore, of importance when it is required to prevent these rises in P.D. on breaking the circuit to so choose the substance of the switch contacts that the arc shall not be prevented from forming or be suddenly extinguished by the action of the condenser, that is to say *that arcing at the switch contacts should rather be encouraged than otherwise*, of course always supposing that no special method such as a non-inductive resistance shunting the switch be provided to dissipate the energy stored in the self-induction.

The following experiments illustrate the importance of the nature of the switch contacts and of the condenser which shunts them. The circuit used was that shown in Fig. 11, the arc being replaced by a switch with brass contacts, and the data of the circuit being those given below the figure. When the condenser F was disconnected, and the insulation between *a* and *b* was made to consist of a single thickness of paper, I found that the circuit might be made and broken by means of the switch, either quickly or slowly, without the paper between *a* and *b* being pierced. After re-connecting the condenser F, however, every time the switch was opened the paper was pierced, and even three thicknesses of the paper could not withstand the rise in P.D. that occurred. The steady P.D. required to pierce one thickness of the paper was found by a separate experiment to be about 550 volts, and that required to pierce three thicknesses about 1,500 volts, so that without the condenser shunting the switch the rise in P.D. on breaking the inductive circuit was under 500 volts, but with the condenser as a shunt to the switch was over 1,500 volts, showing that the metal arc must have been almost completely suppressed, as the maximum value of the P.D. calculated above on the assumption of no arc forming at all was only just over 2,000 volts.

The influence of the nature of the contacts of the switch on the rise in P.D. which occurs when the switch is shunted by a condenser is very marked; thus with the metals, copper and brass, serious rises in P.D. were always found to occur, with solid carbons as contacts the rise was much less, and with cored-carbon contacts was inappreciable. Breaking the circuit between metal contacts under tap-water, or shunting the metal contacts while in air by wires dipping into water, also prevented any serious rise in P.D. It was also found that resistance or self-induction introduced into the connections between the condenser and the contacts greatly reduced the rise in P.D. on opening the switch. I attempted to use an electrostatic voltmeter to measure the rise in P.D., instead of the rough method of the piercing of paper, but although the voltmeter was sufficiently sensitive to read steady P.D.s much below that required to pierce the paper, it failed to indicate the rises in P.D. This is probably due to the short time the rise in P.D. lasts. There are two practical cases in which capacity shunts the switch contacts to which I will refer. The first is the ordinary induction coil in which the circuit is the same as Fig. 11, the switch being replaced by the contact maker. In this case a high rise in P.D. is required so that the nature of the contact points should be such that the arc can be completely extinguished by as small a condenser as possible; for the rise in P.D., if the arc is completely extinguished, will be the higher the smaller the capacity of the condenser. It is evident, therefore, that carbon would be very unsuitable for the contacts of an induction coil. This has lately been shown to be the case by the experiments of Mr. Beattie,* who finds that with a slow break the maximum length of spark obtainable between the terminals of the secondary, using *platinum contacts*, is nearly 2½ times that obtainable when *carbon contacts* are used, the current interrupted at the break being the same in both cases. I think that if *cored carbons* had been used, a much greater disparity in the spark length would have been found. The second case is that of a switch or circuit-breaker connected with a concentric cable so that the capacity shunting the contacts is supplied by the distributed capacity of the cable. Whether this distributed capacity in practical cases will have the same effect as a condenser shunting the contacts, as suggested by Mr. Johnson, is, I think, a matter for further experiment. If it has, then, serious rises in P.D. are to be apprehended on interrupting a *direct* current, through an inductive circuit, by means of metal contacts, the capacity of the cable forming a shunt to the contacts. Assuming this to be true for *direct* currents, may not some of the breakdowns of concentric cables supplying power by means of *alternating* current be also due to the sudden quenching of the arc at metal contacts, and not to the fact that the current is an alternating one? I suppose, of course, that the attempt to interrupt the current is made at some point in the period when the current is large. Before concluding this Paper, I wish to express my indebtedness to Prof. Ayrton and Mr. Mather, of the Central Technical College, not only for allowing me to carry out the experiments in the laboratories of the college, but also for the valuable assistance and advice they have given me during the course of the experiments. I also wish to express my thanks to the many students who have helped me from time to time, and especially to Messrs. Brown, Watson, and Fithian.

*Conclusions.* If the current be suddenly increased through a direct-current arc between two solid carbons, the P.D. and current increase together for less than about $\frac{1}{500}$th second, and at the end of this very short time the P.D. decreases with an increase of current in the ordinary way.

If the current through a direct-current arc varies by as little as 3 per cent. from the mean, and if the frequency of these superimposed variations is even as high as 4,300 ∾ per second, a variation in the light emitted by both the + crater and the vapour column can be detected.

A rapid periodic variation of the order of one part in 10,000 from the mean current will alter the vapour column of the arc sufficiently to produce sound-waves; and a variation of one part in 100 will produce sound-waves even at frequencies as high as 30,000 ∾ per second.

The arc is affected by such small changes of outside conditions as sound-waves produce.

The direct-current arc can be used both as a telephone receiver and transmitter.

In the direct-current humming arc the P.D. current and light emitted vary periodically, the frequency of these variations being the same as that of the rotation of the arc as a whole and of the pitch of the sound emitted.

In the direct-current hissing arc the P.D. current and light emitted vary very irregularly, the larger and slower variations corresponding with a rotation of the arc as a whole and the smaller and more rapid to the hissing proper—*i.e.*, the oxygen of the air obtaining access to the crater surface as demonstrated by Mrs. Ayrton.

Under certain conditions the direct-current solid arc will emit a musical note when shunted by a self-induction in series with a condenser.

When emitting the musical note the direct-current arc transforms direct-current energy into alternate-current energy, the frequency of the latter being determined by the self-induction, capacity, and effective resistance of the oscillating circuit. The pitch of the note emitted may be used as a means of comparing self-inductions and capacities.

If a direct-current arc be shunted with a condenser of several microfarads capacity, the arc will generally be extinguished if the electrodes are of metal, and not if they are of cored carbon, the resistance in series with the arc being non-inductive.

If the resistance in series with the arc be highly inductive, then, when the metal arc is extinguished by shunting it with a condenser, a violent rise in P.D. occurs between the terminals of the arc.

The rise in P.D. that occurs when an inductive circuit is broken by means of a switch, the contacts of which are shunted by a condenser, is much higher if their contacts are of metal than if they are of cored carbons, owing to the condenser extinguishing the metal arc formed at the contacts more suddenly than the arc formed when carbon contacts are separated.

## APPENDIX I.

### On the Resistance of the Cores of Cored Carbons.

I do not remember having seen it pointed out that the much greater stability of arcs between cored carbons than of those between solid carbons cannot be very well due to the high conductivity of the material of the core while in place in the carbon, for the cores have generally a higher

* *The Electrician*, 1900, Vol. XLV., p. 281.

* *Phil. Mag.*, 1900, Vol. L., p. 146.

specific resistance than the solid carbon which surrounds them, as the following experiment shows:—

Three carbons were taken—two cored and one solid—of the same nominal diameter (11mm.), and a current of 9·9 amperes was passed through them. The drop of volts was measured along a length of 20cm. of each after they had attained a steady temperature.

Each of the three carbons then had a hole 3·16mm. diameter drilled through it so as to completely remove the cores of the cored carbons and the centre of the solid carbon, and the drop of volts was re-measured as before. The results are given in the table below, from which it appears that drilling a hole in the solid carbon increased its resistance 7·8 per cent., whereas drilling the same sized hole (which removed the core and a small amount of the solid carbon) in a cored carbon of the same make only increased its resistance by 2·1 per cent.

Allowing for the fact that a small quantity of solid carbon was removed along with the core in drilling, *the specific resistance of the core, of one make of cored carbon, was about 16 times that of the surrounding solid carbon, and in the other the specific resistance of the core was practically infinite.*

| Make of carbons. | Apostle *solid.* mm. | Apostle *cored.* mm. | Brush *cored.* mm. |
|---|---|---|---|
| Mean diameter | 10·97 | 10·95 | 10·70 |
| Mean diameter of core | ... | 2·84 | 2·82 |
| Drop of volts along along 20cm. *before* drilling ... | 1·71 | 1·74 | 1·52 |
| Drop of volts along 20cm. *after* drilling | 1·84 | 1·77 | 1·56 |
| Per cent. increase of resistance due to drilling ... | 7·8 | 2·1 | 2·4 |
| Ratio $\frac{\text{Specific resistance of core}}{\text{Specific resistance of surrounding solid carbon}}$ | about | $\infty$ | 16 |

## APPENDIX II.

### On the Conditions which Govern the Conversion of Direct Current into Alternating Current in the Musical Arc.

(See Fig. 9.)

Let E and C be the E.M.F. and current through the cells, when there is no oscillatory current through the condenser circuit.

Let V and A be the P.D. and current through the arc under the same conditions.

Let R be the resistance in series with the arc, including that of the cells.

Let $r$ be the resistance of the condenser circuit.

Let $\delta V$ be a small change in the P.D. arc which produces a current $\delta i$ through the condenser circuit for a time $\delta t$, and let $\delta V$ and consequently $\delta i$ be assumed to change sign at the end of each interval of time $\delta t$.

Let $\delta A$ and $\delta C$ be the corresponding changes in A and C; E being assumed constant.

The energy supplied to the condenser circuit—

during one interval $\delta t = (V + \delta V)(+\delta i)\delta t$,

„ next „ $\delta t = (V - \delta V)(-\delta i)\delta t$.

Total during one complete period $2\delta t = 2\delta i \delta V \delta t$.

Energy dissipated in ohmic losses during $2\delta t = r(\delta i)^2 2\delta t$.

In order that, during each complex period $2\delta t$, energy may be supplied to the condenser circuit, we must have

$$\delta i \delta V \text{ positive.}$$

And in order that this supply shall make up for the ohmic losses, we must have

$$\delta i \delta V > r(\delta i)^2.$$

Now $$\delta i - \delta C = \delta A$$

and $$C = \frac{E - V}{R};$$

∴ $$\delta C = \frac{-\delta V}{R},$$

and $$\delta i = \frac{\delta V}{R} - \delta A = -\left(\frac{1}{R} + - \frac{\delta A}{\delta V}\right)\delta V,$$

$$\delta i \delta V = -\left(\frac{1}{R} + \frac{\delta A}{\delta V}\right)(\delta V)^2.$$

∴ for a supply of energy to condenser circuit $\delta V / \delta A$ must be negative and numerically less than R.

Supposing $\delta V / \delta A$ negative, then in practice the second condition is always fulfilled, or $\delta V / \delta A + R$ would be negative and the whole circuit unstable.

Next the condition that sufficient energy be supplied to make up for the ohmic losses gives

$$\delta i \, \delta V \geq r(\delta i)^2$$

and as $\delta i \delta V$ is positive,

$$r \frac{\delta i}{\delta V} < 1$$

$$-r\left(\frac{1}{R} + \frac{\delta A}{\delta V}\right) < 1$$

∴ to obtain best supply of energy to condenser circuit we require R very large and $r$ very small.

Suppose $1/R$ may be neglected, compared with $\delta A / \delta V$ then condition becomes $$-\delta V / \delta A > r,$$

Thus it is possible if $\delta V / \delta A$ is negative and numerically greater than $r$, for the condenser circuit to receive sufficient energy during each very small complete oscillation to compensate for the energy dissipated in ohmic losses during the oscillation. For larger oscillations, similar but more complicated expressions will probably be required.

# ELECTRIC TRACTION ON THE NEW YORK ELEVATED RAILWAYS.*

The official trial of the new electric traction system of the Manhattan Railway Co., more familiarly known as the elevated railroad, in New York, was made on Thursday, November 22, 1900, on the Second Avenue division, between the Sixty-fifth and Ninety-second-street stations. A considerable number of invited guests were present to inspect the operation of the train, which made numerous trips between the points mentioned. The trial train, which is a specimen of the trains that will be put in regular service, greatly resembles the trains now drawn by steam locomotives, except that the cars are noticeably wider and seem roomier in their interior arrangements. The same length of car and style of platform and coupling are used, and the electrical connections, as described below, are such that trains of any number of cars, from one up, may be operated—always with a single controller. The motor cars are placed at each end of the train, though doubtless three-car trains may be operated with a single motor car. The motor car in all respects resembles the ordinary passenger cars, except that about 5ft. of one end of it is boarded off with a glazed partition, converting this into a cab, wherein is located the controlling machinery, and the air-brake pump. At the front, or cab end, the platform is omitted, this end of the car having its corners cut off and being fully glazed in front, giving the motorman an excellent view of the track and signals ahead, while, at the same time, fully protecting him from the weather. The frame of the motor car is strengthened by steel I-beams from end to end, and upon its trucks are mounted four motors, one on each axle; these machines are of the single-reduction-gear type, with gearing running in oil, and develop, under normal maximum consumption of current, 150 H.P. each, thus giving the motor car 600 H.P., or 1,200 H.P. for the two cars which are provided for each train. Like all the rest of the electrical apparatus used on these trains, the motors were supplied by the General Electric Co., of Schenectady, N.Y. The third rail is a special-rolled, high T-rail, made of a steel of composition especially selected for its electrical conductivity. These rails are made in 60ft. lengths, and are provided with two holes in the web, and two holes also in the foot, near each end, for the attachment of flexible copper bonds, each of which is about 500,000 circular mils in section. As there is little or no mechanical strain on the third rail, one bolt in each rail end serves sufficiently to connect the two together. These rails are mounted upon large cubical-shaped insulators, made of a material called "reconstructed granite," which is said to possess great mechanical strength and to resist the action of freezing, grease, acid, vapours, &c. The third rail is further protected from mechanical injury and put out of the way of the stray passer-by by being enclosed between boards 2in. thick, which come up on each side to some distance above its head, thus making it not easily possible for workmen or others walking on the tracks to touch the rail except by intention. Upon this rail runs a shoe of cast-iron, supported by two toggle links attached to the framework of the truck of the motor-car. Each truck of each motor car carries one of these shoes on each side, so that whichever direction the train may run in, at least four shoes normally bear upon the third rail, while gaps in the latter as long as the extreme distance between the end trucks of the train may be crossed without loss of current.

The method of control adopted is exceedingly simple, and, apparently, highly efficacious. The four motors on each car are normally connected together in multiple, and under each motor car is a resistance, solidly constructed of sheet metal embedded in asbestos. The controller operates first by throwing the groups of motors on the two cars in series with one another and with the resistance, then cuts out the resistance progressively, finally shifting over so that the two sets of motors are in parallel with one another, and also in series with the resistance. The last steps for high speed cut out the resistance altogether and leave all the motors connected in parallel. It will be readily seen that this system of connection requires only one conductor connecting the two motor cars. Hence the wiring of the intermediate passenger cars consists simply of a straight conductor through them and flexible conductors between cars. Another cable is also led along the train for furnishing current to the electric lights in the cars and the electric heaters of the Gold pattern, which are placed under the seats. The lighting of the cars is accomplished by 20 lamps in each car, 10 on a side, these being in the slant portion of the roof between the window frames and the monitor—in other words, just over the heads of seated passengers. By this simple arrangement, even when passengers are standing in the aisles, they will not cast their shadows upon one another, so that those fortunate enough to have seats are not compelled, as at present, to sit in gloom unable to read their newspapers. In the motorman's cab at each end of the train is a multipolar enclosed motor direct-coupled to a two-cylinder air-pump for supplying air to the Westinghouse air-brake system used on the train. In

* Abstract from the *Electrical Review* of New York.

F

the cab also are located magnetic circuit-breakers in the main circuit, the limit switch controlled by air pressure for starting and stopping the air-pump motor, magnetic blow-out fuses, and switches for controlling the lighting and heating of the train.

On the trial run the movement of the train was surprisingly easy although its acceleration was very rapid. The normal current consumption with a six-car train, somewhat lightly loaded with passengers, when running at a rate of 35 miles an hour, approached about 500 amperes at 550 volts. There was very little sparking under the contact shoes, although the third rail having been laid some time and not being in regular use was very rusty. For this official trial current was furnished from the power-house of the Third Avenue Railway Co. at Sixty-seventh-street and Third Avenue, the new station of the Manhattan Railway not yet being being ready to supply electrical energy. It is believed that the whole system can be in operation by the autumn of 1901, the only delay that may be serious being the completion of the power-station. All the apparatus for this station has already been ordered, and much of it is nearing completion, while the station building itself, with its four high brick chimneys, is also well under way. The greatest credit is due to Mr. W. E. Baker, electrical superintendent of the railway, for the skilful work he has done in designing so simple, and what promises to be so satisfactory, a solution of the many difficulties presented in the problem offered him in the electrical equipment of these most important lines.

## BOOKS RECEIVED.

*Copies of any of the undermentioned works can be had from The Electrician Office post free, on receipt of published price.*

"Hazell's Annual. 1901." 16th year. (London: Hazell, Watson and Viney). 3s. 6d.

"The Principles of Magnetism and Electricity," by P. L. Gray. (London: Methuen & Co.) 3s. 6d.

"Calvert's Mechanics' Almanac" for 1901, by W. Calvert. (London: John Heywood.) 4d.

"L'Electricité à L'Exposition de 1900," by E. Hospitalier and J. A. Montpellier. No. 4. Téléphonie et Télégraphie. (Paris: Vve. Ch. Dunod.)

"Kalender für Elektrotechnicker" for 1901, by F. Uppenborn. (Leipzig: R. Oldenbourg.) 5m.

"Rapports Présentés au Congrès International de Physique," at Paris, 1900. 3 vols. Edited by C. E. Guillaume and L. Poincaré. (Paris: Gauthier-Villars.) 50fr.

"Practical Lessons in Metal Turning," by Percival Marshall. (London: Dawbarn and Ward.) 2s.

"The Practical Electrician's Pocket Book for 1901." Edited by H. T. Crewe. (London: S. Rentell & Co.) 1s.

## ELECTRICITY WORKS ACCOUNTS.

### The Reading Electric Supply Co.

The accounts of this concern for 1899 show a splendid improvement in the position of the undertaking. It will be remembered that last year we had occasion to comment on the satisfactory contrast between the 1897 and the 1898 working, the result of the latter year's operations being a considerable reduction in the deficit—the legacy of preceding years. Last year the advance was well maintained, for, after extinguishing the adverse balance of £715 brought forward, there remained available for distribution £1,651, out of which the first dividend—one of 3 per cent.—has been distributed. A study of the costs column in our table shows that these results have been arrived at almost entirely through economy of working, the total revenue having but slightly increased by a sum of £719 received in compensation for delay in delivery of plant. With the exception of the item of salaries under "management" expenses, all the items of expenditure have been reduced, and, without any exception, they stand at values remarkably low, considering the moderate output and the extremely low load-factor which prevailed.

The business has increased rapidly, the advance in the lamp connections being nearly 59 per cent., while that of the output was 44·5 per cent. It is satisfactory to find that the load factor is improving, even if slowly. This factor averaged 6 per cent. in 1898; last year it was 6·4 per cent.

Making allowance for the unusual sum referred to above as included in the total revenue, the receipts per unit are below the average in company stations of similar output and load factor last year.

The following table will serve to indicate the improvement which has lately been effected in the status of this undertaking:—

| Year | No. of consumers. | Equiv. No. of lamps connected | Output. Units sold. | Plant capacity. (Kw.) | M'x. supply demanded. (Kw.) | Total rev. per unit sold. | Total cost per unit sold. |
|---|---|---|---|---|---|---|---|
| 1894 | 38 | 2,150 | ... | ... | ... | ... | ... |
| 1895 | 83 | 4,300 | 42,596 | 375 | 126 | ... | ... |
| 1896 | 154 | 8,708 | 82,165 | 375 | 176 | 6·24d. | 5·22d. |
| 1897 | 201 | 12,299 | 123,702 | 375 | 208 | 6·20d. | 5·41d. |
| 1898 | 244 | 16,190 | 160,316 | 375 | 304 | 6·17d. | 3·94d. |
| 1899 | 345 | 25,710 | 231,700 | 775 | 412 | 6·49d. | 2·74d. |

### The Harrow Electric Light and Power Co.

The business of this undertaking increases at a very satisfactory rate. During last year the lamp connections advanced from the equivalent of 8,150 to 11,135 8 c.p. lamps, or by nearly 37 per cent. The year's output was higher by 43 per cent. than that of 1898, while the load factor was 11 per cent. as compared with 9·9 per cent. in 1898. With such a favourable load factor we are sorry to find the costs no less than they are. Even considering the low output on which the results have to be secured, the total costs are quite a penny per unit over their reasonable value.

The items which appear to need the engineer's attention are the management charges, and, among the generating costs, wages and repairs and maintenance. If these costs could only be reduced to normal figures the undertaking would greatly benefit.

At present the financial results, fairly satisfactory as they are in themselves, are bought at rather too high an average revenue—a condition which, if allowed to continue will seriously hamper the development of the concern.

Besides the ordinary dividend of 3½ per cent., absorbing £745. 5s. 5d., there was paid a preference share dividend of 4½ per cent., which absorbed £92. 14s. 5d.

The increased demand has necessitated the installation of a new generating set of 150kw. capacity. A new boiler was also installed during last year.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 18, 1900 | Kingston-on-Thames (Mun.) | July 10, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Jan. 19, 1900 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Sept. 8, 1899 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | June 22, 1900 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.) (Municipal) | Dec. 15, 1899 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Nov. 17, 1899 |
| Brompton & Kensington (Co.) | Mar. 23, 1900 | Notting Hill (Company) | Mar. 16, 1900 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Dec. 1, 1899 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 13, 1900 |
| Cambridge (Company) | April 13, 1900 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Dec. 15, 1899 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 9, 1900 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 23, 1900 | Reading (Company) | Oct. 13, 1899 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Dec. 8, 1899 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Feb. 16, 1900 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Dec. 29, 1899 |
| Dewsbury (Municipal) | Nov. 24, 1899 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Southampton (Municipal) | Nov. 10, 1899 |
| Dundee (Municipal) | Nov. 2, 1900 | Southport (Municipal) | July 7, 1899 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Stafford (Municipal) | Aug. 17, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Sunderland (Municipal) | Nov. 9, 1900 |
| Folkestone (Company) | April 27, 1900 | Taunton (Municipal) | June 16, 1899 |
| Glasgow (Municipal) | Sept. 14, 1900 | Tunbridge Wells (Mun.) | Sept. 1, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Walsall (Municipal) | June 22, 1900 |
| Hammersmith (Vestry) | June 29, 1900 | Wandsworth (Company) | May 18, 1900 |
| Hampstead (Vestry) | Oct. 19, 1900 | Westminster (Company) | Mar. 9, 1900 |
| Hanley (Municipal) | July 27, 1900 | Whitehaven (Municipal) | July 28, 1899 |
| Harrogate (Municipal) | Oct. 20, 1899 | Winchester (Company) | Oct. 26, 1900 |
| Harrow (Company) | June 16, 1899 | Windsor (Company) | Dec. 21, 1900 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Woking (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woolwich (Company) | Jan. 12, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kensi'gton & Knightsbr (Co.) | Mar. 16, 1900 | Yarmouth (Municipal) | Nov. 3, 1899 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | | |

| | READING. | | | | HARROW. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Reading Electric Supply Co. | | | | The Harrow Electric Light & Power Co. (Ltd.) | | | |
| *Date of Commencement of Supply* | 1889. | | | | September 25, 1896. | | | |
| *System of Supply* | Alternate current transformer sub stations. | | | | Three wire continuous current. | | | |
| *Chief Engineer* | Arthur T. Cooper. | | | | Arthur H. Shaw. | | | |
| **YEAR ENDED** | DEC. 31, **1898.** | | DEC. 31, **1899.** | | DEC. 31, **1898.** | | DEC. 31, **1899.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 174,816 | | — | | 89,315 | | 134,670 | |
| ,, SOLD (TOTAL) | 160,316 | | 231,700 | | 79,419 | | 113,551 | |
| ,, sold to consumers | 160,316 | | 231,700 | | 79,419 | | 113,551 | |
| ,, sold for public lighting, &c. | — | | — | | nil | | — | |
| ,, used on works | 1,450[a] | | — | | 6,680 | | 7,673 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 13·7 | | 9·58 | | 12·4 | | 17·9 | |
| Maximum supply demanded | 304 kilowatts | | 412 kilowatts | | 92 kilowatts | | 117 kilowatts | |
| Number of public lamps | — | | — | | nil | | nil | |
| Number of consumers | 244 | | 345 | | 145 | | 237 | |
| Connections to mains in 8-c.p. lamps | 16,190 | | 25,710 | | 8,150 | | 11,135 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 11,700 | | 24,200 | | 6,380 | | 6 350 | |
| CAPACITY OF PLANT IN KILOWATTS | 375 | | 775 | | 204 | | 203 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | — | — | — | — | — | — | £45.000 | £196 |
| Share | £75,000 | £200 | £75,000 | £96·8 | £25,000 | £123 | 35,000 | 152 |
| Loan (including Debenture charges) | — | — | — | — | — | — | 10,000 | 43·5 |
| RECEIVED (TOTAL) | 53,725 | 143 | 71,640 | 92·4 | 31 075 | 152 | 39,185 | 170 |
| Share | 37 144 | 99 | 71,640 | 92·4 | 19,950 | 97·8 | 27,860 | 121 |
| Loan (including Debenture charges) | 16,000 | 42·7 | — | — | 11,125 | 54·5 | 11 325 | 49·3 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | — | — | 5,815 | 25·3 |
| Share (unissued) | 37,876 | 101 | — | — | 5,050 | 24·8 | 7,140 | 31·0 |
| Share (uncalled) | — | — | 3,360 | 4·34 | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | — | — | — | — |
| REPAID (TOTAL) | — | — | — | — | — | — | — | — |
| RESERVE OR SINKING FUND | — | — | — | — | — | — | — | — |
| DEPRECIATION FUND | 1,455 | 3·88 | 2 000 | 2·58 | 85 | 0·416 | 535 | 2·33 |
| EXPENDED (TOTAL) | 54,188 | 144 | 75,635 | 97·6 | 35,917 | 176 | 43,018 | 187 |
| Lands and buildings | 13,015 | 34·7 | 13,867 | 17·9 | 7,713 | 37·8 | 7,788 | 33·8 |
| Plant | 22,400 | 59·7 | 32,056 | 41·4 | 10,052 | 49·2 | 11,897 | 51·8 |
| Mains | 14,827 | 39·5 | 25,753 | 33·2 | 14,175 | 69·5 | 17,328 | 75·4 |
| Miscellaneous | 3,947 | 10·5 | 3,959 | 5·11 | 3,977[a] | 19·5 | 6,010[f] | 26·1 |
| BALANCE OF CAPITAL ACCOUNT | - 463[b] | - 1·23 | 3 995[b] | 5·16 | - 4,842[b] | - 23·7 | - 3,833[b] | - 16·7 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £4 121 | 6·170d. | £6.262 | 6·486d. | £2,876 | 8·695d. | £3,773 | 7·975d. |
| Revenue from supply | 3,961 | 5·930d. | 5,221 | 5·408d. | 2,593 | 7·850d. | 3,332 | 0·704d. |
| ,, meters, &c. | 147 | 0·220d. | 202 | 0·209d. | 74 | 0·224d. | 99 | 0·209d. |
| ,, public lighting | — | — | — | — | — | — | — | — |
| ,, sale of lamps, &c. | 6 | 0·009d. | 74 | 0·077d. | 92 | 0·278d. | 82 | 0·173d. |
| ,, miscellaneous sources | 7 | 0·010d. | 765[d] | 0·792d. | 117 | 0·354d. | 259 | 0·548d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £2.629 | 3·936d. | £2 645 | 2·740d. | £1.597 | 4·830d. | £1.970 | 4·164d. |
| WORKS COSTS | 2 023 | 3·027d. | 1,840 | 1·906d. | 996 | 3·009d. | 1,250 | 2·641d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 826 | 1·236d. | 1,011 | 1·046d. | 170[c] | 1·023d.[c] | 518 | 1·095d. |
| Oil, waste, water, stores | 115 | 0·173d. | 77 | 0·080d. | 14[c] | 0·035d.[c] | 44 | 0·093d. |
| Wages at station | 815 | 1·220d. | 668 | 0·692d. | 206[c] | 1·246d.[c] | 418 | 0·883d. |
| Repairs and maintenance at station | 120 | 0·180d. | 77 | 0·080d. | 47[c] | 0·284d.[c] | 190 | 0·402d. |
| *Distribution of electricity* | [illegible] | [illegible] | 8 | 0·008d. | [illegible] | [illegible] | 80 | [illegible] |
| Wages, &c. | 73 | 0·117d. | 8 | 0·008d. | 34[c] | 0·206d.[c] | 80 | 0·169d. |
| Repairs, renewals of mains, &c. | 25 | 0·043d. | | | 27[c] | 0·163d.[c] | | |
| *Public lighting* | — | — | — | — | — | — | — | — |
| Attendance | — | — | — | — | — | — | — | — |
| Renewals | — | — | — | — | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 606 | 0·907d. | 803 | 0·832d. | 601 | 1·816d. | 719 | 1·520d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | [illegible] | [illegible] | 119 | [illegible] | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | 63 | 0·094d. | 284 | 0·294d. | 275 | 0·831d. | 353 | 0·746d. |
| Stationery, &c. | [illegible] | 0·041d. | 30 | 0·031d. | 57 | 0·172d. | 102 | 0·215d. |
| Establishment charges | 87 | 0·130d. | 48 | 0·050d. | 28 | 0·085d. | 31 | 0·066d. |
| Law charges, &c. | 108[e] | 0·162d. | 112[e] | 0·116d. | 122[e] | 0·369d. | 61[k] | 0·129d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap exp'nded | Total. | % to mean cap.exp'nded | Total. | % to mean cap.exp'nded | Total. | % to mean cap.exp'nded |
| WORKING PROFIT FOR YEAR | £1.493 | 3·09% | £3.617 | 5·58% | £1.279 | 3·98% | £1.803 | 4·57% |
| Sum carried to Depreciation Fund | 593 | 1·25% | 545 | 0·840% | 126[f] | 3·92% | 450 | 1·14% |
| Sum carried to Reserve or Sinking Fund | — | — | [illegible] | 0·123 | — | — | — | — |
| Net interest on loans (incl. Debenture charges) | 851 | 1·76% | 627 | 0·966% | 524 | 1·63% | 521 | 1·32% |
| BALANCE FROM LAST ACCOUNT | 765 | 1·58% | 715 | 1·10 | 1 | 0·003% | 14 | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | — | — | 1 651 | 2·54% | 463[g] | 1·44% | 847 | 2·15% |
| *Deficit* | 715 | 1·58% | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | | — | 3% | — | 2½% | — | 3% | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 63·8% | | 42·3% | | 55·5% | | 52·3% | |
| Expenditure per kilowatt capacity | £7. 0s. 2d. | | £3. 8s. 3d. | | £7. 16s. 7d. | | £9. 14s. 0d. | |
| REVENUE PER KILOWATT CAPACITY | £10. 19s. 10d. | | £8. 1s. 7d. | | £14. 2s. 0d. | | £18. 11s. 5d. | |
| Expenditure per 8-c.p. lamp capacity | 4s. 6d. | | 2s. 2½d. | | 5s. 0d. | | 6s. 2½d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 7s. 0½d. | | 5s. 2d. | | 9s. 0½d. | | 11s. 10½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 5s. 1d. | | 4s. 10½d. | | 7s. 0½d. | | 6s. 9½d. | |
| Price charged for lighting, per unit | 6d. to 5d. | | 6d. to 4d. | | 7d.[h] | | 7d. | |
| Price charged for power, per unit | 3d. | | 3d. to 1½d. | | 4d. | | 4d. | |
| Price charged for public lighting | — | | — | | — | | — | |

READING.—REMARKS.—*a* [illegible] *f* Written [illegible] preliminary expenses.

HARROW.—REMARKS.—*a* Includes £[illegible] on wiring houses and £[illegible] [illegible]. *b* Over expended. *c* Includes £[illegible] to generation of electricity and £[illegible] to maintenance of station, paid under contract to the contractors Messrs. Crompton & Co. as inclusive charges for half year to June 30, 1898. [illegible] Includes [illegible] to insurance, and [illegible]. *f* Includes £[illegible] to depreciation in respect of leasehold property and [illegible]. *g* After writing off £[illegible] preliminary expenses. *h* Taking effect from [illegible] Christmas and [illegible] Lady-day quarters and [illegible] a day during Midsummer and Michaelmas quarters. [illegible] Includes £[illegible] on wiring houses and £[illegible] improvements to property. *k* Includes insurance of station £[illegible] and auditing £[illegible].

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence ; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 16s. 0d. ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## THE EXTENSION OF SUPPLY NETWORKS.

A short Paper by Mr. C. TURNBULL, published in another column of this issue, touches on a question of considerable interest, affecting, as it does, the design of what is frequently the most costly item of an electricity supply works. The distributing network is not only answerable for a large proportion of the capital expenditure, but its extension and amplification necessitates the undoing and re-making of a large part of work which has been previously carried out and left as finished. An extension of the generating plant calls for relatively little alteration in the arrangements existing previously. Boilers, engines and dynamos have merely to be added, and sometimes also an extra panel to the switchboard; and if there is no room for these in the station as it stands, the removal of a "temporary end" and the extension of the building is no serious matter. Thus the cost of the original buildings and generating plant plus that of the additions, is relatively little greater than what it would have been had the works been built with greater capacity initially, and interest and sinking fund on the additional plant has been saved. With the distributing network, however, the case is otherwise. Suppose cables are laid of sufficient size for the demand in two or three years from the date of the erection of the station. When this time has elapsed, and the consumers' demand becomes greater, new mains must be added and old ones strengthened in sectional area. This does not merely mean, however, the addition of cables in new streets put on to the end of the network in the same way as the new plant and building is added to the old one. In the streets where mains are already laid, the demand will have been increased by a number of new consumers, the fall of pressure will have become too great, and the mains will have to be increased in size, or additional feeders or distributors added in the same position as the old ones. Moreover, as well as the cost of opening and re-making the streets a second time, there will be to some extent a double expenditure in insulation and sheathing, as two cables of like section, for instance, cost considerably more than a single cable of double the section. It is therefore difficult to hit off the happy mean in designing the cable network of a new electricity works. Companies have often been too apt to economise copper in the first instance, so that their networks have had to be almost remodelled within a very short period of their inauguration; and, on the other hand, consulting engineers to local authorities frequently err in too lavish an expenditure on mains at the outset. The difficulties in design in this connection, and the

occasional bad solutions of the problem, have been hidden to a large extent by the change-over from 100 volts to 200 volts "declared" pressure which has taken place in nearly all the British electricity supply works. We have heard from time to time of the difficulties of the change over, of the wonderful and successful makeshifts to avoid interruptions of supply, and of the trouble occasioned by the few refractory consumers who refused to receive their electrical energy at a higher pressure; but these difficulties are nothing to those which would have been met with in quadrupling the sectional area of the mains (to which a doubling of supply pressure is equivalent on the basis of percentage drop of pressure), and the expense incurred will have been but a small fraction. As an increase of permissible consumers' pressure to above 250 volts is improbable, the designer of networks must now make the most of the possibility of shifting the balancing points of his three-wire system, varying the positions of his main feeding points, branching or swallow-tailing his feeders, and drawing in additional ones, and other similar measures.

These matters were, however, not entered into by Mr. TURNBULL. Looking at the subject from a narrower point of view he indicates that the electricity supply engineer must devote his attention to increasing, by hook or by crook, the "density factor," or the number of eight candle-power lamps per £1 of mains. Leaving on one side the needlessness of manufacturing a new name for every ratio that may occur to the author of a Paper on an electrical subject, Mr. TURNBULL's dictum, "get the mains loaded up with every kind of consumer within reach—and the load factor will take care of itself," is condemned at once by the first two figures given in his Paper. Brighton, with 1·03 lamps per £1 worth of main sells 25·4 units per annum per £1 worth of main, while at Aberdeen, where the "density factor," as above defined, is 1·21, or 20 per cent. higher, the number of units sold per annum per £1 of main is 7·8, or less than one-third of the Brighton figure. This ratio—number of units sold per annum per £1 worth of main—Mr. TURNBULL suggests as an optional definition of the density factor, presumably thinking that the name is more important than the definition. To complete his investigation, he must define an encouragement factor, a live-over-your-shop factor, an early-closing factor, and, last but not least, a total-abstinence factor. It is not additional consumers that are needed per yard of main or additional lamps, but additional long-burning lamps—in fact, a better load factor.

Mr. TURNBULL's method of increasing the number of consumers needs little comment. He gives an account of the Tynemouth terms for what was originally called free wiring, and has since been called the easy-payment system, and the precautions which are taken to prevent its becoming a free-and-easy payment system. Finally, he describes a two-meter system, which may be considered as a modification of the Wright system, to get over the consumer density factor, or the density of the consumer in appreciating the true value and importance of the maximum demand indicator. He suggests that each consumer's lamps should be divided into two circuits, the long-hour and short-hour lamps to have a meter on each circuit, and that the charge should be at different rates on the two circuits, the engineer presumably to decide which lamps should be connected to the long-hour and which to the short hour meter. A simpler method still would be to have different tariffs for different classes of consumers, but, unfortunately, both these systems would be preferential charging, and therefore illegal. The Wright system is probably the nearest to preferential charging that the supply engineer can legally venture.

Reverting to the main question, Mr. TURNBULL has either mistaken the nature of the problem before the distributing engineer, or else he attempts to solve it in the wrong manner. What is required is not an increase or decrease in a factor of consumer-density, in whichever way this be defined, but a network so designed that, while the initial capital expenditure is kept as low as possible, the cost of extensions and amplifications shall not be unduly great.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

**Contents Subject-Index to General and Periodical Literature.** Compiled by A. COTGREAVE, F.R.Hist.S. (London: The Author, Public Library, West Ham, E.) 10s. 6d.

Mr. Cotgreave has devoted an immense amount of labour to the compilation of a contents index which occupies about 750 8vo. pages of closely printed matter. The library at West Ham contains 55,000 volumes and that of the Guille-Allès, Guernsey, of which Mr. Cotgreave is hon. librarian, 65,000 volumes. The author has been assisted in his labours by a number of librarians. The book may be regarded as an attempt of a busy librarian to give some idea of how valuable such an index might be made if undertaken by a large body of experts and issued periodically. Mr. Cotgreave has had the satisfaction of securing a subscription for more than 1,000 copies of his book, and the favour with which the volume has been received must be the measure of the credit due to him for the good work he has put into it. The number of works which have been referred to for notes and references in the preparation of the Index exceeds 100,000 volumes, and the author's fitness for dealing with so complex a subject is shown in the success attained by his "Guilles-Allès Encyclopædic Catalogue," "Subject and Chronological Index of Fiction," and other works. In addition to the references which are given, a useful feature is the biographical and other notes, which will prove of infinite service to those who are not informed on the subjects to which the notes refer. To electricity only a small space is devoted under the headings of "Electric Light," "Electric Railways," "Electric Telegraph," "Electrical Engineering," "Electricity," "Electro Magnet," "Electro Metallurgy," and "Electrolysis," and there is evidence that the libraries of which Mr. Cotgreave has the call, as well as those of the many leading librarians who have come to his assistance in the compilation of the work, are deficient in the principal standard works dealing with electrical science and engineering. The indexed articles and books on these subjects are in only a few cases recognised text books or standard works of reference, but are chiefly popularly-written magazine contributions. This, however, points only to the impossibility of anything like a comprehensive subject-index being compiled by one man, however enthusiastic and competent. In any new edition of the "Contents Index" we hope to find a great extension of the "List of Books on Various Subjects," which forms an appendix. The arrangement of the "Contents Index," the clearness of printing, and the general get-up is most creditable to all concerned.

**Leçons sur l'Electricité.** By ERIC GERARD. (Paris: Gauthier-Villars et Fils. 1900.) 6th edition. Two vols., 12f. each.

M. Gérard's fine work will remain one of the best text books on electricity, and will doubtless continue to be used, not only at the Institut Montefiore of Liège, of which M. Gérard is director, but in numerous other French-speaking schools and colleges. Successive editions of the book have enabled the author to keep pace with the rapid developments of the science and practice of electricity, and in this he is the more to be congratulated, as his "lessons" give not only a thorough theoretical groundwork for the student, but also afford him the means of acquiring more than a superficial knowledge of the technical applications of electricity and of the problems actually presented to the electrical engineer. This is particularly noticeable in the portion of Vol. I. dealing with dynamo design.

## THE PRICE FRICTION CAR BRAKE.

The ordinary hand ratchet brake for tramcars has three principal defects: (1) It takes a comparatively long time to apply, (2) its force of application is limited by the strength

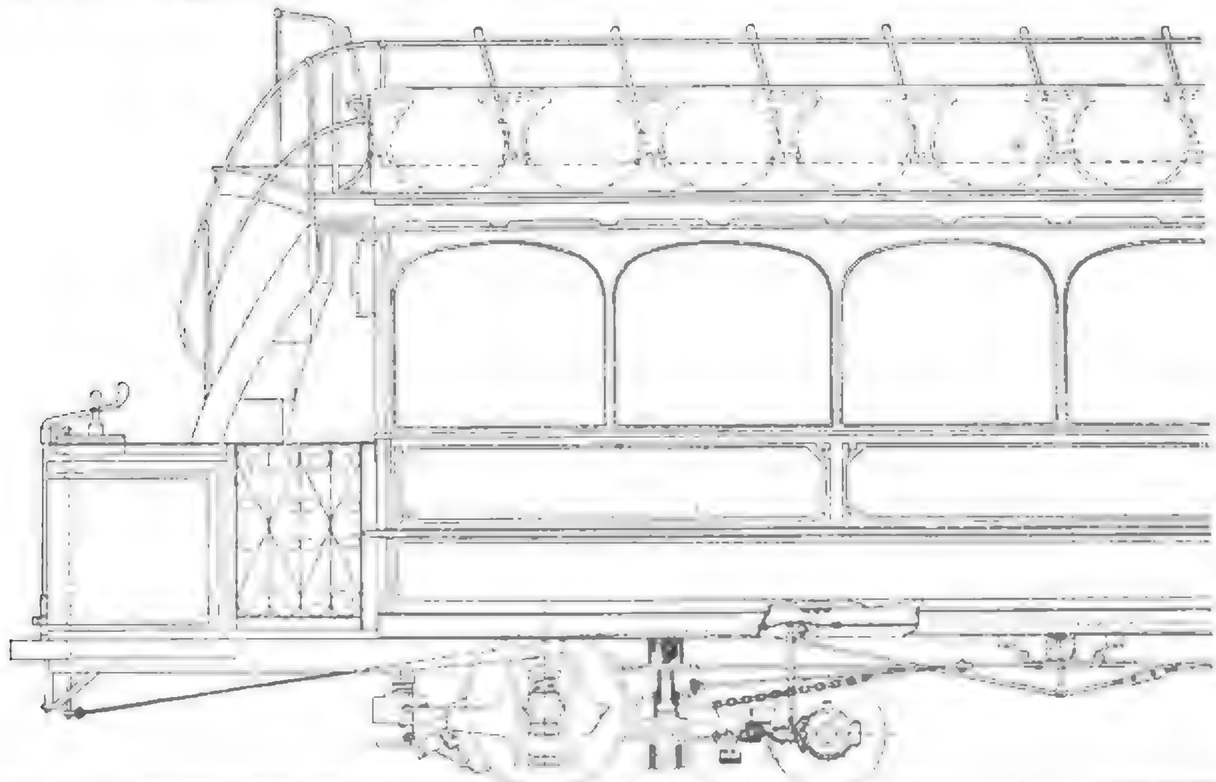


Fig. 1.—Car Fitted with the Price Friction Brake.

of the driver, (3) to prevent a constant strain upon the driver when the brake shoes are applied to the wheels, a ratchet and pawl are introduced, which prevents the driver from gauging

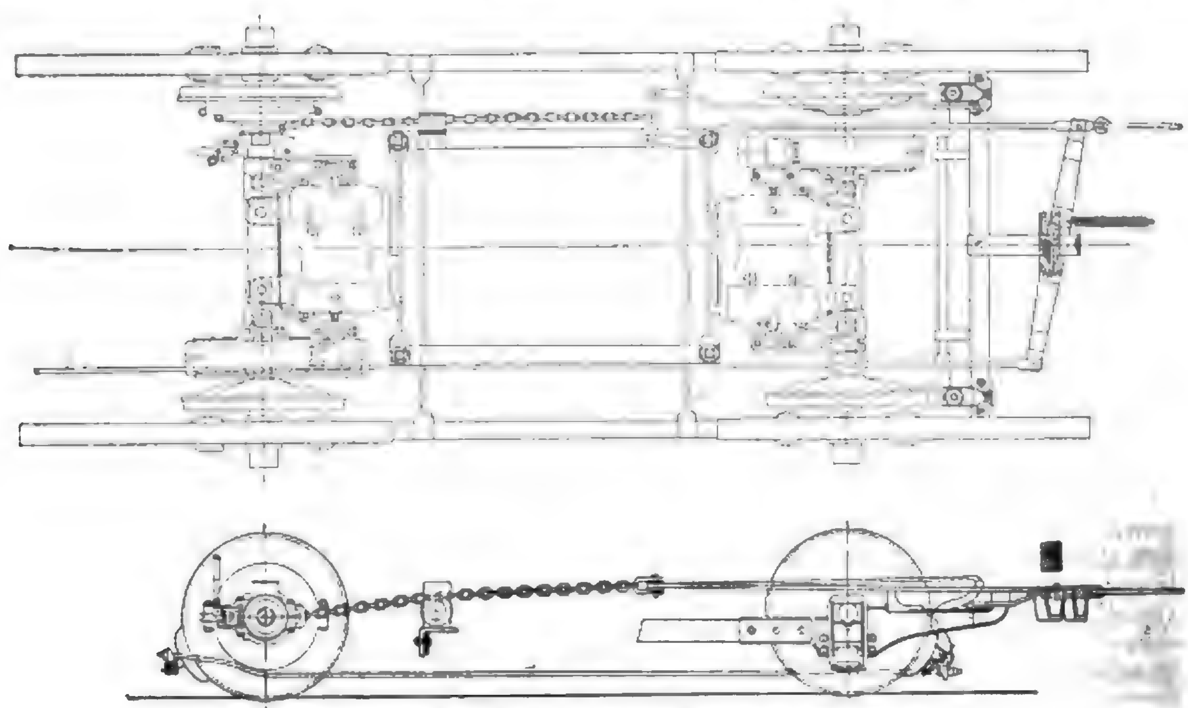


Fig. 2.—Plan and Elevation of Brake and Brake Gear on Car.

the amount of braking action. The Price momentum friction brake was invented to overcome these disadvantages. It does this successfully without the aid of electricity, compressed air, or any force other than that due to the energy of the moving car. In the ordinary hand brake, the levers which actuate the brake shoes are moved by a chain which is wound up on the brake spindle. In the Price brake the chain is wound upon a sleeve which fits over the axle of the car wheels. This sleeve is thrown in and out of gear with the axle by means of a friction clutch operated by the driver. This general arrangement is shown in Figs. 1 and 2. The several disadvantages of the ordinary hand brake, as mentioned above, are met as follows: (1) The Price brake is applied by the moving wheels, and the quicker the wheels are moving the quicker can it be applied, (2) the possible force of appli-

cation is practically *unlimited*, (3) the driver can feel exactly how much slip is taking place in the friction clutch and consequently can gauge to a nicety the braking action he wishes to apply. The maximum braking action of a brake, as is well known, is when the wheels just do *not skid on* the rails. The driver can obtain this maximum braking action with greater

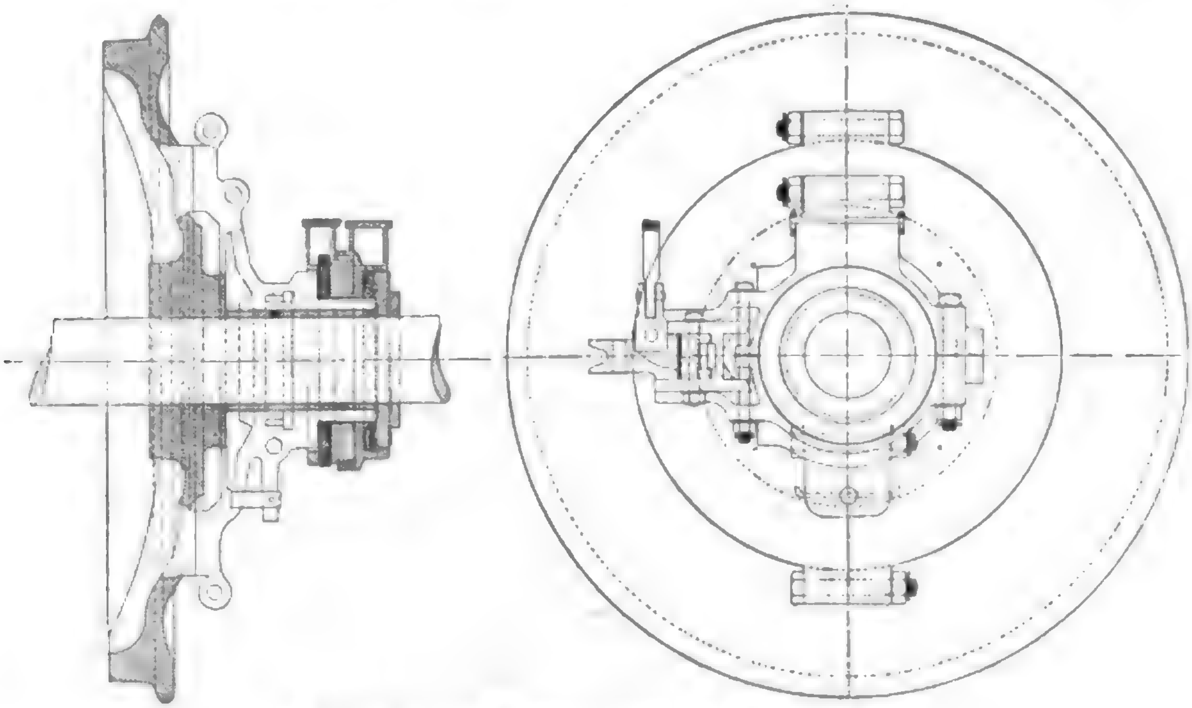


Fig. 3.—End View and Section of Clutch on the Price Car Brake.

ease, quicker action, and more certainty than with any other brake.

The brake consists essentially of three parts: (1) An arrangement of levers for operating the friction clutch, (2) the friction clutch and barrel for winding the chain upon, (3) the ordinary levers for applying the brake shoes such as

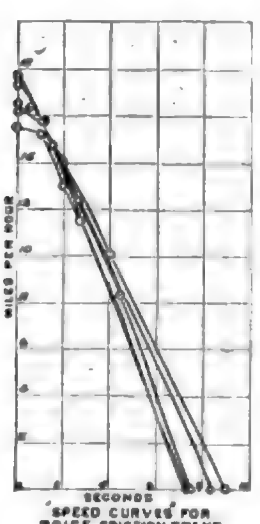


Fig. 4.

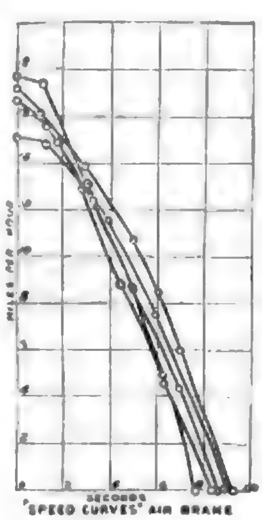


Fig. 5.

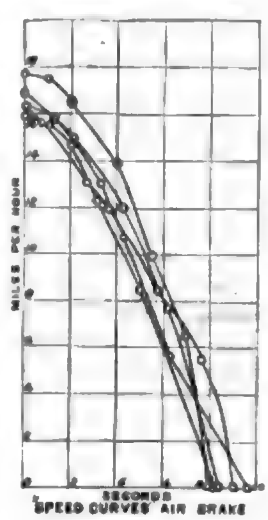


Fig. 6.

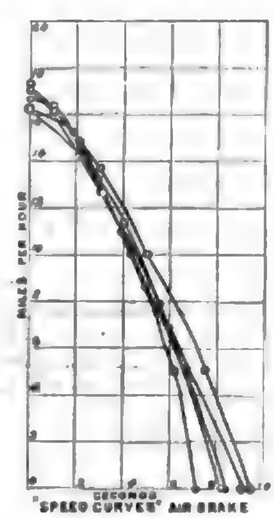


Fig 7.

are fitted to the ordinary hand brake. The brake is operated by means of a short handle which is attached to a staff placed close to the centre of the dashboard. This handle is detachable, and the driver uses the one handle for either end of the car in the same way as a controller handle. To the lower end of the staff under the platform is attached a lever arm which is connected to a wire rope with a spring in it. The rope leads from each platform in as nearly a direct line as possible to a cross-arm lever which is supported by the car body frame and attached to the top of a telescopic rod. The rotation of the telescopic rod moves one of the discs of the friction clutch against the other. Figs. 1 and 2 show the connections for this. The friction clutch (Fig. 3) consists of two cast-iron discs. One of these discs is cast with a barrel or sleeve, which is free to move upon the axle of the car wheels. This barrel is free to move in two ways—first, in the direction of rotation of the axle; second, parallel with the axle. It is moved in the second direction by the operation of the telescopic rod, and when it is thus pressed against the second disc, which is cast on the car wheel, it moves in the first direction. To lock the friction clutch, and make the barrel move with the wheels, the driver only has to move the handle through a distance of about 2in. Then the brake shoes are pressed tighter and tighter against the wheels until the

wheels are nearly skidding, when the driver releases his handle a very little bit and allows slip to take place in the friction clutch.

Some severe tests have been carried out in New York on a series of different makes, and the results obtained are most interesting. These tests were made on the power brakes in use on the Brooklyn Heights Electric Tramways. The brakes tested were one air brake, with axle-driven compressor, and two air brakes with motor-driven compressors, so as to compare the air brake with the Price friction brake. Representatives of the several companies whose apparatus was being tested were present during the tests. Cars were taken from service to one of the depôt shops where the brake rigging was properly adjusted for service conditions, and the necessary instruments installed on the cars, which were then loaded with 10,000lb. of iron spikes. The cars tested were mounted on

*Comparative Tests of Air Brakes and Price Momentum Brake.*

| Type of brake. | Speed of car in miles per hr. when brakes put on. | Distance taken to stop in feet. | Time taken to stop in seconds. | Distance in feet when wheels skidded. | Efficiency of brake if expressed by weight × speed / distance |
|---|---|---|---|---|---|
| Air brake axle-driven compressor | 16·67 | 129·4 | 8·65 | 6·35 | 77·6 |
| Air brake motor-driven compressor | 16·65 | 125·5 | 8·62 | 0·00 | 79·4 |
| Air brake motor-driven compressor | 16·69 | 138·6 | 8·66 | 3·62 | 74·6 |
| Price momentum brake | 16·68 | 109·0 | 7·92 | 39·3 | 92·4 |

N.B.—The above results were obtained by taking the average of five distinct tests in each case.

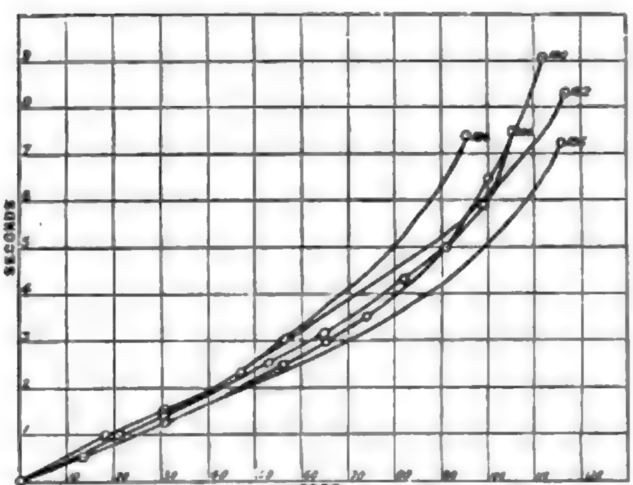


FIG. 8.

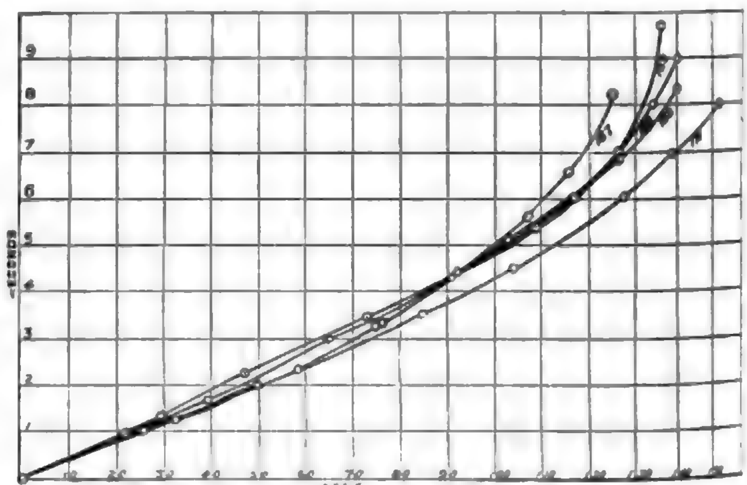


FIG. 9.

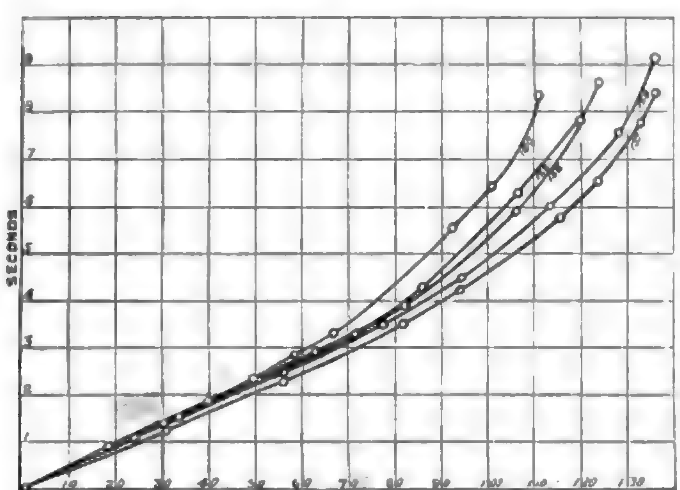


FIG. 10.

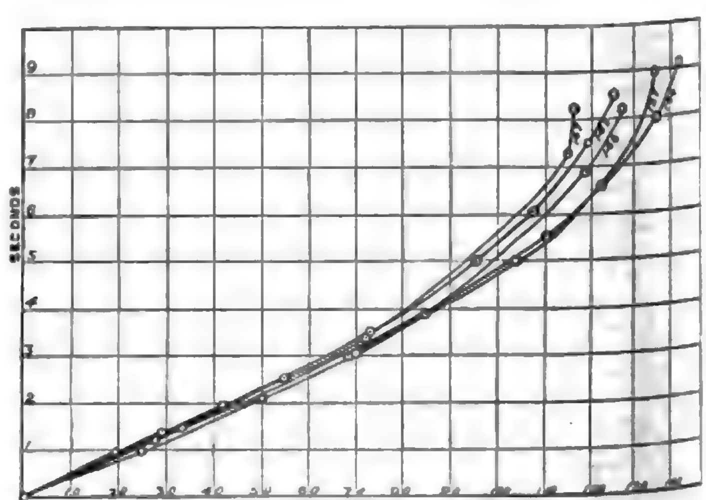


FIG. 11.

maximum traction trucks. The speed of the cars at any instant was computed from the record of a chronograph revolution recorder (which furnished an exact count of the wheel revolutions), from the time occupied by each revolution and from a record of the signal to put on brakes and the stop of the car. The wheel circumference used was obtained by rolling the car slowly through 10 revolutions and taking tape measurements of the distance travelled. When the wheels did not skid the length of a run computed from the number of revolutions, when checked with the tape measurements, agreed within $\frac{1}{10}$th of 1 per cent. The car was, in each case, made to accelerate very slowly so as to avoid skidding during acceleration. At speeds less than 18 miles per hour the several cars were tested on the same track on a down grade of 0·11 per cent. The results of the several tests, as supplied to us by Messrs. Robert W. Blackwell & Co., are shown in the above table.

Fig. 4 shows the speed curves for the Price momentum friction brake, and Figs. 5 to 7 show the corresponding curves plotted from the results obtained with the air brakes. Fig. 8 shows the distances and times taken to come to a standstill with the Price brake, Figs. 9 to 11 being similar results with air brakes.

## PHYSICAL SOCIETY.

At an ordinary meeting, held in the Physical Laboratory of the Royal College of Science (by invitation of Prof. A. W. Rucker), on December 14, 1900, the President, Dr. Oliver Lodge, being in the chair, a Paper

### "On Electric Inertia and the Inertia of Electric Convection"

was read by Prof. A. SCHUSTER.

Calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes where electricity is conveyed by a number of irregularly distributed ions. In the immediate neighbourhood of such an ion the magnetic field is many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is under-estimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of positive and negative electrons moving with different velocities. It is the object of the Paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may affect experimental results. The mathematical investigation shows that it is necessary to add a correcting term containing a quantity which may conveniently be called electric inertia. The author has calculated the numerical value of this quantity in the case of a solid conductor and finds it to be about $2 \times 10^{-12}$ C.G.S. units. It is of the dimensions of a surface. The experiments of Hertz have proved that if electric inertia exists it must be less than $18 \times 10^{-5}$. In the case of liquids and gases the electric inertia of the moving ions becomes much more important, and the calculation of self-induction by the ordinary processes gives erroneous results. The introduction of a term representing inertia alters the general equations of electric motion, and the author has applied his modified theory to Leyden jar discharges, the electrodeless discharges of J. J. Thomson and the electromagnetic theory of light. In the case of electrodeless discharges in a vacuous tube or globe it is suggested that the absorption of energy may not only be due to the conductivity of the gas but also to the inertia which it possesses.

A Paper

### "On Magnetic Procession"

was then read by the same author.

The most delicate method of investigating the influence of electric inertia is based on the electromotive forces introduced by the motion of conductors carrying electric currents. If electricity behaves like a body possessing inertia, the rotation of a body through which currents pass should affect the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air. If the earth's magnetism is due to electric currents, it is interesting to see if the effects of inertia can explain the secular variation. The investigation shows that a magnetic precession of the character of the secular variation would be produced, but that the precession would be very much slower than the variations actually observed. The subject is worked out mathematically, dealing first with the case of currents in a spherical shell, and then extending the result to the case of a solid sphere. The calculated period of a cycle comes out as $7 \times 10^{11}$ years. If the currents are confined to a thin slice of the earth, the time would be reduced to about $14 \times 10^{6}$ years. To produce the actual period of the secular change the current sheet would have to be of molecular dimensions. This suggests the possibility of the phenomenon of secular variation being rather of a molecular than of a molar character.

Prof. RUCKER congratulated the author upon his attempt to solve the problem of terrestrial magnetism, and expressed the hope that further calculation would throw more light upon this difficult subject.

Mr. BLAKESLEY asked if the time of the secular variation would be altered if the interior of the earth were liquid or solid.

The CHAIRMAN observed that the precession was rapid in the case of a thin layer of gas, and mentioned J. J. Thomson's notion that the electrons were thrown off by centrifugal force and formed a molecular layer. Hertz in his experiments on electricity had looked for material inertia besides electromagnetic inertia. In the present theory the distinction disappears and there is only one inertia, and that electromagnetic.

Prof. AYRTON said if the two forms of inertia were electromagnetic he would like to know why in detecting the second form it was necessary to associate it with an absorption of energy as in the case of an electrodeless discharge. In the case of ordinary self-induction there is no absorption of energy, and if there is absorption in the second form, and if they are both electromagnetic, he would like to know the difference between the two.

Prof. SCHUSTER replying to Mr. Blakesley, said that if the interior of the earth were treated as liquid, the period of the cycle would be about 100 times less. In reply to Prof. Ayrton, he said he had only cited one experiment to show that a phenomenon explained by the gas being a good conductor could also be explained by its electric inertia. It was impossible to say in general whether self-induction caused an absorption of energy or not.

Prof. A. W. RÜCKER read a Paper

### "On the Magnetic Field produced by Electric Tramways."

Taking the case of a tramway in which the current flows along a trolley wire from the power-house and returns partly through the rails and partly as earth currents, the author has shown that the vertical disturbing force at any point is due to the currents in the feeders and rails, and that the earth currents affect the horizontal force only. Experiment shows that it is chiefly the vertical force instruments which are affected by the establishment of an electric railway, and since this disturbance is due to the wires and rails, it is impossible for an observatory to be protected by rivers or other natural features of the district. A preliminary investigation is based on the assumption that the trolley wires and rails are insulated conductors, and that a fraction of the whole current returns along the rails to the generator. The effect of the railway at a distant point is due to the difference of the current in the trolley wire and the hypothetical uniform rail current, the effect of which at the point considered is equivalent to the actual rail current, which varies from point to point. It is thus shown that the disturbance increases with the length of the tramway, and for a tramway of given length the disturbance is a maximum at points on a line perpendicular to and bisecting it. Experiments made at Stockton on the magnitude of the disturbing force gave, with the vertical force instrument, a leakage of 16·3 per cent., and with the horizontal force instrument a leakage of 15·9 per cent., a fairly close agreement. The assumption that the terminals of the line are above and below the average potential of the earth by the same amount respectively, and that the leakage at any point is proportional to the potential difference between the rail and the earth leads to the ordinary theory of a Fourier bar. This more accurate assumption has been developed and applied to the results obtained at Stockton. The leakage as calculated from the amperes and volts comes out as 20 per cent. The calculation of the disturbing vertical force gives $10{\cdot}5 \times 10^{-5}$ C.G.S. units, which is in fair agreement with the value $7 \times 10^{-5}$ actually observed. In conclusion, it is pointed out that for practical purposes it is sufficient to deal with the average return current through the rails, the formulæ for which are quite simple.

Dr. R. T. GLAZEBROOK read some

### "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents."

In this Paper the author has thrown the extended formula, obtained by Prof. Rucker in the previous Paper, into a workable form, and has tabulated numbers which show at what distances the disturbances are negligible for tramways of different lengths.

Prof. R. THRELFALL exhibited a

### "Quartz-Thread Gravity Balance."

Prof. Threlfall gave a short description of this instrument, which has been described in full elsewhere. He drew attention particularly to its accuracy and portability.

Mr. SIMPSON asked how far the fibre had been calibrated, and if the instrument would be reliable at the freezing point of mercury.

Dr. GLAZEBROOK asked how far the instrument was suitable for Antarctic expedition work. He drew attention to the difficulty of calibrating a new fibre should one get broken in the field.

Mr. APPLEYARD suggested the use of a bath kept at a constant temperature with a thermostat.

Prof. S. P. THOMPSON suggested a special meeting to discuss the physics of the Antarctic expedition.

Prof. THRELFALL said that there was no difficulty in measuring the relation between temperature and coefficient of stiffness down to very low temperatures. A more difficult matter is the coefficient of temperature of the instrument. Shrinkage of the instrument as a whole affects both the fibre and the spring which supports it. The difficulty of a broken fibre in the field can be got over by taking two or three instruments. Working with a thermostat is useful in a laboratory, but decreases the portability in exploration work.

Mr. WATSON then exhibited a set of half-seconds pendulums. In these pendulums special attention is paid to the stability of the support. They are covered by a hood from which the air can be exhausted so that the logarithmic decrement is diminished. The motion of the pendulums is shown by rays of light reflected from right-angled prisms attached to them, and the period of oscillation is determined by the method of coincidences. For this purpose an accurate astronomical clock is used, and observations are made continuously between two time signals. An accuracy of one part in a million is attainable.

In reply to Prof. Threlfall, Mr. WATSON said that the knife edges were on the pendulums and not on the supports.

The Society then adjourned until January 25, 1901.

## THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.

**The Glasgow section of the Institution of Electrical Engineers met on the 12th inst. for the purpose of discussing the Paper on the above subject, recently read by Mr. W. Langdon (vice-president) to the Institution of Electrical Engineers in London. Lord Kelvin wrote regretting that he was unable to be present, so Prof. McLean, who occupied the chair, opened by giving a short summary of the Paper, and then read the following communication which the secretary (Mr. E. G. Tidd) had received from Mr. Langdon :—**

"Your section is to do me the honour of discussing my Paper on the 'Supersession of the Steam by the Electric Locomotive" on the evening of the 12th. I hope it may not be thought that in submitting for the consideration of your president the following observations I am attempting in any way to direct or influence the discussion, but questions having been raised on the occasion of last Thursday's discussion, at the Electrical Engineers in London, of the accuracy of the formula employed by me for obtaining the pounds tractive effort per ton, on which, of course, my calculations are very largely based, I am particularly anxious that this important question should, if opportunity arises, be dealt with. It may be that you may be favoured with the presence of locomotive or mechanical engineers who may be prepared, if the formula which I have used is in their opinion inadequate, to furnish a formula which they may regard as reliable. I may, perhaps, add that I have every confidence in the source from which I received the formula which I have used. I know it to be the result of a number of practical experiments, but I have not yet ascertained that it is applicable to goods trains. The various formulæ given do not attempt to make a distinction between goods and passenger trains. If reference is made to the diagram furnished in Fowler's 'Mechanical Engineers' Pocket Book for 1900, it will be seen that there are three curves which practically coincide, whilst that of Clark's deviates from these three to a very great extent. Molesworth expresses Clark's as follows :—

$$6 + 0{\cdot}009\ V^2.$$

If this is carried out in respect of the No. 1 class of train shown in my Table IV, it will be found to result in a per train horse-power of 1,045 as against 477 by the formula which I have used ; and if it is applied to No. 4 class of train, the demand will be 386 horse-power as against 183. The difference is, as you will see, very great—indeed so great as to raise the question whether a steam locomotive, travelling at the speed of 50 miles an hour, could give that horse-power output.

"Another point commented upon was the scheme of plant—whether it was more desirable to employ a central generating station, supplying certain sub-stations, or for the sub-sections to be provided for by what I may perhaps call local generating stations. I am clearly of opinion that those who argue in favour of local generating stations have not thoroughly appreciated the many advantages that attach to the central and substation system. If each section is to be worked by local generating services then the machinery established and in operation must be sufficient to meet any demand that may arise on that section, which would mean an increase in cost for plant, coal, and labour. It would be impossible to guarantee a fixed demand. The varying difficulties which arise in working trains at the present time will not be inseparable from trains worked electrically. Practically the same conditions will attend them. The load in the several sections will be continually varying. With a central generating system the load as it shifts from one section to another will not vary, to any great extent, the load at the central station ; that will remain practically constant, depending upon the *sum total* of the load comprised within the demand of the several sections served by the central station. Another argument in favour of the central station and sub-section system is that it will be capable of meeting, to a large extent, without stress, the varying demand consequent upon the starting of trains. At the moment when inertia is being overcome in one place there would no doubt be a relaxation of the demand for power at another point—*i.e.*, as an instance in point, a train may be running into a station simply under the influence of momentum without any help whatever from current, whilst at another station a train may be starting and will require, for a moment of time a large accession of current. Of course, this would apply to some extent in a local section generating its own current, but it will apply very much more largely with the central station scheme—that is, as it will take a larger area, so the opportunity for equalisation will be greater.

"If after reading this you should think that the matter I have taken the liberty to submit to you is of sufficient importance to read to the members at your meeting, I should feel obliged if you will do so. My great desire, of course, is to get at reliable data. In adopting the formula which forms the basis of my calculations, I placed, as I still do, every confidence in it ; but if it can be proved to be wrong to such an extent as to materially modify my deductions, it would be only honest that such should be done. I need hardly, however, add, that the matter is one of so great importance that there should be no doubt as to the absolute accuracy and source of any formula that may be advanced in place of that which I have used.—Yours faithfully, "(Signed) W. LANGDON."

"P.S.—Since inditing the above I have received from the author of the formula used by me a communication thereon, copy of which I append. The data was, as you will see collected, from actual experiment in 1891, since which date the tendency due to improved lubrication, &c., should be, if anything, to reduce the tractive effort result."

"Midland Railway Locomotive Department, Derby.
"W. Langdon, Esq., Derby. "Dec. 10, 1900.

"Dear Sir : I am sorry that I was unable to be present to hear your Paper read, and offer some facts in support of the train resistance figures you submitted, for I quite agree with your conclusions on this matter. The formula you have adopted agrees with the results I obtained in 1891 with trains running on the Midland Railway between London and Nottingham. In all about 400 sets of figures were taken, and in calculating the train resistance from them, proper allowance was made for gradient acceleration, energy of revolving wheels, &c. The results agree closely with others obtained by Barbier, Du Bosquet, and other careful investigators. The train resistances at high speeds given by Clark and some others are quite unreasonable. The coal and water consumption of a locomotive is well known, and if such high train resistances were met with we should have to take it that locomotives, sometimes run as economically, or even more so, than the best stationary compound condensing steam engines. Barbier found that the locomotive resistance was greater than that of the train. A comparison of the resistances I found for long trains as compared with short trains on the Midland do not support this view. He also found that four-wheeled coaches offered greater resistance than bogie stock. The figures you have quoted are about midway between those given by Barbier for the two kinds of stock. It must be remembered that, on the Midland, every care has been taken to use the best possible form of axle bearing for coaches and waggons, and to lubricate the bearings also as perfectly as possible. The locomotive has also been designed, as will be seen upon reference to Mr. Johnson's presidential address, with a view to reduce frictional resistance in every way. It should be borne in mind that even if some steam locomotives offer greater resistance to motion per ton than do the trains they draw, such would not be the case with the electric locomotive, owing to its shape, small size as compared with its weight, evenly distributed load, and absence of all friction except that of the journals. The figures found for passenger trains will, I think, also apply to goods and mineral trains. Should you desire to do so, you may, with pleasure, make use of this letter.—Yours sincerely,

"(Signed R. M. DEELEY."

Mr. H. A. MAVOR said that Mr. Langdon's Paper appeared to him to be a most useful one for the initiation of the discussion which had been begun by it. There were about 44 electric railways authorised by Parliament in this country. Four of these had come into operation. It seemed on the face of it that the figures in the Paper were of less importance than the subject itself. Mr. Langdon had pointed out that the prime factor was that of efficiency in the generating plant and the electric transforming plant, and in transmission. He (the speaker) did not quite agree with Mr. Langdon. The figures in Table VII. as to the generating charges would indicate what he meant. The charges there formed a comparatively small proportion of the total estimated by Mr. Langdon. He (Mr. Mavor) thought that they ought to bulk more largely. According to the Paper the generating charges were somewhat less than one quarter of the total cost for power and haulage. The whole question before them, however, ought to be looked at broadly. What was the probability with regard to the relative efficiencies of steam locomotives running on the line, each with its own boiler, and the large engine combining the power of 50 locomotives ? It would be pretty evident that the large engine was probably most economical, not only in what might be called mechanical efficiency, but in general working. Seeing, however, that from the data before them up to the present, it was not possible to consider the efficiency purely from the standpoint of what was to be expected from strict tests, the question resolved itself into one of experience. Now the experience of fuel consumption on an electric train as compared with steam locomotives, was not available to any large extent. Some of the other items were comparable, and it would not seem unfair to draw comparisons from the experiments on street railways in this country. Of the facts which had been given to them with regard to the working of street railways, the figure in connection with the renewal of plant comes out as low as 10 per cent. of the total in some cases, and as high as 20 per cent. in other cases, but in no case does it approach the 30 per cent. spoken of in Table VII. in the Paper. They had much to learn, however, from experience upon this and other items, but what little experience they had, went to show that the saving in electricity transmission would be borne out in the replacing and renewal of plant even more than in the item of coal, though it might reasonably be expected that in the latter there would be a great saving. With regard to the position of the station, it would appear that Mr. Langdon's contention in favour of the large engine was likely to be modified by consideration of the question in detail. Mr. Langdon had pointed out in his letter that the large engine could readily deal with a large load at various places, but did he remember that the sub-stations would have to be proportionately increased in size. With reference to the 2½ per cent. leakage on the line, allowed by Mr. Langdon, the speaker thought that such a leakage would soon dispose of the line altogether.

Dr. DYSON agreed with the previous speaker that, while Mr. Langdon's Paper was a valuable one, its worth lay more in the general considerations which it contained than in the detailed figures in it. Before anything like a detailed estimate of the probable cost of electric traction could be arrived at, far more fixed data had to be got hold of than those in connection with the formula, which had already been criticised. It was not necessary at present to discuss the different elements that go to make up train resistance, but the speaker thought that all engineers were agreed that the train resistance worked out on the average to a higher figure than that given by Mr. Langdon's formula. That was a point, however, regarding which locomotive engineers would be in a far better position to give facts than electrical engineers. Speaking of the Paper more generally, the question of the efficiency of the various parts as given in the Paper

seemed to him to be not very definitely settled. The aggregate efficiency of the system, as given by Mr. Langdon, was 58 per cent., but of the items which go to make up general efficiency there were two or three that seemed to him (Mr. Dyson) to be very doubtful. With regard to static transformers, their efficiency was given as 93 per cent. He thought 98 per cent. would be nearer it. The efficiency of rotary converters was given as 90 per cent. He though this should be 95 per cent. The loss in rails was set down as 10 per cent. It seemed to him that this could be given as less than 10 per cent.

Mr. DAVID H. MORTON said that when the estimates for the conversion of the Metropolitan Railway to electric traction are made public we should see how widely different are the ideas of experienced men in regard to cost and profit. He reviewed the financial aspects of the existing electric railways in this country, and remarked that on trunk lines the tendency seemed to be to seek economy by pulling longer and heavier trains rather than by shortening the trains and increasing their number. On urban lines the frequency of the trains was limited by the block system of signalling. He placed the mechanical efficiency of the steam locomotive at 60 per cent. The draw-bar efficiency, he said, ranged from 60 per cent. to over 80 per cent., and averaged about 65 per cent. of the indicated horse-power. He gave some figures of the working of the Glasgow district subway, which is worked by direct-cable haulage. The total working expenses per train mile were 7·13d., the receipts per passenger mile 1·26d., and the ratio of expenses to receipts 49·1 per cent. On the Liverpool Overhead Railway these figures were 13·94d., 1·96d., and 60·8 per cent. respectively. He stated that there are reasons for the low cost attending this example of cable haulage, the chief being the compensation through the return of energy to the driving cables when the cars descend a gradient.

Prof. BARR expressed his dissent from Mr. Morton's opinion that electrical engineers were too sanguine and too optimistic. He thought that the question before them of the supersession of steam by electricity for locomotives was a problem in which the arguments for electricity were more favourable than in many other cases to which it had already been decided to apply electricity. There could be no doubt that in a great measure the magnitude of the results as obtained in stations for lighting and tramways are dependent upon the nature of the load factor. There was no case equal to a large main line for constancy of load factor. He (the Professor) did not think that Mr. Langdon had given that matter at all justice in his Paper, and he also thought that it would be found that the load factor would come out very much more constant than is stated in the table in the Paper. It was a pity that they had not more results before them, but he thought that as far as could be judged from appearances, electric driving would not come in through the calculation of probable gain, but through the adoption of electric traction upon lines other than those which are the ruling ones. The underground railways he said would some day be compelled, by public opinion, to use electricity, and he thought also that the time was not far distant when they should have a great deal more objection to the running of locomotives in the vicinity of cities altogether. A great deal of the smoke nuisance had been proved in many instances to be due to the locomotives that run along these lines. Concluding, he said that he had no doubt that under the compulsion of a growing public opinion on the subject, the time was coming when they should see a very large development of electricity on main lines, and he personally would be very glad to see electricity substituted for the present objectionable locomotive.

Mr. W. W. LACKIE drew attention to some of the figures and conclusions come to by Mr. Langdon. It is shown that the maximum number of trains per hour varies from 19 to seven. If this is the case it means that he cannot have, as he states, an absolutely constant load and station output for every hour of the day. His figures would at first lead one to believe that in this railway scheme he would have a load factor of 100 per cent. The kilowatts wanted for the 19 trains he made out to be 8,650, and for the seven trains 2,080, or less than one-third of the maximum load. Mr. Langdon takes an average of 5,000kw., but he strikes his average by taking the maximum average in every case. He says that in each train of this class he has taken it as a loaded train, whereas some would certainly be light trains. He also accords to each their full speed. The average number of trains passing Luton is 11·9, and passing Harpenden 12·4. He has taken an average of 14 trains per hour; 5,000kw. will not drive the 19 trains at their full speed. The units generated per annum he makes out would be 43,800,000. That is taking 5,000kw. for 24 hours and 365 days. The fairer way of getting the total units likely to be generated would be to take Tables II. and III. and work out the units per hour throughout the 24 hours. If this is done the figure is more likely to be 39,000,000. If the units are less, and as low as he calculated them to be, it affected the cost per kilowatt hour, and consequently per train mile, by fully 10 per cent. in every case except the coal bill. All the other items making up the cost per kilowatt hour per train mile are standing charges, and are quite independent of units generated. As a matter of fact, the load factor on such a scheme will only work out at something like 65 per cent.—*i.e.*, the ratio of the units which would be generated if the maximum load, 8,650kw., remains on for 24 hours throughout the 365 days, and the actual units likely to be generated. Further, the engineer in the station is not likely to know when the maximum load would come on, and consequently he would require to keep the maximum power running, in case it did come on. The annual bill of the Liverpool Overhead Railway, including carting and ashes, is stated as 0·118d. per kilowatt hour. Even if allowance is made for a lower number of units per annum the cost per train mile is fully 1½d. in favour of electric driving. Towards the end of the Paper Mr. Langdon discusses the adoption of electric traction on small branch railways, and incidental use of gas plant. He quite agreed with him that there is a very large field for the use of this, as the cost per horse-power hour by using gas on plant not exceeding 400 H.P. is one quarter of that when using coal and steam. Further, in the small branch lines the whole plant could be shut down, as the stations are during the night. For small plant therefore gas engines would be preferable. Fluctuations in pressure are not of serious account.

Mr. M. B. FIELD had read Mr. Langdon's Paper through several times, and each time had felt more and more in total disagreement with the figures given therein. In the first place, the author attempted to imitate the traffic on a certain portion of the Midland Railway, and in doing so had provided for only about half the number of trains actually on the section at one time, and made up his total number of trains with certain numbers of each class, which were in quite a different proportion from those given in the tables he was attempting to imitate; in the second place, the choice of an electric system was not, in his opinion, necessarily the best; and lastly, the items of his cost per train mile for electric working were questionable, or at least needed further explanation. These points he then went into more fully. Looking at Table IV., he was inclined to think that the basis of Mr. Langdon's calculation rested upon a fallacy. The second and third columns gave the number of trains of different classes passing through Luton and Harpenden in 24 hours, with averages of 11·9 and 12·4 passing per hour the two places respectively. On page 10 we were told that the author had taken 14 trains per hour passing a particular point, and he had apportioned them as in column 4, Table IV. In columns 7, 8, 9 and 10 the load, tractive effort, mechanical horse-power, and equivalent in kilowatts corresponding to each train were tabulated. Columns 11 and 12, headed "Total" mechanichal horse-power and kilowatt were obtained by multiplying the number of trains of each class, as in column 4, by the corresponding figures in columns 9 and 10—*i.e.*, the mechanical horse-power and kilowatts per train. Evidently this could *only* give the total kilowatts required to propel all the trains that pass a given point in one hour. But later on the author assumed that there were only 14 trains on the 50-mile route—viz., three to each of four sections and two to the fifth section. But with 14 trains going at an average speed less than 50 miles per hour there clearly could not be 14 trains passing a particular point of the 50-mile route every hour. The tractive effort assumed by the author for the different trains appeared to him to be inadequate, but he assumed that 5,000kw. would work 14 trains travelling at their respective speeds at a total of 480 miles per hour backwards and forwards on the 50-mile route. Looking at Table VII., he said we could divide the total cost into three main heads: Generating and distributing per train mile, 2·11d.; locomotive drivers and assistants, 2·65d.; renewal of machinery, cable, &c., 2·26d.; a total of 7·02d. 2·65d. per train mile for the drivers and assistants was equivalent to 0·25d. per kilowatt-hour. Supposing these men worked *only* eight hours per day—*i.e.*, for the 14 locomotives—it would be necessary to have 84 men who received 0·25d. per kilowatt-hour. He then compared this with Table V.—the wages paid to the men looking after the machinery supplying these 14 locomotives, in which wages were allowed for at least 84 men—and by this table the total cost of these wages per kilowatt-hour comes out at 0·0544d., whereas for the 84 locomotive attendants Mr. Langdon gave in Table VII. 0·254d. per kilowatt-hour, or nearly five times as much. If this were accounted for by the fact that other locomotives were standing idle ready for use, it meant that practically four squads were idle for every one on the move, and this for every hour of the day and night, which was incredible. Looking at it in another way, he said that each locomotive travelled 34 miles per hour, and each squad (if only working eight hours per day) would cover 1,900 miles per week. The combined wage of the two locomotive men would be 80s. per week, or a halfpenny per train-mile instead of 2·65d., hence four squads were paid for each one that was on the move. Mr. Langdon showed that 2·65d. corresponded to a *daily* mileage of from 45 miles to 58 miles. How then could he apply it to his case, where his hourly mileage was 34 per running locomotive, or, taking two idle locomotives, for every one that is moving a daily mileage of 270, unless it could be shown that in the case of the electric locomotive some abnormally great expense which was not at all obvious, was likely to come in? Surely, some explanation of this figure was needed; it could not include cleaners, coal men, tube men, repairs, &c., for these were given as independent items in Table VI., yet it was hardly possible that it stood for the wages of drivers and assistants alone. In any case, it appeared to him that a comparison of costs worked out for a more or less hypothetical case where the daily mileage (24 hours) per locomotive would lie between 270 and 800 with those of the Midland Railway, where, from Table I., we see the mileage for 1899 was but 52 per locomotive per day, could not be of very great value.

Mr. PETER BURNET (chief engineer, Great North of Scotland Railway) said, in regard to electric traction by a conducting rail, he could easily understand that in a subway or tunnel such an arrangement might be quite suitable and proper, but he would like to know how it would be possible in this country. They knew that in this country there were a great many crossings in connection with railways, and the continuous rails would have to be carried over these crossings. He would like to know how they were going to manage this without breaking the electrical connection. Another point that he would like information upon was, what effect electric traction would have in the case of those working on the line. What would its effect be on the surfacemen on the rail if a crowbar was laid over the rails?

Mr. J. R. MACKINTOSH (Caledonian Railway Locomotive Superintendent) said that, like the previous speaker, he was a mechanical engineer, and would have preferred to be a listener only. With regard to the question that Mr. Burnet had asked, he thought that if Mr. Burnet had gone to the Paris Exhibition electric railway, he would have got the information he desired. The speaker had been curious to get information regarding this very point—namely, as to how an electric engine was to get over a crossing, or do shunting, without interruption of the transmission of power. He had seen how this was done. The power was transmitted from the ground rail to the roof of the tunnel in shunting, so that immediately the engine leaves one line for another it takes the

power from the top. Another point that he would like to speak about was the trouble likely to arise in the winter time in connection with snow wreaths covering the power-rail. He had been puzzled to know how snow would affect the transmission of the current from the rail to the locomotive. But he had discovered that this could also be got over in the same way as they do in France, and that was in cuttings, where there was likely to be snow wreaths, the rail could be elevated, so that it could be out of the reach of snow.

Mr. SAM. MAVOR said that towards the latter part of the Paper, Mr. Langdon had selected a very favourable case in support of his figures with regard to load factor—namely, a main line close to London, where there was a continuous stream of trains. If he had gone to a more remote part of the country he would have had a very much smaller load factor, which would have proportionately increased the cost.

Mr. W. PICKERSGILL expressed his appreciation of Mr. Langdon's Paper, but said that there were one or two points regarding which he would like further information. In connection with the 5,000kw. as being the power required for working the line, Mr. Langdon, in his calculations of the average number of trains per hour, had not made sufficient allowance for special traffic on particular days, including excursions, &c. Hence it follows that the number of trains per hour might be two or three times the figure given in the Paper. The result is that they must provide power for the maximum demand. It was not fair just to take the average per day: what they must do was to put down sufficient power to give them the maximum demand for the year. It followed, therefore, that they would probably have to allow for a very much greater capital than that mentioned by Mr. Langdon. Speaking of the tractive effort, he had for some considerable time been going into this matter, and he thought that Mr. Langdon's figures were, according to the results of his own researches, just about correct. Mr. Langdon made out the total tractive effort per express passenger train at 3,575lb., and he (the speaker) found it to come out at 3,300lb. Again, with regard to ordinary goods, Mr. Langdon's figure was 2,750lb., while he reckoned it at 3,000lb.

## AUSTRALIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

ADELAIDE, *Nov. 14.*

**Electric Power in Mining.**—The Deep Leads Electric Transmission Co. is making good progress with its power distribution plant in the mining district of Maryborough, Victoria. Five engines of 600 H.P. each are installed, direct-coupled to polyphase generators of the rotating field type. The current is carried by overhead cables to the various shafts, which are from 300ft. to 400ft. in depth. Three of these are supplied with 250 H.P. and two with 400 H.P. pumping motors. The power is also employed for hauling and lighting. The motors have been made watertight so that they will continue to work when the shaft is drowned, though no opportunity has yet occurred of testing their capabilities under these abnormal conditions.

**Electric Traction.**—The Melbourne Tramway and Omnibus Co. are constructing a double line of electric tramway on the overhead trolley system from the terminus of their cable system at Chapel St., Prahran, to Malvern. This departure is of special interest on account of the recognised success of the cable cars running in the main streets of the city. The company have decided not to undertake the larger expenditure involved in the cable system, as their lease has only some 16 years to run.

**Municipal Lighting in Sydney.**—The Sydney City Council's electric lighting scheme, the plans for which were drawn up by Major Cardew some months back, is now in abeyance, owing to the fact that the proposed site is included in the area of the Darling Harbour resumptions recently made by the Government, and it is still uncertain whether the Council will be able to obtain a lease.

**Proposed Victorian Electrical Institute.**—The *Australian Mining Standard* proposes the formation of a Victorian Electrical Institute. Such an organisation is greatly needed in the southern colonies, but no sufficiently energetic group has yet come forward to reduce the proposal to practical form. The corresponding institution in the parent colony—the Electrical Association of New South Wales—is doing good work, several of its recent Papers being of wide interest. It is to be hoped that the electrical engineers of both centres will follow the example of another southern capital, and form branches of the Institution of Electrical Engineers of London, and thus help to bring the electrical interests of the whole empire into closer touch. Might not such a step have an important bearing on the much-vexed question of foreign competition? It is certainly an unmistakable fact that many large orders from the colonies which one would expect to see carried out in British workshops are going to America, and any proposal which would bring the needs and possibilities of the colonies before the British manufacturer is to be welcomed.

## CORRESPONDENCE.

### MAXWELL'S LAW.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your kindly-worded editorial note on a recent lecture by me at the Society of Arts, writing in reference to Maxwell's law, that the square of optical index of refraction of an Insulator should be numerically the same as its dielectric constant, you say my "treatment of this part of the subject seemed to allow of the inexact impression that by suitably choosing the temperature any recalcitrant dielectric could be coerced into obedience to that law." I am afraid my desire not to exceed the allotted 60 minutes may have been responsible for some hurry and consequent ambiguity of expression, but, as a matter of fact, I *did* desire to convey the impression you seem to suggest is inexact—viz., that by cooling dielectrics having abnormally large values of dielectric constant to very low temperatures these values come nearly or approximately into accordance with the above law.

Perhaps I might be allowed to supplement the imperfect explanations in my lecture by a few suggestions in your columns. For the sake of argument and brevity let me assume the electronic theory. Start then with Dr. Larmor's fundamental conception of the electron as a strain centre in the ether, electrons being either positive or negative. Assume, with him, that atoms are collocations of electrons in stable orbital motion. In a saturated chemical molecule or atom we must then postulate that the positive and negative electrons are equal in number. We may take this to be the case in those chemically inert substances the paraffins and saturated hydrocarbons and other symmetrical atoms or molecules not containing chemical radicles. We must assume that, whatever may be the nature of the ether strain which results from an application of electric force, it is of such kind that it causes, or tends to cause, a displacement of positive and negative electrons in opposite directions. This displacement is instantaneous and of a purely elastic type, so that, whether the force is reversed slowly or rapidly, the ratio of the whole electric strain to the electric stress, *i.e.*, the dielectric constant, remains the same. Accordingly, the existence of electric force in a dielectric creates an ether strain and slightly distorts the configuration of the electronic groups which form the material atoms of a dielectric. The elastic reaction to the stress is the same or nearly the same whether it is reversed billions per second, as in the case of a ray of light passing through the dielectric, or very slowly, say 100 times per second. For these substances, then, Maxwell's law is fulfilled.

Consider next a substance such as *water*. Chemical arguments lead us to regard the molecule of water as capable of fission or partition into two non-identical masses—viz., H and (HO), which are respectively the semi-molecules of hydrogen and hydroxyl. These masses, when free, constitute the *ions* of water, and when free carry electric charges. Hence, on the electronic theory they must each be regarded as collocations of electrons, but the H groups or masses contain more positive electrons than negative and the (HO) groups more negative than positive.

When united to form the water molecule, the collective mass H(HO) possesses an *electric moment*—that is to say, it is equivalent to a mass having a positive charge on one part and a negative on another. All chemical facts lead us to believe that the union between the O and the H in the semi-molecule of hydroxyl (HO) is far more intimate than the union between the H and the (HO) in water. Accordingly, under the action of electric force the water molecule will be *oriented* in space like a small magnet in a magnetic field. This orientation is equivalent to an additional electric dis-

placement over and above that due to mere strain of the electrons in the molecule or of the ether in the same place. According to the theory here suggested it is this orientation of the molecules which bestows the abnormal value upon the dielectric constant. We have next to explain on this theory why these abnormal values of dielectric constant become normal on lowering the temperature sufficiently. Thermodynamic theory seems to indicate that sensible heat is the result of mass movements of molecules. Hence as the temperature is lowered the molecular agitation is quieted down and the molecules may unite into larger groups or aggregations. It is then easy to see that these larger groups of molecules will cease to possess an electric moment, just as groups of equal small magnets united pole to pole so as to form closed magnetic circuits cease to possess a magnetic moment as a whole. Accordingly, external electric force can no longer orient these molecular groups, and their power to contribute to augment the normal dielectric constant disappears. Hence at very low temperatures, if ice consists of molecular aggregates of water molecules, it should have, as in fact it has, a dielectric constant not very different from that value due to a very rapidly reversed electric force when at 0°C., viz., a value lying between 2 and 3. Also, it is easy to see why on this theory high frequency in the electric force reversals leads to the same result as very low temperature.

In the case of the high-frequency alternating electric force (billions per second) the inertia of the water or ice molecule prevents it from orienting. The only effect of the electric force is to produce ether strain and strain of the electrons forming the molecule. At very low temperatures the molecules do not orient because they are bound up in groups and have no resultant electric moment.

We also find experimentally that for such bodies as water, alcohol, &c., there is a temperature at which the large or abnormal dielectric constant has a maximum value. The decrease of D.C. at and above a certain temperature may be explained by the gradual breaking up of water molecules having an electric moment, and therefore capable of being oriented, into *ions* having no electric moment. The gradual increase of conductivity in ice accompanying this dielectric change as it is heated is easily explained in the above theory because the ions at once move under the electric force, and moving ions constitute electrolytic conduction.

I must not trespass upon your space to develop this theory more at any length, but it seems to me to fit in fairly well with most of the observed facts as regards the influence of temperature and frequency upon the values of the dielectric constants of insulators and electrolytes, and to obtain support from the results of the dielectric measurements at low and increasing temperatures, to which I briefly alluded in my lecture.

It is a curious fact that the more complicated and heavier molecules, such as those of the alcohols and glycerine, have their abnormal dielectric constants reduced to smaller and normal values by an increase in the frequency of the alternating impressed electric force not at all sufficient to similarly affect the abnormal dielectric constant of a lighter molecule, such as that of water.—Yours, &c., J. A. FLEMING.

University College, London, Dec. 15.

## STEAM TRIALS AT CARDIFF ELECTRICITY WORKS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have pleasure in giving herewith the results of a steam consumption test made on a 300kw. steam alternator supplied recently by Messrs. Ferranti, of Hollinwood, to the order of the Cardiff Corporation. The figures are sufficiently good to interest, I believe, several of your readers, and the names of the gentlemen who conducted the tests are a guarantee of their reliability and accuracy.

The plant comprises a vertical compound condensing engine having cylinders 18in. and 34in. by 18in. with an alternator of Ferranti's well known copper armature type between the H.P. and L.P. engines, the whole designed to give 300kw., 2,500 volts by 120 amperes 40 periodicity at 200 revolutions per minute. The valves are of the gridiron type driven by cam gear, the governing being effected by a throttle valve, and there is forced lubrication. The alternator drives its own exciter.

The test was made on November 8, 1899, there being present as experts, on behalf of Messrs. Ferranti, Mr. M. Longridge, Mr. A. B. Mountain and Mr. Gillett. On behalf of the Cardiff Corporation there were Mr. H. R. J. Burstall and Mr. Llewlyn B. Atkinson. The test was started at 9:15 a.m. and continued at full power until 4:12 p.m. The steam from the engine was discharged into a surface condenser which only received the steam of this engine. The air pump discharge was measured by being run into two barrels, one being filled while the other was being emptied, each being filled up to a mark. During the trial 69 pairs of barrels were used, making a total of 53,030lb. The next day a test was made to ascertain whether the condenser was tight, and it was found that a leak equal to 1 per cent. existed, making the total water used equal 52,500lb. It was found that 92lb. of water had collected in the drain sump under the engine, having escaped from the glands, which has to be added, making a final total of 52,592lb. The duration of the trial being 6·95 hours, the quantity of steam used by the engine was 7,568lb. per hour. The vacuum, as measured in the exhaust pipe close to the engine, was 18·7in. or 9·2lb. per square inch.

The alternator was run on a water resistance, the power was measured by a number of ammeters and voltmeters, one of each being chosen after comparison with a Kelvin watt balance as being the most accurate, and readings were taking every 15 minutes. There was also a Thomson recording voltmeter, which was read every 30 minutes. Each of the instruments read during the trial were sent to the Board of Trade laboratory immediately after the trial for calibration, and the necessary corrections have been made in the calculations.

The mean output of the alternator was 315kw. The mean horse-power shown by the indicator cards was 499 at the mean speed of 204·9 revs. per min., as got from the engine counter.

The combined efficiency of the engine and alternator, taking the above figures for electrical output and indicated horse-power, was 84·6 per cent. Taking the figures actually obtained the steam per kilowatt-hour was 24·03lb., being practically 2lb. below that required by the specification. I think this is very good, and if the vacuum had been 26 or 27 the result would of course have been materially better. No special preparations were made to prepare the engine for this test. The steam was not superheated, and was supplied from boilers of the dry-back marine type.—Yours, &c., N. APPELBEE.

Cardiff, Dec. 11.

## THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: You have justly called attention in your leader of the 14th inst. to the importance of Mr. Sprague's remarks on the adoption of electric instead of steam traction. I have read your report of his remarks with interest, as it seems to me that the quicker and more frequent service rendered possible by the adoption of electric traction is likely to bring about a radical alteration in the design of electric locomotives, or, for my purpose, their equivalent when the motors are concentrated at one end of the train. For given conditions as to acceleration, &c., there ought to be a limit to the dead weight per unit length of rail if vibrations are not to become serious. If it *is* best to have the motor armatures built direct on the axles, a larger number of smaller motors should be employed. The multiple-control system is fully worked out, and it distributes the force and dead weight upon the rails over a larger wheel-base.—Yours, &c., ERNEST WILSON.

London, Dec. 17.

## CONCENTRIC CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Mr. Duddell, in his brilliant Paper, pointed out a danger with concentric cables and metal break, quick break switches, the following contribution to the discussion may

have some general interest. Mr. Duddell puts the suggestion of damage to concentric cables from the sudden interruption of an arc between metal contacts in the shape of a question. His suggestion is very probably right in certain cases, but I think these cases are at present rare, for several reasons.

(1) The capacity needed to suddenly extinguish a metallic arc when the voltage was 200 was shown by his experiments to be considerable—as cable capacities go. (The entire 11 miles of the Ferranti Deptford main has only a capacity of 3·8 microfarads, and he used 5 microfarads.)

(2) That capacity must be, so to speak, immediately available, not separated from the arc to which it is a shunt by either "self-induction or a resistance, one or both of which are almost always present in the armature of the dynamo, if not in the mains, through which alone can the cable capacity act on the arc of a switch."

(3) Even when accumulators are used and the self-induction then removed, the capacity is almost invariably shunted in low-tension systems by the non-inductive filaments of the lights which are not extinguished at the time of the operation of the switch under consideration, for the load on a central station of any magnitude, such as would have a large capacity on its mains, never falls to zero.

(4) The leakage from main to main is almost invariably sufficient to allow a normal current of a few amperes to flow; thus the capacity shunting the arc is itself shunted by a small resistance, say 100 ohms, even supposing the arc to be struck when there is no load whatever.

(5) It was proved by Northrup and Pierce (*Electrical World*, Nov. 6, 1897), in a Paper quoted by Steinmetz, that the disruptive effect of high-frequency oscillations from a condenser and self-induction, or the peaky volt surgings from an induction coil, is much less than that of a sinusoid alternating voltage on heavy insulating oils (which are the basis of the bulk of modern concentric cables). Hence 2,000 volts does not of itself always mean a very heavy puncturing effort applied to the cable, though it may mean a great deal with a piece of dry paper the path across which is practically an air-gap.

On high-tension mains in ordinary practice, we are far from getting the short, snappy, almost explosive extinction of the spark which Mr. Duddell got on each occasion, signalised by the paper puncturing, and I have been unable to speak to anyone who has seen such a sudden interruption of the arc in practice on the mains. This is due to two facts. Firstly, that a D.P. switch is always used which disconnects the condenser from the circuit while breaking it, and secondly, if one limb of the switch operates before the other has begun to arc, as is frequent, or if a single pole switch is used, the condenser is not directly in shunt across the metal arc between the contacts, but is across them *in series with the self-inductions of the line and alternator.*

Whether alternating generators having self-induction are for this reason to be preferred is a question which is probably settled by the fact that all alternators now made have enough resistance and self-induction to prevent a spark being swamped with this dangerous suddenness.

Everyone who heard Mr. Duddell's Paper must agree that he may justly feel proud of his brilliant success, both in research work and in demonstration.—Yours, &c.,

London, Dec. 18. MERVYN O'GORMAN.

## MUNICIPAL TRADING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I draw your attention to the following extract from a judgment given recently by Mr. Justice Bigham in a case claiming a declaration that the chairman of a certain urban district council was disqualified from sitting as a member of the council, on the ground that he was concerned in a bargain or contract entered into with the council, and participated in the profit derived therefrom:—

Bigham, J., said he was of opinion that the defendant was concerned in the contract, and that, therefore, he was disqualified from remaining a member of the council. His experience showed him that there were on these local bodies too many men—builders and men of that class—who were liable to become, and did become, interested in the work which the councils had to carry out. Such persons, in his opinion, ought not to be elected on such bodies at all, because they were tempted by their own interests to undertake contracts and to enter into dealings with which they ought to have nothing to do.

That this is not an isolated case would appear from the following extract from the *Daily Express*:—

MANCHESTER.—Town Councillor Resigns. Councillor Higson yesterday resigned his position on the Salford Town Council in consequence of allegations made against him of carrying out contracts for the Corporation. He admitted having done sub-contracting work, and said he had no ulterior motive. The mayor did not think there was any council in England some member of which was not interested in a corporation contract.

Again, in consequence of another complaint the Manchester Town Council have laid down the principle that a member of the Council is prohibited from trading directly or indirectly with the Council or any of its committees, and this would seem right, as the members of these Councils are trustees for the ratepayers.

I have pointed out in a previous letter that the outstanding loans of local authorities have increased by 150 per cent. in the last 20 years, and they now stand, according to the Local Government Board report, at £252,135,174.

Local authorities generally throughout the country are embarking more and more in trading undertakings, necessitating contracts for the supply of goods and materials to an enormous extent.

In the result it would seem that either (1) municipal trading must be stopped, or (2) these trustees must be allowed to be personally interested in the contracts they enter into on behalf of those for whom they are trustees. Is the latter desirable in the public interest?—Yours, &c.,

KENRIC B. MURRAY,
Secretary, Municipal Trading Committee.

London, Dec. 19.

# LEGAL INTELLIGENCE.

### Kift v. Capetown Town Council.

In the Supreme Court at Capetown (South Africa) on Nov. 26, before the Chief Justice (the Right Hon. Sir J. H. de Villiers, P.C., K.C.M.G.), and Justices Buchanan and Maasdorp, James Kift brought an action against the Capetown Town Council for £2,500 damages for injuries sustained by him through coming into contact with an electric wire belonging to defendants. On Feb. 27 plaintiff while in Church street, Capetown, came in contact with a wire charged with electricity, which was hanging over the railings of a house and projected into the street. The wire formed part of a system of overhead wires for lighting the streets of Capetown. Plaintiff's counsel (Sir H. Juta, Q.C.) urged that it was the duty of defendants so to place, keep, and maintain the said wire that it could not come into contact with any person, more especially when charged with electricity. In breach of this duty defendants negligently and carelessly allowed said wire to become broken, and negligently and carelessly omitted to repair it, and wrongfully and unlawfully and negligently allowed the wire to project into and remain in the public street charged with electricity. By reason of this wrongful conduct, plaintiff, by coming into contact with the wire, sustained serious damages; was severely burnt, received injuries and shocks to his person, was incapacitated for a long period, and is crippled for life, having permanently lost the use of his right hand, and altogether sustained loss and damage to the extent of £2,500, which amount was now claimed, with costs. Defendants denied that when plaintiff came into contact with the wire it was charged with electrical power, and if the wire was then charged that power was not derived from any work or undertaking of defendants. It was further pleaded that the electric lighting system was a lawful undertaking for the public benefit, and in regard to the placing, keeping, and maintenance of the system, including the wire in question, defendant Council was bound to exercise such care and diligence as the law required, including reasonable care to prevent any of its wires coming in contact with any person when charged with electrical power, but that the defendants were not bound to make good consequences of damages due to accident, the act of others, or any cause not being the act or default of the defendant Council or its servants or agents. Defendants denied that the injuries complained of by the plaintiff were caused by any negligent or careless act or default on the part of itself or its servants, or by any electrical power generated by or under their control, or which was any part of their undertaking. They admitted the serious injury to plaintiff, but did not admit that the damage so sustained amounted to £2,500. The wire referred to was carefully and diligently placed, kept, and maintained by defendant Council, and was fitted and adjusted with a fuse or fuses whereby upon a break occurring in the wire the passage of the electric current or power generated by and under the control of the Council was stopped, and defendants so soon as they had notice that a break had occurred in the wire, forthwith caused the wire to be replaced and repaired.

PLAINTIFF said he was a messenger boy. About the middle of the day he walked up Church-street, and arrived at the house at the corner of

Long-street and Church-street. Something caught hold of him as he passed, threw him down to the ground, and he lost consciousness. He did not take hold of the wire. It caught him and went round his body. He was swinging his hand, and he got a shock. He was taken to the hospital, where he remained a month. He suffered much pain. He could not now use his right hand. The wire hurt him at once. He did say to the attendant at the hospital that the wire only hurt him after he had had it in his hand for a little time. It was only one wire. It twisted round and round his body. He did not take up the wire to play with it.

A coloured witness named FRANCIS said he had seen the wire hanging in such manner that anyone could touch it by raising his hand. Before cutting the wire he tried to remove it from the boy with a poker. He felt no shock through the poker. He did not notice more than one wire dangling.

HENRY HEWETT, hotel proprietor, said when he saw the boy he was encircled in the wire. His hand was smoking as if it was being burnt, and he was screaming.

For the defence, HENRY ROBERT LOWE, electrical engineer to the Town Council, said the wires were up in that locality before he took up his position. There were five wires, two—the inner ones—for street lighting, two outer ones for house lighting, and a neutral wire on the top. The trolley wires of the tramway company crossed them in Long-street. On account of complaints, and because of having had wires broken, witness removed the wires at this particular spot on Feb. 27. If on the 26th the wire touched earth certain lights would be affected. All street lighting wires were dead in the day. All the wires carried a maximum of 220 volts. The tram wires carried 500 volts to 570 volts. If the wire touched an iron fence or entered water it would become dead, but a person standing on earth and seizing a live wire would get a shock. If the wire carried more than 220 volts the lamps would break. No complaint was made to the Council until July. Witness had no knowledge that the wires were down.

Mr. SCHREINER, Q.C., who appeared for the defence, said the theory was that the boy took hold of the wire—which was believed to be dead—and brought it into contact with the overhead trolley wire, the shock being thus communicated from the latter.

WITNESS (continuing) said he did not believe a current of 220 volts would injure the plaintiff. If the voltage went up to 300 volts it would smash the lamps. The defect in the present case was attended to immediately.

Mr. H. D. WILKINSON said he was an electrical engineer of 24 years' experience. The Capetown system was the 240-volt system in vogue in England, and was a perfectly proper system. About a dozen towns in the United Kingdom had a similar overhead system. A majority of the principal towns had an underground system. After the accident he made certain experiments, which went to show that where a wire was cut or broken, as was this one, it would fuse if it touched iron. If the wires in question had touched the rails the wires would have fused, but not if they touched the dry earth. He also experimented with a leg of mutton to ascertain the effect of a broken live wire on the dry skin, the fat, and the meaty parts. He very much doubted if a 220-volt current could have inflicted the injuries on the boy unless he had held it for 10 minutes or so.

By Sir HENRY JUTA: He thought it rather a dangerous thing to have these electric wires crossing over the tram wires. Where they had wires crossing each other, as did these, there should be some protection between the two. One or other of the owners should insulate the wires at the crossings.

Mr. JOHN DENHAM, electrical engineer to the Cape Government Railways, said that from experiments he had made a person would have to be in contact for some time with the wire before any injury would be effected by a 220-volt current. He had purposely touched a 220 volt current, but, though the shock was very unpleasant, he received no immediate injury. A voltage of 220 would cause the injury if kept on long enough.

Sir HENRY JUTA: Do you agree with Mr. Wilkinson that these overhead wires are dangerous without protection?

The WITNESS replied that there was of course a certain amount of danger. The danger could be eliminated at excessive cost, but it would not pay. It would hamper the industry.

It would be far better not to have them naked?—It would be better.

You do not have the naked wires in Europe?—There are about a dozen towns with overhead bare wires.

Those are places with a small number of inhabitants. You do not know any cases where these naked wires cross tram wires?—No.

After hearing counsel,

The CHIEF JUSTICE said the Court did not think damages should be fixed on the scale proposed by plaintiff. The damages should not be more than £300. The plaintiff was still very young, and would be able to learn to do with his left hand what he would otherwise have done with his right. Moreover his general health was good. The sum proposed by the Court would be a very good sum to start life with.

Sir HENRY JUTA asked the Court to give plaintiff such damages as would enable him to secure an annuity bringing him in £20 a year. That would be £400.

The CHIEF JUSTICE, in giving judgment, said that whatever else might be doubtful in this case, there was no doubt that the plaintiff had met with a serious injury. His right hand had been rendered practically useless, but his youth would enable him to overcome this drawback somewhat. Then his position of life and other circumstances had to be remembered, and were reasons for the damages not being so great as they otherwise would have been. He agreed that the Town Council could not be held liable for accidents if there was no proof of negligence. But in the present case there was proof of negligence. It was shown that the wire was slack. It was said the Town Council was in the habit of inspecting the wires all round the town every four days, and that it was impossible to inspect all the wires oftener. In the opinion of the Court this argument did not hold good. They could not lose sight of the fact that in dealing with electricity the Council was dealing with a dangerous agent, and that they were bound to protect the public. In this case there was clear proof of negligence on the part of defendants. The fact that they did not ascertain the circumstance that the wire was down was *prima facie* proof of negligence. The wire had been broken in the same place before. Moreover, 48 hours had elapsed after the wire being down before it was attended to. Then it was urged that there had been contributory negligence on the part of the boy. That he could not admit. He did not see that it would have been contributory negligence on the part of a grown-up person, much less a boy, to take hold of the wire. No passer-by was to know that that harmless-looking piece of wire was charged with electricity, or think that it could possibly do any injury. Certainly on the part of this boy, his swinging his hands could not be taken as contributory negligence. He seemed to have been swinging his hands, and to have got entangled in the wire. There was no wrong in his touching the wire; any passer-by might have done it. It was not as if he had gone out of his way to touch machinery, for example. It seemed clearly proved that there had been negligence on the part of the Town Council, and that there was an entire want of contributory negligence on the part of the plaintiff. The Court would award plaintiff £400 damages, a sum that would give him a fair start in life.

Mr. Justice BUCHANAN concurred, and added that there was one point which had not been touched upon. That was in regard to the crossing wires. He considered it a grave fault on the part of the Town Council in not taking precautions to prevent the contact of their wires with the trolley wires. Therein he considered the Council had been guilty of negligence.

Judgment accordingly, with costs.

## Corporation of Wolverhampton v. British Electric Traction Co. (Ltd.).

This case came before Mr. Justice Joyce, in the Chancery Division yesterday, a case in which his lordship gave judgment on November 29th last. The question raised related to the purchase by the Corporation of part of the tramways known as the Wolverhampton undertaking, the Corporation claiming specific performance of a contract by the defendants to sell and an account of the profits from April 7 last. It will be recollected that defendants refused to carry out the contract unless the Corporation conceded running powers over a portion of the lines, although an agreement and assignment had been prepared on April 5, 1900. Defendants counter claimed for an injunction to restrain the Corporation from doing anything which should prevent the exercise of the running powers which they claimed. His lordship made an order of specific performance, and said the plaintiffs could have an inquiry as to profits. The question now to be decided was whether the plaintiffs were entitled to 5 per cent. interest on £4,250, the amount of the purchase-money. The Corporation forwarded a cheque for £4,250, which was afterwards returned by defendants.

Mr. HUGHES, Q.C., for the plaintiffs, said that the Registrar, in drawing up the order found a difficulty in dealing with the question of interest. The statement of claim asked for an inquiry as to profits, but defendants said there had been no profits, and it was obvious that the inquiry would be a difficult one. He agreed that the plaintiffs could not have both interest and profits at the same time, and the plaintiffs preferred to take the interest, and to leave the question of profits alone.

Mr. THOMPSON, for the defendants, submitted that the plaintiffs had made no proper tender of the money to the defendants.

In the result, his LORDSHIP made an order to the effect that the Corporation was entitled to 5 per cent. interest in lieu of compensation for the non-completion of the purchase from the date that the purchase-money was tendered by the plaintiffs to the defendants.

## Cameron v. P. C. Middleton & Co. (Ltd.).

In the Aberdeen Sheriff Court recently, before Mr. Sheriff Crawford, an appeal was heard against the decision of Sheriff-Substitute Burnet in this case, which was for an injunction against P. C. Middleton & Co. (Ltd.) from creating a nuisance at their electric lighting works at Cults. The Sheriff-Substitute found that the noise complained of did amount to a nuisance, but did not allow an interdict. Sheriff Crawford, after hearing arguments, reserved judgment, which was delivered last week. He confirmed the previous decision. In a note the learned Sheriff states that it was proved the noise of the engines was highly injurious to the comfort of the pursuers, was even detrimental to the health of some of them, and had depreciated the value of their property. Although the works erected in 1893 might have served a useful public purpose, and the electric light to an urban community like Cults may have become almost a necessity, it was not a sufficient defence unless it could be shown that the situation of the works in relation to the villas was so natural and appropriate that reasonable exception could not be taken to it, and also that it was impossible to get rid of the noise or greatly reduce it. There was no evidence that it was necessary to plant those works so near pursuers' property, and even in the largest cities, where the necessity of having those works could not be questioned, they would be liable to be interdicted if placed in similar proximity to residential streets or detached villas. Pursuers were therefore entitled to interdict. Defenders will appeal to the Court of Session, Edinburgh.

## Universal Battery Co. v. Star Electric Co.

In the City of London Court last week plaintiffs sought to recover £3. 5s. 2d. from the Star Electric Co. for telephones supplied. Defendants counterclaimed for £4. 8s., alleging that the telephones supplied would not work properly. It was urged that plaintiffs had got verbal guarantees that the goods would last for 12 or 18 months, whereas when fixed they

ere worthless. Plaintiffs denied that there had been any guarantee, and eir representative said he had no authority to give one. The Deputy dge said that all warranties or guarantees must be in writing. There ust be judgment for plaintiffs on both the claim and counterclaim.

**Crow v. the Board of Works for the District of Whitechapel.**

This case came before Justices Kennedy and Darling, on Wednesday, on defendants' appeal from a decision of Mr. Dickinson, the magistrate at Thames Police Court, in June last.

It appeared that a summons was taken out by Mr. Crow, district surveyor, against the defendants for not having given him notice under sec. 145 of the London Buildings Act, 1894, before commencing the construction of a number of boxes or inspection chambers under the streets in the district for the purposes of electric lighting. Defendants were the local authority within the meaning of the Electric Lighting Acts, and in 1892 were granted by the Board of Trade a provisional order. By secs. 11 and 12 of this order the undertakers were authorised to construct in any street any such boxes as might be necessary for purposes in connection with the supply of electric energy, including apparatus for the proper ventilation of such boxes. The order further provided that notice should be given to the Postmaster-General of the execution of any works under these sections, and a similar notice was to be given to the London County Council. The defendants did not, before commencing the construction of the boxes in consideration, serve Mr. Crow, as the district surveyor, with notice of the intended work under sec. 145 of the London Buildings Act, 1894. Mr. Crow's contention was that the boxes came within the definition of "building, structure or work" in sec. 145, and that defendants were bound before commencing the work to serve upon him, as the district surveyor, a "building notice," as prescribed by the section. Defendants contended that the Act of 1894 did not apply at all to boxes constructed in the streets under the provisional order, inasmuch as the order contained a complete code regulating the materials, situation, and mode of construction of such boxes, and provided a complete machinery for enforcing such regulations and with which special code and machinery the London Buildings Act of 1894 was inconsistent. The magistrate found, as a fact, that the boxes as constructed were "buildings, structures, or works" within the meaning of sec. 145 of the London Buildings Act, 1894, and having regard to secs. 72, 201, and 203 of the said act, held that the provisions of sec. 145 were not inconsistent with the special Act and imposed on the defendants the nominal penalty of 1s., and ordered them to pay £10. 10s. costs. From this decision defendants now appealed.

At the conclusion of the arguments their lordships reserved judgment.

**Tramway Track Sanding.**

On Wednesday, before the Dublin Recorder, Mr. W. M'Clure, carter, sued the Dublin United Tramways Co. for damages sustained through the negligence of defendant company by not keeping their tramlines in proper repair and condition, whereby a horse driven by plaintiff fell, and plaintiff sustained serious injuries. The Recorder said defendants were bound to sand the line through the streets and keep it in proper condition. This accident occurred subsequent to the order of the Queen's Bench, which decided that it was their duty to keep the line in proper order. He gave a decree against the company for £8 8s. and costs.

**City of London Electric Lighting Co. v. Corporation of London.**

This appeal action was in the list for Monday last, but, for the convenience of counsel and the Court, the hearing was postponed until next sittings.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Salford Electric Light committee require an electrical engineer for their electricity undertaking at a salary of £700 per annum. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by 27th inst.

Edinburgh Corporation require an inspector to superintend the installation of electric lighting at a large public building. Applications to resident electrical engineer by 29th inst.

An assistant lecturer in physics is required for the Technical College, Huddersfield. An advertisement gives further particulars.

Hampstead Borough Council require an assistant electrical engineer. An advertisement contains further particulars and applications must be sent to the town clerk (Mr. Arthur P. Johnson), by noon of Jan. 2.

A draughtsman is required for the electricity department of the borough of Islington. An advertisement contains further particulars, and applications must be sent to the acting town clerk (Mr. Wm. F. Dewey), Town Hall, Upper street, N., by Jan. 3.

A switchboard attendant is required for the Plymouth Corporation electricity works; also a cable jointer. Applications to borough electrical engineer (Mr. John H. Ryder) by 22nd inst. See advertisement.

An old-established firm manufacturing electric accumulators requires agents in the provinces. See advertisement.

Burnley Corporation require a general manager for their tramways. Applications by Jan. 19.

Southampton Corporation require a first-class linesman used to the maintenance of overhead trolley lines. Applications to town clerk (Mr. R. R. Linthorne) by 28th inst. See advertisement.

Perth Corporation require a resident electrical engineer. Applications to clerk to commissioners by 22nd inst.

Battersea Borough Council require a resident electrical engineer. Applications on official forms to town clerk by Jan. 1.

Mr. C. McArthur Butler, St. James' Hall, Piccadilly, W., has been appointed permanent secretary of the Municipal Electrical Association, and all communications should be addressed to him.

Mr. James S. Thompson, of the Wimbledon electricity works, has been appointed to the position of engineer-in-charge at Newport (Mon).

**Personal.**—Mr. J. Slater Lewis, A.M.Inst.C.E., M.Inst.E.E., of "Norwood," Ellesmere Park, Eccles, has retired from the position of engineer and general manager to Messrs. P. R. Jackson & Co., of Manchester, and has accepted a seat on the board of the Brush Electrical Engineering Co. (Ltd.).

**Amsterdam.**—The municipal authorities have decided to erect a large generating station for the street and harbour lighting.

**Aspull.**—Messrs. Lacey, Clirehugh and Sillar have been instructed by the Council to prepare a report on electric lighting.

**Barnstaple.**—In a report recently presented to the Council, the consulting engineer (Mr. W. P. Adams) recommends the adoption of the Raleigh water-power scheme.

**Bath.**—Additional land adjoining the electricity works has been purchased for extensions at £4,000.

**Bolton.**—A report on the condition of the track of the electric tramways has been presented by the borough electrical engineer (Mr. A. A. Day). When the Government inspection took place it was suggested by the inspector that the whole of the old lines would require re-laying, the cost being estimated at from £40,000 to £70,000. Mr. Day now reports that the gauge varies at different points, and that the effect of this is obviously disastrous to the cars, and Mr. Day advocates the re-laying of the whole system as quickly as possible.

**Bradford.**—The electric tramway from Four Lane Ends, Bradford, to Thornton, was opened for traffic on Tuesday.

**Bristol.**—Mr. H. Williams has been appointed consulting architect in connection with the erection of the new electricity works at Avonbank.

**Cardiff.**—The Electrical committee have agreed to change the system of electricity supply to continuous current as soon as possible. It has also been decided to accept the recommendation in the recent report of the electric tramways and lighting engineer (Mr. Arthur Ellis) to the joint committee as to concentrating the plant for lighting and tramways at Roath. Instructions have now been given to Mr. Ellis to report upon the plant required.

The Tramways committee were recommended last week by the electric tramways and lighting engineer (Mr. Ellis) to at once consider the purchase of the cars for the electric tramways. 120 cars would be required, 100 for running and 20 as a stand-by, and the total cost was estimated at between £[illegible],000 and £90,000.

Leave has been granted to the Postal Telegraph department to lay a 3in cast iron pipe for telephone purposes in certain streets, and it is reported that the Post Office intend to actively develop their telephone system in Cardiff.

**Ceylon.**—Telegraphic business in 1899 shows an increase of inland messages of 30,000 over 1898. In 1899 five additional offices were opened and 31 miles of telegraph lines added. The introduction of electric tramways has somewhat interfered with the telephone system on the island. To overcome this a twin-wire circuit has been installed. The first motor car ever seen on the island has recently been imported from England, and is being utilised in Colombo.

**Chester.**—The Corporation Tramways Bill was referred to at some length by the mayor (Ald. H. T. Brown) at Wednesday's Council meeting. He explained that at a recent meeting of ratepayers for considering the Tramways Bill, there was a meagre attendance, and a poll was demanded. He thought the poll was demanded under a misapprehension, and that the question was not rightly understood by the public. The Council had purchased the existing tramways, and they now sought to obtain powers to work the tramways themselves, to improve and extend them, and to improve the motive power. Having acquired this property, the Council desired powers to utilise it to the greatest advantage to the citizens. Mr. J. Jones thought the law which permitted one ratepayer to put the city to the expense of a poll should be altered. It was decided that the mayor and town clerk should issue a circular to the ratepayers giving all information regarding the scheme and explaining the object of the bill.

**City of London.**—A letter has been received by the Court of Common Council, from the Charing Cross and Strand Electricity Supply Corporation on the subject of working day and night on the company's work of opening the city streets for the purposes of laying down electric lighting mains. The Company point out that to carry out the views of the Council the expense would be enormous, and that this important class of work, requiring great care in execution, would be far less satisfactorily done at night than in the day. The company, however, offer to meet the Council in every reasonable way.

**Coatbridge and Airdrie Tramways.**—An agreement has been entered into between the Council and the Scottish House-to-House Electricity Co. (Ltd.) to construct an electric tramway in Coatbridge and the company are applying for a provisional order. The Airdrie Council have also agreed to give the company an extension of time to lay their No. 5 line in Airdrie, authorised last year.

**Coventry.**—Acting on the advice of the Electric Light committee, the Corporation have decided that in future the charge for electric current is to be 6d. per unit for 100 units and under per quarter per kilowatt demanded, and 1d. per unit after.

**Darlington.**—The electricity works were formally opened on Monday. Current was switched on by the chairman of the Gas and Electric Lighting committee (Ald. Barron). The system of supply is three-wire continuous-current at 440 volts, and the capacity of the works is about 7,000 8 c.p. lamps.

**Dublin.**—*Important Decision of the Local Government Board.*—The Local Government Board auditor (Mr. J. W. Drury) held an inquiry in Dublin recently (see *The Electrician*, Nov. 23), and the Board has now, by a decision given this week, surcharged members of the Electric Lighting committee of the Dublin Corporation to the amount of £2,000. The surcharge is in respect of payments made in connection with the supply of electric light fittings to private consumers, and falls mainly on the Lord Mayor and four other members of the Corporation. It is stated that, should the present surcharge be upheld, a further surcharge of £3,000 is likely to be made at the next audit. The Corporation, however, has decided to appeal to the Local Government Board on the subject.

**Durban (Natal).**—The Durban Town Council is considering a scheme for the deviation of the main line of railway, which crosses the east end of the town. The proposal is to carry the line overhead, thereby abolishing level crossings, which will prove an impediment to a rapid working of the electric tramway service.

**Edinburgh.**—In reply to an inquiry at the Corporation meeting on Tuesday, the convener of the Electric Lighting committee (Bailie Mackenzie) made an explanation in regard to the failure of the supply of electric current to Portobello on Friday. The committee had, he said, been obliged to employ the high-tension system for the lighting of that part of the city. Current was transmitted to Portobello at a voltage of over 2,000, and it was transformed in Portobello down to 115. On Friday night last, a coil in one of the street transforming boxes had given way at 11 o'clock, and it was 2 o'clock next morning before another coil could be put in. Their engineer had had the matter under consideration, and he reported that all he could do was to make certain alterations in the Portobello system, by which only one part of the suburb should be worked from one transformer and the other part from another.

**Electrical Enterprise in Argentina.**—We have received from Mr. Ernesto Danvers, president of the Institution of Engineers of the River Plate, a copy of his Paper read before the Institution, at Buenos Ayres, on June 30, on "Electrical Enterprise in Argentina." Mr. Danvers has collated a mass of historical data, and in placing this before his readers he early calls attention to the extensive field for electrical operations in Argentina. On the subject of taxation, Mr. Danvers is very outspoken, and urges that in this way the municipal authorities of the country display quite a remarkable hostility to electric lighting and traction enterprise. For instance, the electric lighting company in Buenos Ayres has to hand over to the municipal authorities 5 per cent. of the gross receipts, and the tramway company 6 per cent. Mr. Danvers reviews the progress of matters electrical relating to telegraphs, telephones, electric lighting, tram lighting and electric traction, and the information given shows that from the early eighties considerable enterprise has been shown in electrical matters in Argentina. A messenger service was established at Buenos Ayres as far back as 1888. Great developments are taking place at the present time, particularly in the establishment of electrical smelting works and carbide calcium factories. Already nearly £8,000,000 sterling is invested in electrical undertakings.

**Electricity in Mining.**—*Industries*, of Durban, states that the substitution of electric coal-cutters for hand undercutting is progressing in South Africa. The Elandslaagte collieries are now using electric cutters with great success, and their introduction in other collieries is under consideration. The type of machine adopted, and its working, is described as follows:—

"An electric direct current motor is mounted on a frame and, through gearing, causes a chain to travel around on guides, so placed as to present in front of the machine a straight length of chain about 4ft. long. The chain carries steel cutters, capable of cutting through the coal and any reasonable quantity of hard impurity, such as sulphur veins or slate. The frame carrying the motor and chain is fed automatically against the face of the seam, and as the chain is forced along it digs out a neat, narrow trough under the coal, permitting it to be wedged or blown down with the least production of unsaleable pieces. The weight of the complete machine is slightly over 3,000lb. Current for the cutters is generated on the surface."

**Fareham.**—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £500 for additional transformers, meters and cable. The clerk (Mr. Leonard Warner) stated that they had borrowed £11,041, but £1,601 of this had been repaid. There had been a greatly increased demand for current for lighting. There were 40 private customers in 1896, and the number had now reached 97, and others were waiting for supply. Last year the total cost of maintenance, together with sinking fund and interest, was £900, the revenue being £700.

**Gold Coast.**—In a report just issued on the trade of the Gold Coast for 1899 a steady increase is noted in the revenue collected from telegraphs. The total number of messages transmitted have increased from 119,313 in 1898 to 123,023 in 1899. The number of submarine cable messages over the cables of the African Direct Telegraph Co. increased from 1,954 in 1898 to 2,268 in 1899. A telephone exchange has been established at Accra, connecting with all the Government offices.

**Gourock.**—Messrs. Burstall and Monkhouse have been appointed consulting engineers by the Burgh Commissioners.

**G.P.O. Telephone Service.**—In the House of Commons last Friday Mr. Austen Chamberlain stated that the Postmaster-General was using every effort to expedite the underground work now in progress in connection with the establishment of a telephone exchange service in London, as well as to minimise the inconvenience to the public. It was not possible, however, to carry on all the work by night as well as day. There was no difficulty as regards the work of excavation and filling in, but the laying of the ducts must be carried on by day in order to ensure the proper execution of the work.

**Gravesend.**—The Electric Lighting committee has been re-appointed and the report of the consulting engineer (Mr. W. H. Trentham) has been referred to it for consideration.

**Halifax.**—Mr. A. P. Trotter officially inspected the tramway route from Cote Hill to Sowerby Bridge on Monday. The line was opened for traffic the following day.

**Hammersmith (London).**—In the certificate of the auditors, just presented after examination of the accounts of the old Vestry for the period from March 25 to Nov. 8, the following statement appears:—

We desire to express our great satisfaction with the financial result of the working of the Vestry's electric lighting scheme, and to say that the accounts prove the very satisfactory progress made in the undertaking during the period under audit.

**Heaton Norris.**—A deputation waited upon the Manchester Electricity committee last week to urge the speedy extension of electric lighting to the district. The provisional order for Heaton Norris which was obtained by the City Council in 1899, expires in June, 1901. It appears that Stockport is supplying electricity right up to the Heaton Norris boundary, and the Stockport Council is prepared and anxious to provide electricity for the urban district in the event of any breach of the existing arrangements with Manchester. After a lengthy interchange of views it was resolved that the committee should reply with definite proposals at the next meeting of the Council.

**Hove.**—The Lighting committee have asked Prof. Kennedy his fee for reporting on the subject of carrying out the terms of the Aldrington provisional order, obtained in 1898.

**Huddersfield.**—A report on certain alleged irregularities in connection with the tramways department was presented to the Council on Monday. The report stated that rumours had been set and kept afloat relating to the execution of the electric tramway scheme, and reflecting on the competence and ability of the borough engineer and surveyor (Mr. Campbell) as the engineer in charge of the work. At the inception of the scheme, acute differences of opinion were developed between the officials, and those differences had been kept alive by prolonged criticism, which had probably produced misunderstandings. The committee appointed to consider the matter had gone fully into it. The main questions involved were (*a*) whether the charges of undue interference, incompetence and extravagance against the borough surveyor were well founded; (*b*) whether he had discharged his duties in a proper and capable manner; (*c*) whether he was entitled to the confidence and support of the Council. On all those questions the decisions of the committee are in favour of the borough surveyor. The report was adopted. It is expected that the first electric tramway route will be opened in January.

**Ince.**—A report on electric lighting is being furnished to the Council by Messrs. Lacey, Clirehugh and Sillar, of Westminster and Manchester.

**Islington (London).**—The Borough Council has decided to call in an expert to advise on the present condition of the electricity undertaking. It is reported in the local papers that in the first six months of 1900 there was a loss of £658.

**Lamp Trust in Russia.**—A contemporary states that the success of the recent Trust schemes in Russia has led to a combination of the Moscow and St. Petersburg manufacturers, to be shortly joined by those of Warsaw and other chief centres of the Empire, to form a trust and to petition the Government to raise the duty upon all kinds of foreign lamps imported into the Russian Empire by 50 per cent. An undertaking is to be given by the new Trust to raise the standard of the Russian lamp industry, to build extensive factories at Moscow, and to give employment to over 5,000 persons.

**Lancaster.**—The electrical engineer-in charge (during the absence of Mr. W. A. Fraser at the front) having resigned his office, the Council have decided to appoint an engineer for electric lighting and traction.

**Leeds.**—Extensions of the electric lighting mains were authorised this week.

**Leicester.**—In a report of the Tramways sub-committee, the Council are recommended to adopt the overhead trolley system, to erect the power-station on land adjoining the refuse destructor works, to reconstruct the existing tramway lines, and to construct certain extensions and new lines of a total length of 20 miles.

**Letter-boxes on Tramcars.**—The electric tramcars at Coventry which ply between the outlying districts and the town have letter-boxes attached at the stopping places *en route*, where letters can be posted, which are collected on the arrival of the trams at the principal town termini.

**Light Railways.**—The Board of Trade have confirmed the Gosforth and Ponteland Light Railway Order (1900), authorising the construction of a light railway between Gosforth and Ponteland; the Wotton-under-Edge Light Railway Order (1900), authorising the construction of a light railway between Wotton-under-Edge and Charfield, Gloucester; and the Rhyl and Prestatyn Light Railway (Extensions) Order (1900), authorising the construction of light railways in Rhyl, in extension of the light railway authorised by the Rhyl and Prestatyn Light Railway Order (1900).

**Lisbon.**—The Lisbon Gas Co. holds an exclusive concession for electric lighting, but, so far as we have been able to ascertain, it only makes a sham use of this concession in order to prevent other bodies from competing.

The telephone system of the Anglo-Portuguese Telephone Co. has five exchanges and about 1,500 subscribers.

The Lisbon Electric Tramway Co., whose head offices are in London, holds a concession for the electric tramway now in course of construction. It is anticipated that the electric lines will be working towards the end of 1901.

**Llandudno.**—Additional condensing plant, estimated to cost £1,213, is to be erected at the electricity works, and application has been made for a loan of £1,500. The Electric Light committee reported this week that Mr. H. Morton, resident engineer, had applied for an increase of salary, which had stood at £250 from the beginning. He pointed out that there had been a profit of £400 on the working of the first completed year, and prospects were rapidly improving. The Council in committee had decided to postpone the consideration of the application until the close of the financial year. Mr. Morton thereupon asked for a testimonial, which it was agreed to give him.

**London County Council.**—At Tuesday's meeting, Battersea Borough Council was loaned £20,000 for electric lighting, and the Woolwich Council £15,000 for similar purposes.

The Fire Brigade committee proposed to spend £750 on the installation of the electric light at the new East Greenwich fire station, but the consideration of the subject was postponed till next sitting.

The Highways committee recommended

That, notwithstanding the provisions of the agreement entered into by the Council with Dr. A. B. W. Kennedy in accordance with the resolution of the Council of Oct. 10, 1899, the Council do accept the offer of Dr. Kennedy to act as electrical engineer for the reconstruction, for electrical traction, of the tramways between (*a*) Westminster-bridge and Tooting, (*b*) Kennington-gate and Blackfriars, and (*c*) St. George's-circus and Waterloo-road; that he be paid in respect of his services a commission equal to 4 per cent. on the cost of the reconstruction of the said tramways, and to 1 per cent. on the cost of buildings.

This was agreed to without discussion.

The same committee reported on the powers which the Council had obtained with reference to converting the tramways of London to an electric system. The committee regard it as desirable that the Council should have in its service an official competent to superintend generally the reconstruction for electric traction of the whole of its tramways, and that such official should be appointed as soon as possible in order that he may make himself fully acquainted with the work to be carried out under the supervision of Dr. Kennedy. Such an officer would be competent to carry out the construction of new lines and the reconstruction of the other parts of the Council's tramways, and to advise the Council generally on matters connected with the electric tramways. The total length of the tramways to be constructed and reconstructed was about 100 miles. The committee suggest that a salary of about £1,000 a year should be offered, and proposed that the new officer should be in the chief engineer's department, and should have a position analogous to that occupied by the mechanical engineer.

**Long Eaton.**—Application has been made for sanction to borrow £15,000 for electricity works.

**Madras (India).**—There are now 40 cars running on the electric tramways in this city, 38 of which have single motor equipment and two double motor. The length of line is 10 miles. The tramways are owned by the Madras Electric Tramways Trust, whose line commenced working as far back as May, 1895. The tramways are worked on the overhead system with underground feeders. The station is equipped with E.C.C. electrical plant, the engines in use being two 200 I.H.P. by the Burnley Ironworks, and one 100 I.H.P. and one 200 I.H.P. Willans, the latter not yet erected. A 25 I.H.P. Belliss engine drives the lighting plant.

The Oriental Telephone and Electric Co. have two telephone exchanges with 230 subscribers. The Government departments at Madras have their own telephone system.

The system of charge for local telegrams at Madras is on a graduated scale—one anna per word for deferred messages, two annas per word for ordinary speed and four annas per word for urgent messages.

**Manchester.**—At the adjourned meeting of the City Council, on Wednesday, Dr. Bishop moved the adoption of the report of the Electricity committee embodying the proceedings of the joint sub-committee of the Electricity and Tramways committees, recommending the appointment of Prof. A. B. W. Kennedy as electrical expert. The report stated that Prof. Kennedy had an interview with the sub-committee in Manchester, when it was explained to Prof. Kennedy that it was not expected that he would be under the necessity of attending in Manchester to supervise the general work conducted either at Dickinson-street or Bloom-street stations, but it was desired that he should from time to time advise the committee and the resident engineer upon all points arising in connection therewith and with the supply of electricity form Dickinson-street (and Bloom-street when completed), with a view to the working of tramways by electricity at the earliest practicable date. Prof. Kennedy undertook to send one of his assistants to superintend the work at Bloom-street. After discussion upon the question of terms, the following memorandum was drawn up and mutually agreed to subject to the Council's approval:—

"Prof. Kennedy's inclusive terms for the services rendered will be a commission of 4 per cent. upon all works executed by him, estimated at £400,000. In the alternative Prof. Kennedy will, at the option of the Corporation, accept in lieu of the aforesaid commission an inclusive sum of £15,000, payable by half yearly instalments."

Dr. Bishop said Prof. Kennedy had explained that he would not be able to give what might be called permanent superintendence. The committee never expected from him that which they would expect from a resident engineer; all they wanted was to assure themselves that Prof. Kennedy would exercise such supervision as would give the committee confidence that the work was efficiently done. Prof. Kennedy had undertaken to send down one of his own assistants, who would be present at all times. There was no point of dispute between Prof. Kennedy and the committee. It would be seen that the committee had reserved the right to ask Prof. Kennedy to accept a maximum sum instead of commission, although the reduction might not be so very considerable. He thought the committee, after much labour, had come to a decision which was a good one for the citizens.

Mr. Plummer asked whether the services of Prof. Kennedy's assistant were included in the £15,000 to be paid to Prof. Kennedy, or whether they had to pay the engineer in addition.

Dr. Bishop stated that that was included in the £15,000, but the £400,000 did not include the cost of the buildings.

Mr. Plummer said the main point was that there was nothing in the scheme now proposed which was not the carrying out of works already practically commenced and laid down by Mr. Wordingham, their own engineer. Was there to be any change in the scheme now proposed from that already developed?

Ald. Rawson said the sum of £15,000 to be paid for finishing work which had been well begun, and which had already cost the Council many thousands of pounds, seemed extremely large. Was that sum to be paid concurrently with the salary which, he presumed, they would have to pay, of £1,000 a year, to Mr. Wordingham, or would that payment begin when Mr. Wordingham's services were withdrawn? If those sums were to be paid concurrently it appeared to him to be very unbusinesslike and undesirable in all respects.

Mr. Pennington thought the recommendations of the Electricity committee resembled the changing of horses while crossing the stream. What astonished him in going through the reports which had been presented was not so much what Mr. Wordingham had not done as that he had been able to do so much considering the various details he had also had to attend to. The Electricity committee, he thought, had got into a state of panic, and up went the price of electrical experts. One great fact stood out in the voluminous reports—viz., that Mr. Wordingham in 1896 laid down a scheme for electric lighting, and that system had been recommended by

other experts for other large towns. In those towns it had been carried out to some extent, and had been proved to be a great success. He thought Mr. Wordingham could be very well entrusted with the work.

Mr. LAMBERT said that a fortnight ago he thought Mr. Wordingham should be approached by the Electricity committee in order that some arrangement might be made with him. He had had no communication with Mr. Wordingham, and did not desire to throw any obstacle in the way of the committee, because he fully realised the difficulties they had before them, but he had reason to believe that under no circumstances whatever would Mr. Wordingham consent to remain in his present position after the end of March next. Mr. Wordingham had stated in a letter that much of his scheme had been worked out, a considerable portion of the specifications were prepared, and everything would have been ready in time if he had not been hampered. He could not help thinking that if Mr. Wordingham had been approached by the committee with a view to securing his services in the nature of a consulting engineer, or something of that kind, the citizens would have been saved a very large sum of money. The committee, however, seemed to have made up their minds that it would not be proper to approach Mr. Wordingham, and they had therefore done the next best thing in endeavouring to secure the services of Prof. Kennedy. He thought, however, they had made a mistake in arriving at the conclusion that it was not desirable to secure the services of Mr. Wordingham.

Mr. JOHNSTON was not aware that Mr. Wordingham had made up his mind to leave the service of the Corporation. There seemed to be a wrong impression as to the work already done. It was quite true Mr. Wordingham had prepared specifications, but it did not follow that any other expert who might be called in would adopt those specifications. He regarded Mr. Wordingham as a most estimable and capable man.

Dr. BISHOP having replied, the resolution was adopted.

The telephone problem was again discussed at the meeting of the Corporation on Wednesday, but further consideration was postponed until February. The Telephone committee has been instructed to confer on the subject with the Salford and other urban authorities within the Manchester telephone area and report to a future meeting.

**Maidenhead.**—Sanction to a loan of £25,000 for electric lighting has been received by the Council.

**Marylebone (London)**—At last night's meeting of the Marylebone Borough Council it was decided to apply to the Board of Trade for an electric lighting provisional order.

**Municipal Telephony**—The Local Government Board has offered to grant a period of 25 years for repayment of any loan sanctioned by them for telephone purposes at Huddersfield, notwithstanding that the period specified in the licence was less than 25 years. The Council agreed that a licence for 25 years should be applied for.

**Nagasaki (Japan)**—The extensive Imperial Government Steel Works which are being erected here, and for which large appropriations have been made from the Japanese treasury, are well on the road to completion. The works are of an extremely comprehensive nature, and have been designed to be as complete as those of any other similar undertaking in the world. They already cover an area of about 225 acres, off the excellent harbour formed by the bay of Wakamatsu. On the completion of the works, electric power is to be employed on a large scale. The works are to be divided into three principal departments, in addition to which an extensive electricity generating station is to be established.

**Newton Abbot**. Edmundson's Electricity Supply Corporation, who possess a provisional order for this district, are negotiating for a site for the station.

**Paris-Rome Telephone Service.**—Work is being actively pushed forward on the French side of the Alps with the trunk telephone line between Paris and Rome, and the connections with Paris have been already completed. On the Italian side of the Alps the line is practically complete, the connections with Turin and Novi on to Genoa being all that remains in hand. It is fully anticipated that telephonic communication between the two capitals will be established early in the coming spring.

**Penny Postage.**—From Jan. 1 Imperial penny postage will be established between the mother country and New Zealand.

**Peterborough.**—The electricity supply works were formally opened on Wednesday. The consulting engineer for the scheme, which has cost nearly £20,000, is Prof. J. A. Fleming. Extensions are already being made.

**Private Bill Legislation.**—The City and Brixton Railway Co., incorporated in 1898, has deposited a bill for powers to extend the time to acquire the necessary lands until August, 1903, or two years beyond the time originally granted, and to raise £100,000 additional share capital and £ 3,300 by debenture stock.

As already announced, the directors of the District Messenger and Theatre Ticket Co. (Ltd.) have lodged a bill for powers to carry on and extend their business. This procedure is the outcome of the refusal of the Postmaster-General to reduce the royalties payable by the company and to renew their licences for more than five years. In the preamble of the Bill the directors point out that they have expended £140,000 in organising a messenger system, but that, up to the present, no dividend has been paid to the ordinary shareholders, although the Post Office has received, by way of royalties, 43 per cent. of the company's net revenue during the last five years. It is contended that the conditions imposed by the Postmaster-General are so onerous as to cripple the company's operations, and that, having regard to the large sum already expended, the company's business should be secured to them for an extended number of years, and that the royalties should be considerably relaxed. The company therefore seek statutory powers to carry on their business within 6 miles of the General Post Office for 42 years from April, 1903, with a payment to the Postmaster-General of £500 per annum, and an additional £100 for every 1 per cent. per annum paid as dividend to the shareholders over 5 per cent.

The promoters of the Liverpool-Manchester mono-rail express railway have lodged their revised bill. It is stated that the attempt to disarm opposition has been very successful, as it is understood that the objections of the Mersey Docks and Harbour Board and the Cheshire Lines Committee have been met, and that Salford is practically the only remaining opponent. It is now proposed to construct the line through Salford in a cutting. As to the Liverpool end of the line the scheme shifts the electric railway to the landward side of the Cheshire line, which will give the Cheshire Lines Committee access to the docks which they propose to construct. On the point of excessive speed, it will be submitted when the bill comes before a parliamentary committee, that the Board of Trade has sufficient powers to restrain the speed to safe and practicable limits. The capital has been fixed at £2,000,000, or £100,000 more than was proposed last year, and the Earl of Dysart's name has been added as a promoter.

**Rochester.**—The Council have instructed Mr. F. C. Raphael to advise them as to the value of the present distributing system of the Chatham, Rochester and District Electric Lighting Co. within the city at a fee not to exceed 20 guineas.

**Serambau.**—A correspondent writes us that there is, in this district, an opening for the introduction of small motors for driving sewing machines, &c., motors for pumping out water from and in mines, for wood sawing, coffee pulping, &c. The Government might safely be approached regarding electric lighting. Motor cars are shortly to be introduced to meet the urgent need for better systems of transport. The country is very hilly, and there are a number of small waterfalls.

**Stockton.**—The formal opening of the electricity works took place on Tuesday, when current was turned on and the public streets and shops illuminated. The main contract has been carried out by the Brush Company. £28,000 has been borrowed. Cables have been laid in the principal streets, and altogether there are 3 miles of distributor and 1¼ miles of feeder cables. Extensions of the street mains have already been arranged for. The charge for current is 6d. per unit for the first hour's maximum demand per day, and 2½d. per unit after. The charges for power are 5d. and 1d. respectively.

**Swansea.**—The Local Government Board have declined to sanction the application of the Corporation for a loan of £10,000 for wiring premises on the "easy payment" system, as the Board state that the Corporation have no authority under their act to carry out the work themselves. An agreement has now been entered into for a private company to execute the work. The Electric Lighting and Tramways committee have decided to supply electric current to the Harbour Trust.

**Telegraphic Communication with the Continent.**—The Postmaster-General last Friday received a deputation from the Liverpool Chamber of Commerce and other bodies regarding the delay in telegraphic communication between Liverpool and the Continent, and the congestion of traffic at St. Martin's-le-Grand. It was stated that the cotton market reports were telegraphed twice a day to Havre and Bremen via New York, as by that route they reached the Continent two hours earlier than via London.

Lord LONDONDERRY replied that the fault lay partly with foreign countries, and the points raised by the deputation would have to be placed before the various foreign Governments. The granting of increased communication between Liverpool and other towns would depend very much upon the amount of work which could be promised in return for the extra wires. There was a financial aspect of the question, and, therefore, the Treasury would have to be consulted.

The petition which was presented by the deputation gave a detailed account of the successive efforts of the Liverpool Chamber to secure increased facilities for telegraphic communication between Liverpool and the Continent during the past 16 years. The petition stated that it is still found best to communicate from Liverpool with the Havre and Bremen cotton markets by way of New York rather than through London, as a saving of two hours is, in this way, effected. It is asserted that the average time now taken by Continental messages is longer than it was five years ago, and, finally, the petition contains the following recommendations:—

(1) That the direct wire to Hamburg be worked, if possible, on the Duplex-Hughes system; (2) that the direct wires promised to Madgeburg, Lyons, Zurich, and Buda-Pesth be established, and that Munich and other important business centres of the Continent be connected with this country and Liverpool by direct wires; (3) that new cables to Germany, Belgium, and the Netherlands be provided; (4) that the French Government be urged to establish (a) direct wires between Havre and the cotton manufacturing towns of the north and east

of France, (b) telephonic communication between Paris and French provincial towns; (5) that Germany, France, and other countries of the Continent be urged to adopt the best possible system of delivery of telegrams; (6) that investigation be made into the question of congestion of traffic at St. Martin's-le-Grand, and that means be taken to relieve such congestion speedily, by providing more facilities, including more wires, there or at another English centre, for the rapid transmission of Continental messages; (7) that in order to obtain means for effecting some of the improvements desired the attention of Her Majesty's Treasury be drawn to the necessity of applying some of the large profits of the Post Office and some of the increased Customs revenue derived from Liverpool to telegraph purposes.

**York.**—The City Council have decided to acquire the undertaking of the City of York Tramways Co. for £12,000. The lines will probably be reconstructed and equipped electrically.

**B.E.T. Athletic Club.**—The athletic club attached to the B.E.T. Company recently held its second general meeting, the chair being taken by Mr. J. Devonshire, who stated that the ground at Shepherd's Bush was now being used for football and that the team had won four matches out of the first five played. On Friday last the club gave a successful smoking concert at Anderton's Hotel, London.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED

The *Leeds* Lighting committee will receive tenders for two sets of electricity generating plant, comprising two 2,000 B.H.P. engines, two two-phase 1,400kw. alternators and exciters, and two sets of surface condensing plant. Further particulars are given in an advertisement, and conditions may be obtained from the manager of the department (Mr. Harold Dickinson), 1, Whitehall-road, Leeds. Tenders to town clerk (Mr. W. J. Jeeves), Town Hall, Leeds, by Dec. 31.

*Farnworth* District Council invite tenders for eight 66-passenger tramcar bodies, motors, undertrucks, controllers, &c. An advertisement gives some further particulars, and specifications may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh, and Sillar), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Tenders must be lodged with the clerk (Mr. W. Tyldsley), Council Offices, Farnworth, Lancs., by Jan. 10.

*Dublin United Tramways Co.* require tenders for general stores, including car fittings, castings, electrical supplies, &c., for the year ending Dec. 31, 1901. An advertisement gives further particulars, and tenders, addressed to the Chairman, must be lodged with the secretary, 9, Upper Sackville-street, Dublin, by 31st inst.

Tenders are invited for the supply and delivery of various stores and electrical apparatus for the district asylum, *Mullingar* (Ireland). Further particulars are set out in advertisement, and forms of tender may be obtained from the resident medical superintendent. Tenders to be addressed to the Committee, District Asylum, Mullingar, by Jan. 3.

*Edinburgh* Corporation invite tenders for an extension (about 100 lamps) of the electric lighting installation at the City Chambers. Specifications may be obtained from the resident engineer (Mr. F. A. Newington), Dewar-place, Edinburgh, and tenders must be lodged with the town clerk (Mr. Thomas Hunter, W.S.) by 31st inst. See advertisement.

*Rathmines* District Council require tenders for boiler-house and engine-house plant, condensing apparatus and pipework, switchboard extension, mains, and public incandescent lighting. Tenders to clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, Dublin, by 4 p.m., Jan. 10.

*Partick* Burgh Commissioners require tenders for steam dynamos, battery-charging motor, booster and balancer. Tenders to town clerk (Mr. Jas. Donaldson), 97, West Regent-street, Glasgow, by noon of Jan. 7.

*Middleton* Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves and accessories. Tenders to Town Clerk by Jan. 2.

*Brighton* Corporation require unarmoured and armoured lead-covered electric cables for year ended Dec. 31, 1901. Tenders to Town Clerk, Town Hall, Brighton, by 24th inst.

Visitors' committee for County Asylum, *Winwick*, near Warrington, require tenders for wiring, &c. Tenders to Clerk, County Offices, Preston, by Dec. 29.

*Hendon* District Council invite tenders for electricity generating plant and apparatus. Tenders to Clerk, Public Offices, The Burroughs, Hendon, by 4 p.m. Dec. 31.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal-buildings, Lavender-hill, S.W., before noon Feb. 1 next.

*Ayr* Corporation require tenders for the construction of tramway permanent way, rail-laying, &c., of about 5¾ miles of tramways. Tenders by 28th inst.

*Swindon* Corporation require three steam dynamos, balancer, and motor generator. Tenders to acting town clerk by Dec. 24.

*Thetford* Town Council require tenders for wiring the new Town Hall. Tenders by Jan. 1.

*Worthing* Corporation require tenders for a main switchboard. Tenders to Town Clerk by noon Dec. 31.

The *Metropolitan Asylums Board* require tenders for wiring the new asylum at Tooting Bec. Tenders by Jan. 2.

*Harrogate* Corporation require two boilers, with fittings and economiser. Tenders by 25th inst.

*Manchester Ship Canal Warehousing Co.* require 22 electric cranes. Tenders by Jan. 4.

*Manchester* Tramways committee require tenders for rail bonds. Tenders to chairman by Saturday, 22nd inst.

*Salisbury* Corporation invite tenders for a refuse destructor, two boilers and two steam pumps. Tenders by 28th inst.

*Ayamonte* (Seville) Municipal Council require tenders for the concession for electric lighting. The street lighting is equivalent to over 2,250 c.p., and the price to be paid is £223 per annum. Tenders by 14th prox.

The Director-General of Public Works, *Madrid*, requires tenders for the construction of an electric tramway from Ferrol to Santa Maria de Neda. Tenders by 15th prox.

### TENDERS RECEIVED AND ACCEPTED.

Brighton Corporation received the following tenders for points, crossings, sole-plates, manhole covers, with frames, tie-bars, fish-bolts, and other bolts for fastenings, in connection with the municipal tramways:—

Section A (Points, &c.).—Askham Bros. and Wilson, Ltd. (accepted), **£1,943 0s. 0d.**; Steel Casting Co., £2,153. 2s. 6d.

Section B (Sole Plates).—Askham Bros. and Wilson, Ltd. (accepted), **£760. 8s. 4d.**

Section C (Manhole Covers, &c.).—G. Cash & Co. (*accepted*), **£276. 3s 9d.**; Watson, Gow & Co., £535. 2s. 6d.; Askham Bros. & Wilson (Ltd.), £466. 2s. 6d.; J. and A. Law, £433; Mechan & Sons, £429. 2s. 6d.; T. B. Smith, £415. 2s. 6d.; J. Melborne (Ltd.), £383. 3s. 9d.; Hill and Smith, £347. 13s. 9d.; Bird & Co., £327. 17s. 6d.; Ruabon Foundry Co., £325. 12s. 6d.; C. G. Reed & Son, £324. 17s. 6d.; Brown and Green, £293. 5s.; Pontifex & Co., £288. 7s. 6d.

Section D (Tie-bars, &c.).—Askham Bros. and Wilson (accepted), **£913. 12s. 7d.**; J. Hitchen, £1,630; C. G. Reed & Son, £1,250; A. Horten, £1,141. 17s. 6d.; Patent Nut and Bolt Co., £1,090. 7s. 9d.; Baylis, Jones and Baylis, £1,090. 7s. 6d.

Tenders from Howard Smith, the Lorain Steel Co., E. Le Bas & Co., and Ibbotson Bros. were not to specification.

Brighton Town Council have accepted the tender of Macartney, McElroy & Co. for the construction of the permanent way of the electric tramways, &c., at £102,487. 14s. 5d.

The London County Council have accepted the offer of Messrs. Macfarlane & Co. to erect the lamp standards now being manufactured by them for the electric light installation on the Embankment and Westminster Bridge, for £178. 10s. 6d.

Dublin Corporation received the following tenders for the erection of electricity station buildings on the Pigeon House site: Stewart & Co., Belfast, £41,000; Good & Co., Dublin, £47,000; Martin & Co., Dublin, £47,000; and Pearson & Co., London, £52,000. It was decided to instruct the borough surveyor (Mr. S. Harty) to report on the tenders at the next meeting of the Electric Light committee.

Heywood Corporation have accepted the tender of Messrs. W. J. Fryer & Co. (Ltd.) for wiring premises in the district on the easy payment system.

Ayr Corporation have accepted the tender of Messrs. Hurst, Nelson & Co. (Ltd.) for the supply of electric tramcars for their electric tramway scheme at £5,673.

Barnes District Council have accepted the tender of the Schattner Electricity Meter Co. for the supply of 100 meters at £315.

At a special meeting of the Portsmouth Town Council on Tuesday, the following tenders for electric tramway plant, &c., were accepted:—

| | |
|---|---|
| Dick, Kerr & Co. (permanent way and feeders) ....... | £202,409 6 4 |
| Macartney, McElroy & Co. (overhead construction) ... | 18,280 0 0 |

### BUSINESS NOTICES.

Messrs. D. Urquhart and J. M. Small (carrying on business as Urquhart and Small), consulting electrical engineers, 17, Victoria-street, London, S.W., have dissolved partnership. Debts by Mr. J. M. Small.

Mr. A. P. Lundberg, 477–487, Liverpool-road, N., has appointed Mr. Edward Unsworth, of 8, Greenhill-street, Greenheys, Manchester, his representative for Lancashire.

## BANKRUPTCIES, LIQUIDATIONS, &c.

The Macroom and District Electric Lighting Syndicate (Ltd.) is to be wound up voluntarily. Mr. H. Shaw, 43, Rosamond-street East, Manchester, is liquidator, to whom claims by Jan. 29.

Claims against the Manchester Electrical Works (Ltd.) are to be sent to the liquidator, Mr. J. Fitzpatrick, 147, Leadenhall-street, London, E.C., by Feb. 1.

The creditors of Shirras, Laing & Co., electrical sundriesmen, Aberdeen, will meet at Edinburgh on Dec. 27 to appoint trustees. Claims have to be sent in by April 4.

---

**Plant for Sale.**—Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C., advertise for sale a Willans-Crompton lighting set.

**Westinghouse Plant.**—Belt-driven, single-phase Westinghouse alternators are well illustrated and described in circular No. 1,036 issued by the Westinghouse Company.

**Insulators and Fittings for Electric Tramways.**—Mr. F. Winter, 8, Redcross-street, London, E.C., has issued a pamphlet describing and illustrating a number of accessories for electric tramway working manufactured in vulcanite. These include insulators, insulating bolts, brake handles, soft rubber fittings, &c. Mr. Winter claims that long experience in the manufacture of vulcanite goods, and an extensive acquaintance with the requirements of the electrical industry in regard to this special branch of work, enables the Harburg Indiarubber Co., whom he represents as sole agent for the United Kingdom and the colonies, to satisfactorily cater for these special requirements. Light weight, compactness, strength and durability are among the advantages claimed for these goods.

**Diaries, Calendars, &c.**—A useful diary is sent out by the Gloucester Railway Carriage and Wagon Co., which contains a large variety of illustrations of forms of vehicles for almost all purposes. For vehicles for railways and tramways the company have special facilities. In addition, the "Diary" will be found especially handy from its size and get up.

From Messrs. G. Street & Co., 30, Cornhill, E.C., the well-known advertising contractors, we have to acknowledge a well-executed, framed and glazed calendar for 1901—an old favourite.

From the Eastern Telegraph Co. comes a useful pocket diary and perpetual calendar, accompanied by a map showing the cables of the world, &c.

**Fire.**—A serious fire occurred on Saturday night, between 9:30 and 10 p.m., at Millwall docks, on the river Thames, and the premises involved included those of Hooper's Telegraph and Indiarubber Works, Ltd. Before the fire brigade arrived the testing offices, cable shed and mill were well alight, and were ultimately totally destroyed. A portion of the premises occupied by the engine rooms and machine shops was badly damaged, but the main engines were uninjured. We learn that no finished cable on the premises was burnt. At midnight the fire reached its height and had attacked the adjoining premises of Messrs. W. F. Dennis & Co. By sheer hard work the firemen were soon able to confine the conflagration to the buildings originally attacked, but the fire was not completely extinguished until early Monday morning. It is impossible to estimate the total damage caused by the fire. Hooper's Company were engaged on three contracts for the Great Northern Telegraph Co. and two large contracts for heavy cable for the War Office. Efforts are being made to arrange for the temporary carrying on of the works until permanent arrangements can be made. We are informed that, although some damage was caused to the premises of Messrs. W. F. Dennis & Co., the firm's business will not be interfered with in any way.

**Customs Dues.**—Notification is given by the India Office that dynamos, accumulators, motors and electric fans imported into India are to be treated for tariff purposes as "machinery," and as such, to be exempt from import duty. Electric lamps and cables will continue to be treated as "appliances," and be liable to duty.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 12 to Dec. 18, with the ports of destination:—

*Africa*—Cape Town, £310; Durban, £99. *Australasia*—Fremantle, £1,349; Melbourne, £2,232 (including £909 telegraph material); Perth, £133; Sydney, £2,668 (including £1,264 telegraph material). *Azores*—Fayal, £927 (telegraph apparatus). *Belgium*—Ostend, £194. *Brazil*—Rio Janeiro, £563 (telegraph material). *British Guiana*—Demerara, £770 (telegraph material). *China*—Shanghai, £205. *Colombia*—Santos, £417. *France*—Paris, £16. *Germany*—Hamburg, £300. *Holland*—Amsterdam, £55; Rotterdam, £23 (telegraph wire). *Hong Kong*, £1,037. *India*—Calcutta, £729 (including £212 telegraph material). *Japan*—Nagasaki, £22. *Russia*—Kure, £5,458 (telegraph cable); Libau, £940 (telegraph apparatus). *Siam*—Bangkok, £64. *Straits Settlements*—Singapore, £901. Total £19,362, against £20,973 in the corresponding week last year Dec. 13 to Dec. 19).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

October 6, 1900.

17,715. C. J. VARICAS. Weymouth. Improvements in torpedo-steering and appliance to permit of wireless telegraphic influence being received by submerged torpedoes for steering or other purposes.

17,722. C. M. STEAD and F. SCOTT. Leeds. Improvements in or in connection with electric light fittings.

17,723. C. M. STEAD and F. SCOTT. Leeds. An improved fitting for incandescent electric lights.

17,724. C. T. BATCHELOR. Birmingham. Improvements in dynamo-electric generators. (J. G. H. Batchelor, Brazil.)*

17,757. W. P. THOMPSON. London. Improvements in and relating to electrode plates. (The Akkumulatoren und Elektricitäts-Werke Aktien Gesellschaft vorm. W. A. Boese & Co., Germany.)*

17,765. P. SCHARF. London. An improvement in connecting the glow bodies of incandescent electric lamps to the leading-in wires.

17,773. S. Z. DE FERRANTI. Lancashire. Improvements in alternating current electric generators.

October 8, 1900.

17,811. F. H. BOWMAN and T. A. ROSE. London. An improved electric arc lamp.

17,829. J. WILKINSON. London. An improved device for measuring upward pressures and particularly for enabling the trolley arms of electric tramcars and vehicles being set to exert a certain upward pressure on the wire.

17,846. C. SHORE and C. HEAP. Manchester. Improvements in telephones.*

17,865. T. VON ZWEIGBERGK. London. Improvements in the operating mechanism of electric controllers.

October 9, 1900.

17,904. J. ELLIS. London. Improvements in or relating to electric meters.

17,916. M. W. W. MACKIE and E. J. GLYN. London. Improvements in dynamo-electric machines.

17,917. H. W. WEBB. London. Improvements in means and apparatus for relaying electrical currents.

17,929. C. ADAMS-RANDALL. London. Improvements in telephonic repeaters or relays and circuits connected therewith and therefor.

17,932. C. F. CABIT. London. Improvements in phonographs, graphophones and like sound-recording and reproducing apparatus.

17,941. H. B. SWIFT. London. Improvements in or relating to electrical arc lamps.

October 10, 1900.

18,000. W. E. ROWLANDS. Liverpool. Improvements connected with overhead trolley poles used in electrical traction.

18,001. J. P. HALL. Manchester. Improvements in or applicable to switches for electro motors.

18,006. H. TIGHT. London. Improvements in conduits for electric conductors.*

18,017. F. MYERS. London. Improvements in phonographs.*

18,031. M. G. KELLOGG. London. Improvements in telephone systems.*

18,036. A. J. BOULT. London. Improvements in or relating to thermo-electric generators. (A. Tissier, France.)

18,044. G. E. HEYL-DIA. Liverpool. Improvements in or relating to covering the conductors of multiple or other telegraph or telephone low-capacity cables.

18,045. G. E. HEYL-DIA and W. E. HITCH. Liverpool. Improvements in distributing heads or terminal boxes for electric cables.

18,046. J. POLIAKOFF. Liverpool. Improvements in receiving apparatus for photophones and photophonographs.*

18,056. E. J. KISS. London. Improved encasement for electric cables

18,058. E. DINOIRE. London. Improvements in magnetic rotary motors.*

18,059. G. B. MARZI. London. Improvements in electrical earth lines.*

October 11, 1900.

18,066. A. M. CROOKER and F. N. MCDONALD. Kingston-on-Thames. Improvements in electrical exercising apparatus.

18,099. F. PORSCHE. London. Improvements in or relating to electrically-driven vehicles.*

18,114. C. SCHALLER. Liverpool. Improvements in polyphase alternating-current transformers.*

18,119. H. D. BARLOW and L. BARLOW. London. Improvements in connections for electric fuse-boards, switches, and like apparatus.

18,127. T. VON ZWEIGBERGK. London. Improvements in the distribution of electricity to a plurality of electromotors.

October 12, 1900.

18,156. W. P. MILES. Grove Park. An improved method of automatically regulating the flow of liquids, gases, electricity, chemicals and powders.

18,175. P. ROYER. London. An improved advertising clock either combined or not with an electric alarum or call.*

18,184. THE SPIRAL GLOBE (LTD.) and E. A. LIVET. London. Improvements in shades of electric incandescent lamps.

October 13, 1900.

18,233. R. F. HALL. Birmingham. Improvements relating to electric terminals for cable connections.

18,234. R. F. HALL. Birmingham. Improvements in electrical switches or contact-breakers.

18,235. L. N. WILLIAMS. Bristol. An improved lighting device for electrically lighting miners' safety lamps.

18,254. P. BROWNE. London. An automatic switch to be used on wires carrying electric currents for the purpose of cutting off these currents when the main wires break from any cause or are otherwise interrupted.

18,269. E. A. ASHCROFT and J. SWINBURNE. London. Improvements in or relating to the electrolysis of fused chlorides or metallic salts.

18,281. H. W. LEONARD. London. Improvements in the control of electric motors and similar devices from several different points, and in the means therefor.

18,282. J. A. JECKELL. London. Improvements in the junction boxes for electric cables and in forming branch connections therefrom.*

18,283. J. HETHERINGTON and THE BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.). London. Improvements in junction boxes suitable for connecting electric conductors.

18,284. A. F. BERRY and THE BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.). London. Improvements in electric transformers.

October 15, 1900.

18,298. C. B. WALKER. London. Improvements in electric couplings.

18,345. A. W. GREELY. London. Improvements in telegraphic codes.

18,347. V. I. FEENY. London. Switch apparatus for electrically-propelled vehicles. (Allgemeine Electricitäts-Gesellschaft, Germany.)*

18,357. G. E. HEYL DIA. Liverpool. Improvements in and in apparatus for taping insulated conductors.

18,372. L. SCHREINER and G. E. N. MICHAUX. London. An operating device for the regulating mechanism of the electric ignition of explosion motors.

18,376. R. P. STRACHAN. London. Improvements in or relating to trolley poles for electric traction and power purposes.

October 16, 1900.

18,434. C. OLIVER. London. Improvements in or relating to the feeding mechanism of arc lamps.

18,451. W. A. McCALLUM. London. Circuit controller for electric street railway cars and other uses.*

18,471. W. E. PUGSLEY, H. M. DESCHER, V. L. DOUGLASS, and W. J. ROBINSON. London. Improvements in electric arc lamps.*

18,472. E. C. KINSEY. London. Improvements in phonograph-record carbon receptacles.*

October 17, 1900.

18,497. J. D. MILLER. Glasgow. Improvements in coin-freed apparatus chiefly for telephone instruments.

18,498. W. DEWAR. Dundee. Improvements in automatic guards or protectors for electric or other tramway cars.

18,259. L. SCHRAMM. Westcliff-on-Sea. Improved electric heat generator.

18,534. H. S. ANDERSSON. London. Improvements relating to electrically operated clocks.*

October 18, 1900.

18,557. H. OPPENHEIMER. London. Improvements in and connected with lightning arresters and high voltage guards or heating coils for telephonic purposes.

18,613. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in rectifiers for periodic electric currents. (A. D. Lunt, United States.)*

18,614. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in end play devices for rotary electrical machines. (H. Geisenhoner, United States.)*

18,615. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electro-magnetic blow-outs or fuse boxes. (E. M. Hewlett, United States.)*

18,616. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric controllers. (F. E. Case, United States.)*

18,617. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in high-potential electric circuit-breakers. (E. M. Hewlett, United States.)*

18,618. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electrical indicating and measuring instruments. (L. T. Robinson, United States.)*

18,645. A. PARKER. Manchester. Improvements in electric furnaces.

18,649. H. EDMUNDS. Improvements in or connected with apparatus for making tubes of lead or the like, and for sheathing electric cables with lead or the like.

18,650. P. DE CHIMKÉVITCH. London. A new or improved system of and apparatus for secret electric transmission.

October 19, 1900.

18,661. S. G. BROWN. London. Improvements in wireless telegraphy.

18,681. H. SIMPSON and R. THOMLINSON. Liverpool. Improvements in electric fire alarms.

18,705. J. HAYEM. London. Improvements relating to electrically-heated laundry irons and like appliances.

18,707. H. H. LAKE. London. Improvements relating to micro-telephonic apparatus. (The Telephon-Fabrik Actiengesellschaft vorm. J. Berliner, Germany.)

18,718. W. SECK. London. Improvements in magneto-electric ignition devices.*

18,729. J. G. LEMON and G. PIRIE. London. Improvements in or connected with the generation of electricity.

October 20, 1900.

18,741. J. JOHNSTON. Glasgow. Improvements on those systems of electric tramways and railways in which current is collected from two insulated conductors (positive and negative), such improvements being in connection with crossings and turn-outs.

18,742. C. T. BRISCOE. Halifax. Improvements in electric lamp holders.

18,757. C. R. BELLAMY, W. J. TURNER, and D. R. W. HARDMAN. Liverpool. Improvements in safety devices for the trolley poles of electric cars.

18,762. S. G. BROWN. London. Improvements in wireless telegraphy.

18,779. C. CHEAL and H. J. MILLNER. London. Improvements in electrical circuit closers, particularly adapted for use with the indicators of railway signals.

18,789. F. L. CATENHUSEN. London. Improvements in and relating to electricity meters.

18,793. W. CHAPMAN. London. Improvements in or relating to electric railways operated on the conduit system.

18,794. W. CHAPMAN. London. Improvement in insulators.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

11,406. ZEHDEN. Electrical equipment of railway vehicles for the purposes of lighting, heating and ventilation.

11,429. VOSKUSSEN and LINDENSTRUTH. Electromagnet of high attractive force.

11,557. POTTER. Ballast resistances and cut outs for Nernst lamps.

11,558. WURTS. Systems of lighting by Nernst or like electric lamps.

11,559. WURTS, POTTER and HANKS. Starting apparatus and cutouts for Nernst and like electric lamps.

11,597. OSBURN. Flexible conduits for electrical conductors.

11,659. HAASE and RÖDER. Electric cutout plug.

11,797. BRITISH THOMSON-HOUSTON CO. (LTD.) (Thomson). Regulating devices for alternating electric current circuits.

11,819. SIEMENS BROS. & CO. LTD. (Siemens and Halske Aktiengesellschaft). Instrument for measuring rotary field currents.

11,915. TOMB. Trolleys for electric railways or tramways.

12,003. WETTER (Gomant). Dynamo electric mine exploders or apparatus for firing explosives.

12,009. LAKE (Gordon). Apparatus for receiving and recording messages.

12,321. KAEFERLE. Collector or commutator for electrical machines.

12,434. LAKE (Burke, Kaufhold and Russell). Manufacture of carbon for electrical and other purposes.

12,672. VOELKER. Manufacture of glass by electrical heating and apparatus therefor.

12,673. VOELKER. Manufacture of glass by electrical heating.

12,735. PUPIN. Art of reducing attenuation of electrical waves and apparatus therefor. (Date applied for under International Convention Dec. 14, 1899.)

13,095. MACRAE and MACRAE. Storage battery electrode.

13,720. BRITISH THOMSON-HOUSTON CO. (LTD.) (Berg.) Methods of operating dynamo-electric machines.

13,816. ROOPER. Storage batteries.

13,969. BRITISH THOMSON-HOUSTON CO. (LTD.) (Emmet.) Insulated electric conductors.

13,972. BRITISH THOMSON-HOUSTON CO. (LTD.) (Lunt). Systems of electrical distribution.

13,973. BRITISH THOMSON-HOUSTON CO. (LTD.) (Emmet.) Insulated electric conductors.

# COMPANIES' MEETINGS AND REPORTS.

## Marconi's Wireless Telegraph Co. (Ltd.).

The fourth ordinary general meeting was held on Tuesday under the presidency of Major S. FLOOD PAGE (managing director).

The SECRETARY (Mr. H. W. Allen) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, you will see that the balance sheet is for a period of 13 months, the reason being that Aug. 31 was the day on which we formerly closed our books, and it was found to be inconvenient, and also when the time comes for the International Company to be paying dividends, their financial year ending on June 30, we must give them time to make up their accounts, and, therefore, we have changed the end of our financial year to Sept. 30. Turning now to the report on capital account, the only change is that £1,000 additional shares have been issued. A note to this item says: "Of the unissued shares 13,500 are subject to the option reserved by an agreement of Aug. 30, 1900." That transaction has now been closed. The company have received under it £37,500, but only £1,076 of that amount comes into the present accounts. On the other side of the account stock, as you will see, has been increased from £4,515 to £9,111. The plant and machinery, which last year was under £300, is now £1,692. Patents, which stood last year at £77,010, have increased to £78,164. We hear a great deal regarding German patents, and everybody who has German patents thinks he something of value. This is especially the idea on the Continent, and it appeared a little more than a year ago that we were in difficulties with the German patent office. My colleagues

asked me to go to Berlin, and I was then able to explain to the German patent office authorities something about the Marconi wireless telegraph system. In Germany anyone may oppose the issue of a patent, and, as a matter of fact, from 40 to 60 per cent. of such applications are refused. We were unable to quite convince the gentlemen referred to of the merits of the Marconi system so we offered to give them a demonstration as practical proof, especially as they thought there were certain parts of the apparatus which had been anticipated. By arrangement we manufactured the apparatus which we demonstrated with according to the patents which they regarded as an anticipation of our own. I was accompanied to Berlin by Dr. Fleming, and a commission appointed by the Berlin authorities met us at Borken, where our assistants were at work, and we demonstrated to their satisfaction that that which they had regarded as an anticipation would not work at all, whereas we were working and are still working at a distance of 20 miles with complete ease and regularity. The result is that we have obtained our German patents this month. Our agent also considers that our further applications for German patents—and there are several—have a very good chance of being granted. I should like to say one thing with regard to the German and Unites States systems of granting patents. In this country a patent committee sits at the Board of Trade, and consists of the Lord Chief Justice, Lord Justice Fry, Mr. Fletcher Moulton, the President of the Chartered Institute of Patent Agents, and others. A short time back I was examined before that committee, and I went prepared to argue against the introduction into this country of either the German or the United States system of granting patents. I congratulate this country on the resolution of the committee not to introduce into this country any portion of the United States or German system of granting patents. It is, in my opinion, most improper to give to officials—paid officials—power to reject applications for patents. I will reserve my remarks on Mr. Marconi's new patents to a later stage. With regard to the arrangement with the International Company, by which this, the parent company, has received £100,000 in fully-paid shares; you will see the auditors have not carried this amount out. As to the value of these shares we cannot tell you. There are very few transactions in them, but the shares on which 5s. has been paid are being sold, when they are sold, from 7s. 6d. to 8s. or 8s. 6d. We have not at present put any value upon them, but I anticipate that either myself or my successor will one day have the gratification of congratulating the company on the great value of this £100,000 of shares in the International Company. You will see that cash at bankers and at deposit stands at £9,005, and that the profit and loss account balance, which is the total amount from the commencement of the company's operations, comes to £24,859. The expenditure up to Aug. 30, 1899, the end of the previous financial year, had been £10,960, and we had stock at that time amounting to £4,236. Against this latter item, purchases and wages now stand at £10,854. This is proof that we are beginning to live—that we are now actually earning money. The amount for salaries and directors' fees, £5,926, represents rather more than £1,000 of directors' fees, as the period covered is 13 months. The remainder is salaries, and, with the following item (travelling expenses) may be considered large in so small a business, but we have 24 more or less technical men in our employ who go about to various places, and some of these journeys have been to Hawaii, Germany, Newfoundland, Chili, Malta, Spain, and other countries, as well as doing a great deal of work that has been undertaken for the Navy, some of them being engaged with Mr. Marconi in his important experiments, on the success of which our fortunes materially depend; and when you consider all these things you will realise that these men are expensive men, and that the travelling expenses must necessarily be high. We must have a staff prepared and ready for work and to go anywhere to do that work. The item of sales and royalties appears for the first time in this balance-sheet. It is the first time we have been able to show in any audited accounts that we have practically commenced business. We now come again to the balance-sheet, and to the item of £24,858. When I addressed you in February last I had only a short experience of the company. This experience is now a longer one, and I feel quite sure that the expenditure represented by the above sum is most moderate and has been absolutely necessary, and that without it we could not have attained the position we have attained or have been able to undertake any work which may come to us. The directors' report informs you that the International Company has also commenced work, in the sense that they are employing our men to do certain work which has come to them. We do a great deal with the Belgian Government, as several members of the Cabinet are greatly interested in the Marconi wireless telegraph, and are backing us up in that country. The King of the Belgians is personally interested in the system, and on the occasion of a recent visit Mr. Marconi and myself were graciously received and kindly treated by the King. It would not be right for us not to acknowledge His Majesty's direct personal interest in this great development of scientific discovery. The Belgian Government have had one of their ships fitted with our apparatus, and we look to its extension to other vessels of the fleet. This is not the only reason why I think the action of the Belgian Government is important. There are great difficulties in negotiating with foreign Governments. One of these difficulties we have had to contend with is the action of the great cable companies in closing the cables during the war. You know that Germany has now got a cable of its own, you know that France is about to have one of its own, and there is a very great objection to what they call the increase of the English monopoly of telegraph work. We had hoped that our Continental friends would be able to overcome that. We not only hope, but feel sure, that the assistance they are getting from the Belgian Government, keeping England a good deal in the background, and allowing the negotiations to be done entirely by representative foreigners in their respective nations, will materially assist us, as others will be more likely to follow what the Belgian Government are doing. Then we come to what we say is the chief business event of the year, and it undoubtedly is. We have completed the whole of the 32 sets of apparatus for Her Majesty's navy. I am not going to enlarge on the difficulties that had to be surmounted before the system was adopted by the Admiralty. It was put to a very severe test, and it is a matter of profound satisfaction to know that in every instance there was no failure or breakdown in the slightest degree, and those ships are now going all the world over, and what are they doing? They really and truly are a moving certificate of Mr. Marconi's wireless telegraphy. Not only has the "Glory" gone to China, but the Channel fleet is in Lisbon, and you may have seen the other day that when the "Diadem" was 40 miles away she signalled to the fleet in Lisbon, and the King and Queen of Portugal were very much astonished, and the King sent a message from the "Majestic" to the "Diadem" congratulating our navy on having Mr. Marconi's installation on board. I have not the slightest doubt that before long we shall see the commercial shipping companies following the navy in this matter of wireless telegraphy. With regard to the works at Chelmsford these have been greatly improved, and we can now turn out all the apparatus that we are at all likely, and can possibly, I think, require during the coming 12 months. Not so very long ago, if we had been asked to undertake orders, if they came in rapidly, we should have been—well, I would very much rather be in the present position than that of 12 months ago if orders came in rapidly. Now as to Mr. Marconi. He has made great advances lately, some of which are of most undoubted value. We shall shortly be able to bring them into use, and may expect to derive much advantage therefrom. You may think that I ought to enlarge on the sentence in the report which speaks of the advances made by Mr. Marconi. I shall be obliged if you would allow me not to do so. In one of the newspapers a few days ago, when our report came out, I read these words: "Marconi's Wireless Telegraphy without exaggeration." Gentlemen, if we are to do a sound commercial business it cannot be done by exaggerating and declaring we are going to do things before we have done them. If there is one thing which has distinguished Mr. Marconi it is this, that he never has proclaimed in public that he can do a thing until he has assured himself he is able to do it. It is, however, perfectly true we are making improvements. We have agreed that neither the Admiralty nor anybody else shall see them until the patents are completed. Take our word for it, the improvements are great and give promise of great advances, but do not at this moment ask us to enter into details, because I should hope that by the end of January we shall be able to show the Admiralty what the new patents are, and I should explain that we have a provisional contract with the Admiralty as to their use of the improvements should they think fit to adopt them. I now move the adoption of the report and accounts.

Mr. W. W. GOODBODY seconded the motion which was carried unanimously.

Mr. Guglielmo Marconi and Mr. John Mooney, the retiring directors, were then re-elected, as were the retiring auditors, Messrs. Cooper Bros.

An extraordinary meeting was then held, at which certain alterations were made in the articles of association.

A vote of thanks to the chairman and directors terminated the proceedings.

## Nernst Electric Light (Ltd.)

The first ordinary general meeting of this company was held on Wednesday, under the presidency of Sir HENRY C. MANCE (chairman of the company).

The SECRETARY (Mr. G. Opitz) having read the notice convening the meeting, and a notice sent out by Mr. Benn Zusman (one of the directors) intimating his intention to move resolutions requiring the directors to invite the managing director of the company to resign from that position, and from the position of director of the company, and to allow Mr. Zusman unrestricted access to the books, papers and documents of the company,

The CHAIRMAN said: First, allow me to express the pleasure we all feel at seeing Prof. Nernst once more amongst us, and I take this opportunity of expressing our congratulations at his having been awarded the Grand Prix at the Paris Exhibition on account of his beautiful invention. And now, commencing with the debit side of the balance sheet, the £554 due to sundry creditors is on account of materials, &c., purchased during the month of September, but not paid for until the following month. Passing to the credit side, I may say at this point that if some of the items appear large it is in consequence of the accounts covering a period of 19 months. The payment of £1,523 on account of legal charges is almost entirely for the latter, which amounted to £1,350. This payment was under the advice of counsel. The £771 for law charges in connection with the acquisition and registration of patents is self-explanatory. The following item on account of English royalties has been referred to in the report, and I trust will ultimately prove a very satisfactory investment. Your directors are not without hope that our right to these royalties may enable us to come to some satisfactory and mutually advantageous arrangement when the English company is brought before the public. The expenditure on the laboratory and workshops have, I think, considering the importance of the work which has been carried out, been moderate. The items under development and suspense account are sufficiently in detail to explain themselves. The £562 paid to Mr. Swinburne, our consulting engineer, includes the charge for a good deal of work done in that gentleman's laboratory. The directors' fees include the salary of the managing director, which should, I think, have been placed under the head of management. The item for travelling expenses includes the cost of several visits to Berlin and Gottingen, and also the works manager's almost weekly journeys to Birmingham and Hanley. It will be seen that £20,311 has been invested—half in Bank of England stock and the other half in Consols. Of the £14,347, £10,000 have been placed on deposit account at the company's bankers. As many shareholders were not present at our statutory meeting, and many of you have

become shareholders since that time, I may be permitted to recapitulate. At that meeting Mr. Swinburne, our consulting engineer, advised us not to be precipitate in putting the lamp on the market, and I think he predicted that the autumn of this year would be about the time when we should be prepared to issue the lamps to the public. The invention was handed to us in what I may call a laboratory stage. I quite agree with Mr. W. Swinburne that the invention constituted an immense advance in electric lighting, but the invention was handed to us in a crude form. It was practically untried. We had to deal with a new industry, and with the exception of the technical staff provided for us by the promoters we were absolutely ignorant of the difficulties which might occur in developing the invention into a commercial success. This invention had been in the hands of the promoting syndicate for some time. So far as I can ascertain, they did absolutely nothing to satisfy themselves as to whether the invention was ripe for launching on the public. In my opinion, they knew perfectly well that a considerable amount of work would be necessary before it would be safe to attempt to place the lamps on the market, and this amount of work would necessarily occupy a period of many months. You must remember that we took over a new industry, and we were absolutely dependent on the technical staff. Before we could place out our future policy we had to produce a commercial article. I have reminded you that this industry is an entirely new one. We will put on one side the scientific thought which has been necessary to bring this invention to a point which would justify it being issued to the public commercially. The unfortunate occurrence of the fire has been mentioned in the report, and I need not refer to it any further; a difference of opinion between our landlord and the insurance offices involved an unnecessary delay of many weeks. During this time, however, we were not idle, and additional accommodation for the training of the staff was secured in the immediate vicinity. I should like you to understand that I do not make these remarks by way of apology but simply as an explanation to which you as shareholders are entitled. If I wanted any excuse as regards the delay in placing the lamps on the market I should draw your attention to the fact which has been referred to in the report, but notwithstanding that we are at a great disadvantage as compared with the owners of patent rights of the world we are quite as much advanced. I believe I am correct in stating that Mr. Westinghouse, the General Electric Co., of Berlin, and Messrs. Ganz & Co., of Buda Pesth, had the control of these patents 12 months before us, and I should very much doubt if at the present moment they are any further advanced; indeed, I have just received a telegram from Messrs. Ganz saying they would not be prepared to issue lamps before April or May next. Rightly or wrongly, it was considered a retrograde movement to introduce to the public lamps which required lighting with a match. The technical staff was strongly of opinion that a much better lamp might be placed before the public, and there is no doubt that they were influenced by the consideration that if an immature lamp were placed in the hands of the public there would be innumerable patents taken out which would seriously embarrass the company in the future. In adopting the policy of delay we have only followed the example of all the others who have acquired any rights in connection with the Nernst lamp. The General Electric Co., of Berlin; Messrs. Ganz, of Buda Pesth; and Mr. Westinghouse, of America have all proceeded on similar lines to ourselves. While we have been working towards the development of lamps which can be manufactured with certainty and economy we have steadily pursued our enquiries in all parts of the world within our sphere of action with a view to ascertain the extent of electric lighting and the conditions which it would be necessary to observe in sending lamps to that particular locality. It may interest you to know that the extent of lighting in the various countries appears from the reports to be that there are 38,000 arc lamps and 5,000,000 incandescent lamps in use in our various territories. We have obtained 47 patents in various parts of the world, and our applications for 14 other patents are still pending. The lamps submitted to your inspection to-day are the outcome of our labours. Every detail in these lamps has been most carefully considered by the Technical Committee, who discussed these matters under the presidency of Mr. B. M. Drake, our managing director. I cannot leave this point without endeavouring to do justice to the attention and care which has been devoted by Mr. Drake in supervising the elaboration of the various details. He has been the link between us and the various departments, and it was not until we separated the mechanical from the chemical departments that we commenced to go ahead. I deeply regret that one of my colleagues should have considered it necessary when our labours had reached that point at which we may look forward to attaining some practical results to make an attack on the managing director which I consider unnecessary, inopportune, and unjust. Such a resolution as Mr. Zusman proposes to move would be inoperative, because the Articles of Association provide that there shall be strict secrecy with regard to the concerns of the company, and I think it would be injurious if any director were to ask to have access to secrets which describe the process of the company, and on which a great deal of our success depends. I became aware that a hostile demonstration against the board was being prepared some time ago, and I wrote to Mr. Zusman as to certain matters of which I disapproved. I had received a complaint from the managing director that Mr. Zusman was unduly interfering with the staff, and that he (the managing director) could not maintain discipline if every director were permitted to interfere with the technical staff and in technical matters in which he was not qualified to advise. In reply, I received two lawyer's letters. At the board meeting which followed Mr. Zusman submitted a protest to me declaring that the past conduct of the company has been opposed to his interests and has been a policy of inanition and that the managing-director has been guilty of neglect and mismanagement and has subordinated some of the best interests of the company to those of another company. Let me now turn to a pleasanter topic. A circular has been issued by the Berlin company showing the advantages of the Nernst lamp and the saving which may be effected by it annually even after paying the yearly rental of 3s. for the loan of the lamp. We are about to issue a similar circular ourselves, but propose to sell the lamp outright to customers instead of distributing them on loan. Although we have made temporary arrangements for manufacture, the locality of our future factory will greatly depend on whether we are able to come to some arrangement with the company which we presume will be formed to develop the British patent. I now move the adoption of the report.

Mr. BERNARD DRAKE, seconded the motion, and said:—Just before this company was formed and about the time when Mr. Zusman, the promoter, induced me to take an interest in the invention, promising that I should be joint managing director with himself, an exhibition of the lamp was given. I have before me the historic lamp on which the capital of the company was subscribed, and I myself invested several thousand pounds. This lamp was of large candle-power and was intended to take the place of arc lamps. It will be seen that there is an elaborate hood coated with platinum wires which is lifted bodily from the filament and held there by a large solenoid. The evolution from this lamp to those now on exhibition at the offices represents the result of our labours. As soon as it could be arranged Prof. Nernst summoned all the owners of his patents to a conference at Berlin, which Mr. Swinburne and I attended on your behalf. After long discussion a protocol was drawn up which was to be put in the form of an agreement by one of the most important of the licensees and submitted for signature. This agreement has never been presented, and each licensee has therefore been compelled to develop the lamp independently. While our laboratory was being equipped with the special apparatus which had to be designed and manufactured for the purpose, we were carefully considering to what lamp we should first give our attention. We came to the conclusion, after mature consideration, that inasmuch as the field for domestic lighting was vastly greater than that for street lighting, we would in the first instance confine ourselves to working out if possible a practical automatic lamp to take the place of the ordinary incandescent electric lamp, of which millions are in use in all parts of the world. This process of development involved the creation of designs and models, each of which had to be subjected to a series of tests, and in which countless difficulties were encountered. I will just mention one of those as a fair example: The Nernst filament, or "glower" as we prefer to call it, has to be fitted at each end with wires to take the current in and out. The glower acquires a temperature which will fuse any metal, hence the platinum wires either fused off or the glower itself failed close to the positive pole contact after a short life. After trying a number of methods we hit upon the idea of radiating the heat away at those points faster than it was created, thus keeping the contacts down to a temperature at which the metal wires remained intact. This may sound an exceedingly simple matter to you, but the arrangement greatly increased the life of your lamp. Then, too, we found that the heat of the glower, which is not enclosed in a vacuum, caused the metal parts to become so hot as to destroy the insulation of the wires on our cutouts. This has been overcome in lamps up to 16 c.p. by designing the lampholder so as to get the maximum radiating surface. Above 16 c.p. it was found impossible to get sufficient radiating surface from a simple lampholder, and eventually the difficulty was overcome by the production of the holders which are now in use in this room. It will be seen that there is a special radiating plate, which also serves the purpose of globe carrier, and that the two parts of the lamp are separated from each other with a clear air space in between, the parts liable to derangement by heat being placed in the upper chamber. In connection with the filament itself, Prof. Nernst had already done a great deal of useful work, but here again the staff who were taken over from the syndicate were unable to get uniform results when they tried to repeat the same processes, and it was quite evident that until we could be reasonably sure of being able to manufacture glowers which would always give the same satisfactory results, it would be impossible to start manufacturing. By long and tedious experiments the different causes of variation have been found out one by one, and our present chemists assure us that they now feel reasonably confident with regard to the production of the glowers. In connection with this point it should be mentioned that rare earths, bearing the same name, which come from different factories, are found to differ materially in composition, necessitating special treatment before they can be put to use. You must also appreciate that as each experiment involves about a month's burning night and day before the result can be expected, the process of perfecting is necessarily slow. Then the baking of the glowers has cost us hundreds of pounds in experiments. Every conceivable oven, electric and otherwise, has been tried, and as a result we have now two methods working, either of which seems to produce well-baked glowers. The electric heater is at present made by winding platinum wire round a kaoline rod, and we are especially indebted to the Professor for the assistance he gave us in this portion of the lamp. If the Vogt resistance heater can be made to last, it will be both cheaper and stronger, so that we are giving the Resistance company every facility for developing this invention in the interest of our own company. The cutout looks a simple matter, but this did not reach its present form without many months of patient thought and experiment. The action of this apparatus is, of course, to shut off the current from the electric heater automatically as soon as the heater has done its work, and the problem consisted in making an electric magnet sufficiently small to be placed in a standard lamp cap, which must work with the minimum watts (we have now reduced it to 2 watts), which must not hum with alternating currents, a point we have not yet entirely mastered, must not arc on the contacts, and must not be affected by the heat to which it is subjected. The series resistance was made in quite a number of forms before we arrived at the very simple construction which we have now adopted. These act exceedingly quickly which is essential to the life of

the filament, and experience alone can prove whether this type is better or worse than the iron wire enclosed in a glass bulb, and filled with an inert gas which is being used with the Nernst lamps on the Continent. As this is practically a small incandescent lamp in itself as far as cost is concerned, we naturally prefer to keep to our simpler method if we find it continues to work as well as at present. It is only within the last six months that we felt sufficiently sure of our ground on the different points to venture upon a final pattern for each size which we could manufacture in quantity. This, I might explain, is a serious responsibility, for it often means fixing a standard, of which thousands will afterwards be reproduced, which it will be difficult to change in the future. This is a point you must fully appreciate, and which I emphasise strongly. For instance, I might refer to the waste of money involved in altering the broad gauge railways to narrow gauge. Well, we have now taken the plunge as far as the body of the lamp is concerned, and the replacement pieces which carry the glower, heater and series resistance, can be modified from time to time as experience dictates. Special tools for reproduction have been made; and the lamps which you have been shown are in fact now being reproduced for the market. We have some hundreds of lamps of different sizes and candle-powers which can be sent out in the next few weeks. Within two months we are arranging for a supply of the different parts to be coming in, and within three months, unless something unforeseen happens, I expect our output to be several hundred lamps per day. I think, therefore, the company may be congratulated on being within sight of the money-earning stage. It would of course very much facilitate matters if the company could get permission to manufacture the glowers in England, for until we know whether we shall succeed in obtaining this right or not, it would appear to me undesirable to invest our capital in a factory abroad which would be more difficult to supervise; but I have personally visited a country where there are no patent rights and we have rented a small place with facilities for extension, which will at any rate enable us to commence our issue. I think, therefore, we may claim to be the first company to export lamps, although we started a year later than the rest, had no large organization to draw upon like the others, and were delayed three months by a fire; in fact, Mr. Swinburne's statement at the statutory meeting that we might hope to have lamps for issue at the end of this year was substantially correct. I must add here that our thanks are due to the Allgemeine Elektricitäts Gesellschaft, of Berlin, for having used their large resources to prove that the Nernst lamp is a practical success, and has obtained the Grand Prix in Paris, and we shall test with interest the 300 lamps now on their way to our laboratory from Berlin.

From a notice you will see that Mr. Zusman intends to make a personal attack upon myself. I do not propose to refer to the matter until he has made his attack. I must ask you however to bear in mind that I have not only invested some thousands of pounds of my own in your company, but I have also, which is of vastly greater importance to myself, induced a number of influential friends to follow my example, and it is my fixed intention to prove by results that my recommendation was good. But, even with this end in view, I could not bring myself to continue in a post of responsibility unless I felt that I not only enjoyed the confidence of my colleagues, but also of those whom they represent, and for this reason I practically placed my resignation in the hands of the board about a month ago, which resignation however the board refused to accept.

Mr. BENN ZUSMAN then proposed a resolution on the lines set out in the above opening paragraph, and supported his proposition by a speech which occupied upwards of an hour in delivery.

Mr. B. M. DRAKE proceeded to reply, but, after some interruption, it was decided that an adjournment of the meeting should take place to allow him to formulate a detailed reply to Mr. Zusman's accusations. The meeting therefore stands adjourned for one month.

## Electric Resistance and Heating Co. (Ltd.).

The first ordinary general meeting of this company was held on Tuesday, Mr. Cyril Wanklyn (chairman of the company) presiding. The secretary (Mr. W. Chaplin) read the notice convening the meeting, and the report and accounts were taken as read. The chairman said, although he must admit some elements of disappointment, he trusted the shareholders would see from his remarks that there was some hope of a future for their process. The one feature upon which they could look with unalloyed satisfaction was the statement in the report that the primary or material patents of the company had been granted in all the countries enumerated in the prospectus, with the exception of Germany, Denmark, Norway, and Russia. An application in Russia was still pending, and in the other countries mentioned they were relying on secondary apparatus patents, which had been granted, as had also material and apparatus patents in Cuba. They felt particular satisfaction with regard to Germany, where patents were always difficult to get through. He had been informed by Messrs. Abel and Imray, their patent agents, that in the apparatus patents they had obtained, the material patent was alluded to in such a way as to protect them equally under that head. A great deal of work, trouble, and anxiety had been entailed in the progress of their endeavour to prove the value of their process, and they had had to meet difficulties one by one. The shareholders were aware that the company had failed to receive payment in full in respect of 8,550 shares relied on as part of the working capital (5s. per share only having been paid), and this failure was really a knock-down blow to the board. More than a third of the working capital, £6,500, had never come into the coffers of the company, and that third was the most important of all, as the want of it left them at a point where they were bound to prove what the process could do. If the shares now to be offered to the shareholders, as set out in the report, were not taken up, there was only one course before them, and that was liquidation, with a view to reconstruction. If they could overcome two or three of the obstacles that had appeared in the details of the manufacture he believed there was a very good future before the company. He moved the adoption of the report and accounts.

Capt. BAX seconded the motion.

Mr. GUEDALLA inquired how much cash the vendors got out of the company.

Mr. FRASER wished to know the lines upon which the reconstruction would go, and said it appeared to him that they did not owe any consideration to the vendors, who had pocketed the £32,000, and had given the company a thing which would take months to get into a preliminary state of perfection.

The CHAIRMAN said, as to the terms of reconstruction, that they were not bound to anybody, and it must not be regarded as a certainty. But the idea would be that a new company would be formed to take over the undertaking. There would doubtless be an arrangement for the payment of commission to somebody who would guarantee an adequate sum for working capital to carry them on to the point at which the business would become a commercial success. The vendors got in cash £32,500 and in shares £62,500.

The report and accounts were adopted, the retiring directors re-elected and the auditors re-appointed, and the proceedings terminated with a vote of thanks to the chairman and directors.

The first annual report of the directors of the company from Jan. 1, 1899 to Sept. 30, 1900, stated that the main patent of the company has now been granted in all the countries enumerated in the prospectus, with the exception of Germany, Denmark, Norway, and Russia. In Russia an application is still pending. In the other countries mentioned, reliance is placed on secondary apparatus patents, which have been granted. Material and apparatus patents have also been taken out in Cuba, a country not mentioned in the prospectus. The directors have devoted unremitting care and attention to the development of the company's manufactures, but, as is generally the case with a new process, progress has been slower than was anticipated, and the adaptation of the material to the various requirements has presented many difficulties. In the opinion of the directors, however, most of these difficulties have now been overcome.

The work of the company is now so far advanced that types of completed manufactures have been under trial for some weeks at the company's works and elsewhere. The directors are satisfied with the result of these trials, and believe that the manufactures of the company will show good results in practice.

The directors have had under consideration proposals recently made by Messrs. Ganz & Co., of Budapest, for supplying the company, at fixed prices, with its resistance and heating material in a manufactured state, and in such types as may be required. No definite arrangement has yet been come to, but, under existing circumstances, the acceptance of the proposals, wholly or in part, might be of advantage to the company.

Owing to the great importance of completing types of resistances of various kinds and other manufactures for the market before the end of the present year, the funds at the company's disposal are approaching exhaustion. It has, therefore, become necessary that 8,550 forfeited shares, on which 5s. has been paid, should be subscribed for at 15s. each. These shares are to be offered to shareholders before 12th prox., and allotments will be made pro rata, except that, in the event of the certain negotiations being wholly or partially carried through, the allotment of the 8,550 shares will be restricted to the number of shares available.

**DOUGLAS SOUTHERN ELECTRIC TRAMWAYS (LTD.).**—The annual meeting was held at Manchester on Tuesday. The directors' report stated that although the season had only consisted of 121 days, against 133 days last year, the number of passengers carried was 104,979, against 100,769 last season, the mileage being 34,033, against 37,593 last year. The gross earnings yielded £4,583, an increase of £138. After deducting £763, tolls payable to the Douglas Head Marine Drive (Ltd.), the net passenger receipts were £3,819. The total receipts were £3,844, against £3,719. The net profit was £1,617, against £1,455, and, after adding £271 from last year, there was a disposal balance of £1,889. The directors recommended that the dividend on the 6 per cent. preference shares be declared, and the balance (£355) be carried forward. The company had been no way affected by the bank failure in the Isle of Man. The chairman (Mr. T. J. Hutchinson), in moving the adoption of the report, said they had had a very fair season, and facts indicated that their line was increasing in popularity. Efforts were being made to bring their line into more intimate touch with the town of Douglas, to the mutual benefit of the company and the town. It was matter for regret that the ordinary shareholders did not come in for anything. The company was in a sound financial position, and he anticipated as time went on their property would increase in value. The report was approved.

**INGLETON ELECTRIC LIGHTING AND POWER CO. (LTD.).**—At the annual meeting, held last week, the directors' report stated that the plant was now in working order, and that all capital expenditure, as far as could be seen, had been incurred. Whilst they were unable to recommend the payment of a dividend, owing to the fact that the company had so recently come into operation, they felt confident that the prospects of the undertaking are good, and they are hopeful that the business will shortly become remunerative. The company had secured the contract for the public lighting of Ingleton, and there had been a constant demand for current from householders, about 60 houses being already connected, representing about 500 lights. The chairman (Mr. W. Metcalfe) said the works were now completed and the plant in operation. They had only been at work a few months, but in that short time had made rapid strides. The report was adopted.

**LONDON AND GLOBE FINANCE CORPORATION (LTD.**—The annual meeting was held on Monday under the presidency of the Marquis of Dufferin and Ava, who stated that the Baker-street and Waterloo Railway appeared in their assets at over £750,000. As many of their shareholders had inquired why they entered into an enterprise of that character, which was somewhat at variance with the other purposes of the company, he might say that some years ago when the late Sir Wm. Robinson was chairman of the company, he and the late Lord Loch were strongly in favour of engaging in some undertaking of a different nature to mining enterprise, and in that way the building of the railway was determined upon. Although the enterprise did not strongly appeal to their managing director, whose experience naturally lay in another direction, he and the other members of the board acquiesced in the recommendations of their chairman and his colleague Lord Loch and the latter gentleman became chairman of the railway company. There could be no doubt that Lord Loch was quite right in his estimation of the soundness, value and eventual profit to be derived from this important enterprise. There was a general consensus of opinion that when completed this railway will be one of the most profitable lines in London, but it would still require a large amount of money to finish and equip it. As the London and Globe had undertaken that work, they could readily see how they must husband their resources until they could make arrangements to dispose of it under favourable conditions. Negotiations were now in progress with a syndicate to take over their responsibilities with regard to the railway, and to reimburse the £750,000 already expended.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**CARDWELL, BOORMAN, FORD LLOYD LTD.**—Registered Dec. 13 with a capital of £5,000, in £1 shares, to acquire and carry on the business of electrical engineers and electrical apparatus manufacturers carried on by Messrs. Cardwell and Boorman and by A. Ford Lloyd & Co. The subscribers are J. A. Cardwell (electrical engineer), E. H. Cardwell, A. Ford-Lloyd (electrical engineer), A. R. O. Lowndes, G. Boorman (electrical engineer), E. A. Lowndes and J. H. Cardwell. The first directors are J. A. Cardwell, G. Boorman, and A. Ford Lloyd (managing director).

**EASTON & CO. (LTD.**—Registered Dec. 10, with a capital of £100,025 in 30,000 preference and 70,000 ordinary shares of £1 each, and 500 subscribers' shares of 1s. each, to acquire the sole licence for Great Britain, the British colonies, and the Transvaal to manufacture and sell stationary engines of over 10 H.P. and apparatus in connection therewith under the Schmidt superheated steam patents (subject to a non-exclusive licence already in favour of Sulzer Bros., of Zurich, and the Aschersleben Maschinenbau Aktiengesellschaft), and to take over all or part of the business of electrical, mechanical, civil and general engineers and contractors recently carried on by Easton, Anderson and Goolden (Ltd.) (in liquidation and by the receiver and manager (Mr. W. B. Peat). The first committee of management are E. L. Pease, G. B. Samuelson, H. K. Baynes, T. P. Wilson, and three others—two to be nominated by the debenture holders and one by Mr. H. A. Johnstone. Mr. G. B. Samuelson is the nominee of the Schmidt Stationary Engine Co. (Ltd.)

**ELECTRICAL NAVIGATION PROTECTION CO. (LTD.)**—Registered Dec. 15, with a capital of £100,000, in £1 shares (5,000 B), to carry on the business of electrical engineers, constructors of cables, wires, generators and distributors of electricity, electric light contractors, electricians, mechanical engineers, contractors for public works, &c.

**FLEET AND DISTRICT ELECTRICITY CO. (LTD.)**—Registered Dec. 14, with a capital of £5,000, in £1 shares, to acquire the right to supply electricity in Fleet and district, to adopt agreements with Messrs. H. Blacknell, F. J. Warden-Stevens, and W. Fennell, and to carry on the business of electricians, mechanical and electrical engineers, suppliers of electricity, &c. The subscribers are W. W. Norman, F. J. Warden-Stevens (engineer), F. P. West, W. Fennell (electrical engineer), C. J. Inder (electrical engineer), S. Hutchinson, and T. J. Woods. The first directors are Sir T. L. Brunton, H. Fraser, and F. J. Warden-Stevens.

**L. GARDNER & SONS (LTD.)**—Registered Dec. 13, with a capital of £50,000 in £1 shares, to acquire the business carried on at Patricroft, Lancs., under the style of L. Gardner & Sons, and to carry on the business of mechanical, electrical, gas, oil, and general engineers, iron and brassfounders, motor car, locomotive, and vehicle manufacturers, &c. The first directors are Thomas H., Edward, Lawrence, Ernest, and Joseph Gardner.

**W. S. LAYCOCK (LTD.**—Registered on Dec. 10, with a capital of £150,000 in £1 shares (50,000 preference), to carry on the business of manufacturers of railway plant, railway carriages and fittings (including electric and pneumatic bells and communicators), manufacturers of automatic, electric, and other couplings, &c. The first directors are W. S. Laycock (governing), A. M. Carlisle, and F. D. Docker.

**NORTHERN COUNTIES TRACTION CO. (LTD.)**—Registered Dec. 12 with a capital of £5,000, in £5 shares, to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for all purposes, &c. The subscribers are G. E. Heyl-Dia, electrical engineer, J. J. Wilson, W. J. Glover, cable manufacturer, H. S. Oppenheim, W. Oppenheim, J. Hammill, and H. Tasker.

**WELSH ELECTRIC TRACTION CO. LTD.**—Registered Dec. 14, with a capital of £25,000 in £1 shares, to carry on the business of railway, tramway, telegraph, telephone and general contractors, engineers, builders of rolling stock, electrical, mechanical, hydraulic and general engineers, suppliers of electricity, &c. The subscribers are: C. J. Hall, Dr. C. H. Lees, E. Hewitt, W. G. Rhodes, M.Sc., M.I.E.E., W. H. Robson (electrical engineer), T. Gould, and J. Morris.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29¹⁄₁₆d. per oz. (Dec. 20). Consols (2¾ per cent.) 96⅞–97⅛ for money, 97–97⅛ for account; 2½ per cent. 97–97¼ (Dec. 20). Stocks and Shares Continuation Days, Dec. 24 and Jan. 14; Ticket Days, Dec. 27 and Jan. 15; Pay Days, Dec. 28 and Jan. 16; Mining Share Carry-over Days, Dec. 21 and Jan. 13.

**AFRICAN DIRECT TELEGRAPH CO. (LTD.)**—The coupons on this company's 4 per cent. mortgage debentures to bearer, due Jan. 1st, will be paid at Parr's Bank Ltd., Bartholomew-lane, London, E.C.

**BLACKPOOL, ST. ANNE'S AND LYTHAM TRAMWAYS CO. (LTD.)**—At the annual meeting on Wednesday a resolution was passed that it was inadvisable, until the matter had received further consideration, to proceed with the doubling of the line and its equipment for electric traction. A committee was appointed to consider and report upon the question of future developments.

**BRITISH AND FOREIGN ELECTRIC VEHICLE CO. (LTD.)**—An abridged prospectus of this company will be found on another page of this issue. The company has been formed with a share capital of £150,000, of which the vendors take 96,000 in fully-paid shares in part payment of the purchase consideration. The balance of 54,000 £1 shares are now offered for subscription. The prospectus states that no part of the issue has been or will be underwritten. The company has been formed to acquire the assets of the Leecoll Electric Battery Co. (Ltd.) and one-half share in the Leecoll patents in certain countries, the debts and liabilities of the Leecoll Company being paid off by the new company. The prospectus sets out the patents which are to be transferred to the new company and the foreign patents which have been secured, and of which the new company is entitled to a half share. An instructive report by Sir William H. Preece regarding the merits of the Leecoll battery accompany the prospectus. It is claimed that the battery stands very high in the list of known batteries as regards lightness, and is, in fact, sufficiently light to answer all practical requirements of electric vehicle motive power. It will be remembered that the car "Powerful," which took a prominent part in the recent automotor trials at Chislehurst, Kent, was equipped with the Leecoll battery. A report of these trials appeared in *The Electrician* for Nov. 9 and 15, 1900. At the company's works at Juxon-street, Lambeth, S.E., the charging equipment is one of the finest private electric plants in London, and the directors call the particular attention of investors to the value of the property acquired by the company at Lambeth, Notting Hill Gate, South Kensington, and Shoreditch for the purposes of its business. The purchase price of the assets of the Leecoll Company has been fixed at £60,000 in fully-paid shares, and for the share in the foreign patents of the Leecoll battery at £30,500 (£2,000 in cash and £28,500 in fully-paid shares). The Lambeth property has been acquired for £14,500 (£7,000 in cash and £7,500 in fully-paid shares). For the Notting Hill property £1,000 in cash is to be paid on completion of purchase. If the whole £54,000 now offered for subscription is taken up the company will possess a cash balance of £44,030 for working capital. The vendors (Mr. T. G. Chambers and Mr. E. W. Hart) with Col. J. F. Caldwell, J.P., and Mr. Roger H. Fuller (a director of the De Dion Bouton Co.) form the directorate of the new company. Sir W. H. Preece is consulting engineer, and the secretary is Mr. S. A. Cobbett, 14, Devonshire-square, London, E.C. The chief points of interest in the prospectus may be said to be the value of the properties acquired by the company. The property in Lambeth will be recognised as the well-equipped station of the late London Electrical Cab Co., which is now acquired for £14,500, but which is stated to have originally cost between £30,000 and £40,000. We are informed that the ubiquitous Mr. H. J. Lawson is in no way associated with this latest development of electrical vehicle enterprise.

**CHELSEA ELECTRICITY SUPPLY CO. LTD.**—The transfer books of the debenture stock of this company are closed from 19th to 31st inst. inclusive for the preparation of dividend warrants.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation.. | Dec. 15 | 597 | + 175 | 23 | 19,803 | + 2,944 |
| *Birmingham Tramways | " 15 | 4,465 | – 953 | 23 | 101,413 | + 3,824 |
| Blackpool Corporation... | " 13 | 191 | + 80 | 37 | 27,744 | + 7,323 |
| Blackpool and Fleetwood | " 15 | 146 | + 50 | 24 | 19,990 | + 33 |
| Bolton Corporation ...... | ... | ... | ... | ... | ... | ... |
| Bradford Corporation... | " 16 | 756 | + 451 | 37 | 20,615 | + 6,038 |
| Brisbane Trams ......... | Oct. 31 | 1,871 | + 212 | 17 | 31,047 | + 6,020 |
| *Bristol Trams & Carriage | Dec. 14 | 3,579 | +1,255 | 24 | 73,905 | – 424 |
| *Buenos Ayres & Belgrano | Nov. 18 | 2,624 | + 532 | 20 | 49,151 | + 4,373 |
| Central London Railway | Dec. 15 | 6,006 | ... | 20 | 105,135 | ... |
| City & South London Ry. | " 16 | 1,874 | + 725 | 24 | 39,649 | +15,827 |
| Cork Elec. Trams ........ | " 13 | 373 | + 70 | 50 | 20,368 | + 1,440 |
| Dover Corporation ...... | " 15 | 163 | + 35 | 37 | 8,382 | + 492 |
| Dublin & Lucan Rly. | " 15 | 66 | + 15 | 24 | 2,239 | – 397 |
| Dublin United ............ | " 14 | 3,377 | + 545 | 24 | 93,404 | +11,825 |
| Dublin Southern Dist.... | " 14 | 791 | + 200 | 24 | 23,727 | |
| *Dundee Corporation ... | " 12 | 430 | + 123 | ... | ... | ... |
| *Glasgow Corporation ... | " 15 | 9,083 | +1,195 | ... | ... | ... |
| Hull Corporation.......... | " 15 | 1,552 | + 908 | 24 | 35,253 | +17,716 |
| *Liverpool Corporation... | " 8 | 8,075 | –1,274 | 49 | 305,625 | +50,727 |
| Liverpool Overhead Rly. | " 15 | 1,527 | 95 | 24 | 39,665 | + 759 |
| *Sheffield Tramways ...... | " 16 | 2,804 | +1,205 | 50 | 114,953 | +39,968 |

* Partly electrical.

**EASTON & CO. (LTD.)**—We learn that a powerful syndicate has been formed under the style of "Easton & Co. (Ltd.)" to take over the old-established engineering works of Easton, Anderson and Goolden (Ltd.) at Erith, Kent, with the object of developing in this country the Schmidt system of utilising highly superheated steam, which system has made great progress abroad. No public issue is to be made, the necessary capital having been subscribed privately. (*See* "New Companies.")

**EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH CO. (LTD.)**—An interim dividend for the quarter ended Sept. 30 last of 2s. 6d. per share, free of tax, payable Jan. 15, has been declared by the directors of this company. The share register will be closed from 7th to 14th prox. inclusive.

**ELECTRIC AND GENERAL INVESTMENT CO. (LTD.)**—The directors have declared an interim dividend of 10 per cent. on the ordinary shares (2s. per share, less tax) for the six months to 30th ult.

**GREAT NORTHERN TELEGRAPH CO. (LTD.)**—Coupons due Jan. 1 on this company's shares should be presented for payment at Messrs. C. J. Hambro & Sons, 70, Old Broad-street, London, E.C.

**NATIONAL TELEPHONE CO. (LTD.)**—The transfer books of the 3½ per cent. and 4 per cent. debenture stocks of this company are closed from the 18th to 31st inst. inclusive for the preparation of the warrants for the half-year's interest due Jan. 1.

**PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.)**—Notice is given that the coupons on this company's 4 per cent. guaranteed debentures, due 31st inst., will be paid on and after that date at Parr's Bank, Bartholomew-lane, London, E.C.

**STOCK EXCHANGE NOTICES.**—Thursday, Jan. 3, has been appointed a special settling day in the provisional certificates (60 per cent. paid) for £200,000 4½ per cent. second debenture stock of the *City of London Electric Lighting Co. (Ltd.)*, and the further issue of 2,200 ordinary £10 fully-paid shares (Nos. 10,001 to 12,200) of the *Notting Hill Electric Lighting Co. (Ltd.)*. The committee has ordered the first-mentioned stock as well as the further issue of 30,000 4½ per cent. cumulative preference £5 fully-paid shares (Nos. 20,001 to 50,000) of the *Charing Cross and Strand Electricity Supply Corporation (Ltd.)*, to be quoted in the official list. The committee has also been asked to appoint a special settling-day in, and to grant a quotation to 150,000 6 per cent. cumulative preferred £1 (10s. paid) shares (Nos. 1 to 150,000) of the *Kalgoorlie Electric Power and Lighting Corporation (Ltd.)*, and 77,083 £1 fully-paid shares (Nos. 1 to 40,000 and 100,001 to 137,083) and 60,000 £1 fully paid vendors' shares (Nos. 40,000 to 100,000) of *Marconi's Wireless Telegraph Co. (Ltd.)*

**WOKING ELECTRIC SUPPLY CO. (LTD.)**—During the week this company invited applications for 25,000 6 per cent. cumulative preference shares of £1 each.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 12. | | Price Wednesday, Dec. 19. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Dec. 19. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ¾ | 1 | ¾ | 1 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 19/8 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | 7½ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 30,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 60,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 0 1 | February and August | 9½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | 5¾ | 5½ |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6¾ | ... |
| £180,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 110 | 113 | 4 0 11 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,679 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 | 10 | 9 | 10 | 4 0 0 | February and August | 9¾ | 9½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 13½ | 4 8 11 | January and July | 13¾ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | 12½ | ... |
| £300,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. all ... (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | ... | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ | 12½ | 11½ | 12½ | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2½ | 1½ | 2 | ... | ... | ... | ... |
| 40,040 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures (red.) | 100 | 102 | 99 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12½ | 13½ | 12 | 13 | 4 4 7 | April and October | 13½ | 12½ |
| £720,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 18 7 | June and December | 113 | ... |
| £340,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 98 | 101 | 98 | 101 | 3 10 3 | ... | 100 | 99½ |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6½ | 6½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ½ | 1 | ½ | 1 | 12 15 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 6 15 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 175 | 181 | 175 | 181 | 4 5 11 | April and October | ... | ... |
| £113,500 | 100 | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 6/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | 15½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8½ | 9½ | 3 14 6 | " " | ... | ... |
| £ 50,000 | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 2 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 3 | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 29,018 | 5 | ... | Do. Do. | 11½ | 12½ | 11½ | 12½ | ... | ... | 12½ | 12 |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 16,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 13 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 121 | 118 | 121 | 3 6 1 | February and August | ... | ... |
| 13,629 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 64,000 | 10 | 6/0 | Brixton Elec. Tram. Ord. | 14 | 15 | 13½ | 14½ | 3 17 3 | ... | 14½ | 13½ |
| 64,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 5 9 | February and August | 12½ | 12½ |
| £300,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 121 | 124 | 121 | 123 | 4 1 4 | ... | 124 | 123 |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ | 4½ | 4½ | 4½ | ... | ... | 4½ | ... |
| £200,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 15 5 | ... | ... | ... |
| £150,000 | Stock | 13/9 | Do. 5% 2nd Deb. Stock Prov. Certs. (all pd.) | 93 | 91 | 88 | 91 | 5 1 0 | ... | ... | ... |
| 246,297 | 10 | 3/0 | Central London Ordinary | 9½ | 9½ | 9½ | 9½ | 3 1 6 | June and December | 9½ | 9½ |
| £555,000 | Stock | 1½% | City and South London Railway Con. Ord nary | 63 | 66 | 63 | 66 | 2 9 7 | February and August | ... | ... |
| 32,900 | 10 | 1/5½ | Do. Ordinary (Nos. 22,941 to 57,010) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 134 | 143 | 138 | 143 | 3 9 11 | " " | 135 | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £311,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 118 | 123 | 118 | 123 | 3 11 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896), Ordinary | 17 | 18 | 17 | 18 | ... | ... | ... | ... |
| 30,000 | 10 | ... | Do. 6 per Cent. Preference | 13½ | 14½ | 13½ | 14½ | ... | ... | ... | ... |
| £200,000 | 100 | ... | Do. 4½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 23½ | 24½ | 23½ | 24½ | 3 12 3 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 4 | " " | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 20,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | ... | ... | 9½ | 10½ | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 5% | Liverpool Overhead Railway Ordinary | 8½ | 9½ | 8½ | 9½ | 4 9 6 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 12½ | 13½ | 12½ | 13½ | 3 14 1 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 106 | 108 | 106 | 108 | 3 17 0 | January and July | ... | ... |
| $380,000 | $1,000 | 5% | London Street Rly. (Ont.) 1st Mort. 5% Debs (red.) | 102 | 105 | 102 | 105 | 4 15 7 | ... | ... | ... |
| £... | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 110 | 115 | 110 | 115 | 4 16 0 | ... | ... | ... |
| £440,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 108 | 110 | 108 | 110 | 4 0 ... | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 10,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 11,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | 15 | 17 | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | ... | 10½ | 11½ | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 10½ | 11½ | 10½ | 11½ | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 10 | February and August | ... | ... |
| £125,000 | Stock | 17/0 | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | ... | ... |
| £10,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 1 ... | June and December | 95 | 94 |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 12. | | Price Wednesday, Dec. 19. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Dec. 19. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £95,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 103 | 3 17 5 | January and July | — | — |
| 35,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | — | — |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 85 | 90 | 5 11 1 | ... | — | — |
| £823,720 | Stock | 15/0 | Anglo-American | 52 | 55 | 52 | 55 | 5 11 10 | Feb., May, Aug., Nov. | 53½ | 51 |
| £3,044,640 | Stock | 3/0 | Do. Preferred | 87 | 90 | 87 | 90 | 6 2 5 | ,, ,, | 91¼ | 91 |
| £3,044,640 | Stock | 27/0 | Do. Deferred | 9½ | 10½ | 10 | 10½ | 12 17 2 | ,, ,, | 10⅛ | 10½ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 170 | 180 | 170 | 180 | 4 9 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,363,075 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 17 4 | ,, ,, | 103½ | 103½ |
| 18,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ | 7½ | 6½ | 7½ | 7 6 8 | February and August | ... | — |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 | 16 | 15 | 16 | 6 5 0 | ,, ,, | ... | — |
| 12,931 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | — | — |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | — | — |
| £30,900 | 50 | 4½% | Do. 4½ per Cent. Debentures | 103% | 104% | 103% | 104% | 4 6 7 | January and July | — | — |
| 60,710 | 20 | 2/0 | Direct United States Cable | 10 | 10½ | 10 | 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10½ | 10⅛ |
| £111,000 | 100 | 4½% | Direct West India Cable 4½% Reg. Deb. (red.) | 99 | 102 | 99 | 102 | 4 10 0 | June and December | ... | ... |
| £3,000,000 | Stock | 15/0 | Eastern Ordinary | 139 | 140 | 139 | 141 | 5 0 0 | Jan., Apr., July, Oct. | 139 | 138½ |
| £1,639,400 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 96 | 99 | 98 | 99 | 3 11 1 | ,, ,, | 97 | 96 |
| £1,482,260 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 111 | 110 | 111 | 3 10 4 | May and November | 110½ | 110 |
| 250,000 | 10 | 2/6 | Eastern Extension | 13½ | 14½ | 13½ | 14½ | 4 19 3 | Jan., Apr., July, Oct. | 14½ | 14½ |
| 30,000 | 10 | ... | Do. (Nos. 250,001 to 280,000) £5 p. Liab'd at 2½ pm. all p | 9½ | 9½ | 9½ | 9½ | ... | ... | ... | ... |
| £330,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 | 115 | 113 | 115 | 3 8 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 100 | 103 | 3 17 9 | February and August | ... | — |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 101% | 99% | 101% | 3 19 5 | May and November | ... | — |
| 180,227 | 10 | 1/6 | Globe Telegraph and Trust | 10½ | 10¾ | 10½ | 10¾ | 4 17 9 | Jan., Apr., July, Oct. | 10¾ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | ,, ,, | 15½ | 15½ |
| 160,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 32 | 31 | 32 | 3 15 7 | January and July | 31½ | 31¼ |
| £44,200 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 4 10 0 | June and December | ... | — |
| 17,000 | 25 | 12/6 | Indo-European | 61 | 63 | 61 | 63 | 4 16 2 | May and November | — | — |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | — | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 101 | 104 | 101 | 104 | 3 19 2 | June and December | — | ... |
| 11,820 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,361 | £100 Cert. | 6% | Submarine Cables Trust | 121 | 124 | 120 | 124 | 4 16 6 | ,, ,, | 121 | — |
| 16,630 | 10 | ... | West African Telegraph | 2½ | 3½ | 2½ | 3½ | 4 8 3 | December and July | ... | — |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 102 | 99 | 102 | 4 19 3 | March and September | ... | ... |
| 80,000 | 2½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | ... | ... |
| £160,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 100 | 103 | 3 14 4 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | — | — |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | ,, ,, | 6½ | 6½ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 9 11 6 | ,, ,, | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 105 | 108 | 105 | 108 | 4 13 6 | January and July | ... | ... |
| 277,930 | 10 | 5/0 | Western Telegraph (late Brazilian Submarine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14½ | 14 |
| 475,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1896) | 103 | 104 | 103 | 104 | 4 16 4 | June and December | ... | — |
| £311,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 103 | 105 | 3 18 11 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 6 | August | 3 | — |
| 334,850 | 10/0 | 3% | Consolidated Telephone Con. and Maint. | 3/6 | 4/3 | 3/3 | 4/3 | ... | January and July | — | — |
| 72,680 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | 1 | ½ | 1 | 5 0 0 | November | — | — |
| 96,401 | 1 | 1/0 | Do. 6 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, | — | — |
| 500,000 | 5 | 3/0 | National | 4½ | 4¾ | 4½ | 4¾ | 6 9 9 | February and August | 4½ | 4½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 14 | 13 | 14 | 4 5 9 | ,, ,, | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 13 | 14 | 13 | 14 | 4 5 9 | ,, ,, | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | ,, ,, | 5 | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 93 | 95 | 93 | 95 | 3 11 5 | June and December | 93 | ... |
| £500,000 | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | ... | ... | ... | — |
| 171,501 | 1 | 0/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | ... | — |
| 56,000 | 5 | 4/0 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | — |
| 16,689 | 5 | 2/6 | Do. 5% Cumulative Preference (fully paid) | 5 | 5½ | 5 | 5½ | 4 10 11 | June and December | ... | — |
| 23,361 | 5 | ... | Do. do. (£3. 10s. paid) | 3½ | 3¾ | 3½ | 3¾ | ... | ... | ... | — |
| £179,347 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | June and December | ... | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 9d. | Alliance Electrical Co. 5% Cum. Pref. | ¾ | 1¼ | ¾ | 1¼ | 4 8 11 | ... | ... | ... |
| 145,000 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 7 7 6 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 99 | 97 | 99 | 4 4 3 | ... | ... | ... |
| 73,000 | 5 | 5/0 | British Insulated Wire Ordinary | 11 | 12 | 11 | 12 | 8 6 8 | July and February | ... | — |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6½ | 6¾ | 6½ | 6¾ | 4 16 0 | January and July | ... | — |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | ... | — |
| 93,000 | 3 | 1/1½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 6 8 4 | September | 1½ | 1½ |
| 16,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | — |
| 90,000 | 3 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | ,, | 2⅛ | — |
| 15,731 | 3 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | — |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 111 | 103 | 111 | 4 0 11 | March and September | ... | — |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 105 | 103 | 105 | 4 7 0 | January and July | ... | — |
| 37,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 12½ | 13½ | 12½ | 13½ | 5 11 1 | ,, ,, | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5¾ | 5½ | 5¾ | 4 6 11 | ,, ,, | 5½ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 110 | 114 | 111 | 115 | 3 19 8 | November and May | 111 | 111 |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | — | — |
| 54,000 | 3 | 2/6 | Crompton and Co. (Nos. 1 to 54,000) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | 3½ | — |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 14 0 | ,, ,, | ... | — |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | — |
| 99,361 | 5 | 1/3 | Edison and Swan United ("A" Shares) (£3 paid) | 1¾ | 2¼ | 1¾ | 2¼ | 6 0 0 | February and August | ... | — |
| 17,139 | 5 | 2/9 | Do. (£5 paid) | 3¾ | 4¼ | 3¾ | 4¼ | 6 13 1 | ,, ,, | ... | — |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 5 | June and December | ... | — |
| £100,000 | Stock | [illegible] | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 95 | 100 | 95 | 100 | ... | ... | ... | ... |
| 35,600 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half-yearly | 4½ | 4½ |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 105 | 101 | 105 | 4 7 3 | ... | ... | ... |
| 112,100 | 3 | 1/2½ | Electric Construction Co. (Limited) | 2 | 2½ | 2 | 2½ | 5 6 5 | January and July | 2 | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3¼ | 2½ | 3¼ | 4 4 3 | July | ... | ... |
| £152,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 16 2 | January and July | ... | — |
| 110,000 | 1 | ... | Gilfre Electro Chemical and Power Co. Ord | ½ | ¾ | ½ | ¾ | ... | ... | ... | — |
| 80,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ | 13¾ | 13½ | 13¾ | 5 11 1 | February and August | 13 | — |
| [illegible] | 5 | 2/6 | Do. 4½ per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 3 13 3 | ,, ,, | 5⅞ | — |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 104 | 112 | 103 | 112 | 4 0 4 | ,, ,, | ... | — |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 3 9 2 | ,, ,, | 21½ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 3 18 3 | March and September | ... | ... |
| 37,350 | 12 | 11/0 | Telegraph Construction and Maintenance | 41 | 42 | 41 | 42 | 4 5 9 | March and July | 40½ | 39 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1899 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | — |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 5 19 2 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6½ | 5½ | 6½ | 4 6 11 | ... | 5½ | 5½ |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | 11½ | 10¾ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | ,, ,, | 6⅞ | — |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures xd | 103 | 105 | 103 | 105 | 4 0 11 | May and November | ... | — |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,180. [No. 10. Vol. XLVI.] FRIDAY, DECEMBER 28, 1900. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Every one of our readers will be gratified to hear of the excellent work which has been done by the small unit of Electrical Engineers Volunteers in the South African army, a graphic account of which was given by Lieut.-Col. Crompton in the lecture published in this issue. At the time this contingent volunteered for the front, some sceptically-minded folk may have had a secret suspicion in their hearts that although there was plenty of hard fighting to be done and plenty of railway construction, there would be little work to do of such a nature as to give an opportunity for the employment of the special technical knowledge and training which electrical engineers possess. Circumstances proved the contrary, however. As Lieut.-Col. Crompton explained, the expeditious installation and efficient maintenance of the arc lighting plant alone more than justified the corps' existence; but the unit was able to do more work than this, and the men acquitted themselves well in other engineering work, for which their previous civilian training fitted them eminently. It was gratifying to learn that as a result of the successful employment by the corps of traction engines for the moving of the heaviest guns, this matter is now occupying the attention of the War Office, and Lieut.-Col. Crompton's advice is being taken on the design of traction engines for military purposes. Lieut.-Col. Crompton was also able to state that the Victoria Cross was to be awarded to Lieut. Stubbs for his conspicuous bravery on the railway line near Vlaklaagte. From the account of the incident in the lecture, it is seen that it did not occur in the heat and excitement of action, but was an example of that cool and deliberate courage of which we Englishmen are justly proud.

The attention which has been directed to the subject of electric railroading by Mr. W. Langdon's Paper at the Institution of Electrical Engineers lends additional interest, for British engineers, to the recent opening of the longest third-rail electric railway in existence. This railway, which extends from Albany to Hudson, N.Y., and is worked under standard railway conditions, is 38 miles in length, and it was put into regular operation as recently as the 22nd ult. We give some particulars of its construction in an article on another page. A notable feature of the equipment is the combination of the third rail with the overhead trolley system, the latter being used on portions of the railway passing through the towns on the line. This combination, however, is necessitated purely on account of the American practice of running main railways through city streets and over level crossings, and it would be quite unnecessary in the United Kingdom. Another important feature of the line is that it is worked by water power; but though the energy of the picturesque Stuyvesant Falls may serve to keep the working costs down to a low figure, it will not help the British railway engineer in his endeavour to solve the problem as to the relative cost of steam and electric locomotives in this country. Coal, not water power, is our mainstay and principal source of energy; and the performance of hydraulically-driven railways affords data of costs which, although useful and instructive, are not directly comparable with those derived from steam locomotive practice. Nevertheless, the Albany and Hudson Railroad will be welcomed by electrical engineers as an important step towards the ultimate conversion of the railway systems of the world to electric traction.

We published in our last issue particulars of the arrangement entered into by the Manchester Corporation with Prof. Kennedy for his assistance during the progress of their new electricity works. Prof. Kennedy is to be retained by the Corporation as their consulting engineer, to advise them during the completion of the new works and extensions, and to send an assistant down to supervise the work that is being carried out. For this Prof. Kennedy is to receive a fee of 4 per cent. on the total expenditure on the work he is called upon to see executed (this

expenditure being now estimated at £100,000), or, at the option of the Council, a fee of £15,000. It is satisfactory that an undertaking originally designed by Dr. John Hopkinson, and since then greatly extended under the able guidance of Mr. Wordingham, should have its success as an engineering enterprise assured by securing the best advice obtainable; but as the new works and extensions have already been designed and commenced by Mr. Wordingham, and it would appear that practically nothing remains but to complete the carrying out of the contracts, it is remarkable that the Council should sanction such an enormous expenditure merely for supervision, which in the ordinary course would have been done by Mr. Wordingham himself and his staff. It looks as if the withdrawal of Mr. Higginbottom from office and the approaching retirement of Mr. Wordingham in March have thrown the electricity committee and the Council into a state of panic.

An elaborate judgment of the greatest importance to the work of the evening continuation schools of the London School Board was delivered on Thursday last week by Mr. Justice Wills and Mr. Justice Kennedy in the High Court. In this case a rule had been obtained to bring up for the purpose of quashing them certain disallowances and surcharges made by a district auditor in the accounts of the London School Board. These disallowances and surcharges dealt with sums paid out of the rates for the teaching of science and art classes on the lines laid down in the Directory of the Board of Education Secondary Branch (Science and Art Department), and were fully confirmed by the learned judges. Mr. Justice Wills clearly stated that in so far as the expenses in question were incurred for science and art schools and classes or for teaching adults they were indefensible, and the auditor was right in disallowing them. On the whole the point of the decision seems to consist in the distinction, as regards financial support, drawn between schools for adults and schools for children; the latter, and the latter only, may legally be maintained out of or by the aid of the rates.

We believe that the majority of those interested in the scientific and technical evening-class education of the metropolis deplored the action of the London School Board when it established, on the grand scale, its system of free continuation schools; for the then very recent creation and equipment of numerous polytechnic institutions rendered the step unnecessary and wasteful. Besides, it was scarcely likely that this introduction of cheap competition into the educational field would assist the evolution of a broad system of secondary education. On the contrary, it seemed only too certain to increase the already existing confusion. Unfortunately, it is not probable that this judgment will suffice to remedy to any extent the prevailing educational muddle, for, in Mr. Justice Wills' opinion, the whole question must eventually go before the House of Lords. Apparently, the only purpose which the present case will serve is to call attention once again to the absolute lack of a national system of secondary and technical education. Fresh legislation, in any case, will be needed.

**King's College.**—The Lent Term commences on January 17th.

**Obituary.**—We regret to announce the death of Lord Armstrong, which took place yesterday morning, in his 91st year. A biographical notice will appear in our next issue.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Tangier—Tarifa | Jan. 3, 1900 | Dec. 21, 1900 |
| Pará—Maranham | Mar. 2, 1900 | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | — |
| Pernambuco—Ceara | Nov. 29, 1900 | — |

**Röntgen Society.**—On Thursday next (January 3rd) this society will hold a meeting at 20, Hanover square, W., when Mr. A. W. Isenthal will read a Paper on "Continental Progress in Practical Radiography and Apparatus." On the same evening Dr. J. H. Sequiera will show some cases of Rodent Ulcer treated with X-rays.

**Reduction in Telegram Rates.**—Notice is given by the Eastern Telegraph Co. of the following reduced tariffs to come into operation on January 1st:—Cape Colony, Natal, Transvaal, Orange River Colony, Ascension and St. Helena, 3s. 6d. per word; Southern Rhodesia and Swakopmund, 3s. 8d. per word; and Northern Rhodesia and Nyassaland, 3s. 11d. per word.

**British Association.**—The following have been nominated Presidents of sections for the Glasgow meeting of the British Association, September 11-18, 1901:—A (Mathematical and Physical Science), Major P. A. MacMahon, F.R.S.; B (Chemistry), Prof. Percy Frankland, F.R.S.; C (Geology), Mr. John Horne, F.R.S.; D (Zoology), Prof. J. Cossar Ewart, F.R.S.; E (Geography), Dr. H. R. Mill; F (Statistics and Economic Science), Sir Robert Giffen, K.C.B., F.R.S.; G (Engineering), Lieut.-Col. R. E. Crompton; H (Anthropology), Prof. D. J. Cunningham, F.R.S.; I (Physiology), Prof. J. G. McKendrick, F.R.S.; K (Botany), Prof. I. Bayley Balfour, F.R.S.

**The Michael Faraday Home.**—*Nature* states that a kinswoman of Faraday has made over to the Browning Settlement a 10-roomed house at East Dulwich, to be used as a home of rest and change for the poor, and to be called the Michael Faraday Home. To fit the Home for permanent use, the sum of £150 will have to be spent on alterations and repairs, and the annual cost of maintenance and hospitality will be at least £100. To meet this outlay an appeal has been made for funds, and it is hoped that men of science will give their support to an object which would have had the sympathy of Faraday, and which will stand as a memorial to him in his native parish. Subscriptions should be forwarded to the Warden, Robert Browning Settlement, Walworth, London, S.E.

**An Agricultural Application of Electricity.**—The extremely heavy fruit crop which occurred this year in Switzerland prompted a large boot manufacturing firm in the Canton of Aargau, to turn to account, in a novel manner, a day-time surplus of electrical power. They erected plant for the peeling, coring and slicing of apples, for the further treatment of these ring slices, and for the baking of the prepared slices. The baking or drying of the slices is effected by placing the slices on grid-like trays which succeed one another in an oven which permits of a continuous succession of trays. In this oven the baking of the slices proceeds rapidly under the influence of a current of dry air, warmed by previous passage over a form of electric heater. The product of the process, says the *Zeitschrift für Elektrotechnik*, is of excellent quality.

**Electrolytic Copper Production in the United States.**—The production of copper by the electrolytic process now amounts to about 20,000 tons per annum in the United States, says the *Western Electrician*. This is a little less than 7 per cent. of the total copper output in the States, yet the quantity is a large one and shows the importance of this branch of applied electrolysis. Moreover, the process has by-product

possibilities which may become important. In the electrolytic treatment of the ore the impurities are separated from the metallic copper and drawn off from the vat in a mass called sludge. As this residue is usually rich in the precious metals, it is treated for these, and large amounts are recovered. It has also been found that the non-metallic elements tellurium and selenium accumulate very rapidly in this sludge, and if there were any great demand for them it could be filled from this source at very small cost.

**Large Induction Coils.**—Two induction coils, giving each a spark 42in. in length, representing about 400,000 volts, were exhibited in New York by the makers a few weeks ago. They are described by our contemporary, the New York *Engineering News*. They have been made for the Japanese Government's forthcoming experiments on wireless telegraphy. The secondary of each of these coils contains about 125 miles of No. 32 copper wire wound in vertical layers, which are grouped in two large sections. The core consists of a bundle of iron wire weighing about 250lb. It projects about 15in. beyond the secondary at either end, the best length having been determined by experimentally plotting the field of force. The primary winding takes 20 amperes at 25 volts. The make-and-break apparatus is mounted upon a separate stand, which contains also the adjustable condenser. The break is made in a bath of alcohol between platinum button-shaped electrodes, the upper one of which is moved up and down by a cam movement driven by an electric motor. At the same time the lower button is slowly rotated. The frequency of the break may be varied from one to several thousand per second.

**Institution of Electrical Engineers.**—After the conclusion of Col. Crompton's lecture on the 20th inst., and the usual vote of thanks to the lecturer, proposed by the chairman (Prof. Perry), had been carried by acclamation, Mr. Alexander Siemens proposed the following resolution:—

That the Institution of Electrical Engineers offers the most cordial congratulations to the members of the Corps of Electrical Engineers (Royal Engineers) Volunteers, forming the electrical engineer unit of the South African army, upon the patriotic devotion that they have shown in placing themselves and their technical skill at the service of their country, and upon the successful termination of their arduous and self-denying labours during nine months of service in the field.

This having been seconded in an able speech by Mr. H. Hirst, was carried with great applause. Mr. J. W. Swan then referred feelingly to the losses sustained by the corps, and a resolution in the following terms, seconded by Sir Henry Mance, was carried in silence, all the members rising in their seats:—

That the Institution of Electrical Engineers desires to express its deep sorrow and to tender its heartfelt sympathy to the relatives of Corporal A. Holdaway and Sappers E. C. Short, W. C. Weakley, and E. J. West, who lost their lives while serving with the Corps of Electrical Engineers (Royal Engineers) Volunteers, in South Africa, and so gallantly devoting their technical skill to their country's need.

**New Inventions in Wireless Telegraphy.**—On Saturday last Prof. Slaby delivered a lecture on multiple wireless telegraphy before the German Emperor and his suite and a distinguished audience. Prof. Slaby has been devoting his attention for a considerable time to devising a means of Hertzian signalling between several independent pairs of stations without the messages interfering with one another, and he has now apparently solved the difficulty. The method employed seems to be simple tuning, so that, if we can judge from the small amount of information published with regard to Mr. Marconi's latest researches, it would appear that the two experimenters had been proceeding on the same lines. During the lecture, Prof. Slaby signalled to two stations, one at Schonweide on the Upper Spree, 8 miles distant, and the other in the Professor's laboratory at the Charlottenburg Technical College, about 2½ miles distant. Messages were received from these two stations in the lecture-room simultaneously. For both sets of the receiving apparatus on the lecture table the lightning conductor on the chimney of the Schiffbauerdamm electric lighting station was utilised as an air-wire without removing its earth connection. The lecturer explained that the arrangements were such that the waves in the two cases were of an exactly predetermined length, and that the two sets of apparatus were each tuned to a different wave-length. At Charlottenburg an air-wire 16 metres long was employed, attached to the roof of the Technical College, and at Schönweide the wire was a vertical one hung down between two chimneys. In the latter case the waves had to pass right through Berlin from south-east to north-west and were naturally atenuated by the number of chimneys and high buildings. In order to intensify the received wave Prof. Slaby showed another invention which he called a "Multiplikator," a word which may perhaps be translated as "intensifier." This is a resonator, the action of which Prof. Slaby explained by analogy with a tuning fork which only emits a weak note until it is placed on a suitable sounding board. The resonator increases the potential of the received wave, and renders it easier to detect on the receiving apparatus. This device was worked out by Prof. Slaby in August and communicated to the Allgemeine Elektricitäts Gesellschaft, the company having since that date developed the invention technically with the assistance of Count von Arco, a former assistant of Prof. Slaby's.

**Electric Supply Works and Board of Trade Regulation, B 6.**—As a result of the request of the President of the Board of Trade for further information (see *The Electrician*, Vol. XLV., p. 514), the London electric supply companies and local authorities interested in the supply to consumers at the increased pressure of 200 volts have prepared a draft letter, to be presented to the Board of Trade, in favour of an amendment of the proviso to clause 6, section B, of the regulations of March 4, 1896. The object in view is to obtain an alteration of the clause, so that, failing agreement between the consumer and the undertakers, the consent of the consumer to a change of pressure may be dispensed with and the change be allowed on such terms and conditions as might be settled by an arbitrator appointed by the Board of Trade, as was suggested at the interview accorded by the president last July (*loc. cit.*). The draft letter, which is the outcome of a conference held at the offices of the Westminster Electric Supply Corporation, mentions that certain consumers refuse on any conditions to agree to the proposal, and that one consumer can absolutely prevent the completion of the change of pressure over a whole district. The letter continues:—

The doubling of the pressure of supply now being generally carried out has for its object an increase in the number of lamps which can be supplied from the same mains. From this results: (1) The avoidance of so frequently disturbing the streets for the purpose of increasing the capacity of existing mains. (2) A better service to consumers generally by giving more equable voltage, and a means of lowering the price on account of more economical distribution. (3) A saving to the undertakers.

The matter is of considerable consequence to the local authority, both because of the lessening of disturbance of the streets, which more or less affects all London (except those areas where the pressure has been started at 200 volts), and in view of the possible purchase of the undertaking of supply companies by the local authorities, it is desirable that the capital expenditure should be kept as low as possible. We submit that an increase in the pressure is thus desirable from the point of view of both the local authority and of consumers, and that it is unreasonable it should be in the power of a few indivuals to delay or prevent an improvement in the method of supply. With regard to (3) we desire to state that the immediate saving is no more than that effected in distribution losses, and that the saving in capital outlay is on mains to meet future demands. The undertakers point out that any saving in revenue thereby made is less than the reductions they are in general making in the rate charged to consumers supplied at the higher pressure; in other words, that the probable saving in revenue has been or is being discounted by the reduction of rates. The profits to be gained will arise from the increase of business which the change renders possible. Such an alteration in the regulations as we desire would in practice affect only a few individuals, and would not deprive consumers of any right, except such as has been given them by the issue of the regulation in question.

We further submit (1) that this regulation, without any provision for appeal, leaves it entirely in the hands of certain consumers to at least put undertakers to heavy additional expense, notwithstanding that appeal is allowed if the county council refuse their consent to the change, or impose too onerous conditions; and (2) that the principle of arbitration is allowed in practically every other case under the Provisional Orders where difficulties arise between the undertakers and public authorities or individuals, as well as between the undertakers and their consumers.

We hope on consideration that, as the interests of consumers would be amply safeguarded, you will be able to consent to an alteration of the regulation in question, such as we have suggested—viz., that for the words, "with the consent of the consumer," in the concluding part of the proviso to clause 6, section B, of the Board of Trade Regulations. 1896, there should be substituted the words, "*on such terms and conditions as may be agreed upon between the undertakers and the consumer, or, failing agreement, as may be settled by an arbitrator appointed by the Board of Trade*," or words to this effect.

## BRUSH ELECTRIC TRAMWAY EQUIPMENTS.

The Brush Electrical Engineering Co. have the credit of having been the pioneers of British-made traction equipments, and praise is due to them for the successful manufacture of a line of standard British apparatus, competing in cost and excellence with the foreign-made equipments which were first in the field, and backed by the prestige of a lengthened experience. The company can now point to equipments of their own manufacture, in which all initial difficulties have been surmounted, and can confidently affirm that to-day Brush traction apparatus holds a position second to none in every essential that makes for success. We illustrate in Fig. 1 their standard motor for lines of 3ft. 6in. gauge, known as the 1,000 type, and made with four different windings to give 17, 25, 30, and 35 H.P. at their standard ratings. The lower-rated motor is specially suitable for tramways without heavy gradients and with single-deck cars, where a high speed is not required. It has a very high tractive force factor, enabling a start to be made with a small current. The 35 H.P. motor of this type has been made simply to satisfy the demand which is frequently found in specifications, for a 35 H.P. to fit a 3ft. 6in. gauge. The limitations of space available on a 3ft. 6in gauge are such as to make it inevitable that a motor to develop 35 H.P. must do so at a high speed. This means a low force factor and a very large increase of starting current. Apparently, the only solution of an efficient equipment for narrow gauge lines requiring a high speed on a gradient is the adoption of bogie trucks with four motor equipments. The 25 H.P. motor of this class is a serviceable compromise between these extremes, and fills all the requirements as to speed and tractive effort for an average line. We give its characteristic curve in Fig. 2, which bears out our foregoing remarks.

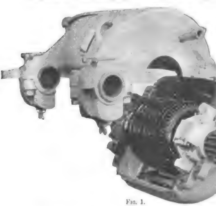
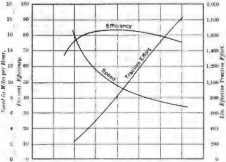


Fig. 1.



Characteristic Curve of 1,000. A. Traction Motor, 500 volts. Gear Ratio, 4·78. Wheels, 30in. diameter.
Axle Speed (revs. per min.) = Miles per hour × 11·25.
Armature " " " " × 53·75.

Fig. 2.

The rating of traction motors, as pointed out by Mr. Sprague in the discussion on Mr. Langdon's Paper before the Institution of Electrical Engineers, is a matter which is of no small importance as it influences both the purchaser and the use to which the apparatus is put. The standard American rating is based on one hour's run at rated load with a temperature rise of 135°F. It is quite clear that this rating is empirical, and is not intended to represent actual working conditions. The Brush Company's rating is based on a rise of 115°F. after one hour's run at rated load, and they claim that this represents more nearly the capacity of the motor to do its work without injurious heating. It corresponds more nearly to what the motor can steadily and continuously perform in daily work.

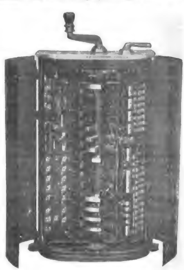


Fig. 3.

Besides the 1,000 type, the Brush Company are also making a type of motor known as the 1,200A type, which is suitable for tramways of standard gauge. This motor is rated at 35 H.P. at a low speed, and can handle the heaviest kind of holiday traffic on steep gradients without any danger of overheating. The question of overheating is in fact the crux of the traction motor problem. The motors may exert on test and show on their characteristic curves the necessary combination of speed and torque, but the proof of a good motor is its capacity to work at a temperature that does not quickly bring it in to the repairing shops. It is true that performances are sometimes demanded which are outside the possibilities of the dimensions available, but on the other hand the influence of good ventilation will often go a long way. The ventilating arrangements on the Brush motors are efficient. The upper pole pieces are

slotted out from their face to the outside of the frame and the openings are protected by a shield and a raised edge. The armature has a ventilating slot from the shaft to the periphery and air ducts, parallel to the shaft, supply air at a low speed, which is thrown out at the periphery and blown through the pole faces to the outside. This ventilation (which is, we believe, the only positive ventilation yet fitted to a traction motor) is extremely effective and has enabled the Brush motors to be rated 20°F. below most of the motors on the market of similar capacity. The frame is made to open downward and the armature, by a very simple arrangement shown in our illustrations, can be lowered with the bottom half, or left suspended in the top half as may be convenient.

Another feature of the motors is the application of automatic oil ring lubrication. This improvement is of the utmost importance in keeping down the cost of repairs and renewals. The life of the bearings is increased from three to four times that which is usual with grease lubrication, and the effect on the wear of the gear-wheels is almost equally marked. The reason for this is often over-looked—viz., that any wear in the motor-axle bearings leads to a displacement of the gear pitch circles, and a corresponding increase of wear and low efficiency. It is, therefore, true economy to give as much attention to the axle as to the armature bearings, and without oil lubrication this is not easy to do.

The Brush Company manufacture also several types of controller, among them being the H1 single motor controller, H2 series parallel emergency brake type, HD2 series parallel controller (Fig. 3) with rheostatic brake, and the HG2 series parallel controller with emergency stop and a regenerative position, by means of which the car may return energy to the line when descending long and steep inclines. Besides the two chief items of traction equipments—viz., motors and controllers—the Brush Company manufacture the smaller accessories, such as rheostats, fuse boxes, and canopy switches. They are also one of the largest builders of car bodies, and have just begun to place on the market a whole line of standard trucks. They are thus in an advantageous position to supply the growing demand for electrical traction apparatus.

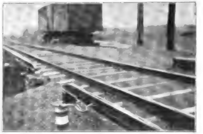
## THE ALBANY AND HUDSON ELECTRIC RAILROAD.

The formal opening of the Albany and Hudson Railroad occurred on November 22nd, and is illustrated and described in some of our American contemporaries, to whom we are indebted for the following article. The visitors, numbering some 75 leading technical men, who were invited to the formal opening, were carried from New York city in a special train. The run to Rensselaer, formerly called East Albany, was made in two of the regular cars of the Albany and Hudson Company, the distance of 38 miles being traversed in 53 minutes. The average speed was about 35 miles to 37 miles an hour, although on some of the long stretches the speed was over 50 miles. Notwithstanding the newness of all the equipment and most of the track, no difficulty of any kind was encountered, and no defect in operation or materials was discovered. The operation of the cars was smooth and easy, although the starting

The Stuyvesant Falls Power House.

Power House Viewed from Tail-Race.

North Chatham Station.



Third Rail Connection at Country Crossing.

View of the Bridge at Albany.

acceleration was high, and none of the unpleasant jerking, due to the reciprocating action of steam locomotives with which all of us are familiar, was felt at any time ; indeed, the smoothness of the running was one of the most noticeable features of the whole trip, and was particularly commented upon by the many steam railroad men present. The cars are so constructed that both the overhead trolley and third-rail connections are available, the overhead connection being necessary in the cities of Hudson and Albany. It was noticeable that there was much less noise when the third rail was in use than when the trolley was running on its wire.

Upper End of Trestle Albany.

The Albany and Hudson Railroad is the longest third-rail electric railway in the world, and the only one even approaching this size. It is operated entirely under steam railroad conditions as regards speed, power, weight of cars, and class of traffic. The operation of the railway, however, is not the only use to which the current generated in the Stuyvesant Falls power-house will be applied, as power will be transmitted to and distributed in the cities of Hudson and Albany, and the towns of Renseelaer, Niverville, Chatham, and others along or near the line of the railway. In addition, the local trolley systems in Renseelaer and Hudson are operated by the same power, as is also the electric lighting of these and other points near by. The same power will be available along the transmission line and throughout the valley of the Kinderhook Creek for economical application to such industries as may need it. Already negotiations are pending for the establishment of new industries to utilise some of the surplus of this fine installation.

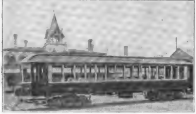
Car Shed at Albany.

Car Shed at Hudson.

Between the thriving town of Hudson, situated on the east bank of the Hudson River, and the city of Albany, N.Y., lies one of the most beautiful agricultural regions in the United States, noted not only for the products of its farms and dairies, but as well for the cloth and other manufactures that have been produced in it for the last century. The valley of the Kinderhook Creek is also a region of beautiful scenery. Not long ago the Albany and Hudson Railway and Power Co. took over the interests of the street railway companies in the town of Hudson, the Greenbush and Nassau

Electric Railway Co., the electric lighting and power companies in Hudson and Rensselaer, and the railway formerly operated by steam locomotives known as the Kinderhook and Hudson Railroad. In addition to these properties and franchises they also secured a fine water-power at the town of Stuyvesant Falls, located on the Kinderhook Creek, about 10 miles from Hudson. At this point the stream, which rises to the eastward in the Berkshire Hills, falls abruptly in two beautiful cascades to a distance of 105ft., furnishing an ample and practically unfailing source of water-power. Here is located in a fine brick building the plant necessary for the production of 2,500 H.P. Exclusive of the exciters there are eight units each directly coupled to a turbine water-wheel. Of these, three are 750kw. three-phase machines, giving directly 12,000 volts at 60 cycles in each phase. These machines supply current for the railway transmission system, and for general sale. Two multipolar 200kw. 600-volt direct-current machines supply power to the section of the road immediately adjacent to the power-house, taking the place of a sub-station for this section. In addition to these dynamos there are two 250kw. and two 125kw. 2,200-volt single-phase alternating machines, which supply the light in Rensselaer and in Hudson. These machines feed some lights direct, but for the long-distance lighting their current is stepped up to 11,000 volts or 22,000 volts for transmission. In addition to these machines, there are two 40kw. 60-volt exciters, making a total of 10 dynamos altogether. Each of the 10 machines is direct-coupled to a horizontal-shaft turbine. In addition to this equipment, one of the 750kw. and the two 250kw. single-phase machines are arranged to be driven by vertical engines in case of any failure of the water-power supply through ice or other obstructions. The impounded water comes down from the pond in two parallel steel tubes 7ft. 6in. in diameter.

From this power-house current is distributed by means of an overhead line, solidly constructed on wooden poles carrying porcelain insulators, to four substations, one located near each end of the line and two at intermediate points. At these stations the high-tension alternating current is received in a battery of transformers, and is by them reduced to a proper voltage for the rotary converters, which changes it to direct current at 600 volts, at which pressure it is fed to the third rail. The railway extends from Hudson to Albany, passing through the towns of Stottville, Stockport, Stuyvesant Falls, Kinderhook, Valatie, Niverville, North Chatham, Nassau, East Schodack, East Greenbush, and Rensselaer, from which point it crosses the Hudson River into the city of Albany upon a steel viaduct. The terminal facilities of the line in Hudson comprise a private right of way entering that town and connecting immediately outside with the Chatham branch of the Boston and Albany Railroad, over which access is had to docks on the river and the tracks of the New York Central and Hudson River Railroad. In the town of Hudson is also a large freight house, so that the freight in bulk and in its original cars may be taken from the connecting railway and hauled by the electric locomotives of the Albany and Hudson Company. On the other end of the line, in Rensselaer, a connection is made with the lines of the United Traction Co., operating in Albany, Troy, Cohoes, and other towns in the neighbourhood. The company also has fine dock facilities on the Hudson River at this point.



ONE OF THE CARS AT HUDSON, NEW YORK CENTRAL DEPOT.

The line is laid throughout with 80lb. T-rails put down upon extra heavy ties, solidly ballasted, the construction being in all ways equivalent to that of high-class steam railroads. The third rail, which is also of steel well bonded together, is laid at one side of the running rails at a slight elevation upon insulators. The total length of the line from end to end is about 36 miles. Upon it will be operated, as a preliminary installation, 10 motor cars, each equipped with four motors developing 75 H.P. each; the contract for these cars requires that they shall maintain schedule speeds in excess of 51 miles an hour.

## THE ELECTRICAL ENGINEERS R.E. IN SOUTH AFRICA.*

BY LIEUT.-COL. R. E. CROMPTON, E.E.(R.E.)V.

At the request of your president I have prepared a narrative of the war services of the small body of electrical engineers who left England early in the spring of this year for South Africa and who have now returned. I must commence by reminding you that the corps of Electrical Engineers R.E. Volunteers was raised by the help of this Institution in order to enable electrical engineers to place their services at the disposal of the country in case of need. It is acknowledged that every year electrical appliances will be more and more used in military operations. Up to last year the special work on which the corps had been instructed and drilled for home service has been the management of the searchlight apparatus used at various points for coast defence, to which has been added some instruction in submarine mining and cognate matters.

As both officers and men of the corps felt that the training which every one in the electrical profession must go through has made us all handy men, not only for electrical, but for general mechanical engineering work, we offered our services for the war in South Africa. Our offer was accepted in December, 1899, and after some consultation with the War Office an equipment was designed by our own officers, and was manufactured with such rapidity that our first detachment was ready for embarkation early in March. Five officers and 47 men were mobilised in February, and on March 16 five officers and 47 men embarked from Southampton on ss. "Tagus." On the 17th two officers and one non-commissioned officer embarked on the "Custodian" in charge of the equipment. The equipment has already been described in the technical journals. I will remind you that its main features are portable searchlights mounted on carriages somewhat similar to those used for field artillery guns, the electrical energy being generated by dynamos carried on small compound steam traction engines. Special cable carts were also provided.

I do not propose to take up your time in giving the details of construction of the projectors, engines, dynamos, or other apparatus. Those interested in these matters will have full opportunity of examining it in March next, when the headquarters of the corps are completed. Although steam-traction engines were chosen, it was foreseen that the oil engines to which the corps is so well accustomed at its annual trainings would have had great advantages if a portable type of oil engine had been procurable. A supply of arc lamps, with special lanterns which could be readily packed, and incandescent lamps with fittings, were also sent out for the electric lighting of working parties, depots, and railway sidings. A novel feature of the equipment was that 20 bicycles were provided with reels on which fine, uninsulated copper wire was coiled, to serve as telephone conductors, and a special light and very portable type of telephone was obtained, which, as will be seen hereafter, gave excellent results. The whole of the remainder of the equipment, which contained, among other things, complete sets of repairing tools, tube wells, pumps, and portable forges, was carefully considered, and subsequent experience showed that it was well chosen.

The "Tagus" arrived at Cape Town on the 4th, and the unit disembarked on the 6th and were encamped at Fort Knokke for a few days. The "Custodian" arrived on April 12th, and the equipment, including two of the 8 ton traction engines and four 5-ton waggons, were unloaded that night. Col. Girouard, the director of railways, at once applied to have the electrical engineers attached to the railway re-construction trains, and they were ordered to get ready to move up country as quicly as possible. On Saturday night, April 14th, the whole of the equipment was packed on five large bogie trucks, but even their start seemed likely to be delayed, as the line was blocked with press of traffic. Under these circumstances the unit received an invitation from the electrical engineers of Cape Town to attend a smoking concert to be given in their honour on the following Tuesday; but, unfortunately, this could not be accepted, as on Monday morning the unit suddenly got orders to start.

After a journey of three days and four nights it arrived at Bethulie at 5 a.m., April 20th, and at once off-loaded the equipment, and within a few hours the first installation of temporary electric light for war purposes was erected on the Bethulie-road bridge, which was then temporarily in use for railway purposes, during the time that the low-level deviation railway bridge was then constructed by the Railway Pioneer Regiment to replace the original railway bridge which had been destroyed by the Boers. At first six arc lamps were found sufficient, and these were erected and worked nightly from one of the dynamos mounted on its traction engine at the river bank. As soon as the low-level railway bridge was complete the installation on the road bridge was dismantled and transferred to the new bridge, the approaches to which, being tortuous and having steep gradients, had to be worked by the engine drivers with the greatest caution, so that for some days the arc lights were used to light these approaches.

---

* Lecture delivered before the Institution of Electrical Engineers, Dec. 20.

The first time the field telephones were put to work to was at this place. A line was laid across the bridge for the use of the railway, and a good telephone service established. During the time that the corps was at Bethulie Sergeant-Major Brown, R.E., and Sapper Phillips, E.E., were sent out with part of the telephone equipment to accompany a flying column which left Bethulie on May 2 to join General Hart, who was then moving south from Smithfield.

As the telegraph line between Bethulie and Smithfield had been destroyed the new field telephones were brought into use to maintain communication with the flying column, and this was kept up without any failure during the time the column advanced until it met General Hart. General Hart was thus enabled to be put into communication with Lord Roberts via Bethulie, temporary communication being made between General Hart's camp, $1\frac{1}{2}$ miles from the telegraph line, by bare copper wire, No. 22 gauge, laid on the ground from the bicycle reels supported by a special belt to the body.

Traction Engines Taken Out by the Corps.

On May 6th the unit arrived at Bloemfontein and was split up into two sections, one going on direct to railhead, which was then at Vet river, the other section remaining at Bloemfontein to carry out the electric lighting of the goods yard and locomotive shops. At this point an installation of arc and incandescent lamps was erected and worked by No. 1 engine and dynamo, and has been running ever since, the installation being gradually increased in size until there are now 16 arc lamps and a large number of incandescent lamps installed. It must be noted that it is somewhat of a feat to carry out a temporary job of railway lighting of this kind, and to work it continuously without any failure or interruption from May to December (*i.e.*, up to the date of writing), using only one engine with no spare plant, and the credit of this excellent service must be mainly given to the small detachment that was left at Bloemfontein under command of Corporal Bicker Caarten, to whom has since been entrusted the design for a permanent installation to replace this temporary plant.

One of the Search-Light Sets.

The advance section at Vet river joined the reconstruction trains and remained with them during the months of May and June—*i.e.*, until the work of reconstructing the railway was completed through the Orange Free State up to the Vaal River. The equipment of this No. 1 section consisted of No. 2 traction engine with its dynamo, two waggons, subsequently increased to four waggons, two projectors with their limbers, two cable carts, extra cable coiled on drums, 16 arc lamps with suitable poles, hoisting gear and the necessary accessories, a supply of incandescent lamps with suitable fittings, 14 sets of field telephones, a supply of insulated and bare copper wire telephone conductors coiled on reels which could be either carried on the bicycle or on special slings strapped to a man's chest in such a position that he could either pay out or wind up a conductor.

The work at Vet River may be taken as typical of many other works at which it was necessary to work all night by artificial light. The Railway Construction Corps R.E. was engaged in constructing

a main bridge across the river approached by long deviations from the main line ; in these were three smaller bridges. The lighting plant had therefore to be erected at each of these bridges in turn.

When the Vet River work was completed the section moved on to Smaldeel, and there was joined by Major Crompton with a draft which had left Cape Town on May 4th. Major Crompton brought with him a third traction engine with its dynamo, an addtional supply of concentric cable, two addional 5-ton waggons, stores, bicycles, &c. Major Crompton then took over command of the unit, and, as the occasion arose, the whole of the Bloemfontein section, with their stores, were gradually moved up to join the unit, leaving only a small detachment of six men, under the command of Corporal Bicker Caarten, to work the temporary lighting plant at Bloemfontein.

Two of the Projectors Limbered.

Early in May Col. Girouard required the services of additional railway telegraph men, and Capt. Bain was detailed for this work, and, with a detachment of seven men, was sent on to repair the telegraph in advance of Railhead. This was a service of great importance, entailing considerable personal risk and exposure. Capt. Bain, who was eventually assisted by Lieut. O'Shaughnessy, remained at this work for several months, and eventually was put in charge of the whole of the railway telegraphs in the Transvaal, under Capt. Manifold, R.E., Administrator of Railway Telegraphs, his detachment being strengthened from time to time by additions from this unit, as well as from the Royal Engineers and other corps.

Battlefield of Leeuwspruit.

The No. 1 section commenced lighting work at Zand River on May 18th, this work being of a very similar nature to that of the Vet River. It afterwards advanced with the railhead construction trains to the Rhenoster Spruit to assist the working party building a crib bridge at that point. Here a particularly smart piece of lighting work was carried out. The orders were received at 2 p.m. The traction engine was off-loaded from its truck and hauled its waggons and stores down to Rhenoster Spruit, 3 miles away, the light stores going down the damaged railway line on a trolley. Eight arc lamps were fixed on poles, and light was furnished to the working party by nightfall, 5:30 p.m. The new and first reconstructed bridge at Rhenoster was completed on the 29th, and there being then no large work ahead requiring arc lights, the detachment went forward with the construction train, and were employed principally on the actual work of building the crib piers, fixing the beams and laying the rails until the line was completed and railhead advanced to Taibosch. During this time the equipment was left behind at Roodeval in charge of Sergeant Phillips.

Locomotive after Battle of Leeuwspruit.

During the next eight days the detachment had an exciting time as the enemy under De Wet and Theron were threatening the line and reconstruction works. The electrical engineers formed part of the reconstruction day shift, the working hours being generally from 6 a.m. to 6 p.m., but sometimes up to 12 midnight, so that on these days the men were 18 hours consecutively at work. From Rhenoster up to Taibosch the enemy at the advice of Theron had destroyed the line very completely, not only the larger bridges, but all the smaller culverts were blown up ; in some places the rails for considerable distances were twisted and contorted by dynamite cartridges fired at every fish joint.

View of Construction Train after Fight.

On Wednesday, June 6, Taibosch Spruit was reached, and seeing that arc lights would again be required at this point and at the Vaal River, Captain Lloyd was sent back with two engines and a few trucks to bring forward the electric light equipment which had been left at Roodeval. His journey down the threatened line to Roodeval was a most exciting one. At Vredefort Weg he was called upon to

arrest the Field Cornet Le Roux, who, although he had taken the oath of allegiance, had been observed signalling to the enemy. This train was expected to be attacked at any point south of this, and the utmost precautions had to be taken. As the water supply at Roodeval was known to be scanty he left one locomotive to fill up its tanks at Rhenoster and took one on to Roodeval. He there found that the small garrison had been threatened for days, and had been on harassing night duty during that time. On his approach to Rhenoster Spruit he found that the line was blocked by some trucks which were being used, somewhat irregularly, for shifting tents and camp equipment required for a new camp.

Repairing Bridge by Arc Light.

As Capt. Lloyd knew that De Wet was preparing to cut the line to the north of Rhenoster this delay seemed likely to result in the unit losing their electrical equipment. As it was the line was only cleared in time to get the train away a few hours before De Wet commenced his attack on the Rhenoster camp, which resulted in heavy losses and in the destruction of the new bridge, the water supply, and of the valuable ammunition and stores then at Roodeval. The return journey northwards was of the most exciting nature. The train was made up with some of the trucks in front of the locomotive so that in case of the leading truck being derailed it could be thrown off more easily, and thus less delay caused than if the locomotive itself were derailed. It was necessary to examine the track with lamps placed on the leading truck and thus by lamp signalling back to the engine driver to control the running of the train. In this manner the train was worked back to Taibosch.

Lieut.-Colonel Crompton at Home, Entertaining his guest Capt. Webber: The Car in which he lived for nearly two months

At Vredefort Weg Captain Lloyd arrested and brought along with him the Field Cornet Le Roux. By the time Captain Lloyd passed Vredefort Weg De Wet had been successful in his attack at Rhenoster and cut both railway and telegraph wires so that the construction trains were entirely cut off from the south.

During the time that the arc lights were being used on the bridge at Taibosch on the nights of the 7th and 8th Lieutenant Pott succumbed to enteric fever. This was a great loss to the unit, as this officer had himself designed a great portion of the arc lighting and projector plant, and the loss of his services greatly crippled the unit. He had to be left at Viljeon's Drift, where he was nursed with extreme care by Dr. and Mrs. Dixon, Dr. Dixon being the medical officer to this section of the railway. Here Sapper Weakly also fell ill of enteric fever, probably brought on by the exposure at Roodeval. He lingered for some time, and eventually died at Viljeon's Drift on the 27th.

A "Biscuit-Box" Laager.

During the time that the unit was at Taibosch Major Crompton, taking with him Sergeant-Major Brown, R.E., and Company Sergeant-Major Rorke, went south with the field telephones to attempt to make temporary communication at the point where the telegraph lines had been cut by the Boers. Major Crompton returned to his command at Taibosch, leaving the two non-coms. with Lord Kitchener, who arrived at Kopjes on the 9th. They were able to establish communication with the south, and thus kept him in touch to north and south until the telegraph lines were again in working order.

Railhead reached the Vaal River on June 10, and at this point an installation of 12 lamps was erected, and on the 11th the first train crossed into the Transvaal and some supplies were sent to Lord Roberts at Pretoria. It may be here remarked that as during the advance of railhead from Bethulie to the Vaal the arc lamps were worked on 19 nights, it is probable that the period of recon-

structing the line was shortened by nearly the same number of days, but even if one night's work is only considered to be equal to two-thirds of a day's work the night work rendered possible by the section must have hastened the advance of railhead by not less than 12 days, and the money value alone of this to the nation must have many times repaid the entire cost of equipping and sending out the Electrical Engineers.

After one night's lighting at the Vaal the very thorough destruction of the line to the south by De Wet necessitated the sending south for a second time both construction trains; the unit accompanied them, leaving the lighting equipment at Viljeon's Drift under Sergeant Brown. The construction trains working south were constantly threatened by De Wet, and on the night of June 14 both trains were attacked by him, and were summoned to surrender. As this was the first occasion in which the Electrical Engineers were under fire, perhaps I may be permitted to describe the attack at some length :—

Very early in the morning of June 14 the night working party, which consisted chiefly of Royal Engineers and Volunteer Royal Engineers, none of them being Electrical Engineers, were at work rebuilding the crib piers of the recently constructed bridge at Leeuwspruit; at this time one of the construction trains was drawn up close to the working party, who were at the break in the line, the other train being about half a mile to the north on its way to shunt empty trucks on a siding a mile further north.

The first trouble noticed was the derailing of the leading truck of the northern train. This was caused by a stone having been wedged by the Boers between the main and the guard rails. As soon as the train was pulled up it was fired on by an attacking party, which apparently surrounded it. The troops on the train promptly replied, and with good effect, as the Boers drew off after half-an-hour's firing, and concentrated their attack on the other party at the Spruit, but during this sharp attack the vans and coaches of the northern train were riddled by bullets, and those sleeping in them had narrow escapes. The attack coming at first from the south side, the engine driver started to move the engine northwards. The Boers then made a rush on the unarmed working party, who, with one officer and 60 men, were taken prisoners; the remainder, however, escaped, but could not rejoin the party defending the trains.

ONE OF THE TRACTION ENGINES.

The Electrical Engineers had formed the day-working party, and having been many hours at work, and consequently very tired, were sound asleep. Those of them who were sleeping outside the trucks, close to the working party, were captured by the Boers before they were able to regain the train. At this time the Boers' firing was very heavy, and three officers—*i.e.*, Lieut. Miclem, R.E., Lieut Bigge, E.E., and Lieut. Holmes, of the Royal Irish, were seriously wounded. Three sappers were killed, the engine driver and a number of others seriously wounded, and of the native workmen about 30 were killed or wounded. At this time De Wet sent in a messenger summoning the train to surrender as the Boers were greatly superior in force and had guns. No attention was paid to the message, and the remaining troops, who were then under the command of the officers of the Electrical Engineers, took up a position on a ridge of rocks which ran transversely to the train, from which the train could be protected without the men being exposed. This position was held for several hours—in fact, up to daybreak—the firing of the Boers being continuous and severe. On the other hand, the position we occupied was so strong that the Boers were unable to approach the train, and soon after daybreak they withdrew from the attack. Towards the latter part of the time the Boers were much disconcerted by the shrapnel which was fired over them by two guns placed by Lord Kitchener in a position to the south.

The night was intensely cold and trying to every one; the whole of the defending party were asleep in the trucks when the attack commenced. Although taken at such a serious disadvantage, every man on the train, without distinction, behaved as coolly and quietly as if they were no enemy present. It was a difficult matter even for old and trained soldiers to free themselves from the crowd of Basutos who formed the native working party, and who cleared out from the train at the commencement of the firing, but, in spite of this, there was no confusion; ammunition was quietly served out, and our men got into such strong positions that it was impossible for the Boers to make their attack successful. Everyone behaved so well that it is difficult to single out anyone present for special praise. Although the Electrical Engineers engaged on this occasion were comparatively a small party, yet, owing to so many of the night-working party having been surprised and dispersed in the first instance, they formed nearly one-third of the troops left to defend the trains. If De Wet had been successful in catching and destroying these two trains, which contained so much construction material and all the tools, as well as the most skilled body of reconstruction officers, the break in the line of communications would have remained open for a long period, and certainly would have seriously affected the future movements of the more advanced portion of the Army then in the Transvaal.

TRACTION ENGINE WITH LARGE GUN.

THE "URSULA" TRACTION ENGINE, EMPLOYED FOR MOVING THE HEAVIEST GUNS.

The attack caused the Electrical Engineers to temporarily lose the services of one officer wounded, and Corporal Sellon and six

sappers taken prisoners. The remainder went south with the construction trains to Rhenoster, and assisted in the building of this important bridge. Whilst there, orders were received from army headquarters, that the whole of the Electrical Engineers should come up to Pretoria at once. They started on the 20th, leaving Lieut. O'Shaughnessy to complete a system of telephones connecting Rhenoster Camp, Leuwspruit, Roodeval, and other points which had been recently threatened or attacked by De Wet. After carrying out this work he joined the headquarters at Pretoria on June 26.

After arriving at Pretoria, the engineer-in-chief found quantities of electrical work for the corps, as all the forts which defend the town had been fitted up with various electrical apparatus, not only for electric lighting, but there were signal signalling, telephone and other wires, which required to be sorted, labelled, and their uses understood. The oil engines which supplied the motive power for driving the dynamos had purposely been damaged by the Boers, and had to be repaired and set to work. The small and inefficient searchlights which had been used by the Boers were replaced by a system of incandescent lamps placed so as to illuminate certain points which were liable to be threatened by the enemy during night attacks.

This work at the forts, which was of a very interesting nature, was followed by teaching the garrisons how to use and maintain the electrical apparatus in working order. Other parties of our men were employed in fitting up electrical lighting in various public buildings which served as supply stores, and in the large hospitals which were then being started inside and outside Pretoria. In some cases these new installations were worked from the public supply of the town, in other cases separate generating machinery—i.e., steam engines, dynamos, and systems of conductors—had to be put down for each job. The plant for this was made up from material found at or near Pretoria, most of which was in a damaged condition and had to be almost re-made before it could be usefully employed.

FIELD TELEPHONE BICYCLE FITTED WITH WIRE DRUM.

During this time, as the whole of the Rand district surrounding Johannesburg is supplied with electric light and power partly from a distant generating centre at Brak Pan, the Military Governor of Johannesburg asked for and obtained the services of Capt. Leaf as his electrical adviser, and from time to time various works were supervised by him and by other officers of the corps, so that the electrical plant of Johannesberg and district was gradually got into order.

It will be interesting to those who have read Rider Haggard's novel, "Jess," to know that our camp at Pretoria was close to the site of Jess's cottage. Its position was well chosen; we had a stream of water handy for washing out our engines and we were close to the railway and railway workshops. Thus, we were in a most convenient position for repairing the various pieces of apparatus that we were installing in the forts and public buildings. Amongst others, the Government Printing Works of Pretoria, worked by their own electric generating plant transmitting power to motors driving each set of printing machinery, was put in order and worked by us.

Early in July, Electrical Engineers were several times called upon to extricate an engine which was proposed to be used to haul 12-ton 6in. quick-firing guns to various positions near Pretoria. This engine and a gun was hauled out of a drift almost in the middle of Pretoria, into which it had sunk in the course of an experimental run. A few days later, after the driver of this engine had placed the gun in position near Deerdepoort, he took his engine down to a spruit in order to fill up his water tanks, but approached too closely to the soft ground, so that the engine turned over on its side and could not be got out until we were sent for.

Great praise is due to Capt. Lloyd and Capt. Leaf and the detachment engaged on this work, which was carried on throughout the night. The way in which the Electrical Engineers handled the engines and gun made it evident to the Officer Commanding the Artillery that the Electrical Engineers were so capable that he placed the engine and the two guns in their charge, and the subsequent work of placing these, the heaviest guns ever taken into the field, was carried out by the officers and men belonging to the corps.

On July 24, a 6in. quick-firing gun, weighing with its carriage 12½ tons, was hauled to the top of Quagga Kop, 7 miles to the west of Pretoria, and 1,300 feet above it! the average slope up which the gun was hauled was 1 in 10, but there were point parts of it which were steeper. On August 1 a similar gun was hauled up a slope averaging 1 in 6, and in some places 1 in 5, to a redoubt on the top of this hill, about 5 miles east of the town. A few days later two large traction engines belonging to the Director of Steam Transport were put under our charge, under the officers of the Electrical Engineers, and with these and the other three engines, making five traction engines, a regular daily service was organised, and stores of every description were transported to various points, chiefly to the westward of Pretoria, the longest run being to Commando Nek, 26 miles distant, where a depôt was formed for flying columns. The service on this road lasted for many weeks; in fact, up to the time the corps started for England, and was carried out without any mishap or loss, although during the whole of the time the line was threatened by the Boers, and we were informed that sniping frequently went on, but as far as we were concerned no one was hit. A new system of escorts was adopted, sufficient men to form two or more escorts being put under the command of the officers of the corps and encamped with us. The anxieties connected with this service were greatly reduced by an excellent system of signalling the position of the trains which was introduced by Capt. Lloyd.

FIELD TELEPHONE IN USE.

Early in June a part of the detachment left at Bloemfontein left under Lieut. Stubbs and worked under the army telegraphs repairing telegraphs and erecting new lines. They trekked the whole journey from Bloemfontein to Pretoria, only arriving at Pretoria towards the end of July. After their arrival at Pretoria Lieut. Stubbs' party were employed for some time on new telephone lines connecting the forts with the town, and later on took another party down westwards to Standerton.

Towards the latter part of August a party of Electrical Engineers, under Capt. Lloyd, were sent up to Brugspruit with a set of searchlight apparatus and accessories, which was erected, and the light shown from the top of the shaft of a colliery near Brugspruit Station, the dynamo being driven from the mine engine. Capt. Lloyd returned to Pretoria and left the detachment for some weeks under the command of Lieut. Bigg, and there is no doubt that the presence of this searchlight greatly reduced the liability of night attacks from a strong commando under Erasmus, which threatened the Pretoria and Delagoa Bay Railway at this point. On September 4 one of the engines, with dynamo and 16 arc lights, were taken down to

Machadodorp by Captain Leaf and a small party of Electrical Engineers, and at this point an installation was erected to supply light to the various running-sheds and loading stages, as at that time convoys which supplied three columns with food had here to be loaded.

On August 31 Sergeant-Major Brown, R.E., and Corporal Dalton were attached to Lord Kitchener's staff to use their bicycles and field telephones as required at the front. Up to the time of the arrival at Pretoria, as the officers and sappers were constantly employed on railway work, little opportunity was given for the sappers to use their bicycles, but after arrival at Pretoria they proved to be of the greatest value; for as the work at the forts and buildings was scattered over a large area it necessitated the officers and men moving rapidly from point to point, and the whole of the bicycles were in full use, so by their aid the 20 men who rode them were almost doubled in value.

On September 17 the writer, accompanied by Capt. Leaf, was sent down by Lord Roberts to the low country to the east of Machadodorp, in order to report whether any of the traction engines could be efficiently used there. At this time Capt. Bain also came down to Waterfal Onder in charge of the railway telephone work, and Lieut. O'Shaughnessy was in command of the more advanced telegraph work near Koomati Poort.

Early in October the writer was ordered to England by Lord Roberts, in order that his recent experience might be utilised in designing traction engines for military purposes. Capt. Lloyd re-assumed command. From this date the work went on uninterruptedly until the later end of October. The unit by this time was in a very scattered condition. The large number of jobs being carried out all over the Transvaal and Orange River colonies demanding small detachments at various places.

It was whilst in charge of his Standerton detachment that Lieut. Stubbs so nearly lost his life. His duties necessitated a journey by rail on a line known to be threatened by the enemy. At a point on the line near Vlaklaagte, a few miles north of Standerton, something was observed on the line which looked rather like dynamite. Lieut. Stubbs went forward to examine, and was immediately fired on by a large party of Boers concealed about 300ft. off. Trying to regain the engine he was hit again and again until at last he rolled into the ditch by the side of the line.* The train was captured and all not killed or wounded were taken prisoners. The train was then blown up and burnt.

Towards the end of October orders were received from the engineer-in-chief to concentrate the unit and hand over the majority of the stores so as to be ready to move homewards on receipt of further orders. The various detachments were gradually collected, and on October 25, exactly four months since they arrived in Pretoria, the unit steamed south for Bloemfontein. Seven men were left behind in Pretoria to take their discharge there; four of these had been given civilian employment under the Imperial Military Government, and three were taken up by private employment on the Rand.

A 48 hours' journey took us to Bloemfontein, where we completed the handing over of equipment and packing for our final departure. But even during this time the "handy man" was not allowed to be idle—6 miles to 8 miles of telephone line connecting outlying camps were laid under Capt. Bain's direction, whilst Capt. Lloyd was sent off to Norvals Pont to report on an electric light installation at the hospital there. He also had to report on the future lighting of the railway depôt at Bloemfontein from the new town central station. Had not orders for the unit to move south finally for Cape Town been received it is probable that the men would still be discovering fresh jobs to turn their hands to.

Yet one more check was met ere the unit finally arrived at Cape Town. No transport was absolutely ready, and so, to avoid the possibility of the hardened and fierce warrior striking terror into the hearts of the peaceful inhabitants of Cape Town the bloodthirsty Electrical Engineers were kept for three days in the safe camp of Stellenbosch, and not until Saturday, November 17, did they reach the port, where the train took them right along side the "Norham Castle." After an uneventful and extraordinarily fine passage the ship was brought alongside the quay at Southampton on the evening of December 6.

## THE TELEGRAPH SYSTEM OF SIBERIA.†

BY H. L. GEISSEL.

Note has been made in New York newspapers within the last few days of the finding of relics in Alaska of the old trans-continental line that was to give the United States almost direct and continuous communication by land, across Siberia, with Europe. So far as the writer is aware, the Russian part of the enterprise has never been narrated in this country. It was an episode of singular international interest. The present situation is not less important.

Some 40 years ago the then chief of the Russian Ministry of Ways and Communications, Gen. Tschewkin, submitted to the Siberian Committee a proposal to connect St. Petersburg with the shores of the Yellow Sea by means of a telegraph line. This proposition was accepted, and at the same time it was suggested that this line be extended from the seashore by a cable to America. Mr. L. Gerhard, who was at that time director of the telegraph department, and to whom the early development of the Russian telegraph system is chiefly due, started the work on this great line with much energy, and in 1861 the line Kasan-Tiumen, 1,356 versts in length, was completed. This line formed the first link between European Russia and Siberia. One year later, in 1862, the line was prolonged as far as Omsk, and in 1863 Irkutsk, on Lake Baikal, was reached. After the connection had been completed so far the further construction was conferred upon the American, Collins. The latter's scheme was the following: To build a line from one of the North-Western Pacific States via British Columbia, the Behring Straits, and across that part of Asia bordered by the Sea of Ochotsk to the mouth of the Amur River. For the construction of the line from Irkutsk to the Pacific coast the Russian Government appropriated the amount of 900,000 roubles. Work on this line was started in 1865, but it met with immense difficulties. The lack of any means of communication rendered the surveying of the line and the transportation of the required materials almost impossible. The latter had to be transported over long distances by means of pack animals, and the roads had to be cut out of the dense virgin forests. If one adds the lack of workmen and the immense difficulty in securing labour in almost uninhabited vast tracts of land it will be apparent that it was no easy task to establish a telegraph system through these parts of Siberia. All the materials required for the construction and equipment of the line—with the only exception of the supporting poles, which were secured on the spot—had to be shipped thousands of miles over the ocean to Nicolaiewsk. In many instances the insulators had to be fixed on trees. In order to afford quicker transportation in the interior, the Telegraph Administration purchased some steamers to be run on the Amur and Schilka rivers, but as the navigation on these rivers is open only during a few months of the year, these means soon proved to be insufficient. It must also be borne in mind that the constructors of the line were compelled to build dwellings along the route. But in spite of all these difficulties and dangers the work was rushed with such energy that in 1866 the line had been extended from Irkutsk to Werknedinsk and Stretensk (1,185 versts). At the same time poles were erected along all other parts of the route in order to prepare the line for its connection with the proposed cable.

At this period, however, a highly important incident occurred in the history of the development of the world's telegraph system. In July, 1866, the transatlantic cable between Europe and America was completed. As a consequence, work on the construction of the Russo-American telegraph line—which had already made good progress—was stopped, as the American company declared that it would not be able to compete in any way with the transatlantic cable. At the same time the Russian Government ordered the abandonment of the work on the extension of the Siberian line.

Nevertheless it was felt more and more in administrative and influential commercial circles in Russia that the immense territories of Siberia could only successfully be controlled by means of an extensive telegraphic system, and in May, 1869, an imperial ukase ordered the prolongation of the Siberian telegraph line to Blagovestchensk, Chabarowsk, the port of Novgorod and to Nikolaiewsk.

On June 25, 1869, after an intermission of almost three years, work on the line was taken up again at Stretensk. Eighteen months later, namely, in the middle of December, 1870, telegraphic communication with Chabarowsk was established, and in 1871 the Pacific Ocean was reached at Vladivostok. At the same time the old telegraph line, Chabarowsk-Nikolaiewsk, which up to that time had only been used for political purposes, was taken over by the Telegraph Administration, which was compelled to rebuild the entire line. Thus, finally—and after the greatest difficulties had been overcome—was completed the longest telegraph line of the world, for this line, from Kasan to Vladivostok, has a length of 8,330 versts (5,523 miles). At the same time of the completion of the Siberian telegraph line, the Danish Northern Telegraph Co. started to lay the cable from Vladivostok to Nagasaki, Japan, and from Nagasaki to Shanghai. The Northern Telegraph Co. started this work in August, 1871, and on November 5 of the same year—eight months after a telegraph office had been established at Vladivostok—the first telegrams were sent over the great Siberian telegraph line between Europe, America, Australia and the countries of the Far East.

It should, however, be mentioned that the Siberian telegraph line soon proved to have many deficiencies, especially on the section east of Irkutsk and in the Amur district. This cannot be surprising when considering the circumstances under which the line was built. One of the most disagreeable features was that the wires, which were 4mm. thick, were found to be insufficient in electrical as well as in other technical respects. It was therefore decided to equip the line

* Lieut. Stubbs has been recommended for the Victoria Cross.
† From the *Electrical World* of New York.

with wires of 6mm., but this was not carried out until 1894 and 1895. Since that time the line has been in regular and satisfactory working order.

The late war between Japan and China showed particularly the great importance of the Siberian telegraph line—especially its political and administrative importance—but at the same time it also became known that further improvements were needed. It was, above all, observed that the line was not able to cope with the great number of telegrams, especially cipher messages of several thousand words it received almost daily. In order to remove this drawback the Russian Government established in 1896 a second line from Omsk via Tomsk and Irkutsk to Stretensk, at the same time increasing the number of Hughes apparatus at the offices in Tomsk, Irkutsk, Stretensk, Blagovestchensk, Chabarowsk, and Vladivostok. Besides this, a direct line from Libau via Moscow, Samara, Omsk, Tomsk, Krassnoiarsk, to Irkutsk, was established during the year 1897, and the translators at the Kansk and Obi offices were doubled. Besides the great main line, the Siberian telegraph network has a considerable number of branch lines, some of which are of the greatest importance. Most prominent among these branch lines are the following: The telegraphic connection between Omsk and Tashkent—via Semipalatinsk and Verny—completed in 1873; the line to Kiatka, a city on the Chinese frontier, built in 1875 and opened the same year; this line is of great economic and political importance, as it can easily be connected with Peking; the lines connecting Chelampo with Blagovestchensk, and Chun-Tun with Novokiewsk, near Vladivostok. Mention should also be made of the line to the island of Saghalin, established by the Russian Government during the year 1881.

The official statistics obtainable on the operations of the Siberian telegraph system present an interesting picture of the steady increase in the traffic of the different lines. During the first year after the opening of the main line to Vladivostok, in 1872, the number of telegrams dispatched was 432,412. In 1885 the number had increased to no less than 2,402,981, the annual traffic during the period of 13 years thus having increased by 151,582 telegrams. The abolition of the so-called zone-tariff in 1886 had a great influence upon the business operations of the Siberian telegraphs, as the rates under this tariff were very high, a telegram of 20 words costing as much as 7 roubles. The new tariff fixed the rates as follows: 5 copecks (1 rouble = 100 copecks = 52 cents) for each word for telegrams within Siberia proper; 10 copecks per word for telegrams between European Russia and Siberia. The beneficial influence of this new tariff was soon shown. In 1887 the number of telegrams dispatched over the Siberian lines was 2 976,149, the traffic thus increasing within scarcely two years by 573,168 telegrams. During the following ten years the average annual increase amounted to 266,000 telegrams, and in 1897 the number reached 5,636,186. As far as the transit traffic carried on over the Siberian telegraph line from Europe, America and Australia to China and Japan is concerned, it may be said that during the opening year of the line, 1872, the number of those telegrams was 6,000, while it amounted during the year 1898 to 63,700. For all transit telegrams dispatched over the Siberian line Russia receives 2·25f. (45 cents.) per word, the income from this source thus being a considerable one. In 1898 alone the number of words of these transit telegrams increased by 116,705 words, as against the previous year, thus increasing the receipts of the Russian Telegraph Administration by the amount of 262,586f.

## ELECTRICITY WORKS ACCOUNTS.

### The Norwich Electricity Co.

It is unfortunate to find that the tendency to increased costs at Norwich which was exhibited in the accounts for 1898 should be confirmed in the present accounts, of which we give a summary in our first table. At the same time it is to be noted that, with perhaps the exception of management and property charges, many of the several items and also the collective works and total costs are little above values very fairly representative of the average costs which in 1899 obtained in company-owned stations of similar output and load-factor. Under generating costs the items of "Oil, waste, water, stores," and "Wages at station" exhibit excellent figures, and the same might be said of the fuel charge if we consider the situation of Norwich for coal supply.

At 0·8d. per unit the management and property charges are rather too high to pass muster. Included in the management charges are law expenses, £184; insurance, £111; and directors' remuneration, £867.

The result of a good policy, the company's reserve funds present a very respectable appearance. Besides £6,764 received, being premium on shares, the reserve and depreciation funds were swelled by contributions from the revenue account, amounting to over 3·05 per cent. on the mean capital. This, and the ordinary dividend of 6 per cent. are very creditable results, coupled with the moderate total revenue of 4·2d. per unit.

The accounts show that while the increase in the lamp connections was no more than 9 per cent. the output rose by nearly 39 per cent. A very satisfactory change is noticeable in the load factor, which has increased from 9·7 per cent. to 11·6 per cent. During the year additions to the buildings, including a new chimney shaft, have been made.

### Yarmouth Municipal Electric Supply Works.

In Yarmouth we have a neighbour of Norwich labouring, as that place, under the disadvantages of heavy coal prices. If any comparison be instituted between the fuel costs at the two places, one important consideration at least has to be borne in mind besides the obvious one of difference in output. The accounts of the Yarmouth undertaking cover a period of three months later than that of the Norwich undertaking, thus involving higher average coal prices. This effect is, indeed, very noticeable in the fuel costs generally of municipal concerns as compared with company-owned works last year. On the whole, the Yarmouth costs are satisfactory. One exception has to be made—viz., in the item of "Oil, waste, water, stores." This item, at 0·804d. per unit is, surely, abnormally high.

A most satisfactory feature of these accounts is the balance for the good which has at last been attained. The working profit of £2,630 has more than afforded the contribution to the sinking fund of £1,061 after satisfying the interest charges of £1,141 and the adverse balance from the preceding year of £57. It cannot be denied, however, that the total revenue is a little high at 5·17d. per unit.

During the year the lamp connections were increased by 55 per cent. and the output by 28·5 per cent. We are glad to note that the load factor also continues to improve. Last year it was 10·7 per cent., as compared with 9·95 per cent. in 1898.

---

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal)......Oct. 12, 1900
Ayr (Municipal)..............Nov. 2, 1900
Bath (Municipal) ...........April 20, 1900
Bedford (Municipal) ......Aug. 3, 1900
Belfast (Municipal) ........July 6 1900
Birmingham (Company)....Sept. 15, 1899
Blackburn (Municipal) ....Jan. 19, 1900
Blackpool (Municipal) ....Oct. 5, 1900
Bournemouth (Company) ..Sept. 7, 1900
Bolton (Municipal) .........Nov. 30, 1900
Bradford (Municipal) ......June 22, 1900
Brighton (Municipal) ......May 4, 1900
Bristol (Municipal) .........Aug. 24, 1900
Bromley (Kent) (Co.) .......June 15, 1900
Brompton & Kensington (Co.) Mar. 23, 1900
Burnley (Municipal) .......Nov. 30, 1900
Burton-upon-Trent (Mun.) April 21, 1899
Bury (Municipal) ............Sept. 28, 1900
Cambridge (Company)......April 13, 1900
Canterbury (Municipal) ....Oct. 26, 1900
Cardiff (Municipal) .........Dec. 15, 1899
Charing Cross (Company) ..Mar. 9, 1900
Chelsea (London) (Co.)......Mar. 23, 1900
Cheltenham (Municipal)....Nov. 10, 1899
Chester (Municipal).........Aug. 3, 1900
City of London (Company)..June 15, 1900
Clerkenwell (Company) ....May 18, 1900
Coventry (Municipal) .......Feb. 23, 1900
Croydon (Municipal).........July 20, 1900
Derby (Municipal) ..........Jan. 26, 1900
Dewsbury (Municipal).......Nov. 24, 1899
Dover (Company) ...........April 27, 1900
Dundee (Municipal)..........Nov. 2, 1900
Eastbourne (Company) ....May 4, 1900
Edinburgh (Municipal) ....Dec 7, 1900
Exeter (Municipal) .........Aug. 5, 1898
Folkestone (Company) ....April 27, 1900
Glasgow (Municipal) ......Sept. 14, 1900
Guildford (Company) ......Oct 19, 1900
Halifax (Municipal). .......Sept. 21, 1900
Hammersmith (Vestry) ....June 29, 1900
Hampstead (Vestry) .......Oct. 19, 1900
Hanley (Municipal) .........July 27, 1900
Harrogate (Municipal) ....Oct. 20, 1899
Harrow (Company) .........Dec. 21, 1900
Hast'gs & St. Leonards (Mun Sept. 7, 1900
Hove (Company) ...........July 6, 1900
Huddersfield (Municipal) ..Aug. 17, 1900
Islington (Vestry) ...........Nov 23, 1900
Kensi'gton & Knightsbr'(Co.) Mar. 16, 1900
Kingston-upon-Hull (Mun.) July 13, 1900
Kingston-on-Thames (Mun.) July 20, 1900
Lancaster (Municipal).......Jan. 19, 1900
Leeds (Municipal).............Dec. 7, 1900
Leicester (Municipal) .......Jan. 26, 1900
Leyton (Municipal) .........Sept. 8, 1899
Liverpool (Municipal).......June 22, 1900
London (Company) ..........June 8, 1900
Londonderry (Municipal) ..Feb. 16, 1900
Manchester (Municipal)....Sept. 14, 1900
Newcastle and District (Co.) Oct. 6, 1899
Newcastle-upon-Tyne (Co.) Dec. 14, 1900
Newport (Mon.) (Municipal) Dec. 15, 1899
Northampton (Company) ..Oct. 20, 1899
Norwich (Company)..........Nov. 17, 1899
Notting Hill (Company) ....Mar. 16, 1900
Nottingham (Municipal) ..Sept. 21, 1900
Oldham (Municipal) .........Dec. 1, 1899
Oxford (Company) ..........April 13, 1900
Pontypool (Company) .......Sept. 28, 1900
Portsmouth (Municipal)....Aug. 24, 1900
Prescot (Company) ..........Dec. 8, 1899
Preston (Company) ..........Dec. 14, 1900
Reading (Company) ..........Dec. 21, 1900
Richmond (Company) .......June 29, 1900
Salford (Municipal) .........Feb. 23, 1900
Scarborough (Company) ....July 13, 1900
St. Helens (Municipal) ....Dec. 8, 1899
St. James' & Pall Mall (Co.)..Feb. 16, 1900
St. Pancras (Vestry) .........June 8, 1900
Sheffield (Municipal) .......Dec. 29, 1899
Shoreditch (Vestry) .........Nov. 23, 1900
Southampton (Municipal) ..Nov. 10, 1899
Southport (Municipal).......July 7, 1899
South Shields (Municipal)..Nov. 9, 1900
Stafford (Municipal)..........Aug. 17, 1900
Sunderland (Municipal).....Nov. 9, 1900
Taunton (Municipal) .........June 16, 1899
Tunbridge Wells (Mun.) ..Sept. 1, 1899
Wakefield (Municipal) .....Dec. 1, 1899
Walsall (Municipal)...........June 23, 1899
Wandsworth (Company) ....May 18, 1900
Westminster (Company) ...Mar. 9, 1900
Whitehaven (Municipal) ...July 28, 1899
Winchester (Company) .....Oct. 26, 1900
Windsor (Company)..........Dec. 22, 1899
Woking (Company) ..........Dec. 22, 1899
Wolverhampton (Municipal) July 27, 1900
Woolwich (Company) .......Jan. 12, 1900
Worcester (Municipal) ....April 20, 1900
Yarmouth (Municipal) ....Nov. 9, 1900

| | NORWICH. | | GREAT YARMOUTH. | |
|---|---|---|---|---|
| *Undertaking Worked by* | The Norwich Electricity Co. | | Great Yarmouth Corporation. | |
| *Date of Commencement of Supply* | October, 1893. | | October, 1894.[a] | |
| *System of Supply* | 3-wire continuous current with batteries | | Alt. cur. transformer sub-stations and transformers | |
| *Chief Engineer* | F. M. Long. | | Gordon Bryant. | |
| **YEAR ENDED** | DEC. 31, **1898.** | DEC. 31, **1899.** | DEC. 31, **1898.** | MAR. 31, **1900.** |
| **QUANTITIES—** | | | | |
| Units generated | 897,000 | — | 322,371 | 410,959 |
| „ SOLD (TOTAL) | 741,300 | 1,028,000 | 232,779 | 299,179 |
| „ sold to consumers | 741,200 | 1,028,000 | 150,329 | 217,920 |
| „ sold for public lighting, &c. | nil | nil | 78,250 | 81,259 |
| „ used on works | - | - | 5,393 | 6,148 |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 21.6 | 26.0 | 17.1 | 16.4 |
| Maximum supply demanded | 871 kilowatts | 1,010 kilowatts | 257 kilowatts | 316.7 kilowatts |
| Number of public lamps | nil | nil | 77 arc | 77 arc |
| Number of consumers | 1,267 | 1,567 | 314 | 410 |
| Connections to mains in 8-c.p. lamps | 51,342 | 56,000 | 14,500 | 22,480 |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 34,300 | 39,500 | 13,600 | 18,270 |
| CAPACITY OF PLANT IN KILOWATTS | 1,098 | 1,264 | 435 | 585 |

| | Norwich 1898 Total. | Per kilowatt capacity. | Norwich 1899 Total. | Per kilowatt capacity. | Gt. Yarmouth 1898 Total. | Per kilowatt capacity. | Gt. Yarmouth 1900 Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| **CAPITAL—** | | | | | | | | |
| AUTHORISED (TOTAL) | £100,000 | £91.0 | £200,000 | £158 | £40,000 | £92.0 | £40,000 | £68.4 |
| Share | 50,000 | 45.5 | 100,000 | 79.1 | — | | — | — |
| Loan (including Debenture charges) | 50,000 | 45.5 | 100,000 | 79.1 | 40,000 | 92.0 | 40,000 | 68.4 |
| RECEIVED (TOTAL) | 86,128 | 78.4 | 101,574 | 80.4 | 34,938[b] | 80.3 | 40,195[b] | 68.7 |
| Share | 50,000 | 45.5 | 65,880 | 52.1 | — | — | — | — |
| Loan (including Debenture charges) | 36,128 | 32.9 | 35,694 | 28.2 | 34,635 | 79.6 | 39,995 | 68.3 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | 13,872 | 12.6 | 98,426 | 77.8 | 5,305 | 1.22 | 5 | 0.009 |
| Share (unissued) | — | — | 30,000 | 23.7 | - | — | — | - |
| Share (uncalled) | — | — | 4,110 | 3.25 | | — | — | — |
| Loan (including Debentures) | 13,872 | 12.6 | 64,317 | 50.9 | 5,305 | 1.22 | 5 | 0.009 |
| REPAID (TOTAL) | - | — | — | | 1,550 | 3.56 | 2,250 | 3.85 |
| RESERVE OR SINKING FUND | 3,000[a] | 2.73 | 10,000[c] | 7.91 | 1,559 | 3.59 | 2,226 | 3.81 |
| DEPRECIATION FUND | 9,000 | 8.20 | 12,000 | 9.50 | | — | — | — |
| EXPENDED (TOTAL) | 97,761 | 89.0 | 114,478 | 90.5 | 35,533 | 81.7 | 40,265 | 68.8 |
| Lands and buildings | 15,035 | 13.7 | 20,335 | 16.1 | 5,321 | 12.2 | 5,322 | 9.10 |
| Plant | 42,279 | 38.5 | 46,340 | 36.6 | 19,400 | 44.6 | 22,768 | 38.9 |
| Mains | 38,258 | 34.8 | 45,593 | 36.1 | 8,948 | 20.6 | 10,311 | 17.6 |
| Miscellaneous | 2,189 | 1.99 | 2,220 | 1.76 | 1,864 | 4.29 | 1,863 | 3.19 |
| BALANCE OF CAPITAL ACCOUNT | -11,633[b] | 10.6 | -12,905[b] | 10.2 | -625[c] | -1.44 | -70[a] | 0.12 |

| | Norwich 1898 Total. | Per unit sold | Norwich 1899 Total. | Per unit sold | Gt. Yarmouth 1898 Total. | Per unit sold | Gt. Yarmouth 1900 Total. | Per unit sold. |
|---|---|---|---|---|---|---|---|---|
| **REVENUE—** | | | | | | | | |
| TOTAL | £14,041 | 4.548d. | £18,050 | 4.215d. | £4,918 | 5.070d. | £6,444 | 5.170d. |
| Revenue from supply | 13,047 | 4.227d. | 16,848 | 3.934d. | 3,774 | 3.890d. | 5,254 | 4.220d. |
| „ meters, &c. | 534 | 0.173d. | 620 | 0.145d. | 156 | 0.161d. | 202 | 0.162d. |
| „ public lighting | — | — | | — | 988 | 1.018d. | 971 | 0.779d. |
| „ sale of lamps, &c. | 65 | 0.020d. | 381 | 0.089d. | — | — | - | — |
| „ miscellaneous sources | 396 | 0.128d. | 201 | 0.047d. | — | — | 13 | 0.010d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £6,879 | 2.227d. | £10,445 | 2.438d. | £3,057 | 3.150d. | £3,814 | 3.061d. |
| WORKS COSTS | 4,852 | 1.572d. | 7,019 | 1.638d. | 2,352 | 2.423d. | 2,922 | 2.344d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | [illegible] | 0.705d. | 3,216 | 0.751d. | 1,200 | [illegible] | 1,687 | 1.354d. |
| Oil, waste, water, stores | [illegible] | 0.050d. | [illegible] | [illegible] | [illegible] | 0.246d. | [illegible] | 0.304d. |
| Wages at station | [illegible] | 0.301d. | 1,161 | 0.271d. | [illegible] | 0.403d. | [illegible] | 0.368d. |
| Repairs and maintenance at station | 660 | 0.214d. | [illegible] | 0.250d. | 213 | 0.220d. | 202 | 0.162d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 822 | 0.266d. | 208 | 0.049d. | 28 | 0.029d. | [illegible] | 0.007d. |
| Repairs, renewals of mains, &c. | | | 1,097 | 0.256d. | 6 | 0.006d. | 7 | 0.006d. |
| *Public lighting* | - | - | — | | [illegible] | [illegible] | [illegible] | [illegible] |
| Attendance | — | — | — | — | 184 | 0.190d. | 178 | 0.143d. |
| Renewals | — | | — | | 61 | 0.064d. | | |
| MANAGEMENT AND PROPERTY CHARGES | 2,027 | 0.657d | 3,426 | 0.800d. | 705 | 0.726d. | 892 | 0.716d. |
| *Royalties* | — | | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | [illegible] | 0.453d. | [illegible] | 0.435d. | 434 | 0.447d. | 563 | 0.452d. |
| Stationery, &c. | [illegible] | [illegible] | [illegible] | 0.042d. | 24 | [illegible] | 28 | 0.022d. |
| Establishment charges | 134 | [illegible] | [illegible] | 0.030d. | 13 | 0.013d. | 24 | 0.019d. |
| Law charges, &c. | [illegible] | 0.052d. | [illegible] | 0.034d. | [illegible] | [illegible] | 77 | 0.062d. |

| | Norwich 1898 Total. | % to mean cap. expended | Norwich 1899 Total. | % to mean cap. expended | Gt. Yarmouth 1898 Total. | % to mean cap. expended | Gt. Yarmouth 1900 Total. | % to mean cap. expended |
|---|---|---|---|---|---|---|---|---|
| **FINANCIAL RESULTS—** | | | | | | | | |
| WORKING PROFIT FOR YEAR | £7,162 | 8.09% | £7,605 | 7.17% | £1,861 | 5.38% | £2,630 | 6.94 |
| Sum carried to Depreciation Fund | 2,500 | [illegible] | 5,000 | [illegible] | — | | — | — |
| Sum carried to Reserve or Sinking Fund | 178 | [illegible] | 236 | [illegible] | [illegible] | 2.78 | 1,041 | [illegible] |
| Net interest on loans (incl. Debenture charges) | 1,192 | 1.35 | [illegible] | [illegible] | 1,058 | 3.05 | 1,141 | [illegible] |
| BALANCE FROM LAST ACCOUNT | 452 | 0.51 | 575 | 0.512% | — | — | 57 | 0.150 |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 3,445 | 3.89% | 3,434 | 3.24% | — | | 371 | 0.980 |
| *Deficit* | — | — | — | — | [illegible] | [illegible] | - | — |
| ORDINARY DIVIDEND PAID | 6 | — | 6 | — | | | | — |

| | Norwich 1898 | Norwich 1899 | Gt. Yarmouth 1898 | Gt. Yarmouth 1900 |
|---|---|---|---|---|
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 49% | 57.9% | 62.2% | 59.2% |
| Expenditure per kilowatt capacity | [illegible] | [illegible] | £7 0s. 7d. | [illegible] |
| REVENUE PER KILOWATT CAPACITY | £12. 19s. 0d. | £14 5s. 7d. | £11. 6s. 0d. | £11. 0s. 2d. |
| Expenditure per 8-c.p. lamp capacity | [illegible] | [illegible] | [illegible] | 4s. 2d. |
| REVENUE PER 8-C.P. LAMP CAPACITY | 8s. 2[illegible]d. | 9s. 1[illegible]d. | 7s. 2[illegible]d. | 7s. 7[illegible]d. |
| REVENUE PER 8-C.P. LAMP CONNECTED | 5s. 5[illegible]d. | 6s. 5[illegible]d. | 6s. 9[illegible]d. | 5s. 8[illegible]d. |
| Price charged for lighting, per unit | [illegible] | [illegible] | 6d. | [illegible] |
| Price charged for power, per unit | [illegible] | [illegible] | [illegible] | [illegible] |
| Price charged for public lighting | | — | [illegible] | [illegible] |

NORWICH.—REMARKS.—[illegible]

GREAT YARMOUTH.—REMARKS.—[illegible]

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861–1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| **United Kingdom** | **26s. 0d.** ... | **13s. 6d.** ... | **7s. 0d.** | Post free, payable in advance. |
| **Postal Union** ... | **30s. 0d.** ... | **16s. 0d.** ... | **8s. 0d.** | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## CONTINUOUS-CURRENT ARC PHENOMENA.

An important increment in our knowledge of the electric arc and its recondite phenomena was furnished by the reading of Mr. W. DUDDELL's Paper "On Rapid Variations in the Current Through the Direct-Current Arc" at the Institution of Electrical Engineers. We have already reprinted this valuable Paper, and in our present issue we give a report of the brief discussion upon it. Not that that discussion was of any great value; it added absolutely nothing to the existing knowledge on the subject: all that was new was embodied in the Paper. Prof. AYRTON, however, aptly expressed the feeling of the meeting both as to the intrinsic worth of the Paper and the admirable manner in which its author made manifest that worth by his lucid experimental demonstrations. Mr. DUDDELL gives promise of a brilliant career, not only as an investigator in the laboratory, but also as a teacher in the lecture-room. Confidence, begotten of an intimate knowledge of his facts, was well blended with a sympathetic appreciation of the difficulties that were likely to formulate themselves in the minds of his hearers; and, as a result, the Institution received a rare intellectual treat.

Mr. DUDDELL divides his subject into two parts, severally dealing with arc phenomena caused by changes in current originating in the circuit outside the arc or in the arc itself. The former presents a pathway of research already beaten by many investigators, and one that has led many towards the high road of electric arc theory; the latter, though not previously unknown, has been utilised by Mr. DUDDELL to an extent that has opened up a rich territory of hitherto little-known or even quite unsuspected phenomena. It is doubtful which of the two furnishes the more valuable contribution to our knowledge of those arc phenomena which will prove useful material in building up a really satisfactory theory of the arc. But, up to the present stage at any rate, the second category includes the more brilliant results, when regarded from the spectacular point of view; the performance of the National

Anthem on a solid carbon arc, by means of a keyboard controlling the pitch of the "hum," was indeed a triumph in this direction. It was, by the way, so far as we are aware, the first public performance of that national air at which the audience remained seated—too surprised to rise.

Phenomena produced by varying the current in the circuit supplying the arc have been investigated extensively by Mrs. Ayrton, whose researches have been published from time to time in *The Electrician*, and one small group of such phenomena were dealt with by Messrs. Frith and Rodgers in a memorable Paper before the Physical Society, on June 26, 1896 (*The Electrician*, Vol. XXXVII.), when the conception of a negative ohmic resistance was put forward and gave rise to a lengthy and heated discussion both at the meeting and subsequently in our own columns. This question is briefly alluded to in the Paper, but was prominently brought into Prof. Ayrton's remarks. Viewing the arc, in the circumstances of Messrs. Frith and Rodgers' experiments, as being an alternator in series with another alternator, Prof. Ayrton demonstrates the instability of the combination, and he further shows that its resistance measured in these circumstances would give a "negative result." What was *not* made clear was whether "negative result" and "negative resistance" were identical, in the Professor's mind. On our part, as we said at the time Messrs. Frith and Rodgers' Paper was published in our columns, we see no objection to the use of the maligned term "negative resistance" in the sense in which its authors employed it (*vide* the Leading Article, *The Electrician*, July 3, 1896). Passing on to consider the other phenomena dealt with by Mr. Duddell in the first part of his Paper, we may note that he has again drawn attention to the previously known fact that the electric arc will act as a telephone, either as a receiver or as a transmitter. In the capacity of receiver the arc undoubtedly acts under the influence of current changes wrought in the circuit outside the arc itself; but when playing the part of transmitter it acts, conversely, in such a manner that the current changes arise within the arc, and in this capacity therefore it has been erroneously placed by Mr. Duddell in Part I. This is but a small point, however, especially when we remember that the telephonic changes of current are but a small proportion of the entire set of variations, rendering its use as a transmitter practically valueless. As a telephone receiver, on the other hand, the action of the arc is much clearer, even articulate speech being reproduced with remarkable distinctness.

Coming now to Part II., in which are considered phenomena occurring when the arc itself gives rise to change of current, we find that Mr. Duddell has first established an important relationship between the rotation-period of Mr. A. P. Trotter's comma, in the humming arc, and the periodic time of the sound, and of the light and current variations. He finds that the periodic time is the same for all the phenomena. When from a humming the arc passes into a hissing state, there appears to be superposed upon these periodic variations a confused, irregular and much more rapid variation in the intrinsic intensity of the rotating crater. The humming of an arc, however, at any pre-arranged pitch can be evoked artificially from a normally silent arc by means of an arrangement that constitutes one of Mr. Duddell's most interesting discoveries. Being thus enabled to prearrange the pitch of the sound emitted by the arc, he has found it possible to construct a musical keyboard, the successive manuals of which vary the pitch and produce a diatonic scale. Upon this curious instrument Mr. Duddell, as already mentioned, played the National Anthem, the tones, although thin, being clear and well sustained. And though it is improbable that musical orchestras have been enriched thereby, the invention will receive a welcome in the physical laboratory. The determining factor in this instrument is the time-constant of the shunt which the depression of any manual places across the arc. In the lower of two octaves comprised in its compass the time-constant, and therefore the pitch, was controlled by means of calculated electrostatic capacities; in the upper octave it was determined experimentally by introducing inductance coils. One feature of this experiment was brought out in the Paper, viz., that there is an alternate current generated by the arc, of the same periodicity as the note emitted; but the experiment itself failed to make this clear. We should like to know whether a telephone receiver placed in the circuit of the arc would emit a note that might be analysed into only the same elements as the tone set up in the arc itself; or whether there are current variations set up other than those to which the shunt causes the arc to resound. In other words, if Mr. Duddell's musical instrument were introduced into a telephone circuit, would the receivers in the circuit play the same tune as the arc itself, or would a jangle of other sounds be superposed upon the tune? We ask this, not with a view to any possible electrophonic developments, but as a matter of theoretical interest. Another question suggests itself, and this time it may possibly have a practical bearing, viz., if two or more arcs in series were to be separately shunted for different tones, would a telephone in series with all the arcs emit the chord combining the several tones?

Finally, we have to consider the remarkably suggestive phenomena brought into prominence by Mr. Duddell in connection with arcs produced between metal electrodes. Using metals with which normally an arc may readily be struck and steadily maintained, the author found that a shunt containing a certain amount of capacity would inevitably extinguish the arc, and that with astonishing promptness. Now it was not unknown that metal arcs could be extinguished, or be prevented altogether from arising, by means of a condenser shunted across the spark-gap; in fact, the effect had been utilised for some time in the construction of induction coils. But it was certainly unsuspected that an advantage might be derived by closing the shunt a very brief interval after opening the spark-gap, a consequence of Mr. Duddell's researches that has been pointed out by Prof. G. F. FitzGerald. Experiment shows that when constructed according to this arrangement, the spark length of an induction coil can be increased many times above its normal length—a fact of no small utility in connection with many lines of modern physical research. Of less value, we think, are Mr. Duddell's deductions with regard to the action of metal switch contacts when shunted by high-capacity cables, though we wish by no means to undervalue the warning implied therein. Beyond question, conditions are liable to occur in power circuits when the resonance due to the capacity in the cables would be such as to generate an enormously multiplied voltage, whenever a metal contact switch is suddenly thrown open. We may even suggest that more than one catastrophic break-down originated in this manner. But the prevalence of these dangerous conditions is not so widespread and common as Mr. Duddell suggests; for in the greater number of circuits there are compensating conditions which effectively check that dangerous rise of voltage which would otherwise occur. Nevertheless, it points to the practical value of Mr. Duddell's researches, that this and other suggestions for improved practice in electrical engineering should so promptly have arisen out of them.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

**Hazell's Annual, 1901.** Revised to Nov. 30, 1900. 16th year. (London: Hazell, Watson and Viney). 3s. 6d.

In the preface to this useful annual the editor, Mr. W. Palmer, B.A., claims that "there is not a topic attracting public attention at the present time, it is believed, which is not dealt with in these pages." It can at least be honestly claimed that in the 700 closely packed pages a mass of information is "concentrated" which though necessarily somewhat scrappy, gives the reader the means of acquiring superficial knowledge of a great many subjects. We naturally turn to the electrical and engineering sections, and may be permitted the comment that very little space is devoted to the former subject. Nevertheless, there is a brief resumé of the chief electrical events of the year, and, as it is unlikely that much will be expected in such a book on this branch of work, what is provided will drive the enquirer to other sources. Under "Engineering" the more important electric tramway and railway developments are described, and under other headings the applications of electricity to practical everyday work find brief reference. The book is certainly a marvel of cheapness, is clearly printed and strongly bound, and should find a place, not only in the library, but in every office in the kingdom.

**A Handbook of Electrical Testing.** By H. R. Kempe. 6th edition. (London: E. and F. N. Spon, Ltd.) 18s.

As in previous editions, this volume appeals only to telegraph engineers and those engaged in the testing rooms of cable factories, the electrical testing requisite in the heavier branches of electrical engineering not being dealt with. As a book of reference for telegraph engineers, Mr. Kempe's work maintains its standard of accuracy, and in the present edition it has been amplified and revised in order to bring it up to date, although the general arrangement remains the same. If the last-mentioned feature is maintained in the next edition, we would suggest that the book be published with uncut pages. A large number of pages containing tedious algebraical operations could then be left uncut by the average "practician" user of the book, and he would find it easier to find his way about it. There are many who consider their "Kempe" an old friend, and are loth to buy a new edition because of the time it takes it to learn to open at the right places.

**The "Practical Engineer" Pocket Book for 1901.**
**The "Practical Engineer" Electrical Pocket Book for 1901.** (Manchester: Technical Publishing Co., Ltd.) 1s. each, or in leather 1s. 6d.

The former of these two compilations has been denuded of its electrical portions, these having been dealt with in the "Electrical Pocket Book," which is now being published for the second time. We devoted some space to our review of the first edition, and offered several suggestions for its improvement, some of which we are glad to see have been adopted. Considering its low price, the book is excellent value.

**The Practical Electrician's Pocket Book and Diary for 1901.** Edited by H. T. Crewe. (London: S. Rentell & Co., Ltd.) 1s.

The chief alteration in this pocket book is the number of advertisements it contains. These now fill 70 of the 270 pages of reading matter, the remainder of the book being filled up as before with a diary and some useful perforated note sheets for wiring foremen. The book does not otherwise show any marked improvement, and the ridiculous definitions we quoted last year remain practically as they were.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.

"L'Annuaire du Bureau des Longitudes pour 1901." (Paris: Gauthier-Villars). 1f. 50c.

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Kahle. No. 4, 1899. (Berlin: Julius Springer.)

"Science Abstracts." December, 1900. Edited by W. R. Cooper. (London: E. and F. N. Spon.) 2s.

## ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.

The following is an abstract of the short discussion which took place in connection with Mr. Duddell's Paper at the Institution of Electrical Engineers on the 13th inst. Time prevented a more lengthy debate, but the President requested that communications should be sent in to the *Journal*. Such communications were wanted, he said, and he hoped that many would be forthcoming, including one from Mrs. Ayrton:—

Prof. W. E. AYRTON said the Paper had given him exquisite pleasure. Not that he had any claim to be its author, but he felt as pleased as if he had been. Nor was it because he felt convinced that the experiments shown them to-day would assist in the development of the electrical industry of to-morrow; but it was rather because it rejoiced the hearts alike of professional men—yea, and of professors—to find a student who so resembled the solid carbon arc that he was ever on the alert to catch on to and magnify any hint which might come from Nature or man. From Mr. Duddell's work two years ago and that evening they had learned much, and among other things it had taught them how valuable was that research made some five years ago by Messrs. Frith and Rogers. For what did that investigation really show? It brought out an absolutely new fact—at any rate, absolutely to him. He then sketched the details of the said experiment on the board, and, after explaining it, mentioned that it had been carried out by these gentlemen because he suggested that if the methods employed by various experimenters to measure the resistance of the arc were applied, for certain theoretical reasons, under certain conditions, a negative value and not a positive one would be obtained for the resistance of the arc. Certain preliminary experiments by Mr. Mather had confirmed his suggestion that if the arc was formed between two solid carbons the instantaneous change of P.D. divided by the corresponding change of current was negative, whereas with cored carbons it was always positive. A howl of indignant criticism had followed, and had Messrs. Frith and Rogers and himself lived in the middle ages they would probably have been put to death in a solid carbon arc. But there were three distinguished investigators who had the courage not to be drawn into this net of conventional antagonism—viz., Prof. Gray, then of Bangor, and now Lord Kelvin's successor at Glasgow, Mr. Oliver Heaviside, and Prof. FitzGerald. He himself had even ventured to suggest that progress would be more expedited if the critics, instead of merely cavilling at what might be called the anatomy of the sugar figures on the cake, would cut it open and see if there really were plums inside. But it had remained for Mr. Duddell to be the real Jack Horner. He did not propose to go into the question as to whether or not what Messrs. Frith and Rogers had measured was the true resistance of the arc, because he hoped there would soon be an opportunity of going fully into this question, but in justice to these investigators, and in virtue of the far-reaching principle they had really brought to light, he desired to emphasise what they had really attained. Their late friend Dr. John Hopkinson proved to them years ago that two alternators could not be run in series, that if one alternator with a certain exciting current driven by a steam engine were mechanically coupled to another similar alternator driven by a similar steam engine and worked up into step, they would immediately get out of step the moment the mechanical coupling was severed. If there had been the slightest necessity for it, Dr. Hopkinson might have added that if two alternators cannot run in series when they have been got into step, still more impossible was it for one alternator driven by its own steam engine to run in series with another when the frequency was being altered within wide limits. This was really what the arc did. Referring to his diagrams on the board he said they had an alternator running in series with another supplying alternate current to a circuit, transforming direct-current energy into alternate-current energy, and doing it in such a way that whether the frequency in one alternator be 70 or 170 or 250 periods per second the second alternator supplied current sufficiently in phase with the current in the other circuit to work in series. Mr. Duddell had not only pointed out the importance of that result—the novelty of it—but had shown that an ordinary so called perfectly silent arc supplied by accumulators was like the mouthpiece of a flageolet or flute not blown, and that the application of a capacity in series with self induction as a shunt to that arc gave rise to vibrations, just as blowing a flute gave rise to millions of rates of vibrations, and that one of these rates of vibrations was picked out by pressing the keys, whereas in the case of the arc the rate of vibration was started and picked out by what capacity was in series with the self-induction. Already they had seen a practical result of this, but the other day at the Central Technical College Mr. Duddell had shown him that with the same circuit supplied with the same induction coil as had been used in the experiments that evening, with a condenser joined up as usual and using his ammeter so as to put the condenser across the arc just after the break was made, he had obtained a spark from five to seven times as long as was obtained with the apparatus in the ordinary way. Calculating on the very best possible conditions with the old way, Mr. Duddell could increase the length of spark some two or three times with his method. There was another point which had come out, in connection with these experiments, of a rather different kind. Some 10 years ago, a Paper was read by Dr. Sumpner and himself before the Royal Society, pointing out what was then new, that the true power given to a solid carbon alternate-current arc measured by some accurate method was considerably less in some cases than the apparent power measured by any alternate-current ammeter, multiplied by the pressure measured by an alternate-current voltmeter. Subsequently he had been pretty well convinced that under certain circumstances a direct-current arc between solid carbons acted in

the same way. At that time he had not been sufficiently certain of the fact to publish it, but now he was certain of it. He was sure from the results of experiments recently made in his laboratory that with a so-called direct-current arc supplied from accumulators the true power measured by a true instrument was less than the product of the ammeter into the voltmeter.

Dr. J. A. FLEMING, who was the only other speaker, thought it difficult to decide who ought to be congratulated the most, the Institution for having had such a Paper read before it or Mr. Duddell for having produced such a splendid piece of scientific work. It was a Paper which must especially gladden the heart of their President, because if he did not mistake, this Paper would have a very important consequence in engineering, and would assist in showing that science did sometimes lead engineering and not always follow it. The matter which had interested him most particularly were the experiments with the continuous-current arc setting up oscillations with a condenser short-circuiting the arc. He had been attempting something in the same direction—viz., with an alternate-current arc, using metal electrodes, and it would be a matter of lifelong regret that he had made such an unfortunate choice. But this effect with the continuous-current arc was exceedingly interesting, because it seemed to depend upon certain critical conditions as to the state of affairs when the arc was extinguished. If he mistook not, a rough explanation of it was as follows:—There was a condenser and induction coil put across the carbons when the arc was in operation; then at that moment the arc was robbed of its current and extinguished. Then the potential rises, the condenser became discharged and it discharged itself back through what remained of the conducting vapour and thus re-established the arc. But this action would not take place if cored carbons or metal electrodes were used, and it seemed perfectly clear from the Paper that the reason why this was so was because the arc finished too quickly with metallic electrodes, whilst with cored carbons probably the reason was that the vapour hung about too long. The final section of the Paper dealing with switch contacts would probably cause some heart-searchings amongst those responsible for the manufacture of high-tension switches. Hitherto the idea of everybody had been that, among other things, a switch should break the arc as quickly as possible, but according to this Paper it ought not to do this. Mr. Duddell would probably encourage the arc on the switch. From experiments made with carbon poles under water he confirmed many of Mr. Duddell's difficulties and dangers of introducing alternate currents into concentric cables. The moral of all these experiments with regard to high-tension switches was to do just the opposite to what seemed right when constructing such switches, and this portion of the Paper would have an exceedingly valuable consequence in directing those who were responsible for the design of large switches to consider their ways and be wise.

The PRESIDENT proposed a hearty vote of thanks to the author, which was carried unanimously.

## ON THE "BLAZE CURRENTS" OF THE FROG'S EYEBALL.*

BY A. D. WALLER, M.D., F.R.S.

The normal electrical response to light is positive. The normal electrical response to every kind of stimulus is positive. The normal response of the frog's eyeball is partly retinal, partly by other tissues. The direction of response is reversed by pressure. The normal

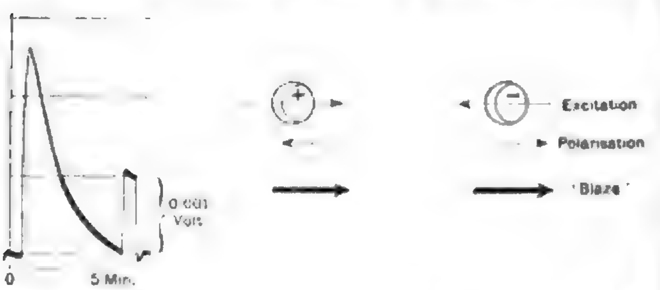


FIG. 1.—Positive Response to a Single Induction Shock sent through the Eyeball in the Positive (upward) Direction.

"blaze currents" excited by single induction shocks, and by condenser discharges, are comparable with the normal discharges of an electrical organ. Their maximum voltage is of the same order as that of the discharge of a single electrical disc (over 0·03 volt). Their magnitude and duration increase with increased strength of excitation. Summation of stimuli, summation of effects, staircase increase, and fatigue decline are manifested by blaze currents. Stimulation of excessive strength abolishes them completely, but only temporarily. The energy of a blaze effect may considerably exceed the energy of its exciting cause. The effects are observable for at least five days after excision of the eyeball; they appear to be diminished under prolonged illumination, and increased under prolonged darkness. The influence of raised temperature and increased pressure is studied, and under the influence of the latter four types of response are recorded. Comparison is made between blaze currents and the responses of electrical organs as described by du Bois Reymond. During and after maximal blaze the resistance diminishes; the diminution is not irreciprocal.

| Direction of exciting current. | | Direction of organ response. | |
|---|---|---|---|
| | | Living. | Dead. |
| Torpedo | Dorsum + ↑ Ventu | + ↑ | − ↓ |
| | Dorsum − ↓ Ventu | + ↑ | + ↑ |
| Eyeball | Cornea + ↑ Fundus | + ↑ | − ↓ |
| | Cornea − ↓ Fundus | + ↑ | + ↑ |

If single electrical currents are passed through a normal eyeball and a galvanometer in a "homodrome" and in a "heterodrome" direction—*i.e.*, with and against the direction of normal discharge—the homodrome (positive) deflection is greater than the heterodrome (negative) deflection. This inequality is the result of positive blaze current, and is abolished by death or strong tetanisation. In the

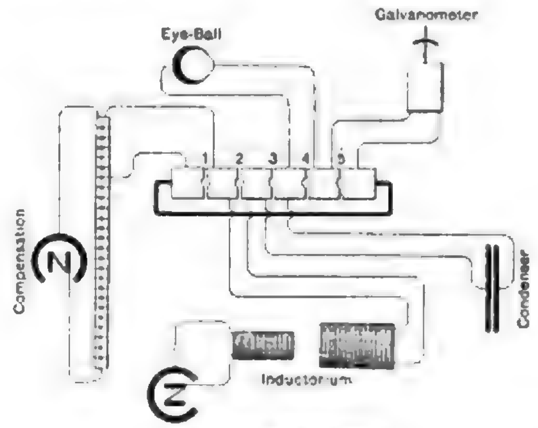


FIG. 2.—Plan of Circuit.

latter case the abolition is temporary. The normal electrical response to light persists undiminished at a time when blaze currents have been abolished by tetanisation. On the other hand, blaze current may be present in an eyeball giving no response to light. The altered state of the eyeball in relation to light does not necessarily run parallel with its altered state in relation to electrical stimuli.

* Abstract of Paper read before the Royal Society.

## RELATIVE ADVANTAGES OF DIRECT-CURRENT AND THREE-PHASE DISTRIBUTION FOR SMALL INSTALLATIONS.*

BY H. A. EARLE, M.I.C.E., M.I.E.E.

When accepting an invitation to read a Paper before this Institution I was for some time in doubt as to what subject I should choose. None was particularly uppermost in my mind as one upon which I wished to discourse, but I came to a decision while travelling abroad; the question covered by the title of my Paper being brought most prominently before me, owing to the competition and different statements I met with, with regard to the relative advantages of three-phase and direct-current machinery for small and medium sized installations. Owing to this it occurred to me that a comparison between the two systems would be of interest and likely to give rise during its discussion to points which would be a guide for

* Paper read at the Manchester Section of the Institution of Electrical Engineers.

the future. Competition is not always—especially in some countries—carried on on strictly commercial lines, and I have experienced instances where a competing firm, finding it could not secure an order for direct-current machinery has offered polyphase machinery as an alternative, singing its praises at great length, setting forth advantages without number, and naturally ignoring the other side of the question; this is not as it should be, but with inexperienced purchasers, with no one to guide them, it is at times successful.

I have found the title I first adopted for my Paper somewhat too limited in its scope, and have briefly considered questions which relate to the distribution from sub-stations, as well as that of the choice of machinery and distribution for small installations. The type of machinery and the system to be adopted for supply and distribution, are in the case of large plants, most carefully considered; simplicity of design, first cost, and subsequently economy, being among the most important of the many factors. In the case of small installations, however, such as are put down to supply light and power for mills and factories, the question is not infrequently decided, irrespective of theoretical considerations. The purchaser in England is very usually in the hands of the consulting engineer, but in countries where this commodity does not exist, he is often guided by the persuasive power of the seller, and sometimes by fashion. For the lowest price may mean but little as regards cheapness when there is no specification. There are many ways of preparing a low tender; and the omission of something in one which is included in another, the adoption of different voltages, various groupings of lamps and motors, different speeds for generators and motors, may give one system an apparent advantage over another which it does not in reality possess.

Many firms have, up to the present, given their chief attention to direct-current work, and this has met the wants of the smaller installations as well as those of the greater portion of the large central stations. Single-phase supply at high voltage, with distribution from transformer stations, has competed keenly with direct current, but lamps of higher voltage, together with three-wire distribution, has given the latter a long lease of life, and has enabled it to be employed for large areas without undue loss or a prohibitive cost of copper.

We have seen 50 volt and subsequently 100-volt lamps in regular use for large installations, but now 200 volt up to 230-volt lamps are quite the accepted standard, and this higher pressure has so largely reduced the first cost of copper that in many stations where the use of alternating currents was formerly warranted, direct-current machinery is being put down, and even in some instances the alternating-current machinery being taken out. Running and driven balancers, together with feeder boosters, are required as auxiliary machines for direct-current three-wire distribution, from sub-stations dealing with large powers, and feeding over a considerable area; but it is more than probable that in the future 400-volt lamps will be available, which, with a two-wire distribution, would render the two first-named machines unnecessary, and eliminate the cost of the centre wire. As polyphase and monophase machinery live on the price of copper, it can be fairly assumed that every saving in this respect will take away their livelihood and reduce their utility. Where lighting constitutes the largest proportion of the load, the copper required is proportional to the watts per candle taken by the incandescent lamps, any reduction, therefore, in this respect, is of great importance; lamps are, I understand, shortly to be put on the market, consuming 2 watts per candle, or even less, and every advance in this direction is, I again hold, to the advantage of direct current, and will enable it to cover a wider field, for who will use high voltages and transform down, if they can use low with equal economy, or include complications when they may be omitted? All auxiliary machinery and apparatus has only one object, and that is to reduce the price of the mains, or, as I have seen it stated, "adopted in the vain endeavour to cheat Ohm's law out of its due tribute of copper."

There are some who blindly champion alternating and polyphase systems, call commutators excrescences, and quote experiments, which claim to show that polyphase weigh a mere fraction of direct-current machines. A statement in Herr von Dobrowolsky's remarks in the discussion on a Paper read by Herr Gorges in 1892 was quoted in the first edition of a book, and has again appeared in the second edition—namely, that a certain multipolar continuous current machine gave 11,000 watts, but that when a three-phase armature was run in the same fields it gave an output of 33,000 watts. I doubt this test being one which one could consider upon a commercial basis. On turning, however, to the Paper in question, I find that Herr von Dobrowolsky also said: "An alternating current machine is so totally different in its construction to a direct-current machine that such comparisons cannot be fairly made, and that it is equivalent to saying that a spoon has an efficiency of 100 per cent. when used for soup, but only one of 50 per cent. when used for cutting." Notwithstanding all this the polyphase system is at the present time the most satisfactory solution of long-distance transmission, and will be utilised more and more to transmit large powers into the centre of towns, and to cope with the many difficulties which present themselves; but the chief point I desire to raise is, whether the distribution from the sub-stations should be by polyphase or direct current, and whether for smaller installations one system offers such advantages over the other as to warrant a preference being given. Notwithstanding the existence of several eminent advocates of single-phase machinery, I do not propose to consider it, nor have I had to deal with it in connection with the competition I have experienced, especially abroad. With regard to the two remaining rival systems, the commutator seems to be the red rag of polyphase exponents; but any trouble that has been experienced on this behalf is merely a passing nightmare, and has only occurred with machines of large power running at high speeds, in connection with which considerable experience is required and very high-class workmanship demanded in order to enable carbon brushes to maintain good contact on a surface running sometimes as high as 40 miles an hour, this difficulty has been experienced by most of us, but is being rapidly overcome, and in a short period it will be a thing of the past. It is, however, much to be desired that the high engine speeds which have been saddled upon us for plants of 1,000 horse and upwards, may in the future be reduced some 20 per cent. With reference to the comparative weights of direct-current and polyphase generators, we may take as a good example of the latter one of the 32-pole three-phase generators, built for the Central London Railway, and which has an output on full load of 850kw. at 94 revolutions; this machine has a weight of 37 tons, or, with exciter, say 39 tons. As an example of a large direct-current traction and lighting generator we may take one of a number of 10 pole machines, now being built at Salford Ironworks, having an output of 900kw., with fixed lead, and running at 95 revs. per min. This machine has a weight of 45 tons, or, correcting for the increased output, it equals 42 tons; this machine could, however, have been built lighter as a shunt generator, with the compound windings omitted, and with the smaller range of voltage then necessary, the magnets would have been lighter, and probably with advantage more in number; the weight would then have been practically identical with the polyphase generator, with which it has been compared. With regard to the weights and prices of still larger generators, I have compared a 1,400kw. $\times \cos\phi$, polyphase generator running at 93 revolutions, with a direct current one of the same output, and for the same speed, the former with exciter would weigh approximately some 64 tons, and the direct-current generator approximately the same. Comparing the prices of the above machines, the polyphase has the advantage and is approximately some 12 per cent. cheaper to build, this being chiefly due to the cost of the commutator on the direct-current machine. There is, however, one point that cannot be passed by unnoticed, and that is the small safety clause attached to the output of the polyphase machine, namely, cosine $\phi$, what is this? Why, it means that on an inductive load this apparent 12 per cent. advantage is wiped out, and may even, and very probably will, put the boot on the other foot, but more of this later on. With regard to smaller sizes of 200kw. to 400kw., I do not find that there is much difference; in fact, the figures I have tend to show that the advantage is on the side of direct current, but I will not press this point. Respecting the weights of the two types of motors, the polyphase type with squirrel-cage rotor is considerably lighter, but the large motors of 50 H.P. to 100 H.P., with wound rotors weigh about the same.

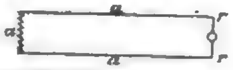
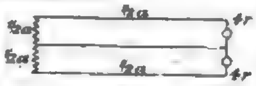
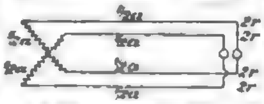
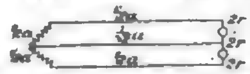
Comparing the price at which the smaller sizes are sold, the polyphase have an advantage of about 5 per cent.; but figures I have carefully examined for motors from 10 H.P. to 100 H.P. with wound rotors show a good average of 10 per cent. in favour of continuous current, when compared with polyphase motors imported into this country, and the cost of importation does not amount to 10 per cent.

Considering next the cost or weight of mains, the advantage is on the side of three-wire direct-current distribution as may be seen from the table on the next page.

In the table it is assumed that the various systems are for incandescent lighting as well as for power, and that the voltage is limited by the lamps, the circuits being so arranged that each lamp can be switched on singly. As regards the voltage, column 1 gives the virtual volts between any two wires when lamps of the same pressure, namely, 200 volts, are employed on each system, but this figure may certainly be taken exception to in the case of the alternating systems, for it must not be forgotten that their maximum voltage is the $\sqrt{2}$ times their working voltage, or 1·41 times as great, And this cannot be lost sight of when taking into consideration the questions of insulation and risk from shocks. I have accordingly given in column 2 the maximum voltage between any two mains on this basis.

There is also another point to be borne in mind in connection with the mains for polyphase systems which contain many motors, and that is for equal loss they must be increased in section at least 10 per cent. above that given in the table, and required for continuous current systems, in order to allow for the loss due to wattless currents, and this figure may have to be still further increased to 20 per cent. or even more should many of the motors be put down to deal with very variable loads; in fact, the section of the mains in the table must be increased in the inverse ratio of the power factor of the system,

EQUAL PRESSURE ON THE LAMPS. EQUAL POWER TRANSMITTED. EQUAL LOSS IN THE LINE.

| System. | Diagram of System. ~~~~ represents dynamo windings. —o— " 200-volt lamps. | Virtual volts between any two wires = V. | Maximum voltage. | Current in outers for equal total power = 200$a$. | Resistance of each outer for equal total loss = $2a^2r$. | Weight of each outer. — No current in centre wire. | Weight of the centre wire taken as ¼ of each outer. | Total copper for equal lamp pressure power and loss. | Weight of copper cc. = 100. |
|---|---|---|---|---|---|---|---|---|---|
| Continuous Current 2 wires |  | 200 | 200 | $a$ | $r$ | 1 | ... | 2 | 100 |
| Continuous Current 3 wires |  | 400 | 400 | ½$a$ | 4$r$ | ¼ | 1/16 | 9/16 | 28 |
| 2-phase 4 wires |  | 200 | V √2 283 | ½$a$ | 2$r$ | ½ | ... | 2 | 100 |
| 2-phase 3 wires |  | 200 √2 283 | V √2 400 | ½$a$ | 2$r$ | ½ | ½ same as outer | 1½ | 75 |
| 3-phase mesh |  | 200 | V √2 283 | $\frac{1}{\sqrt{3}}a$ | 2$r$ | ½ | ... | 1½ | 75 |
| 3-phase star |  | 200 √3 346 | V √2 490 | ⅓$a$ | 6$r$ | ⅙ | 1/24 | 13/24 | 27 |

taking into consideration both motors and lamps. In the comparison, a third or common wire has been included, where necessary, to fulfil the condition of individual control, but the systems are assumed to be in balance, *i.e.*, there is no loss in the centre wire, which has been taken in all cases as 25 per cent. of the weight of an outer. It is seen that continuous-current three-wire systems are only beaten by one, namely, in the case of the three-phase star with common return, but then the saving by having only three wires instead of four to fix and insulate would cancel this small difference, not to mention the better regulation which can be obtained with continuous-current machinery. With regard to this small difference of one, the three-phase star has, moreover, no right to it, for it is entirely eliminated, and the tables are turned, by what I have said respecting the loss due to wattless currents when motors are used; and the three-wire direct-current system is then found to be at least 10 per cent. the best of all, as regards the weight of copper. From the way I have drawn the diagrams of the three-phase star circuits, it can readily be seen why, when lamps are used, the fourth or common wire is necessary to maintain proper regulation of voltage on the lamps, for without it the system would be comparable to a continuous-current two-wire system with three lamps in series.

Turning next to the question of running motors upon the circuits, the points to be considered are: (1) Starting torque, (2) Regulation of speed, (3) Constancy of speed, (4) Efficiency. Polyphase motors are essentially constant-speed machines, and the speed of the smaller sizes is high, the arrangement of the winding is limited, and, in this respect they do not so readily lend themselves as continuous-current motors do to windings by which any desired speed can be obtained; various ingenious methods have been adopted to meet the requirements, which are more or less satisfactory, but there is still considerable room for further development.

1. *Starting Torque.*—A continuous-current motor, even when shunt wound, exerts its full torque, with a small increase of current over the full-load current, and is capable of satisfactorily dealing with any work for which it may be employed; small three-phase motors with squirrel cage rotors, starting with full torque, require a momentary rush of current, approximately equal to 2½ times the full-load current, this is an undesirable feature, and to obviate it motors of larger powers are started up with a resistance in the rotor circuit, this minimises but does not remove this defect. This behaviour would prevent a three-phase power installation being arranged so that all motors may start up with the generator, with respect to this, I arranged a power installation of 850 E.H.P. in a large spinning and weaving mill abroad, in which are included some 10 compound-wound continuous-current motors, placed long distances apart, and ranging from 220 H.P. to 30 H.P., in this installation all the motors can start up simultaneously with the generator, on practically full load, the starting current required being not more than some 50 per cent. in excess of the full working current. In cases where the running torque is constant, but where a great starting torque is required, series-wound continuous-current motors offer the best solution. I have one case especially in my mind, in connection with a polyphase installation in a cotton mill, where a large number of motors of 8 B.H.P., with squirrel cage rotors, were put down, each to run a line shaft driving 24 narrow looms; in this case trouble was experienced in starting up, belts coming off, or the motors, especially on Monday morning, when everything was stiff, refusing to start at all. Larger motors were in some instances put in, and in others fast and loose pulleys were added: a 7 H.P. direct-current motor would have done the same work, and have given better results. One method of increasing the torque of polyphase motors, on starting, is to increase the voltage on the stator by means of a booster transformer. Another method is to alter the connections of the stator windings from star to mesh; this increasing the pressure in the ratio of 1·73:1. Another arrangement is to change the connections of the stator coils from series to two sets in parallel. The requisite starting torque can, however, be obtained from a direct-current motor, whether shunt or series-wound without any of these devices.

2. *Speed Regulation.*—The regulation of speed, either of continuous-current or of polyphase induction motors, is effected by somewhat similar means. The speed of an ordinary shunt-motor can be varied in three ways, either by inserting a resistance in the armature circuit, by altering the voltage of supply, or by varying the strength of the fields. Like shunt or series direct-current motors, polyphase motors, except the smallest sizes, require a resistance to be inserted in the rotor or revolving windings to keep the starting current within bounds, merely by the use of such a resistance any desired variation of speed can be obtained with either type, with this method of regulation, however, the input remains practically constant and it is therefore too wasteful to be adopted where a high average efficiency is imperative throughout the whole range of speeds. A direct-current motor running on a three-wire system with two voltages available, combined with regulation of the field, can be made to yield a very high mean efficiency equalling 83 per cent. for the whole of the working range, that is for some 66 per cent. of the speeds and an average of 75 per cent. throughout the whole range. Weakening the field by introducing resistance into the stator circuit of a polyphase motor increases the slip and the motor runs slower, but as the field supplies the rotor current in the same manner as the primary of a transformer supplies the secondary, the torque falls off very rapidly. By doubling the number of poles in the stator winding the speed can be halved, this necessitates, however, an inconvenient number of windings, increases the complication of the switch, &c., and is rather impracticable. Considering the various devices as a whole, one cannot but be drawn to the conclusion that the direct-current motor on a three-wire system, with two voltages available, or on a two-wire system with double-wound armature, together with the provision for some field regulation, is the simplest and most desirable, for it gives all variations of speed most economically, and it can be easily arranged so that there is no jump whatever between one speed and another. Three or four instances have come to my notice where power has been transmitted to a works from a considerable distance by polyphase current, but in connection with which motor generators have been added to supply direct-

current to motors requiring to be operated through a large range of speed at a high mean efficiency.

3. *Constancy of Speed under Varying Loads.*—In this respect a shunt-wound continuous-current motor acknowledges no superiority to the polyphase, the slip on the latter increases with the load, but shunt-wound motors are available which can maintain constant speed from no load to full load. For tramway work a polyphase motor will maintain a more constant speed when climbing hills than a series-wound continuous-current motor, but as this is at the expense of current, a high speed on the level and a slower speed on hills seems more to be desired, and likely to reduce the maximum current demanded from the station.

4. *Efficiency.*—I have compared the efficiencies of direct-current motors which have been most accurately tested, with figures which I consider are fairly representative of what can be obtained with polyphase, and give the comparisons below :—

| | 3½ | 6 | 10 | 25 | 50 | 100 B.H.P. |
|---|---|---|---|---|---|---|
| Direct current... | 82% ... | 85% ... | 86% ... | 91% ... | 92% ... | 92 |
| Polyphase......... | 76% ... | 80% ... | 84% ... | 88% ... | 90% ... | 91 |

This shows a large superiority for direct-current motors of small power, and a small advantage on the larger sizes. The power factor of polyphase motors, as far as any published figures go, as well as those which are obtained from various makers, vary more widely than seems at all necessary, and in order to obtain a fair average, I dotted all the power factors I could get upon a sheet of paper, and then drew a curve through the lot, and I give you below the readings which resulted from this curve. Power factor for polyphase motors on full load :—

| B.H.P. | 5 | 10 | 15 | 25 | 50 | 100 |
|---|---|---|---|---|---|---|
| | 0·76 ... | 0·79 ... | 0·81 ... | 0·83 ... | 0·86 ... | 0·88 |

With regard to the above, it is needless to remark that the power-factor of continuous-current motors is unity. Having considered how the various operations are effected for changing either the speed or torque, or both, let us consider the conditions under which motors have to work, these may be divided under four heads, and stated as follows : (1) Constant speed with constant torque, (2) Constant speed with variable torque, (3) Variable speed with constant torque, (4) Variable speed with variable torque.

*Constant Speed with Constant Torque.*—This condition is one which exists, when motors are used to drive lengths of shafting, from which again are driven a considerable number of small machines, such as are found in a cotton mill, or a large machine shop, in this instance the load is fairly constant, possibly not varying more than some 10 per cent. It is in such cases that a polyphase motor is at its best, and endeavours to rival the shunt-wound direct-current motor, which, however, is just as good for the purpose, or probably a little better.

*Constant Speed with Variable Torque.*—This second condition occurs in cases where large portions of the load are being frequently thrown on and off, the shunt-wound motor is all that can be desired, as regards speed on such work, and the current taken is in fair proportion to the load. The polyphase motor is also satisfactory as regards speed, but the current is high on the lighter loads, a considerable percentage is certainly wattless current, but it adds up the $C^2R$ losses, and at the same time decreases the capability of the generator for useful work, and this is a point which must be borne in mind when comparing a polyphase generator with a direct current one. We have seen how a power factor, less than unity for the motors, necessitates an increase in the size of the mains, and this acts in a similar manner upon the generator. If the current were in phase with the E.M.F. : that is, if the power factor were 1, in place of averaging, say, 0·85, the polyphase generator could do 17½ per cent. more work than it would be able to do under the latter condition. But, again, with many motors working on a system, a power factor of 0·85 cannot always be relied upon, and one of 0·75 or even lower may have to be reckoned with. We see from this that the first cost of an installation may be considerably increased by this consideration, and, besides this, the wattless currents exercise a very bad effect on the regulation of a three-phase machine, very much more so than if the currents were in phase, necessitating very much heavier windings on the magnets to deal with a low power factor than a high one.

*Variable Speed with Constant Torque.*—This third condition is met with very frequently, for instance, when driving callenders, paper-making machinery, and in pumping, &c. To meet it with polyphase motors the regulating switches are more complicated, and to effect many changes of speed the groupings of the winding become many in number and efficiency is sacrificed ; in this respect the continuous-current motor is more easily managed and will yield a higher mean efficiency.

*Variable Speed with Variable Torque.*—The fourth condition is especially present when driving calico printing machinery, an eight-colour machine, for instance, may be utilised for printing any desired number of the eight colours ; the torque increasing practically in direct proportion to the number of rollers in use, the speed of printing the goods at the same time varies in accordance with the number of colours being printed, and with the class of work the machine is doing. For this class of work a very even turning moment is necessary ; one must be able to run up to any desired speed without jumps or jerks, and the contemplation of a three-phase motor arranged for high efficiency at all speeds and to comply with the requisite conditions is not a taking one.

I have heard the point raised that, for factories where there is much inflammable dust about, a chance spark from the commutator might set the place on fire, but perfectly satisfactory entirely enclosed direct-current motors are at work, not considering the thousands on tram-cars, but also in factories of all descriptions ; fireproof gauze covers are also employed for motors, these do not exclude all ventilation, and render the motor quite reliable even where spirit vapours are present. The facility for the use of batteries on direct-current systems is one which must receive careful consideration. These are continually improving in quality, give excellent results in the hands of those that understand them and offer great advantages, both as a stand-by and as regulators. They can therefore frequently be utilised to assist direct-current supply, and at times to effect considerable economy, whereas a three-phase battery has yet to be invented. Polyphase motors appear specially suitable for long lines of railway where considerable distances are travelled without a stop at a uniform rate of speed, and where crossing points which would complicate the conductors do not exist, for beyond a comparatively limited distance high voltage must be used, and then, whichever system is employed, transforming apparatus is necessary ; in such instances polyphase supply, with polyphase motors on the train, would not call for rotating transformers, stationary transformers along the line being the simplest and cheapest arrangement. Such a system is, however, unsuitable for use in towns, with frequent stops and a very variable rate of speed ; besides this, I am sure that it would create a great commotion among the inhabitants of a town not 100 miles away if it were proposed to erect two trolley wires in place of the one, which to some already appears distasteful. Judging from what some of the larger firms on the Continent are doing with respect to polyphase machinery, I understand, that although they have given it the very greatest attention, they find that the volume of their direct current work exceeds that of the polyphase.

I have endeavoured to consider the chief points which should guide us in the choice of a system for use for the smaller installations. In cases where lighting alone is required the first cost of polyphase or direct current would appear to be very similar, the simplicity of the latter system both as regards the wiring and the regulation of the voltage, to my mind, gives direct current the preference. Where a number of motors are on the circuit for whatever purpose they may be required, and whether the system includes lighting or not, I consider that direct current shows a very decided advantage except in a few very special cases, moreover, the use of batteries is all but excluded with polyphase systems, even for a night load, and this is frequently of considerable importance. I have doubtless to some minds left unsaid many things I ought to have said and to others said many things I ought not to have said, but this may be more an advantage than otherwise for it will admit of those shortcomings being criticised during the discussion, and may enable me to fill the gaps and correct my errors.

## THE RATING OF INCANDESCENT LAMPS.

In a Paper on this subject, recently read by Prof. Arthur J. Rowland before the Franklin Institute, the author gives some interesting details of his measurements of the candle-power in different directions of various types of lamps all rated at 16 c.p. On the whole the Paper is a protest against the usual methods of rating—including that adopted by the National Electric Light Association, whose method consists in measuring the candle-power in a direction inclined 45deg. to the axis of the lamp while the lamp is revolving upon its axis, the distance of the lamp from the photometric screen being regarded as the distance between the centre of the axis of its bulb and the screen, and 120 revs. per min. being the speed of rotation recommended.

The author thinks that the candle power of a lamp should be measured, for rating, in the direction in which the light is most useful. He argues that as most lamps are so fixed that the axis of the lamp is vertical and the tip downwards, the direction in which the light is most useful is along the axis. He then proceeds to compare the radiation in chosen directions from lamps with different types of filaments. For this purpose he classifies lamps as follows :—

(*a*) Straight U-shaped filament.

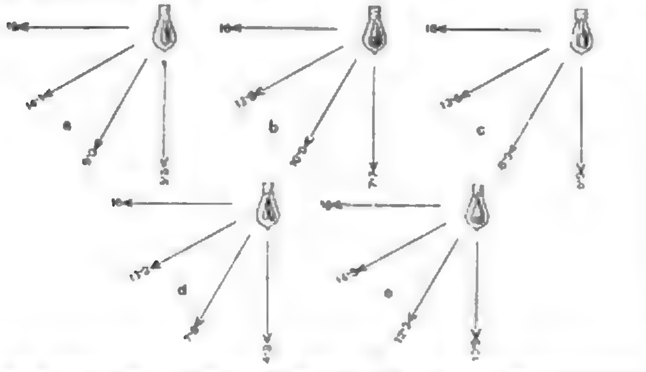
(*b*) Single-curl filament—a type much used, having a circular loop in the filament midway of its length.

(*c*) Long curl anchored filament—a type differing from type *b* in that the loop is long in the direction of the lamp axis, and is anchored to the part of the lamp where the leading-in wires pass through the glass.

(*d*) Double filament—a type which uses two filaments like type *a*, set so that the current passes through them in series, the filaments being in planes approximately parallel.

(*e*) Double-coil filament—a type like *b*, except that there are two turns in the coil instead of one.

Seeing that the candle-power delivered in a given direction depends greatly on the length of filament visible from that direction, the distribution of the radiation varies considerably among these types. Fig. 1 shows average candle-power values in the directions shown by the arrows for lamps of the five types all rated at 16 c.p. The lamp that gives the greatest candle-power along its axis belongs, it will be seen, to the type *e*.



(a) Straight U-shaped Filament ; (b) Single Curl Filament ; (c) Long Curl Anchored Filament ; (d) Double Filament ; (e) Double Coil Filament

FIG. 1.—Showing Average Candle-power Distribution from Incandescent Lamps of various types.

Fig. 2 shows the floor illumination produced by lamps of types *c*, *d* and *e* respectively. These diagrams were obtained by calculating from the observed candle-powers the illumination in candle-feet, and plotting these values vertically from the base-line. The lamps were taken 5ft. above the illuminated level surface.

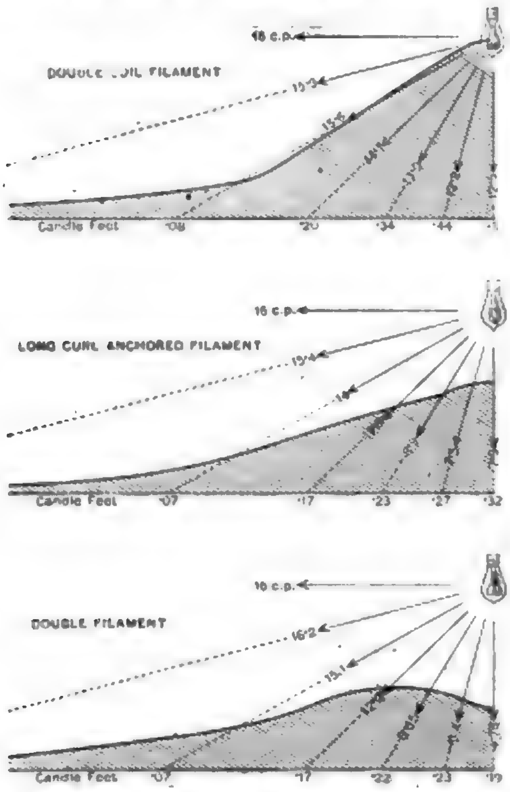
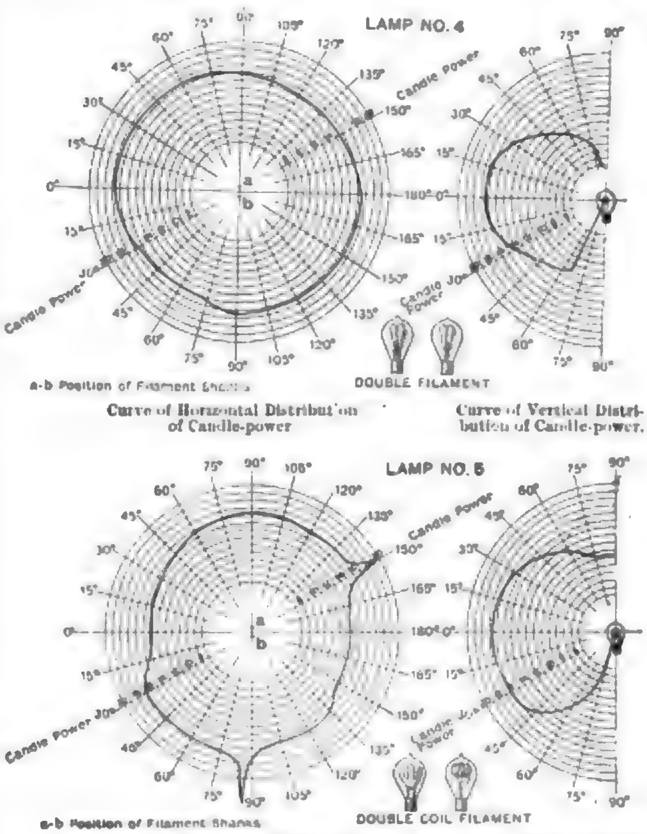


FIG. 2.—Illumination by Filaments of different types

The author next gives a series of measures of the distribution of candle-power in a horizontal plane through the lamp. These results are plotted as curves, and one such typical curve is given for each of the above five classes. Alongside these diagrams there are also curves of candle-power distribution in a vertical plane through the lamp. We reproduce in Fig. 3 the curves obtained from a double filament lamp and from a double-coil filament lamp.

The ideal manner of rating a lamp is to measure the mean spherical candle-power. The approximate method of doing this adopted by the Franklin Institute gives a result which is very nearly the true average of all measurements when the lamp is viewed from all possible directions. But this approximate method requires between 40 and 50 measurements with the photometer at least, and the average of 38 determinations is taken to get the result. Thus two operators working together in a well-equipped photometer laboratory need about two hours' time per lamp. In consequence manufacturers do not use the method. Most of them rate their lamps by the horizontal candle-power in a selected direction, till, in recent years, they adopted the mean horizontal candle-power as measured when the lamp is rotating about its axis with a speed of rotation commonly about 180 per min. The voltage marked on the label is that required to give 16 c.p. under these conditions. Again, as before mentioned, the National Electric Light Association has proposed that the candle-power should be measured in a direction inclined at 45deg. to the axis. The disparities between measurements taken by these and other methods are well shown in the



Curve of Horizontal Distribution of Candle-power. Curve of Vertical Distribution of Candle-power.

FIG. 3.

following table, where, in obtaining all the figures, each lamp was set at that voltage which yielded 16 c.p. in the horizontal plane when the lamp was revolving at 180 per min. with its axis vertical :—

| Candle-power taken. | Candle-power. | | | | |
|---|---|---|---|---|---|
| | Single U-shaped filament. | Single curl filament. | Long curl anchored filament. | D'ble filament. | D'ble coil filament. |
| (*a*) At 180 revs. with axis vertical | 16·0 | 16·0 | 16·0 | 16·0 | 16·0 |
| (*b*) Mean horizontal (standard method) .................... | 15·8 | 16·2 | 16·6 | 16·0 | 15·72 |
| (*c*) Mean horizontal (from plotted values) .................. | 16·0 | 16·7 | 16·7 | 16·1 | 15·6 |
| (*d*) Mean spherical (Franklin Institute method) .......... | 12·7 | 13·5 | 13·75 | 13·2 | 13·8 |
| (*e*) Mean with axis at 45deg. ... | 10·5 | 12·0 | 11·7 | 12·0 | 14·0 |
| (*f*) Mean hemispherical ..... ... | 14·3 | 14·6 | 14·6 | 14·0 | 14·5 |
| (*g*) Mean within 30deg. from tip | 8·7 | 10·3 | 8·7 | 7·9 | 10·9 |
| (*h*) From the tip .................. | 5·7 | 8·35 | 7·05 | 4·8 | 10·1 |

The author then proceeds to point out that to give good vertical illumination the globe of the lamp should be tipless, or, in other words, should be sealed off elsewhere than at the apex of the globe.

The Shelby lamp, upon various forms of which the author has made many measurements, satisfies very well most of the conditions imposed above. The filament is a double curl flattened horizontally, and the globe is, if desired, tipless and is, in any case, much flatter towards the end than the standard form of globe. The candle-power is well maintained in every direction in a vertical plane, and according to the author's figures is 16·8 horizontally, 16·5 at 45deg. and 14·9 in the vertical direction.

## AN AMERICAN CRITICISM OF THE PARIS EXHIBITION.*

BY CARL HERING.

A large international exhibition, like the one about to close, may be judged from two standpoints. For commercial reasons a necessary feature is its general attractiveness, that is, its beauty, architecturally as well as in the arrangement of the grounds and in the decorations, its proper combination of instruction and entertainment, and its purely entertaining features. On the other hand such an exhibition should be a representation of what is called the state of the art in the various industries, and to a certain extent at least, show the relative importance of competing industries. From the first of these standpoints this exhibition may be said to have been a great success. From the other standpoint, the exhibition may have been, and undoubtedly was, a success in many departments, but that claim can hardly be made for the electrical industry. For France, Germany, Switzerland, and a number of the other Continental countries, the electrical exhibits doubtless represented the true state of the art and the best general practice as far as these countries were concerned; but the absence of a proper representation from the United States proportionate to the enormous development, made the exhibition an incomplete representation of the present state of this important industry. The fact that several of our largest manufacturers have ceded their rights in foreign countries to local companies and therefore claimed to have no interests there, may explain in part the absence of some of the important American electrical exhibits.

England also was very inadequately represented in the electrical classes. The English claimed that they were tired of exhibitions, but another reason is no doubt the unfortunate political relation with France. England's exhibits in other groups also seemed to fail to represent the proper magnitude of the respective industries in that country. Of all of those foreign to France, Germany, its former bitter enemy, had by far the finest exhibits in most of the groups, including the electrical. Another feature of interest politically, is that Hungary had in many respects better exhibits than its stepmother country, Austria, and was represented as an independent nation; it bids fair to become one of the greater industrial countries of the east.

Among the classes of exhibits of well-developed industries, there were three in particular which may be mentioned here specifically, as each marks a distinct and important direction of development, and was exhibited for the first time very prominently at a large international exhibition. They are the automobile, the incandescent gas lamp (known here as the Welsbach), and the three-phase generators, motors and systems. The automobile exhibit was very large, but unfortunately for the electrical industry, it seems that the gasoline vehicle is gaining very fast in the race with the electric. The incandescent gas lamp was used in large numbers on the Champ de Mars, the only large open area in the exhibition where arc lights would otherwise have been installed. Even the friends of the electric light must admit that the illumination produced by it was very effective, brilliant and white without being dazzling. This lamp is getting to be a very serious competitor to the electric light, and some of the European central stations, particularly in the home of its birth, Austria-Hungary, are having serious difficulty in competing with it. The third of these prominent classes of exhibits, the three-phase machinery, will be referred to below. Another feature of indirect interest to the electricians is that most of the acetylene illumination was relegated by the authorities to two small strips of land unoccupied by any buildings, along the banks of the river, which seems to indicate that acetylene illumination is limited to a narrow field of its own.

There were no quite novel, epoch-making electrical inventions shown, although a few quite interesting ones that were already known to readers of the electrical journals, were exhibited there for the first time. One of the striking features was the great prominence of three-phase generators, and their size. One obtains the impression that the three-phase current has triumphed over all the others, including the continuous current, when large amounts of power are concerned, and that it would be poor practice now to instal large units of any but the three-phase system unless one is forced to use another. There was shown a decided tendency towards the use of large units, and quite a number were exhibited having outputs of about 1,000kw. and over. The greater number were for three-phase currents and all formed the flywheel of their direct-connected slow-speed engines, while all of the few large continuous-current machines exhibited had to have a separate flywheel. That the field is made the revolving part seems to be almost universal practice, as also the distributed winding on the armature. Single and two-phase alternators and large continuous-current machines were the exception.

Two very ingenious attempts were shown to compound large, three-phase generators, without commutating the main current, one by Hutin and Leblanc and the other by Boucherot. While they are interesting studies, it does not yet seem to be proved that for large units at least, a cheaper attendant than these would require, with his hand on the rheostat and his eyes on the voltmeter, is not a more practical solution. The amortisseur of Hutin and Leblanc, consisting of a short-circuited cage through the poles of the magnets, for facilitating parallel running, seems to be meeting with some favour and is being commented upon very favourably.

The largest generator exhibited was a 72-pole, 3,000kw. three-phase machine, of the Allgemeine Elektricitäts Gesellschaft, of Berlin. It was claimed to be the largest in the world, but this is an error, as generators of 4,000kw. and over are in use in this country at even slower speeds. Several others above 1,000kw. were shown, the slowest speed being 72, of the 2,700kw. mixed single and three-phase current Helios machine. The direct-generated voltages of the three-phase machines was from 2,000 volts to 6,000 volts; there was one exhibit of a comparatively small generator for 30,000 volts, but as long as good transformers can be bought, such excessively high-voltage machines will probably be used only for exhibitions and laboratories. There were a number of inductor alternators exhibited, which indicates that they are meeting with some favour.

Connecting lamp circuits to three-phase generators does not seem to be considered a sufficiently serious matter to overbalance the advantages of that system. The method used by the General Electric Co., of Berlin (that is, the Allgemeine Elektricitäts Gesellschaft, which even in Germany is generally abbreviated to A.E.G.) is simply to distribute the lights as evenly as possible over the three branches. All three mains are run into the buildings of even small consumers, although only two may be used, the third being available for changing over a batch of lamps, if necessary, for balancing. The voltage can thus be regulated only for all three branches together and not for each separately; but this is not considered a serious disadvantage. The Oerlikon Company, on the other hand, connects lamp circuits between the ends of only two of the three branches of a star-connected winding, the third branch being then idle; this enables the voltage of that single-phase alternating-current circuit to be regulated at the machine. By overloading these two circuits 15 per cent. the capacity of the generator is about the same as for motor circuits with a power factor of 0·8. The units in a station can then be alike, and it does not interfere with paralleling, or running motors and lights from the same machine if necessary. Another method used in Switzerland, but only with two-phase generators, is to construct a sort of double machine, the two halves of which may be mechanically displaced relatively to each other to generate two-phase currents for power purposes, or they may be connected in line with each other to generate single-phase currents for lighting.

The high-voltage, direct-current series system for power transmission and very limited distribution, made another and probably unsuccessful appeal for recognition, in the form of an exhibit by its indefatigable champion, Mr. Thury.

The large engines exhibited were, as a rule, slow-speed, which is the prevailing practice on the Continent. The very high-speed steam turbines are also meeting with favour.

Among the various types of motors the most interesting was the three-phase induction or Tesla type, which seems now to have demonstrated its superiority over all the others, except perhaps the continuous-current motor, upon whose field it is, however, encroaching very decidedly, with the present prospect of becoming its equal in importance. The largest company in Germany, and perhaps in the world, estimates that its sale of three-phase induction motors will before long exceed that of its continuous-current motors. Its very large factory, including even the rolling mill, is equipped with these induction motors mostly direct-connected. There is a single textile factory in Switzerland in which 500 of these motors are used for direct driving. The induction motors, almost exclusively of the three-phase and not two-phase type, are being introduced very largely now, especially in Germany and Switzerland. A nearly uniform type seems to have been adopted by most of the makers. In this, the primary circuit is the stationary one, and is distributed over the surface like a drum winding, as distinguished from the coils used in the earlier forms of Tesla. It is this distributed winding which is the chief improvement that has made them such a success; it seems to have been first introduced by Dobrowolsky in Berlin. The larger ones are almost always started with a resistance in the secondary external to the motor; in some cases a short-circuiting device is provided on the rotor for use

* Abstract of the inaugural address by the President at the 147th meeting of the American Institute of Electrical Engineers, New York, October 24.

after starting, so that the brushes may be raised while running to prevent wear. It will be noticed that in some respects this nearly universal practice abroad differs from that in this country, where even large motors up to 800 H.P., if not more, are made without any brushes, being started with a transformed current at lower voltage; others are made with the starting resistances on the rotor itself, which also dispenses with brushes.

Among the few other devices exhibited for starting such motors, the object of all of which is the avoidance of slide rings, may be mentioned the ingenious one of Fischer-Hinnen, who uses an inductive resistance of very low ohmic resistance, in parallel with a non-inductive one of high ohmic resistance; together they act like a high ohmic resistance when the motor starts, owing to the high frequency of the secondary currents, and diminish automatically as the motor increases in speed, because the frequency of the secondary then diminishes; they are permanently connected to the rotor. In the Déri motor the number of poles is changed by a switch in the primary, and the resistances are permanently connected between points of the secondary which have a difference of potential for one number of poles, but are of the same potential for a different number of poles; they are, therefore, either in or out of circuit, and admit of no gradation, which is a disadvantage. Boucherot uses practically a double motor, the field of one of which may be mechanically turned through a certain angle for starting; the two secondaries are permanently short-circuited in series with each other, but have resistances connected between the coils through which the secondary current is forced to pass when one of the fields is displaced, but only then; it seems like a rather complicated device as compared with the simpler slide rings which it replaces.

For the A.E.G. induction motors Dobrowolsky claims that they will stand a 200 per cent. overload, have a power factor of over 0·9, and still give the normal output for two-thirds the normal voltage. Induction motors are built on the Continent for high voltages up to 6,000 and, I believe, even 10,000, thus saving the transformers for all but higher voltages than these.

As to single-phase induction or non-synchronous motors, it looked as though most of their makers thought it best not to exhibit them, or to evade questions asked about them. Among the exceptions may be mentioned the Brown and the Oerlikon motors, both of which start with an auxiliary winding. Brown, who constructs them up to 100 H.P., states that they start with one-fourth to one-third full load torque at about normal full-load current. He has even made them for starting with full-load torque at about double normal current. The air-gaps are very small, from 1mm. to 1½mm. A cheap liquid condenser, made of iron plates in soda solution, is used for producing the artificial starting phase. The Oerlikon motors are claimed to start with one-quarter normal torque, requiring 80 per cent. normal current, and to stand an overload of 50 per cent. An impedance coil is used for starting. A very interesting installation of single-phase motors, and quite a unique one, exists in Frankfort-on-Maine, Germany, where about 500 such motors, mostly by Brown, are connected to the large single-phase alternating current plant, the motor load of which has levelled the load curve very decidedly. They vary in size up to 100 H.P., and are used even for elevator work. They appear to be satisfactory to the users, even though they must always be started unloaded. This is probably the largest motor plant of its kind, and shows what can be done even with single-phase motors.

Returning to the subject of alternating-current generators and motors in general, there is a characteristic difference between European practice and that in this country which seems worth mentioning. Here the coils are usually form-wound and then laid into open slots; there the wires are more generally threaded through completely closed holes as in the Oerlikon and Brown machines, or through holes of which the webs have been cut through with a very thin saw cut, as in the Dobrowolsky machines of the A.E.G. Mr. Brown gives the following reasons for his preference: Lower magnetic resistance, smooth surface of core, seamless tube insulation, solid poles, ease in parallel running and avoidance of wedges, binding wire, &c.; his experience is that it takes as long to replace a form-wound coil as to thread in a new one in place. Dr. Behn-Eschenburg, the engineer of the Oerlikon Company, gives his reasons as follows: The smoothness of the surfaces enables the air-gap to be made as small as 0·001 of the diameter in induction motors, which is hardly possible with teeth; with a web over the hole of only 0·1mm. the coefficient of magnetic straying can be reduced to 0·04 and a maximum power factor as high as 0·92 can be obtained; the maximum torque will correspond with 3·5 times normal current, and the possible overload can be 2·5 times the normal; if the holes were changed into teeth, all else remaining the same, the magnetisation current would be at least doubled, the straying coefficient reduced to about 0·03, and the best current for the resulting maximum power factor of 0·94 would then be more than doubled and the copper conductors therefore increased, or for the same load the power factor reduced to 0·91; the slotted armature would have to be made longer axially if it is to have the same current at no load as the one with holes; moreover, seamless insulation tubes of micanite can be used in the holes, which if 1mm. thick will be quite safe for 3,000 volts. However, he quite impartially recognises the favourable features of slots with form-wound coils and admits that they may outweigh the others if a factory is suitably equipped for such work; he believes that under certain circumstances the one, and under others the other, is the better.

Another interesting characteristic difference between American and Continental practice, is that here synchronous converters combined with transformers are more generally used for transforming high-voltage three-phase currents into low-voltage direct currents, while on the Continent dynamos driven by high-voltage induction or synchronous motors are the rule. Although the favourable features of each are well understood, the reasons given by such a successful constructor as Brown for preferring motor generators, may nevertheless be of interest here. He states that: They can be regulated with ease and precision, no transformers, both parts can be better designed without making concessions, no hunting, ease in starting, no depolarisation possible, secondary voltage absolutely independent of the primary. He admits that the synchronous converter is cheaper and more efficient, but claims that the differences are but slight; he has obtained 90 per cent. combined efficiency for a 250kw. motor-generator set.

The difficulty of not being able to regulate the voltage of a synchronous converter, is overcome by Dobrowolsky in a very ingenious and apparently successful way. Instead of passing the continuous current through a booster, which would require an expensive machine, and generally with a very large commutator, he passes the alternating current through an alternating-current booster on the same shaft; this is separately excited with a continuous current and therefore permits of regulation. The one shown to me would raise or lower the voltage 25 per cent., making a range of adjustment of 50 per cent. It either drives or is driven by the converter. Although this overcomes one of the chief objections to synchronous converters, he has not changed his preference for motor generators. Another modification of interest used by this same engineer and others, is that six-phase instead of three-phase currents are led into the synchronous converter, the advantage being that its output is thereby increased, according to a French constructor about 45 per cent. The attending disadvantage of six slide rings instead of three is said to be more than balanced. The general use of three-core transformers, for three-phase currents instead of a single one for each phase, as is customary here, is another instance of a difference in practice.

It was of some interest to note the almost complete disappearance of the Gramme ring armature among generators and motors, and the use of multipolar fields for smaller sizes than formerly, especially with motors. The Dobrowolsky system, hardly known here, of supplying three-wire circuits from a single generator, by connecting the neutral through induction coils and slide rings to two opposite parts of the armature winding, seems to be meeting with favour on the Continent.

A criticism of American motors made by a prominent German manufacturer who has bought and tested many, was that an American horse-power was only three-quarters of a real horse-power.

In electric railroading there seemed to be comparatively little of special interest to Americans besides the three-phase motor system and the contact bar, both of which deserve more attention here than they are getting. The new Metropolitan underground electric road quite recently opened in Paris, is apparently an excellently constructed but wretchedly managed road. American management would diminish the total time of transit and increase the profits greatly. It is an improvement over the new underground road in London in that motor cars are used instead of locomotives, but being directly under the street instead of very deep, as in London, the excellent device of a descending and an ascending grade between stations, to aid acceleration and stopping, cannot be taken advantage of. Both of these roads use American electrical machinery.

In the exhibition itself may be mentioned the 2 miles of moving platform which differed from the one in Chicago in that the motors were stationary while the rails moved. The third rail electric railroad paralleling it but running in the opposite direction, was virtually an American exhibit and was managed more like American roads, making a refreshing contrast to the wretchedly managed tramways and omnibuses in the city. The conduit road which was shown, was also virtually one of those developed in this country. A short section of the "suspended" railway was exhibited, but whether this struggle for recognition was successful seems questionable. Another curious departure shown in operation was the trolley automotor, a system of running electrically driven vehicles on ordinary roads, but taking current from an overhead trolley wire. The novel feature was that the small contact carriage running on the two wires, was geared electrically to the motors by means of a local three-phase current, so that it tended to travel slightly faster, thereby always leading and keeping the connecting cable taut. A field for it might exist where omnibuses are now used. A number of large electric locomotives were exhibited, notably one from Berlin, showing that heavy electric traction is making progress. One weighing about 45 tons exhibited by the French steam railroad known as the P.L.M.,

was operated with accumulators carried on a tender, but the claims made for it by the attendant were so remarkable that a verification is desirable before they can be considered. Although it was dated 1896, I was told that it was "not yet" in constant use.

In electric lighting, one of the most interesting features was the début of the Nernst lamp. This lamp is now claimed to be ready for the market; but although several hundreds were burning there daily it was not possible to buy one. Either alternating or continuous currents can be used but the filament must be exposed to the air. The lamps are made for 25 c.p., 50 c.p., and 100 c.p. at 220 volts and therefore do not yet compete directly with the usual 16 c.p. lamp. The efficiency is said to be 1·5 watts per candle, or about twice as good as the present carbon lamp of the same voltage. The filament is said to be made of magnesia mixed with the rare earths like zircon, thorium, &c. The life is claimed to be very satisfactory, though no figures could be obtained, but the perishable parts, valued at only 25 per cent. of the probable cost of the lamp, can easily be replaced, the bulb being open. The material of which the filament is made, has a rapidly falling temperature coefficient, much worse than carbon, which would make it extremely sensitive to changes in voltage. This is overcome by a very ingenious method to which the present success of the lamp is due. It consists in placing a very fine iron wire in series with the filament, the wire being so proportioned that it is heated by the normal current to that temperature (about 450°C. to 500°C.), at which it has a very rapidly rising temperature coefficient; the resulting characteristic of the two in series is therefore a rising one. This fine wire consumes about 10 per cent. of the voltage. The price of the lamp, it is thought, may be about 5s.

Among the novelties in arc lamps which attracted some attention during the few days it was on exhibition was the Bremer lamp, in which the carbons contain certain salts, like those of magnesia, together with fluor calcium, that deposits a white oxide on surrounding bodies, which acts both as a Nernst conductor and a white reflector, the carbons being inclined like the letter V. A reliable German authority found the efficiency to be 0·13 watts per hemispherical candle-power. The light is said to be steady and bright, but soft. The only enclosed arc lamps exhibited were from this country, directly or directly. These lamps, which are so largely adopted here, are scarcely known on the Continent; and in France, at least, it seems that they are not even wanted, on the ground that the light is too blue and unsteady, and the efficiency too low. As manual labour is much cheaper there than here, and arc lamps are not used nearly as much, the chief advantage of this lamp is not appreciated, at least not yet. The arc lights there are, as a rule, much steadier, and are almost universally connected to constant potential circuits, our series system being almost unknown. The general type of regulating mechanism which is in favour, is that in which the coil applies a brake to an escapement wheel which tends to revolve by the weight of the descending carbon; the regulation is therefore very sensitive and gradual. Cored carbons of a fine quality are moreover almost universally used. Generally only two lamps are in series across the usual 110-volt mains, but in some cases as many as three are connected with an increase in light efficiency; in such cases the lamps are of the differential type in which the regulating mechanism is actuated not only by a shunt coil but also by one in series.

The exhibits of electric chandeliers and like fixtures were mostly French, and were generally very tasteful, artistic, and often very beautiful, although frequently marred by external wiring, as with many of them concealed wiring is impractical. The accessories, on the other hand, such as circuit breakers, small switches, lamp sockets, motor starting resistances, &c., were frequently quite bad or too complicated from an American standpoint. There would seem to be quite a market abroad for the better classes of American goods of this kind. It is hard to understand why electrically-started fires are not more frequent on the Continent with such poor appliances of this kind that one finds in use there.

The relatively large number of exhibits of switchboard switches for breaking currents of very high voltage indicates the rapid introduction of high tension currents. In many of them the well-known double horn is used for extinguishing the arc, which is an indication of the effectiveness of this simple device. A novel departure in switchboards, especially for dangerously high-voltage machines, consisted in placing all the switching apparatus belonging to one machine on or under a post or pedestal near the machine itself, and so that the attendant faces the machine. The actual switches are under the floor, where they are out of the way and easily accessible from a pit below, only the levers, hand-wheels and instruments being on the pedestal; the attendant is thereby protected from all the possible danger. It is the standard practice of the Oerlikon Co. The use of silver fuse wire in place of lead alloys, by a very large German company, on the ground of greater reliability and constancy, deserves mention. For the same fusing current the amount of metal volatilised is the least for silver. The non-interchangeable fuses of Siemens and Halske were of some interest, and seem to supply a need.

Among the cable exhibits there were three for underground work in which multiple cored cables were subjected to 25,000 volts and 30,000 volts alternating, the insulation in one of these being impregnated paper without any rubber. A German maker of aluminium goods showed that this metal can be welded without solder or flux by simply heating it to a certain definite temperature at which it softens. The use of aluminium line wires makes this simple method of interest to electrical engineers.

The number of different types of meters exhibited was about equal to the number of their exhibitors, but the Thomson meter in nearly the same form as made in this country, is the one most frequently used; several hundred a day are claimed to be made by the French company which manufactures them. The field for a good, cheap and simple ampere-hour meter for small consumers of continuous current, is filled very satisfactorily in France by the O'Keenan meter, of which 11,000 are already installed. In principle it may be said to be like a d'Arsonval galvanometer or Weston instrument, in which, however, the coil is mounted so that it may revolve continuously, the number of its revolutions being registered. This coil or armature is a shunt to a very low resistance in the main circuit. It is extremely sensitive and the coil requires only 0·6 microwatt to start it; it will register as little as 5 watts in the lamp circuit or 1 per cent. of its range, has a straight line characteristic and is not appreciably affected by temperature changes. A somewhat similar one is about to be introduced in this country and there is no doubt a large field for it. The well-known and ingenious Aron double-pendulum meter was well exhibited in various forms, including one for three phase currents. It is said to be used to some extent in Germany but would probably not find much favour in this country.

An interesting and promising modification in the Thomson type of watt-hour meter, shown in the German section, consisted in using a three-coil armature like that in the original Thomson-Houston arc light machines; this enables the same magnetic force to be produced by a much smaller weight of the revolving part, with several attending advantages of importance. Prepayment meters are meeting with some favour, and there might also be a field for them in this country among small consumers.

In telegraphy the exhibit which seemed to attract most attention was the very ingenious printing telegraph system of Prof. Henry A. Rowland, of Baltimore. There were several exhibits of the wireless telegraph system, though none by Marconi's company. The modifications were only in details and did not include any way of making the system selective. It is now being introduced commercially and there are a number of installations in regular use.

The telegraphone was one of the very few entirely novel inventions of promising value exhibited. This extremely ingenious and very interesting invention of Poulsen, a Dane, has been so thoroughly described in the journals that a mere mention will suffice here. I had the pleasure of hearing it, and can vouch for the statement that it is much clearer than from an ordinary phonograph as there is an entire absence of that objectionable scratching noise, there being no mechanical contact at all. Its suggested applications are numerous, including duplex and multiple telephony.

Those interested in the controversy between the vertical and the horizontal telephone switchboard, found a good opportunity to compare them, as each was exhibited by its most ardent defender, the vertical board being advocated by one of our large and prominent companies, and the horizontal by a similarly prominent German company which is introducing it in its country, notably in Berlin. The chief advantage claimed for the latter is that two operators sitting on opposite sides can use the same board, and that therefore the length of board for the same number of subscribers is halved.

Electrochemistry was one of the electrical classes in which the most pronounced recent development was shown, although the exhibits were not sufficiently complete to show the true state of that art. This branch of electrical science has opened what promises to be one of the important fields in which there is an opportunity for great development. Products which not many years ago existed only as rare and expensive specimens, and some which were not even known, are now made electrically by the ton. Electric furnaces were shown in operation. There was also a very fine exhibition of the extremely interesting collection of products obtained by Moissan in his classical researches. Judging from two other large exhibits, copper is successfully deposited directly in the form of mechanically strong tubes, simultaneously with the process of electrolytic refining. A single company in Germany refines electrically about 5,100oz. of gold and 24,000oz. of silver a day. A very large ozone apparatus was shown in operation, for sterilising 200,000 cubic metres of water per 24 hours by the Marmier and Abraham process, but a confirmation of the claims made is very desirable. The interesting process of Goldschmidt for obtaining very high temperatures of about 3,000°C. by the combustion of aluminium mixed with metallic oxides was well exhibited and deserves mention, although only of indirect interest to electricians. The expense of the aluminium naturally limits its application, but this seems to be more than balanced in some

cases by the other advantages. It is already in commercial use for obtaining pure metallic chromium and manganese for the iron industry, and for welding rail and tubes or mending broken iron parts.

In accumulators there was shown a general tendency, though not a universal one, to use Planté positives and Faure negatives, a combination which seems to have given the least trouble. Accumulators are now the rule and not the exception in Continental lighting and traction stations. Now that the fundamental patents have run out in this country, we ought to use them more freely here. As an electrical flywheel and a comforting reserve in a central station the accumulator has no equal. It is impossible, of course, from mere inspection, or from catalogue data, to judge of the success of the light-weight accumulator for transportable purposes, notably for the automobile. But from the awards of the jury, which were based on reliable knowledge of their performance, the Fulmen, the Pulvis and the Phœnix were among the best of their kind; all three are French.

The most satisfactory development in primary batteries is that inventors—or perhaps the capitalists—seem to have at last been convinced that it is cheaper to burn coal than zinc.

A very interesting and promising method was shown in operation by its inventor, Rieder, for electrolytically engraving deep, hard steel dies, such as are used for pressing the reliefs on coins and for embossed work in general. A porous negative of plaster of Paris, saturated with chloride of ammonium, is lightly pressed against the steel blank and the metal is dissolved off electrolytically by a current, wherever the negative touches it. The cost is said to be only half that of the usual hand method.

The exhibitions of instruments were very fine, chiefly from France, England and Germany, but it would take too long to enter into a discussion of them here. That a d'Arsonval galvanometer is made with a sensitiveness of $1\cdot2 \times 10^{-10}$ amperes per millimetre-deflection, is of interest; it is claimed to be the highest sensitiveness yet reached with that type of instrument. Among the station and laboratory instruments which are not generally used in this country, but which are very convenient, are the phase meters of Dobrowolsky, indicating directly the difference in phase. A curious but characteristically European criticism of a certain world-renowned type of American instrument was, that "they are bad because they are expensive." The very general introduction of micanite, an American invention, for generators and motors, is of interest. The electric plant supplying the exhibition did not seem to be a success, judging from the very numerous stoppages and the excessive variations in the voltage.

The largest number of electrical exhibits were, naturally, from France. Among the foreign countries Germany was far ahead of all others in importance, and promises to become the leading manufacturing country for electrical goods in Europe, if it is not so already. One company alone employs 14,000 hands, and ranks with our largest American company. It is of interest to us that this successful company uses American methods quite largely. The Reichsanstalt, that creditable German institution, has, no doubt, contributed to the rapid strides made by that country in the electrical industries, and shows what Government aid can do for the industries of a country. England has already started its Electrical Standards Laboratory of the Board of Trade, a very interesting and creditable Government department, which was shown to our Institute this summer during its first official visit abroad. France has its "Central Laboratory," and is considering the enlarging of its Government department. Russia has a large Government electrical laboratory. The United States alone, among the large countries, has practically nothing of the kind.

Switzerland follows Germany in importance. The United States and England were inadequately represented in this department for reasons already mentioned, although there were some excellent exhibits from each. The lists in the catalogues cannot be taken as a guide in such a comparison, because a simple little device of no importance has the same prominence there as a large important exhibit of several thousand horse-power of machinery. Moreover many American exhibitors who were entered in the catalogues did not exhibit. In one class alone the number of actual exhibitors was only 40 per cent. of that in the catalogue of the United States exhibits, and many of these were quite small. It would therefore not be just to judge the state of this industry in our country by the exhibits or by the awards.

A characteristic difference between American and foreign practice in manufacturing, as, for instance, such goods as dynamos and motors, is that here the manufacturer establishes certain well studied and well developed standard types and sizes of machines once for all, and then reproduces them in large numbers, making the parts interchangeable. The foreign manufacturer, on the other hand, constructs each machine according to the detailed specifications of the one ordering it. He argues that if he should make bids with standard sizes in stock, the purchaser would accept the bid of some one else who would construct the machines exactly according to the specifications. As a matter of fact, however, it was noticeable that those companies which have adopted the American method were, as a rule, the most successful. There is also a field in and around Paris, at least, for American methods of managing and operating electric tramways, as existing practice is there very poor.

Another difference is that here the manufacturer, as a rule, devotes his whole effort to a single class of goods, and makes these in large quantities, while abroad he attempts to make a large range of widely different kinds of articles; this seems practical only when each branch is a large business in itself. Still another difference is is in the fine external finishing of even those parts of an apparatus which are concealed. Their argument is that all parts of a well-made apparatus ought to look well, and that it will then be handled with greater care and respect. Here we would consider it a useless expenditure of money to polish all the concealed mechanism of arc lamps, for instance. The foreigner, however, is apt to judge our our goods from his standpoint, at least until he can be convinced of their advantages.

The Jury of Awards had many delicate questions to settle, both technical and diplomatic. While mistakes are possible, it is more than likely that complaints of exhibitors can generally be traced to unworthy or inadequate exhibits, or to circumstances beyond the control of the jurors. One-half the jurors were French, and in the electrical group they were very liberal and generous to the foreign exhibitors, more so than to their own countrymen. If they erred at all, it was on the side of generosity, for which they deserve our thanks instead of abuse. Only two of the United States jurors for the electrical group were members of the Institute.

The first meeting which our Institute held abroad was a memorable event, and bids fair to be the beginning of a series of international meetings of electrical engineers. It brought the Institute into considerable prominence abroad, increased its influence, and afforded great pleasure to those of its members who attended. Such international meetings therefore can hardly fail to be of benefit to all who take part, as they enable one to find, through personal observation and personal intercourse, that which is the best the world over, just as our home meetings bring before us the best in our own country. If we want to manufacture the best there is, especially if we want the foreigner to buy it from us, we should have international intercourse. In London our sister society, the Institution of Electrical Engineers, entertained us with true English hospitality for three well-filled days with a most delightful programme, in which pleasure and instruction were harmoniously combined. It will long be remembered by the 28 or 30 of our members who attended as one of the most enjoyable features of the whole meeting. In Paris the official joint meeting with the British Institution, held in the National Pavilion of the United States, through the courtesy of Commissioner Peck, was well attended and was followed by receptions of both institutions, visits to objects of interest, and the Electrical Congress, making a total of two well-filled weeks of international intercourse between electrical engineers, and constituting one of the most important meetings in the history of the Institute. The success of our first meeting abroad should encourage us to follow the excellent example of the Institution of Electrical Engineers by making official visits to the different foreign countries to study their practice and examine their work. Our foreign colleagues will then be encouraged to visit our country, as many of them have promised to do next year on the occasion of the Pan-American Exhibition in Buffalo.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

London County Council require an electrical engineer, experienced in the construction of electric tramways, to superintend, under the Council's chief engineer, the work of constructing or re-constructing for electric traction the Council's tramways, &c. Salary £1,000 per annum. Further particulars are given in an advertisement, and applications must be sent in by 10 a.m. of Jan. 14.

Rotherham Corporation invite applications for the post of borough electrical engineer. An advertisement contains additional particulars, and applications must be sent to the town clerk (Mr. H. Hampton Copnall), by noon, Jan. 14.

West Ham Guardians require an expert to advise on the engineering work in connection with their new infirmary at Leytonstone. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. Fred. E. Hilleary), Union Workhouse, Leytonstone, N.E., by 23rd prox.

The Council of the Foreign Community, Shanghai, require a municipal electrical engineer. Further particulars from Messrs. John Pook & Co., 53, Leadenhall-street, London, E.C., to whom applications should be forwarded before Jan. 12. See advertisement.

Burnley Corporation require a general manager for their tramways. Applications by Jan. 19.

Battersea Borough Council require a resident electrical engineer Applications on official forms to town clerk by Jan. 1.

Hampstead Borough Council require an assistant electrical engineer. An advertisement contains further particulars and applications must be sent to the town clerk (Mr. Arthur P. Johnson), by noon of Jan. 2.

The Governors of Sir John Cass's Technical Institute, Jewry-street, Aldgate, E.C., require a principal. An advertisement gives additional particulars, and applications must be sent to the clerk (Mr. W. H. Davison), 10A, Idol-lane, Eastcheap, E.C., by Jan. 26.

An assistant lecturer in physics is required for the Technical College, Huddersfield. An advertisement gives further particulars.

---

The Commissioners of National Education, Ireland, have appointed Mr. E. G. Ingold, of the Birmingham Municipal Technical School, assistant organiser of instruction in elementary science in the Irish National Schools.

Mr. H. Ade Clark, Wh.Sc., A.R.C.Sc., A.I.E.E., has been appointed assistant lecturer and demonstrator in mechanical and civil engineering to Prof. Goodman at Yorkshire College, Leeds.

---

**Aldershot.**—At the last meeting of the Council a tender was accepted for the erection and equipment of electricity works, and it was decided to apply for sanction to a loan of £20,000. The contractors (Messrs. Thomas Parker, Ltd.) are to undertake the working of the station for six months after completion, and for a further period of 2½ years if required, upon certain terms, the Council to have the option to determine the agreement by three months notice. The chairman of the Electric Lighting committee (Mr. Smith) said on May 16 last they recommended that invitations be sent out to respectable firms to tender for an installation capable of supplying electric current to 6,000 8 c.p. lamps. This was done, and a site was selected. In the meantime an extension of one year for carrying out the provisional order had been obtained. The amount of Messrs. Parker's tender was £14,446, but allowing £3,000 for buildings, &c., the total outlay was estimated at £17,446. Adding another £2,000 for contingencies, the committee recommended that the Council ask sanction to a loan for £20,000. The committee's proposals were adopted.

**Alleged Theft of Electric Current.**—At the Liverpool City Police Court last week Mr. E. Isherwood, electrician, South John-street, was summoned by the Corporation, as owners of the electricity supply works, under sec. 38 of the Gas Works Clauses Act, 1871, for fraudulently abstracting electric current from the corporation mains. For the prosecution it was stated that the defendant, who is an electrician in business for himself, had been a consumer of electric current for some time. In the early part of 1900 it was observed that his consumption, according to the meter, was not so large as it was considered by the department it should have been considering the number of lights on the premises. The meter was examined and tested several times, and found to be in order. From careful inquiries made the Corporation alleged that they found defendant had been abstracting current by an ingenious trick. A former apprentice, named Lake, gave evidence against defendant. Mr. Alfred Clough, assistant electrical engineer to the Liverpool Corporation, said he had examined defendant's meter on account of the low consumption, and had examined his premises, and found a burnt brass nut, which might have been caused by placing a wire there and tapping the main. Mr. Quilliam, for the defence, said the charge was a serious one to bring against a respectable tradesman. The defendant emphatically denied the charge. He had never made any connection whatever. The lowness of consumption was accounted for by the fact that very little light was used on the premises, which were often shut during the whole day while defendant and his employes were engaged on outside work. The chairman said that he and his colleague were divided in opinion, and the case would be adjourned for 14 days.

**Ayr.**—The Lighting committee offer to supply current to the Glasgow and South-Western Railway Co., for lighting the railway station, &c., on the following terms—Up to 100,000 units, 2½d. per unit, up to 200,000 units 2d., and up to 300,000 units 1¾d.

**Bournemouth.**—An inquiry was held here last week into the application of the Council to borrow £12,000 for electric lighting. The town clerk (Mr. J. Druitt, jun.) explained that the money was required to enable the Corporation to utilise the proposed generating station for electric traction, and to light by electricity the various tramway routes. The total estimate was £12,661, although only £12,000 was asked for. The surveyor (Mr. F. W. Lacey) said the reason of this was that the estimate had been amended since the application was made. The surveyor and the consulting engineer, Mr. E. M. Lacey (Lacey, Clirehugh and Sillar) presented plans and gave technical details. Mr. E. M. Lacey stated that between 7 miles and 8 miles of streets would be lighted electrically. There would be 220 arc lamps (each of 2,000 c.p.), at distances varying between 60 yards and 80 yards, and each lamp-post would have two 16 c.p. incandescents attached.

**Brazil.**—The *Rio News* states that a project is under development for the construction of an electric railway from Piracicaba to Villa Americana, in the State of San Paulo. The estimated cost of the line is 2,500,000 dols., and an application for a concession is now before the San Paulo Legislature.

**Bridgwater.**—With reference to the application by the Council to borrow £20,000 for electric lighting, a communication received from the Local Government Board asks whether, after the adverse result of the recent municipal elections, the Council are desirous of proceeding with or withdrawing the application. A recommendation by the Lighting committee that a case be prepared for the opinion of counsel as to the position of the Council in connection with the tenders for electric lighting plant has been adopted.

**Bristol.**—The permanent way of the new electric tramway routes was officially inspected on behalf of the Board of Trade on Thursday and Friday last, and the lines were opened for traffic on Saturday. The Bristol Tramways and Carriage Co. has now 30 miles of electric tramway open.

**Cape-to-Cairo Telegraph.**—This line has now been constructed to a point 50 miles beyond Kasanga (German East Africa) and 100 miles beyond the southern end of Lake Tanganyika.

**City of London.**—At last week's special meeting of the Court of Common Council the subject of the alleged vibration from the "tube railways" was discussed, and sufferers from this cause were recommended to compile full and accurate data with regard to their respective basements. The City Remembrancer pointed out that complaints must rest upon two different legal processes—one the danger arising from the manner in which the tube railway is constructed, and the second the danger caused by the running of the trains. The Remembrancer further stated that the Board of Trade was taking exceptional steps to ascertain the facts, and any person who considered himself seriously affected would have his claims considered. It was most likely that in all future bills a clause would be inserted for protection against this danger.

Another subject discussed was the disposal of the City's dust and refuse, and Deputy C. T. Harris moved an amendment to the Streets committee's recommendation to adopt the principle of barging dust and refuse from the City into the country. Mr. Harris urged that the barging system would cost 3s. 3d. per ton, while the cost of cremation would not exceed 2s. 4d. per ton. Mr. Brooke-Hitching hoped that the electric lighting companies would be approached with a view to the destruction of the City's refuse.—Further consideration of the subject was adjourned.

In reply to a question of Mr. A. C. Morton on the subject of the increase of voltage by the City of London Electric Lighting Co. from 100 volts to 200 volts, and whether consumers could refuse to accept the increased voltage, Mr. Pryke said the City Lands committee had decided not to consent to the proposal made by the company to increase the voltage, and judging from the informal conference which had been held with other committees it was unlikely that they would agree to the change. Consumers who were on the company's books before June, 1896, could refuse to accept the increase, which it was commonly stated would involve the consumer in an increased cost of about 25 per cent. for fittings, the higher voltage necessitating lamps of great efficiency.

**Dublin.**—We gave particulars last week of the decision of the Local Government Board to surcharge the members of the Electric Lighting committee in respect of certain payments made in connection with the supply of electric light fittings to consumers, &c., to the amount of £2,000 odd, and now some further particulars are to hand. The greater portion of this sum, it is said, was expended on alterations and in constructing a new switchboard at the electricity works, some £400 odd only being for fittings. It is stated that this £400 does not cover the cost of the fittings, and should the present surcharge be upheld another surcharge, amounting to £3,000, will probably be made at the next audit. The surcharge will fall upon the Lord Mayor (Sir T. D. Pile), Sir Robert Sexton, Ald. Russell, the late Ald. Meade's representative, Councillors R. Jones, Gorevan, Hutchinson, M'Call, Dr. Kennedy, and P. O'Hara. Only those members who actually signed the cheques can, it is claimed, be held liable. The Corporation are appealing to the Local Government Board in order to induce them to alter their decision, which it is strongly held in Dublin the Board has power to do. As to liability of individual members of the Electric Lighting committee, the opinion prevails amongst the surcharged members that, according to the law as it stands, as every committee is appointed by the Council, and is the servant of the Council, the Council is directly responsible for the acts of its servants.

At last week's meeting of the Electric Lighting committee a report from Mr. R. Hammond concerning the cost of the new electric power station buildings at Pigeon House Fort was considered. It will be remembered that Mr. Hammond's original estimate was £20,000, and that the tender which found most favour was that of Pearson & Co., London, which amounted to £52,000. Mr. Hammond in his report on the subject points out that his original estimate of £21,000 did not include several items which are

embraced in the tenders recently sent in, and he contends that the committee from time to time decided upon certain additions to and amendments of his original scheme which tended to increase considerably the amount of the estimate. It was ultimately decided to postpone the consideration of the report for a fortnight, and Mr. Hammond was asked to supply details to enable a reduction in the expenditure on the buildings to be made.

**East Ham.**—A Board of Trade inquiry has been held here into an application of the Council to borrow £42,220 for electric tramways. The inspector (Col. P. G. von Donop) said he understood the amount was made up of two items—viz., £16,000 odd to cover the cost of carrying out the tramways authorised by the 1898 Act, the Board of Trade having originally sanctioned £19,000, whereas the work involved an outlay of £35,000; and there was also a further sum of £26,000 for extensions, and providing cars, machinery and buildings.

The electrical engineer (Mr. W. C. Ullmann) stated that the loans which were sanctioned on the first estimates provided for the permanent way being laid with tar macadam, but in the principal streets they proposed substituting granite setts. Only the single lines would be paved with macadam. The extra cost of 14,000 sq. yds. of granite was roughly £10,000, and there was another item of £451, increased cost of wood block paving, the Council having decided to pave in front of all places of worship with Jarrah paving instead of granite or macadam. That was not included in the general estimate. The further sum of £1,430 was for works in anticipation of extensions, the Council having considered the advisability of obtaining a provisional order for extension lines in various parts of the district. The total cost of removing gas and water mains amounted to £2,555, and they had not put anything down for the removal of these mains originally.

The Inspector: That makes the total cost of these lines £35,000, and just over 5 miles in length.

Mr. Ullmann said the estimate for extensions came to £15,283.

The Inspector: I must say your estimate is exceedingly high. That is about £12,000 a mile, and it generally comes out at £7,000.

Mr. Ullmann said there were two cross-overs and two loops. The contracts for the work had been let subject to the Board of Trade inquiry.

**Edmonton.**—There is considerable opposition to the proposal of the Council to join with three other local authorities (see also "Electricity Supply in North London") in promoting a bill for electric lighting powers.

**Electric Railway Block Apparatus.**—The *Commercial and Industrial Gazette* of St. Petersburg, announces that the Russian Ministry of Ways and Communications is collecting expert data as to the working on Russian and foreign railways of every kind of electrical and mechanical block apparatus, with a view to the adoption of the most suitable system throughout the Russian railway service.

**Electricity Supply in North London.**—We learn that Mr. Robert Hammond and Mr. W. C. C. Hawtayne have been selected to advise the joint Councils of Tottenham, Edmonton, Wood Green, Enfield and Southgate in connection with their scheme of electricity supply for lighting, power and traction, combined with dust destruction. The estimated capital expenditure is nearly £400,000, of which £50,000 is to be spent on public lighting and £25,000 on an "easy payment" wiring scheme. Generating works are to be established on the banks of the Lea at a point near Angel-road. The price to be charged for current to private consumers has been fixed at 3½d. per unit, and 1s. 6d. per quarter for meter rent. At Tottenham the public gas lighting costs between £3,000 and £4,000 per annum, and for this district the electric lighting scheme is estimated to involve a total yearly expenditure of £38,900 per annum with an estimated income of £39,350 per annum. Under the scheme of joint control, Tottenham, from its greater rateable value, will have four representatives and the other districts two on the committee of Joint Control to be appointed. The project is not to go through without strong opposition, but this opposition is unlikely to prove successful, the consensus of public opinion in all the five districts being generally favourable to the enterprise.

**English Plant from the Paris Exhibition.**—A smart piece of work is reported in connection with the supply to the Sheffield Corporation lighting undertaking of a Parsons steam turbo-alternator which it was decided to purchase on Nov. 28 last on the advice of the chief engineer and manager, Mr. S. E. Fedden. The machine was at the Paris Exhibition, and was immediately taken down, packed and despatched to Sheffield, and at noon on Dec. 21 was running with 200 amperes. The machine was sent by passenger train, weighed 14 tons, and was a 500kw. machine. The 16in. exhaust mains and steel riveted steam mains were ordered and delivered in 17 days and on arrival were found to fit accurately. The steam and exhaust piping was supplied by Tasker's Engineering Co., Sheffield, and Mr. Fedden joins in considering that credit is due to both firms for the smart manner in which the whole of the work was carried out.

**Exhibition.**—The Prince of Wales has agreed to open the Glasgow International Exhibition of 1901. The space available for exhibits, excluding the fine art galleries, gives an area of 289,533 sq. ft., of which 162,344 sq. ft. has been allotted to the British exhibits, 69,414 sq. ft. to the foreign, 47,775 sq. ft. to the Colonial, and 10,000 sq. ft. to the Women's Industries exhibits.

**Failsworth.**—A report on electricity supply has been presented to the Council by the Electric Lighting sub-committee, who are satisfied that for a compact district like Failsworth, where the most distant consumers would probably not be more than three-quarters of a mile from the centre of the township, the low-tension system of distribution will be the most suitable. A plant of 150kw. capacity is recommended, the estimated cost of which is £18,300. The committee have been in communication with the Corporations of Manchester and Oldham (the two neighbouring authorities most conveniently situated) in regard to the supply of electric current and they were asked for terms for a supply of current in bulk, or for supply and distribution. Oldham replied that they were not prepared to entertain either question, and Manchester that so many objections existed, and so many difficulties might arise in connection with the working of such supply, that it would be unwise to pursue the matter. If a transfer of the Failsworth provisional order could be agreed upon Manchester would be willing to take a transfer for 21 years, paying all costs up to and including the obtaining of the order. The report makes no definite recommendation.

**Fire Losses.**—The official report of the estimated loss at Hooper's Telegraph and Indiarubber Works, Millwall Docks, puts the amount at £8,000. The buildings and contents were well insured.

**Glasgow.**—In presenting the minutes of the Electricity committee last week, the convener (Bailie Maclay) referred to the accident which occurred on the 18th inst. to one of the mains in Waterloo-street, which was due to the accumulation of gas in one of the junction boxes. An accidental spark set fire to the gas, causing an explosion, and the supply to certain important districts was cut off. No time was lost in getting the mains put in order, and they were all right now.

It was also announced that at a meeting of the Finance sub-committee a report was submitted as to the proportion of risks which the new fire insurance department of the Corporation should be asked to undertake on behalf of the electricity department. The sub-committee agreed to recommend that two-fifths of the risks be taken over by the new department. The property of the electricity department was at present insured to the extent of about £170,000. At a meeting of the Electricity committee a motion was carried that the entire risks of the electricity department be given to the Corporation insurance department, and

Mr. Shaw Maxwell, who moved this motion in committee, now moved approval of the report of the Electricity committee containing this recommendation. He argued that if private insurance companies could profitably insure the properties of the Corporation, the Corporation could profitably insure for itself.

Mr. Bruce Murray moved that the portion to be insured with the Corporation department be 10 per cent. of the property, viz., £17,000. He understood that the sum to be saved by insuring the whole of the risk was from £200 to £300 a year. Any business man must admit that this was an enormous risk for a very inadequate gain.

Mr. Webster said he had a list of six risks of Corporation property the insurance of which it was proposed they should undertake themselves. The smallest was £7,500, and the largest £102,500. Assuming that the smallest property were destroyed, it would take 20 years to recoup themselves from the saving in premiums, while the largest would take almost a century. The risk they were asked to undertake was quite outside any possible benefit which they could derive.

Bailie Maclay moved that two-fifths of the risk should be undertaken. It should, he urged, be remembered that the new insurance department had no reserve fund.

Bailie Ferguson said the old system of insurance was most extravagant, and 40 per cent. could be saved by the Corporation undertaking their own insurance. The capital of the Corporation was unlimited, there was no danger of bankruptcy, and they could recoup any loss they might incur in 25 or 30 years.

Treasurer Murray said it was preposterous for the Electricity department to allow them to take a risk of £40,000, of which no insurance company would take £10,000. What was the Insurance committee going to do when the question arose of providing the guarantee fund which they were bound to provide in proportion to the amount of the risk they undertook? He moved that only one-third of the risk should be taken.

On a division the two-fifths proportion proposed by Bailie Maclay was carried by 26 votes to 24.

**Glasgow and West of Scotland Technical College.**—A powerful and representative committee was appointed (with the Lord Provost as convener) at a public meeting held last week for the purpose of considering the scheme proposed by the Governors of the Glasgow and West of Scotland Technical College for the provision of new buildings and to help the Governors in securing £150,000, the estimated cost of the buildings and their equipment. Already about £65,000 has been obtained.

**Greenock.**—Additional generating plant is to be put down at the electricity works to meet next winter's demand. The Burgh electrical engineer (Mr. W. M. Nelson), in a preliminary report, estimates the cost of a 300kw. steam dynamo at £3,300. The engineer was instructed to prepare a report for a special meeting at an early date.

**Growth of the Telephone Service.**—*The Times* states that the following table, showing the receipts of the Post Office from the

telephone service, has been compiled in response to an order of the House of Commons :—

| Year to March 31. | Royalties from licensed companies. | Revenue from local exchange business. | Revenue from trunk line business. | Total. |
|---|---|---|---|---|
| 1881 | £205 | — | | £205 |
| 1882 | 6.905 | £1,868 | £132 | 8,905 |
| 1883 | 11.301 | 9,321 | 174 | 20 796 |
| 1884 | 16,063 | 16,223 | 548 | 32,834 |
| 1885 | 18,813 | 21,694 | 908 | 41,415 |
| 1886 | 22,430 | 25,433 | 1,189 | 49,052 |
| 1887 | 26,170 | 22,786 | 1,312 | 50,268 |
| 1888 | 28,245 | 24,864 | 1,553 | 54,662 |
| 1889 | 34,099 | 25,628 | 1,914 | 61,641 |
| 1890 | 39,935 | 26,806 | 2,575 | 69,316 |
| 1891 | 43,495 | 27,697 | 3,283 | 74,475 |
| 1892 | 46,528 | 23,646 | 8,612 | 78,786 |
| 1893 | 56,501 | 23,826 | 10 139 | 90,465 |
| 1894 | 63,395 | 25,031 | 11,342 | 99,768 |
| 1895 | 70,990 | 21,609 | 14.575 | 107.174 |
| 1896 | 79,676 | 21,603 | 24.207 | 125,486 |
| 1897 | 85,289 | 21,034 | 113.294 | 219,617 |
| 1898 | 95 237 | 20,172 | 145.325 | 260,734 |
| 1899 | 110,195 | 21,644 | 182,525 | 314,364 |
| 1900 | 130,272 | 22,338 | 207,417 | 360,027 |

**Hebburn.**—The Council obtained a provisional order this year and also succeeded in getting their district excluded from the area of the County of Durham Electric Power Co.'s bill. The Electric Light committee have, however, now come to the conclusion that the township can be better served by private enterprise, and it has been resolved to approach various companies to ascertain the terms upon which they would be prepared to supply electric current to the district.

**Hornsey.**—The Council, on the advice of the Electricity committee, have declined the terms of the North Metropolitan Electric Power Distribution Co. for supplying electric current in the district.

**Hull.**—The Electric Light committee recommend the Corporation to increase the salary of the borough electrical engineer (Mr. A. S. Barnard) by £50 per annum.

**Islington (London).**—The Borough Council have decided to carry out the proposal of the late Vestry for providing additional water storage by the erection of a water tower and tanks, and of a switch gallery along the engine-house, and other works, at the Eden-grove electricity works at an estimated cost of £7,433.

**Kingston.**—The chairman of the Electric Lighting committee (Ald. Collings) asked permission at the Council meeting last week to bring forward a recommendation to apply for a further loan of £2,800 for an additional exciting dynamo and engine and an extra arc lighting dynamo and engine at the electricity works. He explained that it was proposed to extend arc lighting to the borough boundary in three directions, increasing the number of arcs from 36 to 72, and for this purpose an extra steam dynamo was required. It was further necessary, in order to bring the machinery for private lighting up to the proper standard, that they should have another exciting machine. The application, therefore, would be for a loan of £17,800, instead of £15,000. The proposal was agreed to.

**Light Railways.**—The East and West Yorkshire Union Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by January 12.

The Light Railway Commissioners have intimated to the Middlesex County Council that it would be better to grant an order for the construction of light electric railways to the Council alone instead of to the Council and to the North Metropolitan Company, the original applicants. The Council have acquiesced in this proposal. The projected lines include a connection with the present system from Finsbury Park to Ponders End, from Tottenham through Wood Green and Southgate to Friern Barnet, from Highgate Archway to Whetstone, and along the Edgware-road from Cricklewood to Edgware. The cost of construction, &c., is put at £347,420. The lines are to be leased to the North Metropolitan Tramway Co., who will provide the plant and work them upon a profit-sharing basis. The Parliamentary committee of the Middlesex Council have been authorised to oppose the Hendon and Finchley light railway scheme, and also the bill of the London United Tramways (Ltd.) for powers to make extensions of their system.

At the meeting of the Glamorgan County Council last week the chairman (Mr. J. Blandy Jenkins) moved the following resolution :—

That in the opinion of this Council it is desirable that tramways or light railways in the nature of tramways, upon the roads in the county shall be owned by the County Council or by District Councils, and that the Parliamentary committee be instructed to employ skilled advisers to prepare a scheme of the lines that may be advantageously promoted for consideration of Council.

Mr. Jenkins said the traffic of the country was undergoing a serious revolution in the nature of locomotion employed. Probably within the next 12 months they would have an enormous number of motor cars and a great many more locomotives running along the roads of the county. Whenever a light railway company was promoted they picked out the places which they thought would actually pay, and tried to get their bills through without making any provision for widening the roads to enable the work they had in hand to be done properly. In a recent Rhondda Bill for a light railway or tramway the promoters had put down £500 as sufficient for making the roads fit to carry the traffic. The Rhondda Council found the cost for making the necessary improvements would be no less than £14,000, and when the Light Railway Commissioners came to deal with this they directed that the promoters should spend at least £7,000. The resolution was adopted.

**Llandudno.**—Sanction to an additional loan of £1,045 for electric lighting extensions has been received.

**London Electric Omnibus Co. (Ltd.).**—The directors have issued a circular to the shareholders setting out certain proposals for placing the business on a sound financial basis. The directors express the view that electricity as applied to street traction (except tramways) has not been developed sufficiently to warrant their advising the shareholders to experiment further. There is ample scope for a business capable of meeting the requirements of the overloaded traffic in London, and the directors consider that a service of a least 300 street cars could be effectively utilised for the public service. They have reason to believe that a type of street car to carry 14 passengers can be procured which would, in the directors' opinion, be suitable for London street traffic, at an inclusive price of about £450. Twenty of these cars are considered a sufficient number with which to start business. The order for the cars would be conditional upon the makers' guarantee, and a satisfactory running test of one or two of the cars for at least 30 full working days consecutively. If shareholders in sufficient numbers assent within 10 days to the scheme set out by the directors it is proposed that the present company be wound up voluntarily, and a new company formed to acquire and work the undertaking.

**Manchester.**—An interesting discussion on the allocation of the profits of the gas department took place at the Corporation meeting last week. The chairman of the Gas committee (Ald. Gibson) moved that the present system of subsidising the rates out of the profits of the gas undertaking should be discontinued. He said that when, a few months ago, the Council took £40,000 out of the pockets of the gas consumers, openly and avowedly for the sole purpose of giving it to lessen the general rate, he felt a great injustice was being done and a blow being aimed at the prosperity of an undertaking in which he was deeply interested, and for the success of which he would, in the main, be held responsible. In 1890 a resolution was carried paying over to the city fund the net profits, if any, of the gas undertaking. The proviso "if any" clearly showed that at that time the Council never anticipated, even if there had not been any profit made at all, that the price of gas should be raised for the sole purpose of making one. That they need not have raised the price was shown by the fact that the committee offered £10,000 as the net profit, but the Council refused to accept it, and put 3d. on the price of gas in order to make £40,000 more profit to pay over to the rates. He argued that the system now in vogue was unjust in practice. There were upwards of 3,000 ratepayers who had given up using gas and were using electricity for lighting, besides which there were 500 motors in use worked by electricity. He held that they had no right to penalise or put an extra tax upon the gas consumer and offer a premium to the electric light consumer. The Corporation had had the gasworks under their entire control for 57 years; during that time they had made a gross profit of £5,345,194. After a lengthy debate an adjournment was agreed to.

**Medan (Sumatra).**—The Deli Spoorweg-Maatschappij, a Dutch company owning the telephone in this district, possess five exchanges with 213 subscribers, the tariff being 15f. per month for private service, from 20f. to 30f. per month for "estates" service, and the Government or public service is free.

**Moffat (N.B.).**—A preliminary report on electric lighting has been prepared by Mr. W. G. Forman, for the Police Commission. It is proposed to utilise the water power of the Birnock Burn, near the Moffat mineral well.

**Municipal Finance.**—Maidstone Corporation require tenders for a loan of £38,000 for electric lighting. Tenders to town clerk by Jan. 5.

**Ormesby.**—It was reported at a recent meeting of the Council that the Electric Lighting committee had endeavoured to obtain terms for the supply of electricity in bulk in the district, and for this purpose had approached the Middlesbrough Corporation and the Imperial Tramways Co. No reply had been received from Middlesbrough, but the Imperial Company stated they were prohibited under their act from furnishing current to local authorities or private individuals.

**Private Bill Legislation.**—In the bill deposited by the City and South London Railway Co. powers are sought to construct a subway from the already authorised Islington extension to the Agricultural Hall, to extend the time until August, 1902, for constructing the extension, and to create £400,000 additional capital, of which £100,000 may be raised by debentures.

Power is sought to construct a line from the Islington terminus of the City and South London Railway, and terminating under Drummond-street, St. Pancras. The capital is £420,000 in £10 shares, with power to sub-divide the shares into preferred and deferred half-shares. The borrowing powers are fixed at £140,000. The directors of the City and South London Company are the promoters.

Under the first bill of the Charing Cross, Euston and Hampstead Railway Co. power is sought to authorise working and other agreements with the Brompton and Piccadilly Circus and Central London Railway Companies, and to sanction an extension of the company's authorised line from Hampstead to near Golder's Green, and the construction of subways at Tottenham Court-road, New Oxford-street, and Charing Cross-road. The additional capital required is £1,800,000. By the second bill the company seek to extend their authorised railways in one direction to Highgate, and in another to Victoria, and to enter into agreements with the Midland, Central London, Baker-street and Waterloo, London, Brighton and South Coast, Victoria and Pimlico, and S.E. and C. Companies. The capital powers sought are £1,800,000.

The Central London Company wish to construct a loop line in Hammersmith, a loop line to join the existing railway under Old Broad-street, and terminating by a junction with the same railway under Threadneedle-street, &c. The new capital powers are not to exceed £600,000.

The Brompton and Piccadilly Circus Railway Co. seek authority to extend their authorised railway from Piccadilly to Hart-street, Bloomsbury-square, thence to High-street, Islington, near White Lion-street, and from a point on the authorised line under Fulham-road to near Stamford Bridge, with branches connecting the existing and authorised lines of the Metropolitan District Railway at points near Fulham-road, and a subway for foot passengers near Apsley House, Hyde Park Gate. The further capital powers asked for are £1,800,000.

Power is also sought to incorporate the Piccadilly and City Railway Co. to construct an underground railway from Piccadilly Circus to Queen Victoria-street, E.C., the proposed capital being £1,500,000.

Power is being sought to authorise an underground railway from Paddington to Kennington, the capital being £2,500,000.

A bill has been lodged for powers to construct an underground electric railway from New King's-road, at its junction with Wandsworth Bridge-road, to Buckingham Palace-road, near the entrance to Victoria-square. The capital in this case is £1,250,000, with borrowing powers.

Another bill seeks authority for a line from near Charing Cross to Park-lane, Kensington, and Hammersmith, the capital being £2,100,000.

It is proposed to construct an underground line from Victoria to the City, and from thence to Peckham, the proposed capital being £3,300,000.

Another bill is promoted to construct an underground electric line from the City to Tottenham, Walthamstow, and Leyton, the capital being £4,500,000; and from the City to Walthamstow, Epping Forest, and Waltham Abbey, at a capital cost of £2,400,000.

A bill has been deposited to incorporate a company to be known as the Derbyshire and Nottinghamshire Electric Power Co., to establish works for producing and supplying electric energy within the counties of Nottingham and Derby (except that part of Derbyshire to the south of the Trent and to the north-west of the boundary between the Unions of Bakewell and Chapel-en-le-Frith). The share and loan capital of the proposed company is fixed at £2,400,000, of which £600,000 may be raised by debentures and £1,800,000 by the issue of £1 shares, but with the right to divide the shares into preferred and deferred half-shares. Power is also sought to proceed to acquire the land necessary for their purposes as soon as £100,000 of the capital has been subscribed. The promoters are Sir E. H. Carbutt, Bart., Mr. F. Faithfull Begg, Mr. F. Carver, Mr. F. Clench, Mr. Duke Fox, Mr. A. Grove, Mr. M. H. Mills, Mr. W. O. Plowright and Mr. J. W. Thunkerey.

The Caledonian Electric Power Co.'s bill seeks power to incorporate a company for the supply of electric energy for all purposes over an area in the west of Scotland. The promoters of the company are Messrs. J. C. Cunninghame, D. Murray, R. A. Murray, R. M. Paterson, A. R. C. Pitman, P. Rottenburg and G. S. Campbell Swinton. The area of supply includes the whole of the county of Renfrew (excepting any portion of Glasgow), the whole of the Lower and Middle Wards of Lanarkshire (excluding Avondale), and portions of the counties of Dumbarton, Stirling and Ayr. The capital of the company is £1,000,000 (of which £500,000 may be preference), in £10 shares, with power to borrow £333,000. The generating stations will be in Renfrew, Port Glasgow and Cardross (Dumbarton).

In the Tramways and Street Widenings Bill of the London County Council power is sought to authorise the Council to expend on new streets and street improvements £1,188,000, and on 28 miles of tramways and land for a electricity generating station, £957,000.

The Clyde Valley Electrical Power Co. seek power to erect electricity generating stations and to generate, distribute, and supply electric current for all purposes in the counties of Lanark and Renfrew. The capital of the company has been fixed at £900,000 in £10 shares, with borrowing powers up to £300,000.

The Metropolitan District Railway Co. seek power to provide for the conversion and adaptation of their railway for electric traction, and propose to create 4 per cent. debenture stock up to £500,000 as a first charge upon the undertaking, prior to existing and authorised debentures and debenture stock, but not to affect existing rights attached to certain specified rent charge and guaranteed stocks; to reduce and limit the dividend on their 5 per cent. preference stock to £3. 10s. per cent.

**Revised Electricity Supply Tariff for the City of London.**—The City of London Electric Lighting Co. give notice that from the date of the December meter readings the following revised rates will be charged for electric energy for lighting:—

For current consumed during the March and December quarters, up to and inclusive of the first six units per 8 c.p. lamp (or its equivalent), 8d. per unit. In excess of six units per 8 c.p. lamp, 2d. per unit.

For the June and September quarters, up to and inclusive of the first three units per 8 c.p lamp (or its equivalent), 8d. per unit. In excess of three units per 8 c.p. lamp, 2d. per unit.

**Romford.**—At the meeting of the Council, last week, the Parliamentary committee reported their consideration of a communication from Mr. A. P. Trotter stating that the application of Messrs. Ind, Coope & Co., the great Romford brewery firm, for exemption in respect of their electric lighting cable across South-street had been referred to him to inspect and report, and he suggested that the matter should be compromised. The committee, however, decided to uphold the Council's decision on the subject, and the Council now re affirmed its decision.

**St. Pancras (London).**—The Borough Council have authorised an expenditure of £29,390 for laying additional feeders to the King's Cross, Highgate-road, and Prince of Wales-road districts.

**Sleaford.**—The Council has received sanction to a loan of £7,000 for electric lighting.

**South Dublin.**—It is announced that Prof. Geo. Forbes has offered to prepare a report on electric lighting and refuse destruction at 50 guineas.

**Sunderland.**—The annual dinner of the staff of the electricity department was held on Thursday last, Mr. J. F. C. Snell, borough electrical and tramways engineer, presiding. In proposing the toast of the Mayor and Corporation, Mr. Snell said the electric lighting department of Sunderland was, for a town of its size, second to none in the kingdom. The chairman of the Electric Lighting committee (Ald. Bruce) said that had it not been for the rise in the price of coals they would have made £1,000 this year. They were preparing for the opening of the new station at Hylton-road, for which tenders would be in on the 28th inst., while the contracts for the plant had already been let.

**Sydney (N.S.W.).**—According to an *Express* correspondent a big scheme for supplying the whole of Sydney with electric current for lighting, power and traction is being worked out by the Public Works Department. The project provides for the utilisation of the water of the Blue Mountain rivers and the provision for water storage on a large scale. The total capital cost is put down at £1,500,000, the annual maintenance, &c., charges at £158,000, and the annual receipts at £639,000.

**Telegraphists' Strike in America.**—The strike of telegraphists on the Gulf of Colorado and Santa Fé division of the Atchison Railway has terminated, the leaders of the movement having decided that it would be useless to continue the struggle.

**Telephone Development in Germany.**—According to statistics recently published, at the close of the year 1899 there were 12,710 telephone offices in Germany, an increase of 1,214 over 1898. The number of subscribers was 159,561, against 141,724 in 1898, an increase of 12·6 per cent. 574,000,000 conversations took place over the lines in 1899, an increase of 51,000,000, or 9·8 per cent., over 1898. The service employed 6,724 persons, of whom 4,527 were females. The receipts from the telephone service in 1899 were 30,405,061m., against 25,970,999m. in 1898, an increase of 17·1 per cent.

**Telephone in Japan.**—At Tokyo the Imperial Government own 16 telephone exchanges which had in October last 15,305 subscribers. The highest subscription is 66 yen (£6. 10s.) per annum, the lowest 18 yen. There are in course of construction in the city seven new exchanges, which will increase the number of subscribers by more than 1,600.

**Telephone "Rights."**—At Richmond (Surrey) the local authorities are the superior landlords of some residential property, the tenant of which has recently agreed with the National Telephone Co. to allow a post with wires attached to be erected in the garden adjoining his residence. The tenant holds the dwelling-house under a form of lease which contains the common stipulation that no business whatever shall be carried on on the premises during the tenancy. It is urged by the local authority that the arrangement entered into with the Telephone Company transforms the dwelling-

house from private into "business" premises. The National Company, on the other hand, contend that no such interpretation can be placed upon the tenant's action, and that hundreds of agreements of a similar nature have been made between the company and householders and others in all parts of the country. The point raised by the Richmond authorities is the first of its kind. So far the National Company are not parties to the pending legal proceedings. The tenant receives payment for the permission granted, and notice has been served upon him for the forfeiture of his lease under the Conveyancing Act.

**Telephone Trunk Extension.**—The trunk telephone system has been extended to Horsham (Sussex).

**Upholland (Lancs.).**—A preliminary inquiry by the Lancashire Electric Power Co. as to the supply of electric current in the district has been favourably received by the District Council.

**Water Power Utilisation in Spain.**—Application has been made to the Spanish Government for a concession to utilise the water power of the river Galleyo at Javierrslater, Huesca, for the generation of electric energy.

**Yorkshire Electric Power Scheme.**—In a communication to the Bradford Chamber of Commerce, the consulting engineers (Messrs. Gibbings and Baker) to the promoters, the Yorkshire Electric Power Syndicate (Ltd.), give some particulars of this scheme:—

The syndicate proposes to supply electricity in bulk to local authorities throughout the southern or manufacturing area of the West Riding of Yorkshire. The portion of the West Riding included in the scheme is that lying south of the river Wharfe and the turnpike road from Bolton Bridge, through Elslack and Skipton, to Foulridge, on the Lancashire boundary. It includes Leeds, Bradford, Keighley, Halifax, Todmorden, Brighouse, Huddersfield, Dewsbury, Batley, Morley, Pudsey, Wakefield, Ossett, Barnsley, Sheffield, Rotherham, Doncaster, Goole, &c. The area is about 1,800 square miles, with a population of about 2½ millions. It contains 17 boroughs and county boroughs, 119 urban districts, and 22 rural districts; in all 158 local authorities. The syndicate do not propose (says the communication) to encroach upon the power of the local authorities to deal with the distribution of electric energy within their respective areas, and it is desirable to express definitely that no monopoly is asked for in the bill, but to supply electricity in bulk to any of the authorities who may apply for it, or manufacturers requiring it for power purposes, with the consent of the local authority, at a cheap rate. Electricity will be generated and transmitted on a large scale from four generating stations located on colliery sites (or with easy access thereto) each of about 20,000 H.P., supplying an area of 16 miles radius. The sites proposed for the stations are in the neighbourhoods of Bingley, Mirfield, Wath-upon-Dearne and Methley.

This communication has been referred to the Finance committee for consideration and report.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers' or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"BIBLIOGRAPHY OF X-RAY LITERATURE AND RESEARCH."—A valuable compilation. Being an attempt to classify the data relating to X-Ray work. This work contains a quantity of general as well as special information bearing upon the whole subject of electrical discharge research. Edited by C. E. S. Phillips. Price 5s., post free.

"THE MANUFACTURE OF ELECTRIC LIGHT CARBONS."—A Practical Guide to the establishment of a Carbon Manufactory. Fully illustrated, price 1s 6d.; post free, 1s. 9d. In this work the author gives useful hints as to the manufacture of electric light carbons, including the preparation of material, firing, saturating, and coring, together with a description and estimate of cost of the plant required.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"THE CENTENARY OF THE ELECTRIC CURRENT, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d.; strong cloth, 2s. 6d., post free.

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

## TENDERS INVITED

*Southampton* Corporation require tenders for overhead electrical equipment of about 1¾ miles of tramway route. Specifications may be obtained at the borough engineer's office, or can be inspected (but not obtained) at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster. An advertisement contains further particulars, and tenders must be forwarded to the town clerk (Mr. R. R. Linthorne), by noon of Jan. 7.

*Sunderland* Corporation invite tenders for the supply of (*a*) condensing plant and cooling tower, (*b*) secondary battery, (*c*) main switchboard, (*d*) travelling crane. Specification obtained from the borough electrical engineer (Mr. J. F. C. Snell), and tenders (addressed Chairman of Lighting committee) must be delivered to the town clerk (Mr. Fras. M. Bowey), by noon Feb. 1. An advertisement contains additional particulars.

The Council of the Metropolitan Borough of *Poplar* requires tenders for an electric crane for a maximum load of 5 tons. Further particulars are given in an advertisement, and forms of tender can be obtained from the Borough electrical engineer, Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders to the acting town clerk (Mr. Leonard Potts), Council Offices, 117, High-street, Poplar, E., not later than January 16.

*Glasgow* Corporation are open to receive tenders for the supply of telephone apparatus in connection with the Glasgow Corporation tramways. Specifications, &c., can be obtained from Mr. John Young, general manager, 83, Renfield-street, Glasgow, and tenders must be sent in to the town clerk, Sir J. D. Marwick, by 9 a.m. on January 18. An advertisement gives further particulars.

*Sheffield* Tramways committee invite tenders for a slow-speed vertical engine for driving a 1,000kw. tramway generator. Specification, &c., may be obtained from the general manager of the tramway department (Mr. A. L. C. Fell), Town Hall, Sheffield, to whom tenders must be sent by Jan. 21. An advertisement contains further particulars.

*Partick* Burgh Commissioners require tenders for steam dynamos, battery-charging motor, booster and balancer. Tenders to town clerk (Mr. Jas. Donaldson), 97, West Regent-street, Glasgow, by noon of Jan. 7.

*Dublin United Tramways Co.* require tenders for general stores, including car fittings, castings, electrical supplies, &c., for year ending Dec. 31, 1901. Tenders to Chairman, 9, Upper Sackville-street, Dublin, by 31st inst.

Tenders are invited for various stores and electrical apparatus for the district asylum, *Mullingar* (Ireland). Forms of tender from resident medical superintendent, and enders (addressed to Committee, District Asylum, Mullingar), by Jan. 3.

*Rathmines* District Council require tenders for boiler-house and engine-house plant, condensing apparatus and pipework, switchboard extension, mains, and public incandescent lighting. Tenders to clerk (Mr. F. P. Fawcett), Town Hall, Rathmines, Dublin, by 4 p.m., Jan. 10.

*Rotherham* Corporation invite tenders for the supply of electricity meters. Further particulars are given in an advertisement, and tenders must be sent to the town clerk (Mr. H. Hampton Copnall), Council Hall, Rotherham, by Jan. 19.

*Leeds* Lighting committee require tenders for two 2,000 B.H.P. engines, two two-phase 1,400kw. alternators and exciters, and two sets of surface condensing plant. Tenders to town clerk by Dec. 31.

*Farnworth* District Council invite tenders for eight 66-passenger tramcar bodies, motors, undertrucks, controllers, &c. Tenders to clerk by Jan. 10.

*Edinburgh* Corporation invite tenders for an extension (about 100 lamps) of the electric lighting installation at the City Chambers. Tenders to town clerk by 31st inst.

*Middleton* Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves and accessories. Tenders to Town Clerk by Jan. 2.

Visitors' committee for County Asylum, *Winwick*, near Warrington, require tenders for wiring, &c. Tenders to Clerk, County Offices, Preston, by Dec. 29.

*Hendon* District Council invite tenders for electricity generating plant and apparatus. Tenders to Clerk, Public Offices, The Burroughs, Hendon, by 4 p.m. Dec. 31.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal-buildings, Lavender-hill, S.W., before noon Feb. 1 next.

*Thetford* Town Council require tenders for wiring the new Town Hall. Tenders by Jan. 1.

The *Metropolitan Asylums Board* require tenders for wiring the new asylum at Tooting Bec. Tenders by Jan. 2.

*Manchester Ship Canal Warehousing Co.* require 22 electric jib cranes. Tenders by Jan. 4.

*Greenock* Council invite offers for a 300kw. steam dynamo. Tenders by 30th inst.

*Worthing* Corporation require tenders for a main switchboard Tenders by noon Dec. 31.

*Worthing* Corporation Electric Lighting committee invite offers for constructing and maintaining electric tramways. Tenders by 31st inst.

*Wolverhampton* Corporation require tenders for materials and labour for constructing tramway track, &c. Tenders by Jan. 15.

### TENDERS RECEIVED AND ACCEPTED.

St. Pancras (London) Borough Council have received the following tenders for the supply of cables for extensions :—

| | | | |
|---|---|---|---|
| Callender's Co. (*accepted*) ... | £2,597* | Western Electric Co. ......... | £2,820 |
| British Insulated Wire Co... | 2,868 | Siemens Bros. & Co. ......... | 2,789 |

* Less 2½ per cent.

Fulham (London) Guardians have accepted the tender of Messrs. C. Cooper & Co. for wiring the receiving school, Parson's Green, at £185. 7s. 6d.

Aldershot District Council have accepted the tender of Messrs. Thomas Parker (Ltd.) for the erection and equipment of electricity works at £14,466, subject to consent being received for the necessary loan.

Hampstead Borough Council have accepted the tender of Messrs. Neil & Co. for a boiler, foundation, &c., for the electricity works at £3,094. 4s. 6d.

The Guardians of Greenwich Union have received 15 tenders for the electric lighting of the Grove Park Workhouse ranging from £7,550 (Messrs. Pearson & Co., London, S.E.) to £4,340 (Messrs. G. F. Cook & Co., Lightcliffe, Halifax).

### BUSINESS NOTICES.

We are informed that the combined businesses of Laing, Wharton & Down (Ltd.) (acquired from the receiver), and J. S. Cunnington & Co. will in future be carried on by Messrs. J. S. Cunnington and H. King Smith, at 93, St. Martin's-lane, London, W.C., under the style of Laing, Wharton & Cunnington.

The Pioneer Electric Light and Power Co. of China (Ltd.), the British Pioneer Electric Light and Power Co. of India (Ltd.), the Pioneer Electric Light and P[illegible] of Japan (Ltd.), the Adelaide Electric Tramways Co. (Lt[illegible] New Zealand Electric Light and Traction Co. (Ltd.) have [illegible] 27 and 28, Broad-street-avenue, London, E.C.

The New Zealand Electrical Syndicate has removed to New Broad-street House, New Broad-street, E.C.

Messrs. Doherty & Donat have removed from South King-street to 82 and 83, Deansgate-arcade, Deansgate, Manchester.

### BANKRUPTCIES, LIQUIDATIONS, &c.

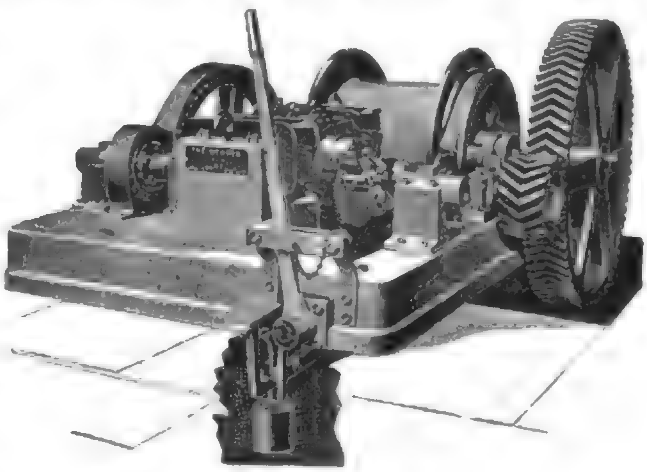
The West Kent Electricity Supply Co. (Ltd.) is to be wound up voluntarily, and Mr. A. E. Jones, 3, Lothbury, London, E.C., has been appointed liquidator.

A first and final dividend of 1s. 7½d. will be payable on 27th inst. at the O.R.'s, Exchange-street, Bolton, in the bankruptcy of W. Haines, electrician, &c., Bury New-road, Whitefield, Lancs.

**Plant for Sale.**—Messrs. A. Verey & Co., Dover, advertise in another column some direct-current electric motors for sale.

**B.T.H. Plant.**—In pamphlet No. 81 the British Thomson-Houston Co. illustrate a variety of incandescent lamp ornaments and fittings, and several types of incandescent lamps for various purposes are described.

**"Taunton" Plant.**—A well-arranged and very fully illustrated list of "Taunton" dynamos and motors, transformers, switchboards and switches is issued by the Newton Electrical Works. A variety



20 B.H.P. "Taunton" Electric Haulage Machine.

of heavy plant is described for traction, mining, winding and other work, and our illustration shows a 20 B.H.P. electric haulage machine

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 19 to Dec. 21, with the ports of destination :—

*Africa*—Alexandria, £64; Durban, £613; Port Elizabeth, £76. *Argentina*—Buenos Ayres, £189; Santa Cruz, £79. *Australasia*—Adelaide, £22; Sydney, £1,175; Wanganui, £30. *France*—Rouen, £35. *Gibraltar*, £19 (telegraph material). *Hong Kong*, £83 (telegraph cable). *India*—Calcutta, £514. *Japan*—Yokohama, £106. *Russia*—Reval, £151. *Siam*—Bangkok, £100. Total £3,256, against £8,767 in the corresponding three days last year (Dec. 20 to Dec. 22).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

October 22, 1900.

18,806. D. B. FOSTER, G. P. GIBSON and H. FOSTER. Leeds. Improvements in "trolleys" and junction "frogs" for use on electric railways and tramways.

18,813. B. HOPKINSON. London. Improvements in electric locomotives.

18,816. C. L. CLARKE. London. Improved electrical indicator for use with alternating-current apparatus.*

18,820. H. BREMER. Germany. Improvements in electric arc lamps.

18,834. N. VASILESCO-KARPEN. London. Improvements in voltmeters.

18,855. T. HUMPAGE and EPICYCLIC MANUFACTURING CO. (LTD.). London. Improvements in connection with electrically-driven machine tools or other mechanism.

18,865. J. A. FLEMING and MARCONI'S WIRELESS TELEGRAPH CO. (LTD.). London. Improvements in apparatus for the production of electrical oscillations.

October 23, 1900.

18,874. W. H. Dunn and E. Scott. Bradford. A revolving centre-piece of two storey electric cars.

18 880. J. F. McLaren. Glasgow. An electrical indicating or recording apparatus for restaurants or other places.

18,889. V. Hope. Manchester. A new or improved electrically operated billiard marker.

18,898. P. Singer. Paignton. Improvements in electric recording instruments for motor cars.

18,904. W. J. Crawford and T. B. Turley. London. Improvements in or relating to thermo-electric batteries.*

18,914. T. A. Edison. London. Electric meters.*

18,921. G. Benedicks. London. Improvements relating to electric furnaces.*

18,924. W. H. Chifferfield and E. S. Cook. London. Improvements in electric switches.

18,925. W. H. Chifferfield and E. S. Cook. London. Improvements in electric switches.

18,934. R. Trimmel. London. Improvements relating to electric incandescent lamps.

18,940. Evershed and Vignoles (Ltd.) and S. Evershed. London. Improved means for the electrical illumination of the dials of ships' telegraphs and for similar purposes.

18,967. R. B. Ransford. London. Improvements in electric incandescent lamps. (A. W. W. Miller, United States.)*

18,975. W. L. Wise. London. Thermo-electric generators. (M. J. Wightman, United States.)

October 24, 1900.

19,029. C. Schneider. London. Improved process for the electrolytic oxidation of solutions of chromium oxide salts.

19,040. E. R. Johnson. London. Improvements relating to hand driving gearing for use in connection with gramophones and the like.*

19,050. F. Cossor. London. An improved electric-circuit closing thermometer.

19,058. F. C. Newell. London. Improvements in electrical brakes for railway cars. (Date applied for under Patents, &c., Act, 1883, sec. 103, March 28, 1900, being date of application in United States.)

October 25, 1900.

19,071. F. T. Reid and W. Shepherd. Exeter. Improvements in and relating to a magneto-electric generator with governing arrangements for ignition purposes on motor cars, stationary gas and oil engines and other purposes.

19,072. G. J. Gibbs. York. Improvements in electric accumulators.

19,076. J. C. Best. Leeds. Improvements in or in connection with means for electrically lighting miners' safety and similar lamps.

19,095. C. W. Watling, Jun. Manchester. Improvements in or applicable to electric ceiling roses, electroliers, and the like.

19,099. J. Meerea. Holland. An improved electrode for accumulators of electricity.*

19,118. P. Stiens. London. Improvements in secondary electrical batteries or accumulators.

19,119. G. E. Vaughan. London. Improvements in or connected with the electro-deposition of metals or metallic alloys. (H. Koegel, Germany.)

October 26, 1900.

19,150. A. H. McNaught. Ayr. Improvement in electric light lampholders with shade carriers.

19,151. R. J. Urquhart and H. Goodwin. Liverpool. Improvements in trolley heads for overhead conductors of electric railways.

19,163. W. Thomson (Baron Kelvin of Largs). Glasgow. A frictionless balance for weighing gravitational electric or other forces.

19,167. J. T. Armstrong and E. A. Goddin. London. Improvements in and relating to electrical resistances variable by light and certain other rays or waves and in the manufacture of the same.

19,183. E. G. Harcourt. Birmingham. Improvements in and connected with electrical pushes and switches.

19,188. E. R. Johnson. London. Improvements relating to gramophones and other sound-recording and reproducing machines.*

19,208. P. la Cour. London. Improvements in the production of chlorine and pure solutions of alkaline hydrates by the electrolysis of dissolved alkaline chlorides.*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

13,692. Edison. Phonographic recorder.

14 212. Boult. (Union Carbide Co.) Electric furnaces.

14,275. Dymond. (Kopier Telegraph Gesellschaft mit beschrankter Haftung.) Electro-chemical or copying telegraphs.

14,281. Ferrie. Telegraphy by means of alternating currents and imperfect contacts. (Date applied for under International Convention, January 9, 1900.

14,288. Szczepanik and Kleinberg. Electromagnetic apparatus for jacquards.

14,289. Pearson. Electric switches.

14,367. De Kando. Collectors for use in overhead systems of electric traction and the like.

15,167. British Thomson-Houston Co. (Ltd.) (Davis). Systems of electrical distribution.

15,285. British Thomson-Houston Co. (Ltd.) (Lunt). Systems of electrical distribution.

15,313. Lombard-Gerin. Auto-motor trolleys for electric current.

15,381. British Thomson-Houston Co. (Ltd.) (Emmet.) Thermal electric cut outs.

15,717. Dion. Electric railways working on the closed-conduit system.

15,918. British Thomson-Houston Co. (Ltd.). (Lunt.) Electrical phase transformation.

15,919. British Thomson-Houston Co. (Ltd.). (Davis.) Electric rotary transforming apparatus.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**JOHNSTONE, BENJAMIN & CO (LTD.)**—Registered Dec. 17, with a capital of £15,000 in £1 shares, to acquire the business of electric wire and cable manufacturers and metal merchants, now carried on by Messrs. L. and E. E. Benjamin under the style of Johnstone, Benjamin & Co., and to carry on the business of electricians, electrical and mechanical and engineers, &c. The subscribers are L. A. Somers, R. Warner, E. E. L., and J. Benjamin, F. Elesborne, and M. Mendelssohn. Messrs. L. and E. E. Benjamin are permanent managing directors.

**OZONIC VENTILATING CO. (LTD.)**—Registered, with a capital of £3,000, in £1 shares, to carry on the business of ventilating, warming, cooling, humidifying and other apparatus manufacturers, electrical, ventilating, hydraulic and general engineers, motor manufacturers, &c.

**RICHARD JOHNSON & NEPHEW (LTD.)**—Registered Dec. 19, with a capital of £200,000 in £10 shares (10,000 preference), to acquire and carry on, at Bradford Iron Works, Manchester, and at Alderwasley, near Ambergate, Derbyshire, the business of wire drawers, galvanisers, electrical, hydraulic, chemical and gas engineers, electric cable manufacturers, &c. Messrs. H. A. and E. Johnson are permanent governing directors.

**TANGYE TOOL AND ELECTRIC CO. (LTD.)**—Registered Dec. 17, with a capital of £100 000 in £1 shares, to acquire Tangye's Machine Tool Co. (Ltd.), and carry on the business of machine and other tool makers, electrical and general engineers, electricians, motor car and cycle, telephone, bell, lamp and dynamo manufacturers, &c. The subscribers are H., C., W., and A. L. Tangye, G. H. Haswell, W. J. Parkins and W. R. Nicholl The first directors are Sir R. Tangye (chairman), G. Tangye (vice-chairman), G. H. Haswell, H. L. Tangye, and W. Tangye.

**TOMLINSON AND HAYWARD (LTD.)**—Registered Dec. 18, with a capital of £36,500, in £10 shares (500 preference), to carry on the business of chemical manufacturers, druggists, and makers of electrical and scientific apparatus and materials, &c.

**UNIVERSAL TELEPHONE AND ELECTRICAL CO. (LTD.)**—Registered Dec. 15, with a capital of £10,400 in 2,000 ordinary shares of £5 each and 400 founders' shares of £1 each, to carry on the business of a telephone, telegraph, and electric light, heat, and power supply company. The first subscribers (each with one share) are A. Dennis (merchant), T. A. Held (merchant), F. W. Dennis, H. L. Green, L. Held, W. Gosling, and H. Newington. The first directors are A. Dennis, R. Bumiller, and F. Held.

**WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)**—Registered Dec. 17, with a capital of £200,000, in £5 shares, to carry on the business of electrical engineers, electricians, engineers, railway, tramway, electrical, and other apparatus manufacturers, &c. The subscribers are J. Devonshire (electrical engineer), J. S. Raworth (civil engineer), C. H. Dade (secretary), G. J. Somerville (electrical engineer), W. L. Madgen (electrical engineer), C. S. Hilton, and J. A. Lycett (managing director).

**MONTE VIDEO TELEPHONE CO. (LTD.)**—According to the annual return to Nov. 14 the capital is £160,000, in 87 000 preference and 73,000 ordinary shares of £1 each, of which 85,492 preference and 72,680 ordinary have been taken up.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Dec. 22 | 607 | + 99 | 29 | 20,501 | + 3,042 |
| *Birmingham Tramways. | „ 22 | 4,592 | + 320 | 24 | 109,005 | + 4,144 |
| Blackpool Corporation... | „ 20 | 185 | + 70 | 33 | 27,929 | + 7,393 |
| Blackpool and Fleetwood | „ 22 | 164 | + 42. | 25 | 20,164 | + 81 |
| Bolton Corporation ...... | „ 23 | 1.237 | ... | 38 | 51,444 | ... |
| Bradford Corporation... | „ 23 | 852 | + 490. | 38 | 21,467 | + 6,569 |
| Brisbane Trams ......... | Nov. 7 | 1,907 | + 328 | 18 | 33,554 | + 6,348 |
| *Bristol Trams & Carriage | Dec. 21 | 3,802 | +1,038 | 25 | 83.708 | + 1,462 |
| *Buenos Ayres & Belgrano. | Nov. 25 | 2,810 | + 478 | 21 | 51,961 | + 4,856 |
| Central London Railway | Dec. 22 | 6,135 | ... | 21 | 111,668 | ... |
| City & South London Ry. | „ 23 | 1,320 | + 725 | 25 | 41,569 | +16,553 |
| Cork Elec. Trams ........ | „ 20 | 380 | + 48 | 51 | 20,748 | + 1,538 |
| Dover Corporation ...... | „ 22 | 183 | + 31 | 38 | 8,564 | + 523 |
| Dublin & Lucan Rly. | ... | ... | ... | ... | ... | ... |
| Dublin United ............ | „ 21 | 3,570 | + 341 | 25 | 101974 | +12,427 |
| Dublin Southern Dist.... | „ 21 | 763 | + 114 | 25 | 24,490 | |
| *Dundee Corporation | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation .. | „ [illegible] | 9,347 | + 742 | ... | ... | ... |
| Hull Corporation......... | „ [illegible] | 1,661 | + 951 | 25 | 34,927 | +18,670 |
| *Liverpool Corporation... | ... | ... | ... | ... | ... | ... |
| Liverpool Overhead Rly. | „ 23 | 1,516 | + 74 | 25 | 41,174 | + 824 |
| *Sheffield Tramways...... | „ 23 | 2,835 | + 978 | 51 | 117,789 | +40,946 |

* Partly electrical.

**NEW ST. HELENS AND DISTRICT TRAMWAYS CO. (LTD.)**—The annual return to Oct. 22 has been filed. The capital is £150,000 in £5 shares, 24,980 of which have been taken up. £4 has been called up on each share and £99,870 has been received. £510 has also been paid on 1,020 forfeited shares.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since July 19, 1900). Price of silver 29⅜d. per oz. (Dec. 27). Consols (2¾ per cent.) 97$\frac{1}{16}$—97$\frac{3}{16}$ for money, 97½—97⅝ for account; 2½ per cent. 97½—97¾ (Dec. 27). Stocks and Shares Continuation Days, Jan. 14 and 29; Ticket Days, Dec. 27 and Jan. 15; Pay Days, Dec. 28 and Jan. 16; Mining Share Carry-over Days, Jan. 11 and 28.

**BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)**—An interim dividend on the ordinary shares of 6 per cent. per annum (tax free) for the six months ended September 30 has been declared.

**CAPE ELECTRIC TRAMWAYS (LTD.)**—An interim dividend of 6 per cent., tax free, has been declared.

**PEARSON FIRE ALARM CO. (LTD.)**—A meeting of the shareholders of this company, owners of an electric fire alarm system, takes place this day (Friday). We have been unable to obtain a copy of the directors' report and accounts.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed Jan. 3 as a special settling day in 150,000 6 per cent. cumulative £1 (10s. paid) preference shares (Nos. 1 to 150,000), of the *Kalgoorlie Electric Power and Lighting Corporation (Ltd.)*, and 77,083 £1 fully-paid shares (Nos. 1 to 40,000 and 100,001 to 137,083) and 60,000 vendors' £1 fully-paid shares (Nos. 40,001 to 100,000) of *Marconi's Wireless Telegraph Co. (Ltd.)* Application has also been made to appoint a special settling day in 205,557 5 per cent. cumulative £1 fully-paid preference shares (Nos. 1 to 205,557) of the *British Motor Traction Co. (Ltd.)*, and to allow 24,000 5 per cent. cumulative £5 fully-paid preference shares of *Dick, Kerr & Co. (Ltd.)* to be quoted in the official list.

**UNION LIGHT AND POWER CO. (U.S.A.)**—The re-organisation committee of this company announce that on and after the 1st prox. the National Provincial Bank of England will pay to depositors of bonds under the scheme of re-organisation £6 in respect of each $1,000 first mortgage 5 per cent. gold bond deposited, and £2 in respect of each $1,000 consolidated mortgage bond deposited.

**WESTERN TELEGRAPH CO. (LTD.)**—Coupons on this company's second issue of 5 per cent. debentures, due 31st inst., will be paid at Parr's Bank Bartholomew-lane, London, E.C.

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 19 | | Price Monday, Dec. 24. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Five Days Ending Dec. 24. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd. | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13½ | 12¾ | 13¾ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 12/8 | Do. 4½ per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 6 6 | ... | ... | ... |
| 19,641 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | 1/8 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 60,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6⅞ | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 110 | 113 | 111 | 114 | 4 0 6 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,679 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 | 10 | 9 | 10 | 4 0 0 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 13½ | 13 | 14 | 4 5 9 | January and July | 13$\frac{7}{16}$ | 13½ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 125 | 130 | 125 | 130 | 3 17 10 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | 11$\frac{15}{16}$ | 12 |
| £200,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 108 | 111 | 108 | 111 | 4 1 10 | ... | ... | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | House Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ | 12½ | 11½ | 12½ | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures (red.) | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 55,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 4 7 | April and October | ... | ... |
| £230,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 112 | 115 | 112 | 115 | 3 14 7 | June and December | ... | ... |
| £450,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 98 | 101 | 98 | 101 | 3 10 3 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 12 15 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate E. Lt. & Traction, Ltd., 5%, 1st Mor. Deb. | 75 | 85 | 75 | 85 | 6 15 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 190 | 170 | 180 | 4 [illegible] 11 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 104 | 104 | 104 | 104 | 4 6 7 | " " | 104 | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | ... | Do. 3½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | ... | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 85 | 95 | 85 | 95 | 4 4 3 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 13 | 13 | 12¾ | 13¼ | 4 15 4 | March and September | 13 | ... |
| 29,014 | 5 | ... | Do. Do. | 11½ | 12½ | 12 | 13 | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brazilian Tramway 5 per Cent. Debentures | 101 | 106 | 101 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 2 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 10½ | 10½ | 10½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 15,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10 | ... |
| 6,000 | 10 | 6/0 | British Elec. Trac. Ord. | 13½ | 14½ | 13½ | 14½ | 5 17 3 | ... | 14¼ | 13½ |
| 6,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 13 | 13 | 12 | 13 | 4 [illegible] 9 | February and August | 12$\frac{7}{16}$ | ... |
| £30,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 123 | ... |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 16 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ | 4½ | 4½ | 4½ | ... | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5 per Cent. Debentures | 101 | 107 | 101 | 107 | 4 15 5 | ... | ... | ... |
| £100,000 | Stock | 12/0 | Do. 5½ 2nd Deb. Stk. Prov. Certs. (all p'd.) | 93 | 99 | 93 | 99 | 6 1 0 | ... | ... | ... |
| 260,297 | 10 | 3/0 | Central London Ordinary | 9½ | 9½ | 9½ | 9½ | 3 1 6 | June and December | 9⅝ | 9½ |
| £455,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 51 | 53 | 52 | 56 | 2 3 7 | February and August | ... | ... |
| 37,500 | 10 | 1/7½ | Do. Ordinary (Nos. 22,501 to 60,000) | 4½ | 5½ | 4½ | 5½ | 2 17 0 | " " | ... | ... |
| £120,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 141 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £244,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 115 | 120 | 115 | 120 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896), Ordinary | 17 | 18 | 17 | 18 | ... | ... | ... | ... |
| 51,452 | 10 | ... | Do. 6 per Cent. Preference | 15½ | 15½ | 15½ | 15½ | ... | ... | ... | ... |
| £200,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 23½ | 24½ | 23½ | 24½ | 3 13 [illegible] | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 14 5 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 113 | 115 | 113 | 115 | 3 17 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | 9½ | 10½ | ... | ... | 4 17 7 | May and November | ... | ... |
| 37,000 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8½ | 8½ | 8½ | 8½ | 4 [illegible] [illegible] | February and August | ... | ... |
| 30,000 | 10 | 5% | Do. 5 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 14 1 | " " | ... | ... |
| £20,000 | Stock | 4% | Do. 4 per Cent. Debentures | 105 | 108 | 105 | 108 | 3 17 0 | January and July | ... | ... |
| $[illegible] | $1,000 | ... | London United Tramways, 1st Mort. 5% Debs. | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| [illegible] | 100 | ... | Montreal Street Railway 4½% Mort. Debs. (1908) | 104 | 108 | 104 | 108 | 4 15 0 | ... | ... | ... |
| £[illegible] | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 0 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 6,000 | 5 | 5/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 1 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 13 | 7 | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 8/0 | Do. 5 per Cent. Preference | 10½ | 10½ | ... | ... | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 10½ | 11½ | 10½ | 11½ | ... | ... | ... | ... |
| 130,000 | 10 | 5/- | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £120,000 | Stock | 37/0 | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | ... | ... |
| 640,000 | Stock | 2% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 2 2 0 | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 19. | | Price Monday, Dec. 24. | | Rate per Cent. Yields. | Dividend Due. | Business Done During Five Days Ending Dec. 24. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | Highest | Lowest |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 105 | 99 | 103 | 3 17 8 | January and July | ... | ... |
| 36,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 88 | 90 | 88 | 90 | 5 11 1 | ... | ... | ... |
| £822,720 | Stock | 15/0 | Anglo-American | 52 | 55 | 52 | 55 | 5 11 10 | Feb., May, Aug., Nov. | 52 | ... |
| £3,038,640 | Stock | 30/0 | Do. Preferred | 97 | 99 | 97 | 99 | 6 2 5 | " " | 93½ | 97 |
| £3,038,640 | Stock | 37/0 | Do. Deferred | 10 | 10½ | 10 | 10½ | 12 17 2 | " " | 10½ | 10¼ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 170 | 180 | 171 | 180 | 4 3 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,361,975 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 17 4 | " " | 103½ | ... |
| 18,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ | 7½ | 6½ | 7½ | 7 6 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 | 16 | 15 | 16 | 6 5 0 | " " | ... | ... |
| 11,981 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 101% | 100% | 101% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 8/0 | Direct United States Cable | 10 | 10½ | 10 | 10½ | 6 13 4 | Jan., Apr., July, Oct. | ... | ... |
| £108,300 | 100 | 4½% | " W.Ind.C'ble4½%Rg.Db (with Nos. 1 to 1,203) red. | 93 | 103 | 93 | 103 | 4 13 0 | June and December | ... | ... |
| £6,000,000 | Stock | 25/0 | Eastern Ordinary | 138 | 140 | 138 | 141 | 4 19 3 | Jan., Apr., July, Oct. | 138 | 139½ |
| £1,939,480 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 93 | 93 | 93 | 3 11 1 | ... | ... | ... |
| £1,482,300 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 111 | 110 | 114 | 3 10 4 | May and November | 112½ | 111 |
| 250,000 | 10 | 2/6 | Eastern Extension | 13½ | 14½ | 13½ | 14½ | 4 19 3 | Jan., Apr., July, Oct. | 14½ | 13¾ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £8 pd, is'd at 63pm, all pd | 9½ | 9½ | 9½ | 9½ | ... | ... | 9½ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 | 118 | 118 | 119 | 3 8 7 | February and August | 118 | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | 102½ | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 101% | 99% | 101% | 3 15 5 | May and November | 101 | ... |
| 183,237 | 10 | 1/9 | Globe Telegraph and Trust | 10½ | 10¾ | 10½ | 10¾ | 4 17 9 | Jan., Apr., July, Oct. | 10⁹⁄₁₆ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 6 | " " | 12½ | ... |
| 180,000 | 10 | 5/0 | Great Northern of Copenhagen ... (1 to 1,200) (red. | 31 | 33 | 31 | 33 | 3 15 7 | January and July | ... | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb. (with Nos. | 99 | 101 | 99 | 102 | 4 10 0 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 48 | 52 | 48 | 52 | 4 16 2 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 101 | 104 | 101 | 104 | 3 16 3 | June and December | ... | ... |
| 11,830 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 2,301 | £100 Cert. | 6% | Submarine Cables Trust | 123 | 128 | 123 | 128 | 4 14 6 | " " | ... | ... |
| 15,000 | 10 | ... | West African Telegraph | 3½ | 3½ | 3½ | 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 102 | 99 | 102 | 4 19 8 | March and September | ... | ... |
| 30,000 | 3½ | ... | West Coast of America | | | | | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 100 | 103 | 101 | 103 | 3 14 4 | January and July | ... | ... |
| 80,211 | 10 | 6d. | West India and Panama | | | | | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £90,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 105 | 106 | 103 | 4 12 6 | January and July | ... | ... |
| 307,980 | 10 | 5/0 | Western Telegraph (late Br zil'n S'bm'rine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14½ | ... |
| £76,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 108 | 106 | 100 | 106 | 4 14 4 | June and December | ... | ... |
| £311,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 103 | 103 | 103 | 106 | 3 16 11 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 | 4/3 | 2/6 | 4/3 | ... | January and July | ... | ... |
| 72,880 | 1 | 3½% | Monte Video Telephone Ordinary | | | | | 5 0 0 | November | ... | ... |
| 96,492 | 1 | 1/0 | Do. 5 per Cent. Preference | | 1 | | 1 | 5 0 0 | " | ... | ... |
| 500,000 | 5 | 3/6 | National | 4½ | 4¾ | 4½ | 4¾ | 5 17 2 | February and August | 4⅝ | 4½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 14 | 13 | 14 | 4 5 9 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 12 | 14 | 11 | 13 | 4 13 4 | " " | ... | ... |
| 350,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 | 5½ | 5 | 5½ | 4 15 3 | " " | 5 | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 93 | 93 | 93 | 93 | 3 11 5 | June and December | 93½ | ... |
| £500,000 | Stock | ... | Do. 4 per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | ... | ... | ... | ... |
| 171,504 | 1 | 1/6 | Oriental | | 1½ | | 1½ | 5 3 9 | April and October | ... | ... |
| 34,000 | 5 | 4/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | ... |
| 16,589 | 5 | 2/6 | Do. 5% Cumulative Preference (fully paid) | 5 | 5½ | 5 | 5½ | 4 10 11 | June and December | ... | ... |
| 22,351 | 5 | ... | Do. do. (£3. 10s. paid) | 3½ | 3¾ | 3½ | 3¾ | ... | ... | ... | ... |
| £179,317 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 | 107 | 104 | 107 | 4 13 6 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 3d. | Alliance Electrical Co. 5% Cum. Pref. | | 1½ | | 1½ | 4 8 11 | ... | ... | ... |
| 124,030 | 1 | 7½d. | Aron Electricity Meter 6 per Cent. Cum. Pref. | | | | | 7 7 8 | March and September | ... | ... |
| 80,000 | 1 | ... | British Electric Works Co. Ordinary | | | ... | | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | | | ... | | ... | ... | ... | ... |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 97 | 99 | ... | | ... | ... | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 11 | 12 | 11 | 12 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 5/0 | Do. 6 per Cent. Preference | 6½ | 6½ | 6½ | 6½ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Brush Electrical Engineering | 1¾ | 1¾ | 1¾ | 1¾ | 6 8 4 | September | 1½ | ... |
| 16,721 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | " | 2½ | 2⅛ |
| 15,721 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 111 | 103 | 111 | 4 0 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 103 | 106 | 103 | 105 | 4 7 0 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 12½ | 13½ | 12½ | 13½ | 5 11 1 | " " | ... | ... |
| 40,000 | 5 | 5/0 | Do. 5 per Cent. Cumulative Preference | 5½ | 6½ | 5½ | 5½ | 4 6 11 | " " | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 111 | 115 | 111 | 115 | 3 19 8 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | | 1 | | 1 | 6 19 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | | 1½ | | 1½ | 6 6 8 | ... | ... | ... |
| 54,000 | 2 | 2/4½ | Crompton and Co. (Nos. 1 to 32,023) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 14 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | | 1½ | | 1½ | 5 6 8 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 90 | 92 | 90 | 92 | 4 7 5 | June and December | ... | ... |
| £100,000 | Stock | 2½ 4½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 93 | 100 | 93 | 101 | ... | ... | ... | ... |
| 38,500 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half-yearly | 4½ | 4½ |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 105 | 103 | 106 | 4 7 2 | ... | 103 | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 2 | 2½ | 2 | 2½ | 5 6 8 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3½ | 2½ | 3½ | 4 4 2 | July | ... | ... |
| £162,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 16 2 | January and July | ... | ... |
| 110,000 | 1 | ... | Gilfre Electro Chemical and Power Co. Ord. | | | | | ... | ... | ... | ... |
| 30,000 | 5 | 6/0 | Henley's Telegraph Works Ordinary | 13½ | 13½ | 13½ | 14½ | 5 11 1 | February and August | 13½ | 13½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5½ | 5½ | 5½ | 3 19 3 | " " | 5½ | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 | 112 | 109 | 114 | 4 0 4 | " " | 111½ | ... |
| 50,000 | 10 | 5/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 3 9 2 | " " | 21½ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 8 | March and September | 101½ | ... |
| 37,350 | 12 | 11/0 | Telegraph Construction and Maintenance | 39 | 42 | 39 | 41 | 4 5 9 | March and July | 40 | 39½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 15,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 5 19 2 | ... | ... | ... |
| 30,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5½ | 5½ | 5½ | 4 6 11 | ... | ... | ... |
| 80,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | 10½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | " " | 7 | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures rd. | 103 | 105 | 103 | 105 | 4 0 11 | May and November | 103½ | 103½ |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,181. [No. 11. Vol. XLVI.] FRIDAY, JANUARY 4, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 9d., or 18 cents, or 90c., or 75pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

On issuing this the first number of *The Electrician* in the twentieth century, the Editor and all connected with the production of the journal desire to express their wish that its readers may enjoy health, happiness, and prosperity in the new era upon which the world has now entered.

The list of New Year honours at the opening of the twentieth century is notable for two peculiarities—the absence of any new peerage and the paucity of the recognition of science. The former omission may, indeed, have been designed by Her Majesty in order that the first peerage honour of the twentieth century might be reserved for the elevation of Lord Roberts to an Earldom. The closest approach to electrical science in the honours list is represented by the knighthood of Hiram Maxim, whose labours and inventions in the early days of electric lighting some of our readers will remember; but it is evidently for his more close association with military engineering that he has received this distinction. If, however, as some believe, flying machines are to be greatly developed in the new century, there is a certain fitness in bestowing honour on an engineer who has laboured well and long in the design and construction of a machine of this description. Among other honours bestowed we may notice that Mr. John Aird, M.P., has been created a baronet, and Lieut.-Col. G. T. Plunkett, Director of the Secondary Branch of the Board of Education at Dublin, has been made a C.B.

One of the last of the Annual Reports from the Australian colonies previous to their being merged in the Federal Government has just reached us, and relates to the post and telegraph service in Queensland for the year 1899. It is chiefly interesting for its Appendix, which gives a full report of the agreement so far arrived at between the Imperial Government and the colonial representatives with regard to the Pacific cable scheme; also of the remonstrance addressed to the Home Government by the Eastern Extension Telegraph Co. with regard to that project, and the Government's reply thereto. Further, we have the proposals of the company set forth at length, embodying offers of reduced cable rates to the colonies—offers which were accepted by the colonies of South Australia, West Australia, and Tasmania, but rejected by the others. This important matter, as well as the general financial positions of the various colonial telegraph services, will, it is expected, be among the earliest down for consideration by the Federal Government. Already a draft bill is being prepared by the several State departments to secure uniformity in postal and telegraph affairs throughout the Confederation. In these circumstances it would be idle to comment upon the revenue account for the past year as shown in this report from Queensland, except to say, as regards the telegraph service of that colony, that although it has never been charged with interest on capital outlay, the expenditure is far in excess of receipts, and increases every year with the augmentation of business. Not unnaturally some hope is expressed that on their transference to the Federal State the whole of the telegraphs and telephone services will be placed on a more businesslike footing.

It is not good for us to know the financial results of the telephonic business undertaken by the Post Office, but a return just issued permits us to ascertain the revenue accruing to the department from this source. This revenue may be divided into three parts: The royalties paid by the National Telephone Co. (10 per cent. of the company's gross receipts), the small revenue from the Post Office local exchange business, and the revenue from the trunk lines. Of these three items the last is the greatest, amounting to £207,417 during the year ended March 31st last, but the royalty item (£180,272 during the same period) approaches closely to this, and must have a much more important effect on the general financial result, as it implies no corresponding expenditure. The revenue derived from the Post Office local exchange business

was £22,338 and has varied but slightly during the last fifteen years; in 1884-5 it was £21,691, in 1885-6 £25,488 (£3,000 greater than the present year) and in 1890-1 it reached a maximum of £27,697. The limited success which has attended these small exchanges is well known, so that it is reasonable to suppose that in the case of this item the expenditure is not likely to have fallen far short of the revenue, if indeed it has not far exceeded it. In view of these figures, it is interesting to estimate the financial value to the Government of the National Telephone Co.'s present telephone system, a system which the Goverment has refused to purchase on the ground that the price would be too high to pay for the increased public convenience. Capitalised on a 3 per cent. basis, £130,272 a year represents over £4,000,000. The total capital of the company is something over six millions; and, in order to lessen the value of this, the Government are competing with the company with the result that, if they are successful, they will lose a revenue equivalent to two-thirds of the last-mentioned figure. Add to this that at present the chief complaint against the company is the high price it is obliged to charge for its service,—a high price which is presumably necessary if it is to earn a dividend after paying off the Government royalty on its gross receipts,—and the absurdity of the present position is still more evident. Perhaps, after all, the Government may find it economical to avail itself of its option to purchase the company's undertaking in 1904, by which time possibly the Post Office will have almost completed its underground mains.

For several weeks past there has been a deadlock between the London United Tramways Co. and Kew Observatory, resulting in a postponement of the starting of the electric tramways in the west of London pending the dilatory decision of the Board of Trade as to how the differences are to be adjusted. Dr. R. T. Glazebrook, Director of the National Physical Laboratory, contributes a most timely letter to our columns this week, in which he discusses the alleged conduction of stray currents along the tramway track rails, and the influence of these currents upon the magnetic instruments at Kew. It has been asserted somewhat triumphantly by the tramway experts that they have actually discovered leaking along and from their track rails currents exceeding the limit which the Kew authorities desired to have imposed, and this notwithstanding that no current has been fed into their trolley wire. Such currents are believed to have strayed into the tramway rails from the leakage from the Central London Railway.

Dr. Glazebrook does not concern himself with the existence or otherwise of these vagrant currents; he admits that he has no material to criticise the experiments by which they are stated to have been determined. He is content to accept the possibility of their existence, and even that they are of considerable strength; and then, by a pretty piece of mathematical reasoning, he shows that even with strong currents of this nature the authorities at Kew need not be afraid of them. They are absolutely innocuous as regards magnetic records. Neither H nor V nor any other closely-watched quantity in terrestrial magnetism is appreciably altered by them at Kew Observatory. The reasoning is faultless, if Dr. Glazebrook can be sure of his premises; but a possible element of weakness in it is his assumption that by placing the rails in the ground, only currents that were already in the neighbourhood are transferred to the rails, whereas, in fact, the currents are actually brought by the rails into the neighbourhood from a remote distance. Has not Dr. Glazebrook assumed for the tram rails a more restricted area of influence than is actually the case? Our columns this week also contain reprints of a correspondence on this question which has appeared in *The Times* during the past few days.

**Crystal Palace Co.'s School of Practical Engineering.**—The Easter term will commence on Monday, January 7th.

**Institution of Electrical Engineers.**—A students' visit to the works of the India Rubber, Gutta Percha and Telegraph Works Co., Silvertown, has been arranged for Saturday the 26th inst. Those desirous of taking part in this are requested to inform the hon. sec. of the students' section before the 15th inst.

**Cable Interruptions.**

| | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiro | Nov. 26, 1900 |
| Pernambuco—Ceara | Nov. 29, 1900 |
| Bolama—Bissao | Dec. 23, 1900 |
| Falmouth—Bilbao | Dec. 28, 1900 |

**Breakdown on the Central London Railway.**—Traffic on the "Tube" was interrupted for about an hour on Friday morning last week, owing to a short circuit between the middle rail and the track rails. The short circuit was caused by defective brake gear on a train between Marble Arch and Notting Hill stations, portions of the gear coming into contact with the middle rail.

**Institution of Electrical Engineers (Birmingham Section).**—We are informed that the inaugural meeting of the Birmingham local section of the Institution will be held in the buildings of the Birmingham University at 8 p.m., on Wednesday, January 23rd. Dr. Oliver Lodge, the chairman of the section, will then deliver his address. The president and secretary of the Institution have accepted an invitation to be present.

**Municipal Regulation of Tramway Speeds.**—The City Council of Alexandria, Va., recently passed an ordinance restricting the speed of the electric cars to not more than 5 miles an hour. The *Street Railway Review* remarks that, as no minimum limit was fixed, the inter-urban line which passes through the town now moves its cars at a snail's pace while within the city limits. As might be expected, the citizens are up in arms against the Council, and are clamouring for a repeal of the ordinance.

**The Metric System in the United States.**—The Committee of the House of Representatives in charge of the bill to substitute in 1903 the metric system of weights and measures for the common system in use has reported the matter favourably. The *Electrical Review* of New York considers that the bill is almost certain to become law, and comments on the prospects appreciatively. Our contemporary proceeds, nevertheless, to enumerate the disadvantages of the metric system, and puts foremost among these the length and uncouthness of the names of the units; and, while admitting that, on the whole, the metric system is a good thing, thinks that the American public will not continue the use of such a word as centimetre, or any other four syllables long.

**The Spread of Knowledge.**—As an illustration of up-to-date newspaper science we quote the following from a West of England paper:—

The word electricity is formed from the Greek "electron," meaning "amber." The ancients knew that when amber was rubbed other things

stuck to it. That which caused the object to stick was and is electricity. Just what electricity is no man knows. Electricity is in everything. Rubbing is a way of bringing it to life. Rub a comb with a piece of silk and bits of paper will cling to the comb. You have brought electricity to life. Brushing the hair sometimes makes the head itch because electricity is produced by friction, and touches the nerves in the scalp. Cats rub their ears when it is likely to rain because the air is filled with more electricity than usual, and the electricity pierces the skin of the animal. Electricity at this time is also in the hair of the cat and makes her feel as though she were covered with cobwebs. Electricity may make light and heat; yet electricity itself no one can see. Electricity has a smell of its own. If you stand near a big motor you smell something called ozone—the same odour you will notice in the summer after a heavy shower.

High-Voltage Difficulties in Utah.—According to our contemporary, *Electricity* of New York, disturbances of a rather remarkable kind occur only too frequently on the high-voltage line running from Provost, Utah, to Tintic. During the salt storms which are not infrequent in that region, thick coverings of damp salt-dust are often deposited on the poles, and as a result, short-circuits are established. As a rule, the discharges are merely momentary; the lights dip, and sometimes the operation of the motors is interfered with. These discharges are usually of dazzling brilliancy and at times startling. The flames are said to reach a height of from 6ft. to 8ft., holding for a second or two, then breaking from one of the wires and dying away. It is only when the arc is continuous between the wires that there is any interruption of the service. One flash which blew out the station fuses and caused a shut down held its place between the wires for five or six seconds, but most of the flashes cease almost on the instant of completing connection.

Wireless Telegraphy.—The War Department of the United States Government maintains two stations for wireless telegraphy at San Francisco, one at Alcatraz Island, and the other at Fort Mason. Staffs 75ft. high have been erected at each station. It is stated by the *Western Electrician*, of Chicago, that the Marconi system is used. It is also stated that the Chilian Government has authorised Luis Zegers, representative of Marconi's Wireless Telegraph Co., to establish a service of telegraphic communication between Punta Arenas and Ancud, or Puerto Montt. The Government reserves the right to terminate Mr. Zegers' concession upon six months' notice.——The Russian Government is adopting wireless telegraphy for use in the navy. The Popoff system is used. All the lighthouses in the Black Sea are to be provided with the Popoff apparatus, and will be able to communicate with the coast and warships in the immediate vicinity. Two hundred complete pieces of apparatus were shipped recently from Vladivostok to Port Arthur, in order to fit out Russian warships in the Pacific, and also to connect the two towns by means of stations along the Corean coast.

Municipal Telegraphy at Tunbridge Wells.—The "inauguration" of the Tunbridge Wells municipal telephone system took place on Monday. The Tunbridge Wells Town Council appears to have been so anxious to be the first local authority to start a municipal telephone exchange that, although there are some 400 subscribers to be connected to the system, the present inauguration took place to celebrate the successful establishing of communication, through the municipal exchange, between the public offices and institutions. Notice has been given to determine the agreement with the National Telephone Co. for the renting of wires and instruments, and notice is also to be served upon the company to cancel all wayleaves for poles and wires on Corporation property. The Council has received a letter from the General Post Office with reference to the extra annual charge of 10s. per quarter-mile for telephone exchange circuits under the toll system referred to in our issue of December 14th, p. 292, and it is intended to apply for an amendment in clause 2 of the telephone licence, so as to provide for such extra charge being made to subscribers beyond 1 mile from the exchange. The Tonbridge District Council has agreed to its district being included in the telephone area of the Corporation.

Paris Exhibition Literature.—It appears that some difficulties have been experienced in getting together the necessary information for MM. Hospitalier and Montpellier's work, "L'Electricité à l'Exposition de 1900" (Vve. Ch. Dunod, Paris), and in consequence the numbers are not appearing in the order originally chosen. The publishers inform us that the difficulties have now been overcome, and the remaining numbers are to succeed one another rapidly. The fourth number, which has just reached us, forms the first part (Telephony) of Section 9 (Telephony and Telegraphy), and is written by M. L. Montillot. In literary style it is well in advance of the previous numbers, but too much space is devoted to descriptions of old and well-known types of instruments, while the actual novelties are not brought out with sufficient prominence from the mass of other matter. No description is given of the large-current microphones of which so much has been spoken recently without publication of the technical details of their construction; the Poulsen recording telephone is not mentioned; and the fine 14,000-subscriber Siemens and Halske flat board is passed by with a brief notice and without illustration. On the other hand the various permutations and combinations, devised by French manufacturers, of the essential parts of the d'Arsonval and Ader types of receiver are duly chronicled and profusely illustrated.

The National Physical Laboratory.—As already announced in our columns, it has been decided to establish this new institution at Bushey House, Bushey Park, Her Majesty the Queen having granted the use of the mansion and grounds to the Royal Society for this purpose. Bushey House contains some very spacious rooms, and with few alterations of a structural nature the building can be adapted to the special requirements of the physical laboratory. The engineering branch of the laboratory will be established in a new building which is to erected in the grounds, and in connection with it there will be an installation of electrical plant for lighting, power, and general experimental purposes. After a careful consideration of the requirements, the committee of the Royal Society have selected the compound condensing steam turbine with directly coupled dynamo manufactured by Messrs. Chas. Parsons & Co., Heaton Works, Newcastle-on-Tyne, as being the most suitable type of generating machinery. Steam will be supplied from a Lancashire boiler, and the circulating water for the surface condenser will be taken from a cooling pond. The whole of the buildings will be heated by low-pressure steam, upon the "Webster" system, by Messrs. Jas. Simpson & Co. The general scheme is being carried out by Her Majesty's Office of Works, and the electrical engineering details have been arranged by Mr. E. G. Rivers, A.M.I.C.E.

The Institution of Junior Engineers.—At a recent meeting of this society, a Paper on "The Metallurgy of Tin" was read by Mr. J. H. Davy James. In briefly reviewing the history of the subject, the author remarked that tin was one of the articles of commerce of the Phœnicians, who obtained it from Britain and from that part of the British Isles now known as Cornwall and Devon. Several charters were given to the Cornish mines, and in the reign of Edward I. the Stannary laws were instituted, some of which are even now in force. England enjoyed the monopoly of the tin trade up to the eighteenth century. In the early part of that century tin was discovered in Bohemia and in the island of Banca. Minerals of tin are fairly widely distributed over the earth's surface, being found in the Malay Peninsula, Australia, United States, Mexico, Chili and Brazil. Europe contains workings in Saxony, Austria, Gallicia, and at Vauby, in France. The chief mining district in England lies between Truro and Land's End in Cornwall, the most important mine being Dolcoath, which is now 600 fathoms deep, and employs 1,500 hands. The process of calcination eliminated arsenic and sulphur, the former condensing in flues which were cleaned out every three or four months, the white arsenic formed being saleable. Ores containing tungsten received special treatment, being roasted in a furnace with sulphate of soda, forming sodium tungstate, which was then dissolved in water, leaving tin as a residue. The Cornish method of assaying tin ores was then touched upon, and the various properties of the metal were dealt with, including tenacity, ductility, and conductivity, with reference to heat and electricity; its industrial applications were considered; the process of tin-plating was described and reference made to tests applied to tin plates to ascertain their quality.

The various alloys of tin and copper were fully dealt with—bronze, gun-metal, bell-metal, speculum metal, &c. Phosphor-bronze and its uses in engineering were entered into, and the Paper concluded with questions relating to the application of tin to the manufacture of fusible alloys. A discussion followed the reading of the Paper.

**The Behaviour of Electrolytic "Glow-Bodies."**—The last number of the *Zeitschrift für Elektrochemie* contains an interesting and useful article by Nernst and Wild on the behaviour of the electrolytic "glow-body" of the Nernst lamp—a name which the word-coining facilities of the German language renders possible. The samples tested consisted essentially of the oxides of zirconium, thorium, yttrium, and the rare earths related to them, and were in the form of thin straight rods, measuring $17 \times 0{\cdot}32$, $23 \times 0{\cdot}6$, $33 \times 1{\cdot}1$ and $30 \times 1{\cdot}87$mm. A flame was employed to render them conducting at starting, and the temperature necessary for this varied from 500°C. to 700°C., according to the composition of the rod. The specific (c. cm.) conductivity at different temperatures was as follows: At 600°C., $0{\cdot}03 \times 10^{-4}$; at 700°C., $0{\cdot}16 \times 10^{-4}$; at 800°C., $0{\cdot}64 \times 10^{-2}$; at 900°C., $1{\cdot}84 \times 10^{-2}$; at 1,000°C., $8{\cdot}6 \times 10^{-2}$; and at 1,100°C., $9{\cdot}9 \times 10^{-2}$ mhos. The following table gives the result of six experiments with these samples, the three figures in each case representing the observations at the beginning and end of the experiment and the mean values. The last test in the table was made with a rod supplied by the Allgemeine Elektricitäts Gesellschaft. In order to obtain mean spherical candle-powers, the candle-powers in the table must be multiplied by 0·78. The watts must be increased by 5 to 15 per cent. if it is desired to take account of the power lost in the series steadying resistance, which is indispensable in the actual lamp. For a mean efficiency of 1·35 watts per candle, or 1·73 per spherical candle-power, a life of 180 hours can be reckoned on for the thinnest rods, and for thick rods a life double as long.

| Life (hours). | Volts. | Amperes. | Candle Power. | Watts per candle. |
|---|---|---|---|---|
| 231 | 184—191 | 0·21—0·192 | 28·5—24·5 | 1·35—1·50 |
| | 186 | 0·206 | [illegible] | 1·37 |
| 308 | 181—201 | 0·22—0·19 | 30·5—27·0 | 1·30—1·42 |
| | 190 | 0·20 | 29·3 | 1·35 |
| 447 | 190—203 | 0·41 | 64—57·5 | 1·21—1·46 |
| | [illegible] | 0·41 | 58·7 | 1·37 |
| 249 | 183—205 | 0·41—0·40 | 67—70 | 1·12—1·17 |
| | [illegible] | 0·40 | 65 | 1·20 |
| 522 | 184—196 | 0·85—1·0 | 123—130 | 1·27—1·50 |
| | 189 | 0·96 | 129 | 1·41 |
| 334 | 180—192 | 0·38 | 57·7—58 | 1·19—1·26 |
| | 184 | 0·38 | 53·5 | 1·31 |

**Obituary.**—We regret to record the death, at Denver, Colorado, on December 14th, of Dr. Carl Hoepfner, of Frankfort-on-Main. He had only recently returned from Germany to America, in connection with the industrial exploitation of one of his numerous metallurgical processes, and he succumbed to a sharp attack of typhoid fever, but a short time after landing in the States. Dr. Hoepfner was only 44 years of age at the time of his death, yet he had already achieved considerable distinction as an electro-metallurgist, and several of the processes for the extraction of copper, nickel, and zinc from their ores, now in operation in various parts of Europe and America, are due to his pioneer work in this field of research. In the review of the year's progress in electro-chemistry and electro-metallurgy which we print upon another page of this issue, some details will be found of the processes associated with Dr. Hoepfner's name, and it will be recognised that industrial electro metallurgy has suffered a distinct loss by his death at such an early age. It may yet be too early to judge of the financial value of the numerous processes which Dr. Hoepfner worked out and brought to industrial trial; but whether these ultimately succeed or fail, there can be no two opinions concerning the loss to technical science which results from his early removal from the sphere of active life.——The death occurred on Sunday last of Mr. William Pole, F.R.S., Mus. Doc., at the age of 86. From 1844 to 1847 he was professor of engineering at Elphinstone College, Bombay. Between 1859 and 1867 he was professor of civil engineering at University College, London, and lecturer at the Royal Engineer establishment at Chatham. He was member or secretary of many Government commissions, notably on those concerned with armour, artillery, railway, gas and water, and the South Kensington Science Museum inquiries. He was also for 12 years consulting engineer to the Imperial railways of Japan, being decorated on his retirement with the Imperial Order of the Rising Sun. Dr. Pole was hon. secretary of the Institution of Civil Engineers from 1885 to 1896, and was a vice-president of the Royal Society in 1876 and 1889. His publications included a treatise on the steam engine, calculations on bridge construction, biographies of Sir W. Fairbairn and Sir W. Siemens, several works on music and whist, and a number of contributions to the *Quarterly Review*.

**The Midlands Electric Power Scheme.**—The Midland Electric Corporation for Power Distribution is gradually making headway with its large power distribution scheme. Provisional orders have been obtained for the following districts, covering an area of about 70 sq. miles: Wednesbury, Wednesfield, Bushbury, Willenhall, Darlaston, Coseley, Kingswinford, Quarry Bank, Upper Penn, Heath Town, Bilston, Sedgeley, Tipton, Brierly Hill and Rowley Regis. The company, acting on the advice of Messrs. Kincaid, Waller, and Manville, has decided on an extra high-pressure two-phase system, at a frequency of 50 ∽ per sec. Current will be supplied at 7,000 volts to transformers in sub-stations, where the pressure will be reduced to 2,700 volts, the further reduction to 200 volts taking place in street transformers. Consumers will be furnished with single-phase or two-phase current as required, and the price is to be 6d. for the first hour and 3d. after for lighting, and 3d. and ¾d. respectively for power. "Free" wiring will be adopted, and it is proposed to give the consumer the choice of two or three systems. Initially, 6,100kw. of generating plant will be put down. This will consist of five Ferranti flywheel alternators, two driven by ropes from Ferranti 1,500 I.H.P. engines running at 166 revs. per min., and the other three directly coupled to Yates and Thom 2,500 I.H.P. engines running at 95 revs. per min. Steam will be supplied by 16 water-tube boilers each with Babcock-Wilcox chain grates, 4,750 sq. ft. heating surface, and induced draught supplied by fans driven by two-phase motors. Surface condensers will be employed, using canal water for circulating. Town water from the waterworks company will be employed for make-up feed, the pumps being of the Weir direct-acting pattern. The feed water will pass through a 2,620-pipe Green economiser. A Hunt coal-handling plant is also being put down. An interesting feature is the mains, which include 82 miles of conductors on the trunk mains, 18½ miles of high-pressure feeders, and 12 miles of low-pressure feeders and distributors. The cables are made up of two cores, insulated and twisted together, and these are surrounded with a concentric outer. They are all of the B.I.W. lead-covered make, laid "solid." Transformers with an aggregate capacity of about 3,000kw. have already been ordered, in 30, 50, and 100kw. units. A tariff has been fixed for public lighting, for which a fair demand may be expected as the price of gas in the different districts varies from 2s. 4d. to 4s. 2d. A traction load is also to be provided for.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**WEDNESDAY, January 9th.**

INSTITUTION OF ELECTRICAL ENGINEERS. (GLASGOW SECTION).

*8 p.m.* Ordinary General Meeting at the Institution of Engineers and Shipbuilders in Scotland, Bath-street, Glasgow. Paper to be read: "The Utilisation of Water Power for Electrical Purposes," by R. F. Yorke.

**THURSDAY, January 10th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Paper to be read: "Capacity in Alternate Current Working," by W. M. Mordey, and, time permitting: "The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure," by J. B. C. Kershaw.

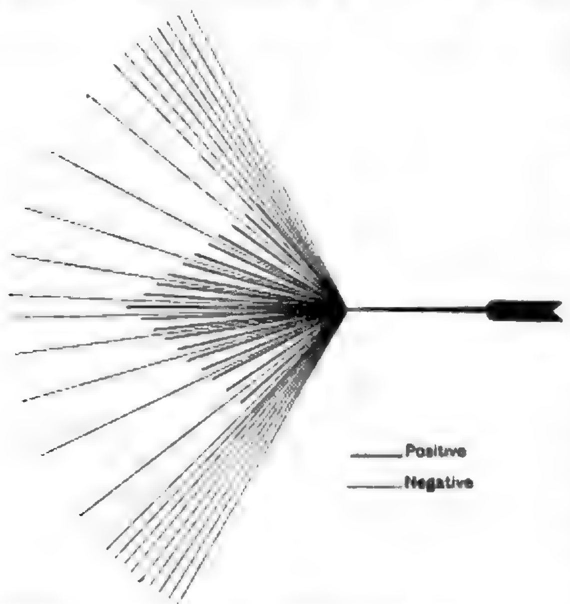
## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Electrolytic Effects of Secondary Currents.*—It is often assumed that the evolution of explosive gas at the submerged electrodes of the secondary circuit of an induction coil is due to the alternate formation of hydrogen and oxygen at both electrodes in accordance with the change in the direction of the induced current. But K. R. Johnson proves that while gas is evolved at both electrodes by the current induced at break, no gas is evolved by the current induced at make. He further found that the gas evolved at both electrodes is explosive, and that therefore both oxygen and hydrogen were evolved at both electrodes. The electrodes were of Wollaston pattern—platinum wires fused into thin glass tubes—and the electrolyte was either acidulated water or a solution of sugar and calcium nitrate. The experiment affords an elegant proof of the fact that the secondary current at break is alternating. The author also found an interesting analogy between the amount of gas evolved and the maximum spark-length in air. Both are inversely proportional to the square root of the capacity of the primary condenser, provided that capacity is considerably above the capacity required for suppressing the primary break-spark.

[K. R. JOHNSON, *Ann. Physik*, No. 12, 1900.]

*Point Discharge from a Tesla Pole.*—The discharge from a Tesla pole is known to charge an insulated metallic plate positively at a certain distance, and negatively at a greater distance. This is no doubt due to the greater speed and penetrative power of the negative ions.



E. Knoblauch has studied the distribution of the ions by means of perforated plates, and found that the positive charges are due to visible brush discharges. When these brush discharges are prevented from impinging upon the plate by cutting out a central portion, no positive charge is obtained. The distribution of the ions is shown in the diagram. The positive ions are strongest in the axial portion of the discharge.

[E. KNOBLAUCH, *Phys. Zeitschr.*, December 15, 1900.]

*Spectra of Radium and Polonium.*—By means of Runge's method of fusing the salt into a platinum coil and then using it as an anode for a spark-gap, G. Berndt has discovered no less than 15 lines of the polonium spectrum. This is all the more interesting as no measurements of the lines due to polonium had yet been made. The two strongest lines in the photographic spectrum have a wave length of 3,861·5 and 3,349·2 Angström units respectively, with a maximum error of 1·5 units. Active bismuth nitrate of intensity 300 was used for the measurements. For extending the known spectrum of radium, the author used active barium chloride and bromide. Salts of the intensity 240 only gave the radium line at 3,814·59. But a salt of activity 1,000, prepared in Paris, gave, in addition, the lines 4,682·346, 3,814·591, and a new line 2,708·6. Down to $\lambda = 2,100$, no further radium lines were found. The spark was in all cases furnished by two Leyden jars charged by a large induction coil, and the platinum coil was kept in a state of incandescence. Under these circumstances, the space between the electrodes was filled with the vapour of the salt, and the platinum and air lines were quite faint.

[G. BERNDT, *Phys. Zeitschr.*, December 22, 1900.]

*Electric Micrometer.*—A detailed account of P. E. Shaw's electric-contact micrometer gives particulars of the supports, covers, contacts, and circuits, the calibration of the instrument, and the measurements already carried out with it. The instrument is based upon the substitution of electric for mechanical contact, and is chiefly used for determinations of the vibration of telephone diaphragms. The telephone diaphragm under investigation bears a small plate of platinum, and above it and nearly in contact with it is mounted a spherometer leg of platinum beaded at its lower end. This leg is brought into contact with the platinum plate by means of a train of levers worked by a fine-pitched screw provided with a pulley, which is worked by hand through a belt-gear to avoid vibration. The multiplying ratio of the levers is such that readings can be taken to within a few $\mu\mu$, and the contact can still be heard in a telephone inserted in a circuit with the contact pieces and a small battery. In this way measurement can be made of the smallest audible impulsive sound given out by a telephone diaphragm. The industrial importance of this is obvious.

[P. E. SHAW, *Phil. Mag.*, December, 1900.]

*Dark Cathode Space.*—By means of Graham's barometer tube and exploring wires, C. A. Skinner has determined the potential gradient in Faraday's dark space. This dark space shows an abnormally low value of the potential gradient as compared with the luminous column. The results obtained by the author in his endeavour to clear up this anomaly are in many respects identical with those obtained by Stark, and attributed by the latter to "ionic shooting." With increasing current, the Faraday dark space increases in extent, driving the luminous column before it. This is accompanied by a decrease in the gradient throughout the dark space. For the same current the amount of dark space decreases with increasing gas pressure. When the gradient falls 25 per cent. below its constant value in the luminous column, the space becomes dark. If we suppose maximum ionisation in the luminous and minimum ionisation in the dark spaces, the velocity in the latter must be sufficient to compensate for the minimum ionisation there, so that the conductivity along the discharge may be greater in the dark spaces, as the gradient requires.

[C. A. SKINNER, *Phil. Mag.*, December, 1900.]

*Electro-capillary Theory.*—M. Gouy proposes a modification of the "double layer" based upon the following reasoning: At the maximum surface tension, the forces of "capillary affinity" bring about an accumulation of the anions at the surface of the electrolyte, and thus produce a negative layer. Since the field is zero in the interior of the electrolyte, an equal positive layer of cations is produced a little behind the anion layer, and thus the electrolyte has two layers very close to the surface. When the mercury layer is negative, the electric forces emanating from it tend to displace the anions, and thus to oppose the action of the capillary affinity. When the negative electrification is strong, the layer of anions is eliminated altogether, and only the two normal layers remain. Then we have the usual double layer, but otherwise there is a triple layer. Capillary affinity diminishes the maximum surface tension, and diminishes it all the more in proportion to the concentration and the "activity" of the anions.

[M. GOUY, *Comptes Rendus*, December 3, 1900.]

## ELECTRICITY SUPPLY WORKS COSTS IN 1898 AND 1899.

In the following tables and curves are given respectively, the actual and average figures of costs, &c., arrived at in our analyses of electricity supply works accounts for 1898 and 1899. Little is needed in introduction or explanation of the tables and figures. We have adhered to the course of keeping separate the results of the working of municipal undertakings and company-owned concerns in consequence of the essentially different forms adopted in the rendering of the official accounts as well as because in other respects the accounts as well as the methods of working are incomparable.

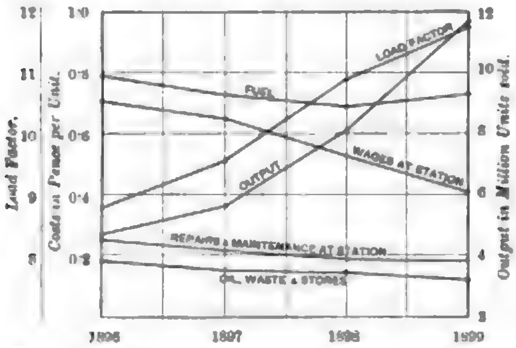


FIG. 1.—Municipal Undertakings. Average Costs for years 1896, 1897, 1898 and 1899.

In 1899 an important feature, from the point of view of central station supply, was the rising price of coal. Judging from the average fuel costs of undertakings whose accounts cover the year 1899 the average price can have been little, if any, higher than in 1898. If, however, the average fuel costs of those concerns the accounts of which cover a period of working three months later—as is the case with the majority of municipal stations—be studied, then there is evident the effect of the higher coal prices which ruled during 1900. A comparison of the fuel curves in Figs. 1 and 7 shows this effect clearly. In the case of the company undertakings it will be seen that the average fuel costs decidedly fell in 1899, having remained practically constant in 1897 and 1898. On the other hand, in the curves relating to municipal undertakings, the fuel value is seen to have diminished rapidly in 1897 and 1898, while for 1899 the average expenditure per unit in respect of fuel was exactly the same as in 1897, viz., 0·729d.

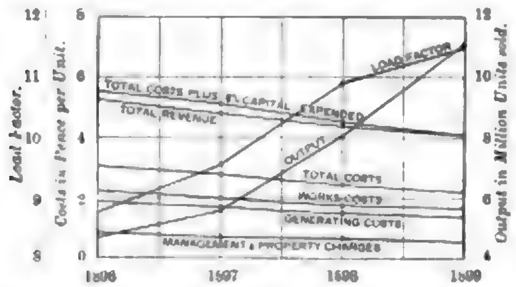


FIG. 2.—Municipal Undertakings. Average Costs for years 1896, 1897, 1898 and 1899.

It is necessary to draw attention to our use of the terms 1896, 1897, 1898 and 1899 indiscriminately, in referring both to the corresponding years ending December 31, and those ending three or more months later.

**Municipal Electric Supply Works.**—In Table I. are given the chief particulars and results of working during 1898 and 1899 of about 52 municipal stations. As in the past two years we have included a column giving the sum of the total costs per unit plus 6 per cent. of the mean capital expended —this latter quantity being intended as an estimate of the total capital charges on the revenue. The record values of the list, Table I., are picked out in heavy type.

In the matter of total costs it will be noticed that Bradford heads the list with 1·18d. per unit, this being a material improvement upon Nottingham's record in 1898. In works and generating costs Leeds takes priority with the figures 0·74d. and 0·68d. per unit respectively. These results, as we remarked in our comments on the Leeds accounts for 1899-1900, are excellent ones. The nearest figure of works costs to Leeds is that of Bradford, which held the lowest works costs in 1898. The Leeds costs are invested with particular merit

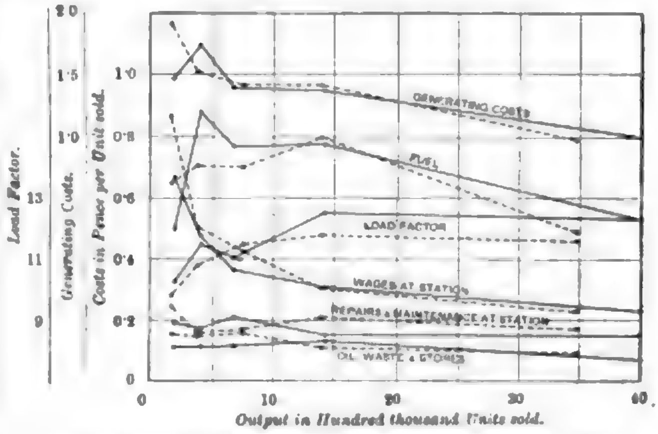


FIG. 3.—Municipal Undertakings. Curves relating Costs per Unit with Output.
Dotted lines 1898, full lines 1899.

in comparison with those of Bradford considering the respective characters of the loads at the two places.

In economy of fuel expenditure, Burton has robbed Stafford of the record. Unfortunately, both these places show abnormally high wages at the station. In the matter of oil, waste, water, and stores, Canterbury, with its modest output of 152,553 units sold, and in its first year of working, shows the lowest figure. Edinburgh again distinguishes itself with a remarkably low total revenue per unit, wages at the station,

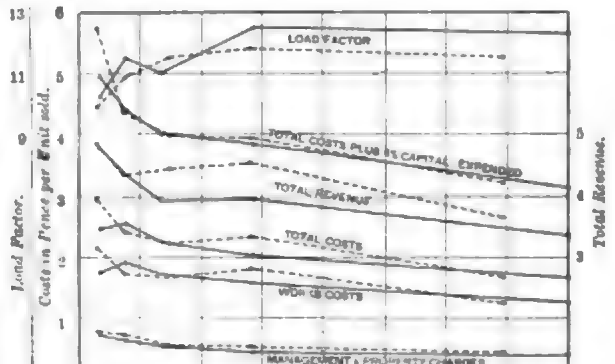


FIG. 4.—Municipal Undertakings. Curves relating Costs per Unit with Output.
Dotted lines 1898, full lines 1899.

and management and property charges. The honour of lowest repairs and maintenance costs at the station was lost by Newport and falls upon Halifax. Newport still, however, presents a very low figure for repairs, and this is the more creditable in view of the long record this place has held. The averages at the foot of the table show that all the items of cost have fallen except that of fuel, which has increased by 6·42 per cent, in spite of the fact that the 1899 average is in conjunction with a mean output 44·2 per cent. and with a load factor 5·5 per cent. above those respectively of 1898.

These averages are more interestingly rendered in Figs. 1 and 2. It is noteworthy how wages at the station have fallen

TABLE I.—*Electricity Works Costs for 1898 and 1899 of the Principal Municipal Electric Supply Undertakings of the United Kingdom.*

| Place. | Output in 1,000 units sold. | | Units sold per 8 c.p. lamp capacity. | | Load factor, units sold × 100 / max. dem. × 8760 | | Total Revenue per unit sold. | | Fuel costs per unit sold. | | Oil, waste, water and stores per unit sold. | | Wages at generating station per unit sold. | | Repairs and maintenance per unit sold. | | Generating costs per unit sold. | | Works costs per unit sold. | | Manag'm'nt and property charges per unit sold. | | Total costs per unit sold. | | Working profit % to mean capital expended. | | Ratio of total costs to revenue (per cent.). | | Total costs plus 6% of mean capital exp'nd'd per unit sold. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 | 1898 | 1899 |
| Aberdeen | 412 | 846 | 13·2 | 23·4 | 19·2 | 12·6 | 4·44 | 3·95 | 0·448 | 0·690 | 0·106 | 0·084 | 0·379 | 0·265 | 0·207 | 0·101 | 1·14 | 1·14 | 1·26 | 1·21 | 0·706 | 0·429 | 1·97 | 1·51 | 7·4 | 9·8 | 44 | 38 | 3·97 | 3·01 |
| Ayr | 297 | 426 | 15·3 | 21·8 | 16·1 | 19·0 | 3·15 | 2·93 | 0·684 | 0·727 | 0·048 | 0·035 | 0·580 | 0·359 | 0·125 | 0·124 | 1·44 | 1·25 | 1·65 | 1·47 | 0·468 | 0·465 | 2·11 | 1·94 | 3·2 | 3·9 | 67 | 66 | 4·05 | 3·47 |
| Bath | 357 | 388 | 11·4 | 12·4 | 12·4 | 11·6 | 4·78 | 4·51 | 1·418 | 1·052 | 0·291 | 0·342 | 0·454 | 0·483 | 0·185 | 0·218 | 2·39 | 2·11 | 2·76 | 2·29 | 1·026 | 0·880 | 3·79 | 3·17 | 3·5 | 3·8 | 79 | 70 | 5·49 | 5·30 |
| Bedford | 328 | 540 | 15·7 | 25·8 | 1·0 | 12·0 | 4·30 | 3·91 | 1·067 | 1·127 | 0·167 | 0·167 | 0·546 | 0·506 | 0·157 | 0·144 | 1·94 | 1·73 | 2·12 | 1·81 | 0·585 | 0·332 | 2·70 | 2·17 | 4·2 | 6·2 | 63 | 56 | 4·99 | 3·84 |
| Belfast | 357 | 622 | 12·7 | 9·6 | 5·7 | 7·4 | 5·54 | 4·51 | 1·066 | 0·677 | 0·143 | 0·095 | 0·662 | 0·438 | 0·144 | 0·136 | 2·01 | 1·35 | 2·18 | 1·52 | 0·740 | 0·698 | 2·92 | 2·22 | 5·2 | 5·1 | 53 | 49 | 5·91 | 4·94 |
| Blackpool | 870 | 1149 | 20·6 | 15·3 | 10·5 | 10·1 | 4·29 | 3·86 | 0·555 | 0·701 | 0·217 | 0·177 | 0·445 | 0·371 | 0·169 | 0·235 | 1·41 | 1·49 | 1·74 | 1·78 | 0·498 | 0·418 | 2·24 | 2·19 | 8·0 | 7·2 | 52 | 57 | 3·78 | 3·57 |
| Bolton | 417 | 825 | 13·3 | 8·8 | 9·9 | 9·9 | 4·57 | 3·52 | 0·483 | 0·785 | 0·201 | 0·116 | 0·626 | 0·401 | 0·068 | 0·109 | 1·38 | 1·41 | 1·42 | 1·41 | 0·537 | 0·388 | 1·95 | 1·80 | 7·3 | 6·4 | 43 | 51 | 4·10 | 3·41 |
| Bradford | 1419 | 2416 | 16·4 | 24·2 | 10·2 | 13·7 | 3·75 | 2·90 | 0·327 | 0·356 | 0·078 | 0·064 | 0·764 | 0·199 | 0·125 | 0·111 | 0·79 | 0·73 | 0·90 | 0·82 | 0·714 | 0·361 | 1·61 | 1·18 | 8·3 | 9·3 | 43 | 41 | 3·16 | 2·29 |
| Brighton | 2649 | 3207 | 26·5 | 24·4 | 15·4 | 16·6 | 3·43 | 3·06 | 0·644 | 0·623 | 0·036 | 0·091 | 0·310 | 0·334 | 0·158 | 0·244 | 1·20 | 1·29 | 1·32 | 1·44 | 0·357 | 0·360 | 1·68 | 1·80 | 8·6 | 6·3 | 49 | 59 | 2·90 | 2·99 |
| Bristol | 1363 | 1813 | 16·3 | 18·4 | 9·1 | 12·4 | 4·60 | 4·23 | 0·864 | 0·825 | 0·064 | 0·068 | 0·336 | 0·290 | 0·154 | 0·144 | 1·42 | 1·38 | 1·73 | 1·70 | 0·649 | 0·683 | 2·37 | 2·38 | 7·5 | 6·2 | 52 | 57 | 4·15 | 4·15 |
| Burnley | 272 | 346 | 28·6 | 12·1 | 10·8 | 10·2 | 4·05 | 4·09 | 0·301 | 0·354 | 0·114 | 0·101 | 0·405 | 0·375 | 0·054 | 0·162 | 0·87 | 1·39 | 1·01 | 1·43 | 0·733 | 0·648 | 1·74 | 2·07 | 7·5 | 6·4 | 43 | 51 | 3·58 | 3·98 |
| Burton | 108 | 154 | 14·4 | 9·5 | 11·4 | 8·9 | 5·74 | 5·81 | 0·406 | 0·246 | 0·166 | 0·115 | 2·038 | 1·570 | 0·264 | 0·112 | 2·88 | 2·04 | 3·09 | 2·17 | 0·608 | 0·476 | 3·70 | 2·64 | 3·0 | 5·6 | 64 | 46 | 7·86 | 6·02 |
| Bury | 116 | 213 | 12·2 | 12·3 | 9·2 | 12·4 | 4·52 | 4·10 | 0·466 | 0·550 | 0·081 | 0·082 | 0·479 | 0·381 | 0·085 | 0·069 | 1·11 | 1·08 | 1·17 | 1·18 | 1·126 | 0·682 | 2·30 | 1·86 | 3·7 | 5·4 | 51 | 46 | 5·94 | 4·35 |
| Canterbury | ... | 153 | ... | 32·5 | ... | 10·8 | ... | 4·99 | ... | 0·549 | ... | 0·027 | ... | 0·411 | ... | 0·058 | ... | 1·05 | ... | 1·22 | ... | 0·752 | ... | 1·98 | ... | 7·5 | ... | 40 | ... | 4·38 |
| Cardiff | 405 | 511 | 12·5 | 15·7 | 11·0 | 11·8 | 4·18 | 4·00 | 0·652 | 0·808 | 0·285 | 0·151 | 0·831 | 0·630 | 0·191 | 0·222 | 2·01 | 1·86 | 2·32 | 2·29 | 0·693 | 0·796 | 3·01 | 3·08 | 3·0 | 2·5 | 72 | 77 | 5·38 | 5·29 |
| Chester | 474 | 618 | 25·5 | 27·5 | 15·4 | 13·3 | 3·86 | 3·49 | 0·302 | 0·445 | 0·083 | 0·119 | 0·310 | 0·307 | 0·158 | 0·194 | 0·86 | 1·07 | 1·02 | 1·33 | 0·507 | 0·444 | 1·52 | 1·78 | 8·9 | 8·2 | 40 | 48 | 3·09 | 3·19 |
| Croydon | 452 | 781 | 16·2 | 18·4 | 10·9 | 12·5 | 4·99 | 4·12 | 0·915 | 0·967 | 0·090 | 0·099 | 0·289 | 0·204 | 0·052 | 0·105 | 1·35 | 1·38 | 1·54 | 1·59 | 0·616 | 0·485 | 2·15 | 2·07 | 8·1 | 6·5 | 43 | 50 | 4·25 | 3·97 |
| Dewsbury | 161 | 200 | 18·4 | 16·4 | 9·7 | 9·9 | 4·87 | 4·84 | 0·632 | 0·594 | 0·237 | 0·193 | 0·626 | 0·496 | 0·598 | 0·246 | 1·99 | 1·53 | 2·14 | 1·64 | 1·232 | 1·107 | 3·37 | 2·75 | 3·9 | 5·8 | 69 | 57 | 5·69 | 4·90 |
| Dundee | 452 | 618 | 24·2 | 28·6 | 8·3 | 9·5 | 3·86 | 3·51 | 0·564 | 0·521 | 0·116 | 0·116 | 0·288 | 0·252 | 0·226 | 0·324 | 1·19 | 1·21 | 1·31 | 1·82 | 0·717 | 0·634 | 2·02 | 2·46 | 8·1 | 5·7 | 52 | 70 | 3·38 | 3·58 |
| Edinburgh | 4175 | 5552 | 28·4 | 21·8 | 16·3 | 13·8 | 2·77 | 2·75 | 0·424 | 0·522 | 0·050 | 0·048 | 0·146 | 0·156 | 0·116 | 0·114 | 0·73 | 0·84 | 1·09 | 1·11 | 0·316 | 0·300 | 1·41 | 1·41 | 6·9 | 6·3 | 51 | 51 | 2·59 | 2·70 |
| Glasgow | 2824 | 4251 | 42·0 | 21·3 | 5·3 | 6·3 | 3·76 | 3·37 | 0·544 | 0·734 | 0·060 | 0·061 | 0·288 | 0·274 | 0·226 | 0·117 | 1·12 | 1·19 | 1·45 | 1·53 | 0·587 | 0·444 | 2·04 | 1·98 | 7·6 | 4·8 | 54 | 59 | 3·38 | 3·74 |
| Halifax | 629 | 1371 | 14·4 | 35·1 | 18·8 | 16·9 | 3·42 | 2·81 | 0·553 | 0·536 | 0·194 | 0·103 | 0·345 | 0·197 | 0·077 | 0·052 | 1·17 | 0·89 | 1·21 | 0·90 | 0·445 | 0·333 | 1·65 | 1·24 | 7·1 | 11·0 | 48 | 44 | 3·14 | 2·28 |
| Hammersmith | 518 | 891 | 23·7 | 22·0 | 11·8 | 14·5 | 4·28 | 3·68 | 1·024 | 0·787 | 0·200 | 0·128 | 0·445 | 0·298 | 0·064 | 0·190 | 1·63 | 1·40 | 1·97 | 1·63 | 0·574 | 0·460 | 2·54 | 2·09 | 6·7 | 6·7 | 60 | 57 | 4·10 | 3·52 |
| Hampstead | 1002 | 1418 | 23·9 | 22·1 | 12·5 | 13·5 | 5·69 | 5·17 | 1·228 | 1·244 | 0·137 | 0·145 | 0·314 | 0·321 | 0·346 | 0·115 | 2·03 | 1·83 | 2·13 | 2·00 | 0·442 | 0·424 | 2·58 | 2·43 | 11·5 | 11·3 | 45 | 47 | 4·19 | 3·89 |
| Hanley | 474 | 538 | 23·7 | 14·0 | 11·8 | 11·2 | 3·90 | 3·93 | 0·707 | 1·134 | 0·168 | 0·205 | 0·393 | 0·435 | 0·404 | 0·592 | 1·67 | 1·37 | 2·08 | 2·86 | 0·598 | 0·551 | 2·68 | 3·41 | 4·3 | 1·8 | 69 | 87 | 4·39 | 5·13 |
| Harrogate | 201 | 365 | 23·4 | 20·3 | 11·6 | 12·0 | 5·56 | 4·29 | 1·224 | 0·820 | 0·189 | 0·156 | 0·820 | 0·415 | 0·334 | 0·236 | 2·57 | 1·68 | 2·69 | 1·86 | 0·645 | 0·378 | 3·34 | 2·26 | 5·7 | 6·9 | 60 | 53 | 5·71 | 4·02 |
| Hastings | ... | 404 | ... | 19·8 | ... | 12·8 | ... | 6·94 | ... | 1·578 | ... | 0·272 | ... | 0·583 | ... | 0·292 | ... | 2·72 | ... | 2·98 | ... | 0·967 | ... | 3·95 | ... | 6·4 | ... | 57 | ... | 6·76 |
| Huddersfield | 593 | 951 | 16·7 | 13·3 | 8·8 | 10·7 | 4·80 | 3·77 | 0·473 | 0·458 | 0·065 | 0·051 | 0·412 | 0·283 | 0·202 | 0·105 | 1·15 | 0·90 | 1·41 | 1·07 | 0·586 | 0·510 | 1·99 | 1·58 | 8·5 | 8·7 | 42 | 42 | 3·97 | 3·09 |
| Hull | 750 | 940 | 17·2 | 15·6 | 8·0 | 7·6 | 5·29 | 4·93 | 0·652 | 0·868 | 0·066 | 0·106 | 0·444 | 0·511 | 0·301 | 0·238 | 1·49 | 1·72 | 1·79 | 2·02 | 0·771 | 0·700 | 2·57 | 2·72 | 10·9 | 7·8 | 49 | 65 | 4·06 | 4·47 |
| Islington | 912 | 1346 | 19·4 | 28·7 | 13·0 | 14·2 | 5·59 | 4·52 | 1·215 | 1·018 | 0·237 | 0·237 | 0·610 | 0·526 | 0·224 | 0·164 | 2·29 | 1·94 | 2·61 | 2·29 | 0·619 | 0·530 | 3·23 | 2·82 | 5·4 | 4·3 | 58 | 63 | 5·85 | 5·22 |
| Lancaster | 205 | 277 | 15·6 | 21·2 | 9·3 | 9·5 | 4·84 | 3·90 | 0·633 | 0·738 | 0·179 | 0·119 | 0·494 | 0·434 | 0·106 | 0·109 | 1·41 | 1·40 | 1·58 | 1·61 | 0·427 | 0·419 | 2·01 | 2·03 | 9·1 | 7·0 | 42 | 52 | 3·87 | 3·63 |
| Leeds | ... | 2006 | ... | 21·1 | ... | 6·7 | ... | 4·34 | ... | 0·310 | ... | 0·043 | ... | 0·224 | ... | 0·104 | ... | 0·68 | ... | 0·74 | ... | 0·451 | ... | 1·19 | ... | 9·7 | ... | 27 | ... | 3·13 |
| Leyton | 249 | 423 | 30·0 | ... | 11·6 | 12·8 | 3·30 | 3·44 | 0·678 | 0·705 | 0·115 | 0·184 | 0·690 | 0·558 | 0·146 | 0·330 | 1·63 | 1·78 | 1·85 | 2·04 | 0·552 | 0·592 | 2·40 | 2·63 | 2·6 | 2·4 | 73 | 76 | 4·57 | 4·64 |
| Liverpool | 2916 | 5729 | 19·5 | 25·9 | 9·2 | 12·7 | 4·77 | 3·04 | 0·483 | 0·424 | 0·104 | 0·069 | 0·253 | 0·190 | 0·133 | 0·086 | 0·97 | 0·77 | 1·17 | 0·91 | 0·609 | 0·392 | 1·78 | 1·31 | 6·5 | 6·1 | 37 | 43 | 4·53 | 3·02 |
| Manchester | 4773 | 6356 | 31·4 | 34·6 | 12·8 | 12·9 | 3·62 | 3·26 | 0·416 | 0·392 | 0·166 | 0·121 | 0·166 | 0·156 | 0·190 | 0·162 | 0·96 | 0·87 | 1·13 | 1·33 | 0·426 | 0·554 | 1·56 | 1·88 | 9·6 | 6·4 | 43 | 58 | 2·85 | 3·17 |
| Newport | 323 | 469 | 22·9 | 14·3 | 9·4 | 10·6 | 4·56 | 4·46 | 0·668 | 0·565 | 0·218 | 0·157 | 0·913 | 0·726 | 0·034 | 0·081 | 1·83 | 1·53 | 2·11 | 1·78 | 0·709 | 0·580 | 2·82 | 2·36 | 4·0 | 5·0 | 62 | 53 | 5·44 | 4·86 |
| Nottingham | 895 | 1491 | 17·6 | 18·6 | 9·3 | 10·8 | 3·47 | 2·96 | 0·432 | 0·567 | 0·101 | 0·120 | 0·246 | 0·220 | 0·112 | 0·100 | 0·89 | 1·03 | 0·95 | 1·00 | 0·435 | 0·363 | 1·38 | 1·41 | 7·7 | 6·6 | 40 | 48 | 3·02 | 2·83 |
| Oldham | 456 | 577 | 13·2 | 16·7 | 9·6 | 10·8 | 3·65 | 3·61 | 0·580 | 0·691 | 0·032 | 0·037 | 0·316 | 0·351 | 0·208 | 0·387 | 1·14 | 1·46 | 1·24 | 1·58 | 0·441 | 0·502 | 1·68 | 2·08 | 6·7 | 5·6 | 47 | 59 | 3·36 | 3·62 |
| Portsmouth | 1225 | 1393 | 28·3 | 22·4 | 12·4 | 12·1 | 3·96 | 4·13 | 0·745 | 0·967 | 0·180 | 0·148 | 0·212 | 0·190 | 0·208 | 0·201 | 1·34 | 1·51 | 1·67 | 1·92 | 0·380 | 0·379 | 2·05 | 2·30 | 7·7 | 7·0 | 52 | 56 | 3·54 | 3·86 |
| Salford | 329 | 567 | 29·3 | .. | 9·4 | 10·6 | 3·85 | 3·60 | 0·648 | 0·588 | 0·183 | 0·147 | 0·608 | 0·407 | 0·249 | 0·229 | 1·69 | 1·37 | 1·93 | 1·80 | 0·989 | 0·522 | 2·92 | 2·33 | 2·4 | 3·7 | 76 | 65 | 5·26 | 4·37 |
| St. Helens | 65 | 320 | 13·9 | 15·4 | 6·9 | 8·9 | 5·75 | 3·78 | 0·601 | 0·500 | 0·111 | 0·041 | 2·054 | 0·596 | 0·259 | 0·175 | 3·03 | 1·31 | 3·23 | 1·34 | 1·254 | 0·743 | 4·49 | 2·12 | 1·9 | 4·2 | 78 | 56 | 3·40 | 4·16 |
| St. Pancras | 1997 | 2478 | 27·4 | 30·6 | 14·9 | 15·8 | 4·59 | 4·34 | 0·845 | 0·920 | 0·071 | 0·095 | 0·397 | 0·328 | 0·222 | 0·253 | 1·54 | 1·60 | 2·56 | 2·22 | 0·381 | 0·416 | 2·95 | 2·64 | 6·0 | 6·6 | 64 | 61 | 4·58 | 4·18 |
| Sheffield | ... | 1330 | ... | 18·3 | ... | 10·3 | ... | 4·20 | ... | 0·376 | ... | 0·066 | ... | 0·330 | ... | 0·178 | ... | 0·95 | ... | 1·01 | ... | 0·434 | ... | 1·44 | ... | 4·6 | ... | 34 | ... | 4·91 |
| Southampton | 265 | 527 | 10·6 | 21·6 | 9·2 | 10·4 | 5·43 | 4·81 | 1·171 | 1·492 | 0·126 | 0·120 | 0·432 | 0·280 | 0·138 | 0·158 | 1·87 | 2·09 | 1·96 | 2·23 | 0·825 | 0·471 | 2·81 | 2·70 | 5·9 | 5·8 | 52 | 56 | 6·48 | 4·87 |
| South Shields | 308 | 502 | 16·0 | 14·6 | 10·9 | 11·5 | 4·08 | 3·81 | 0·456 | 0·442 | 0·179 | 0·110 | 0·586 | 0·360 | 0·137 | 0·125 | 1·36 | 1·06 | 1·62 | 1·27 | 0·784 | 0·618 | 2·40 | 1·89 | 4·3 | 5·5 | 59 | 50 | 4·74 | 4·00 |
| Stafford | 68 | 87 | 11·0 | 14·0 | 7·3 | 8·5 | 5·08 | 4·90 | 0·247 | 0·321 | 0·050 | 0·083 | 1·210 | 1·046 | 0·088 | 0·244 | 1·59 | 1·69 | 2·07 | 2·07 | 0·706 | 0·634 | 2·77 | 2·71 | 3·4 | 4·0 | 55 | 55 | 6·88 | 5·99 |
| Sunderland | 472 | 640 | 16·0 | 18·3 | 12·7 | 10·7 | 3·54 | 3·68 | 0·532 | 0·761 | 0·117 | 0·105 | 0·431 | 0·402 | 0·181 | 0·149 | 1·26 | 1·42 | 1·41 | 1·54 | 0·673 | 0·624 | 2·09 | 2·16 | 5·4 | 5·6 | 59 | 69 | 3·72 | 3·78 |
| Tunbridge Wells | 335 | 496 | 16·0 | 13·6 | 18·0 | 13·4 | 5·29 | 3·96 | 0·969 | 1·183 | 0·078 | 0·083 | 0·359 | 0·274 | 0·087 | 0·095 | 1·49 | 1·63 | 1·64 | 1·79 | 0·861 | 0·708 | 2·50 | 2·50 | 11·3 | 7·5 | 47 | 63 | 3·98 | 3·67 |
| Walsall | 136 | 194 | 11·0 | 14·8 | 8·0 | 7·9 | 4·80 | 4·66 | 0·622 | 0·666 | 0·220 | 0·174 | 0·435 | 0·374 | 0·381 | 0·467 | 1·66 | 1·68 | 1·87 | 1·82 | 1·018 | 0·837 | 2·89 | 2·76 | 4·5 | 5·4 | 60 | 69 | 5·45 | 4·86 |
| Whitehaven | 206 | 219 | 31·5 | 33·4 | 13·1 | 13·2 | 3·94 | 4·23 | 0·476 | 0·589 | 0·091 | 0·073 | 0·391 | 0·384 | 0·172 | 0·144 | 1·13 | 1·19 | 1·67 | 2·01 | 0·378 | 0·542 | 2·05 | 2·55 | 8·3 | 6·9 | 52 | 60 | 3·41 | 4·01 |
| Wolverhampton | 372 | 487 | 19·2 | 14·5 | 10·1 | 6·8 | 5·00 | 4·74 | 0·613 | 0·940 | 0·217 | 0·182 | 0·644 | 0·602 | 0·177 | 0·122 | 1·65 | 1·85 | 1·81 | 1·95 | 0·844 | 0·602 | 2·65 | 2·56 | 7·9 | 6·9 | 53 | 55 | 4·42 | 4·43 |
| Yarmouth | 233 | 299 | 17·1 | 16·4 | 9·9 | 10·7 | 5·07 | 5·17 | 1·236 | 1·354 | 0·246 | 0·304 | 0·400 | 0·368 | 0·220 | 0·162 | 2·10 | 2·19 | 2·42 | 2·34 | 0·726 | 0·716 | 3·15 | 3·06 | 5·4 | 6·9 | 62 | 69 | 5·29 | 4·88 |
| Average | 809 | 1167 | 19·7 | 19·8 | 10·9 | 11·5 | 4·43 | 4·06 | 0·685 | 0·729 | 0·141 | 0·122 | 0·525 | 0·402 | 0·185 | 0·186 | 1·54 | 1·42 | 1·77 | 1·67 | 0·657 | 0·562 | 2·43 | 2·22 | 6·3 | 6·2 | 55 | 55 | 4·50 | 4·08 |
| Per cent. increase | 44·2 | | 0·51 | | 5·5 | | ... | | 6·42 | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | |
| Per cent. decrease | ... | | ... | | ... | | 8·36 | | ... | | 13·5 | | 23·4 | | 2·70 | | 7·8 | | 6·65 | | 16·0 | | 8·64 | | 1·6 | | ... | | 9·3 | |

in the last two years. Another most interesting point—in Fig. 1—is the gradual approach of the average total costs, plus 6 per cent. on the mean capital, to the total revenue. The result is that for 1899 the average total revenue was 4·06d. per unit, while the value of the quantity total costs, plus our estimate of the capital charges, was 4·08d. per unit.

In Table II. are set out in their order of merit the six towns, with municipal supply in 1898 and 1899, which held lowest values for the quantity just referred to, and set forth in the last two columns of Table I.

It is not without significance that the two stations at the head of this list in 1899 have a traction load. Halifax has the highest ratio of units sold to plant capacity in Table I., and it is also only second to Ayr in having the highest load-factor, while the capital expenditure is very moderate, being no more than £72·8 per kilowatt of plant capacity. It may be interesting to remember that of the total output of 1,371,833 units sold at Halifax, 65·8 per cent. was sold to the tramways and 6 per cent. for public lighting, the tramways contributed in return for their supply 47·2 per cent. of the total revenue for current sold by the station. At Bradford the traction supply was 25·6 per cent. of the total output, the motor load called for 19·2 per cent., and the public lighting for 2·44 per cent.

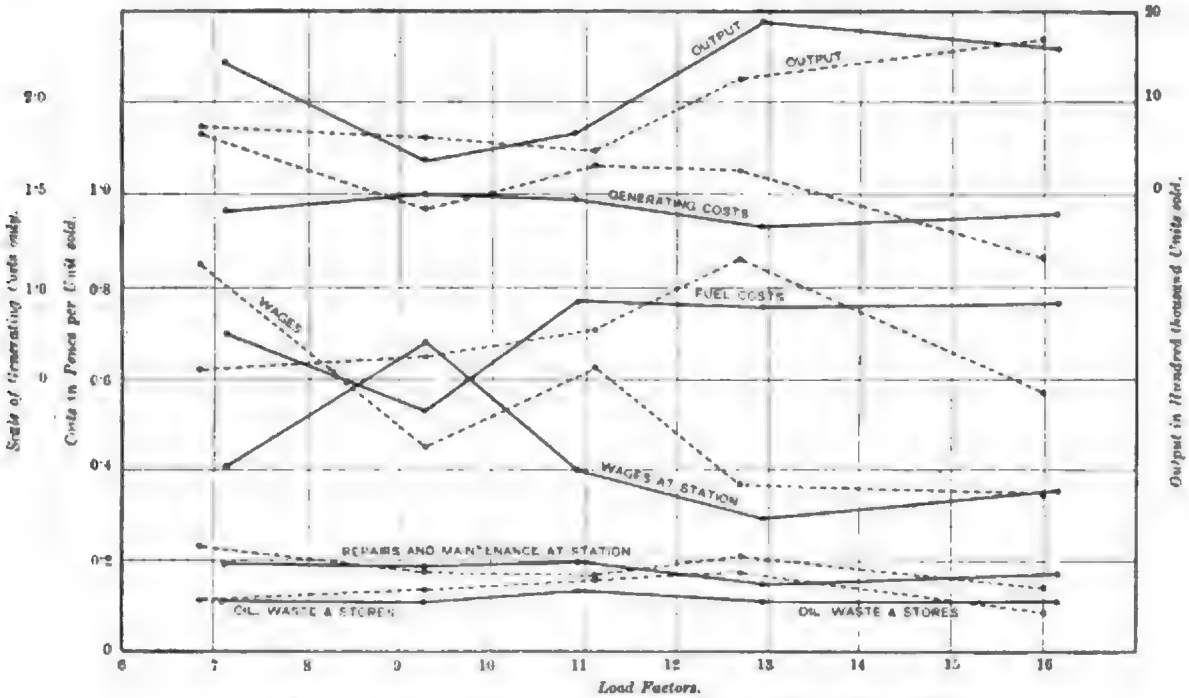


FIG. 5.—Municipal Undertakings. Curves relating Cost per Unit with Load Factor. Dotted lines 1898, full lines 1899.

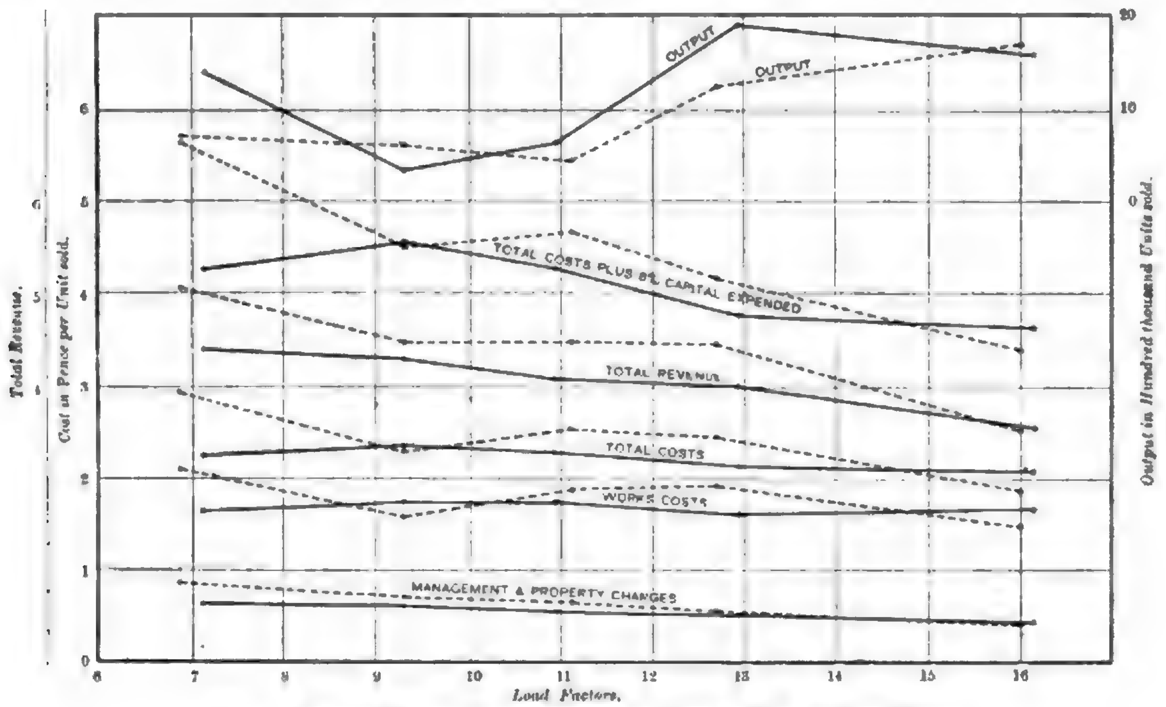


FIG. 6.—Municipal Undertakings. Curves relating Costs per Unit with Load Factor. Dotted lines 1898, full lines 1899.

In Figs. 3 and 4 are given curves showing the influence of output on costs. The values corresponding to the points in the several curves were obtained by taking the means of groups of stations of the same order of output and plotting them against the means of the output. In both sets of curves we have included a curve giving the corresponding mean load factor in order to obviate misleading deductions of the influence of output. This curve of the load factor is, by the way,

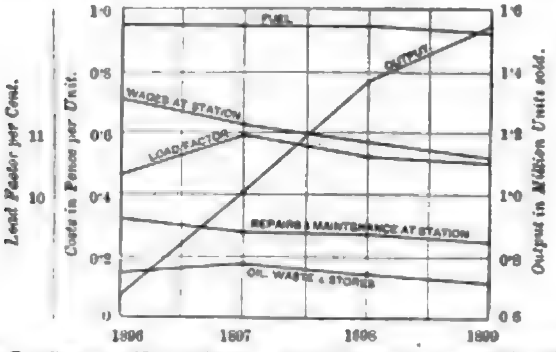


FIG. 7.—Company Undertakings. Average Costs for years 1896, 1897, 1898 and 1899.

interesting as showing that high load factors are generally associated with high outputs—at any rate in the section dealt with. Another point of interest is the dependence of the item of wages at the station on the output. The influence of output on fuel cost is less marked, although appreciable. Another curve which has been included in Fig. 4 is that of the total revenue. In order to avoid confusion the scale of ordinates of this curve has been displaced in respect to that hand, oil, waste, water and stores, and repairs and maintenance appear more dependent on variations of load factor than of output.

Company Undertakings.—In Table III. are recorded the results of working during 1898 and 1899 of about 88 company-owned stations. As in the case of the table referring to municipal concerns the record values are distinguished by heavy type. Instead of assuming 6 per cent. of the mean

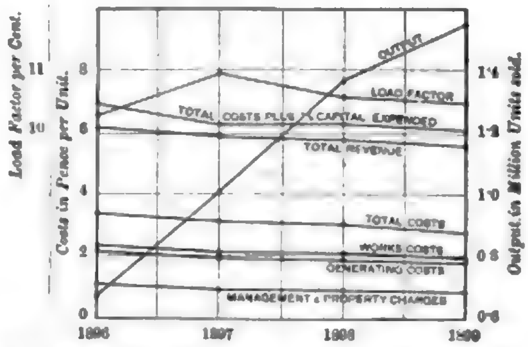


FIG. 8.—Company Undertakings. Average Costs for years 1896, 1897, 1898 and 1899.

capital as representing the capital charges on revenue, 7 per cent. is taken, and the last two columns give the values of the sum of this quantity with the total costs. Although blessed with a high output in combination with the highest load factor in the list, we think it is still highly creditable to the Charing Cross station to head the list with total costs at 1·18d. per unit. Even more commendable is the position of the St. James' station in respect to the quantity in the last two columns in

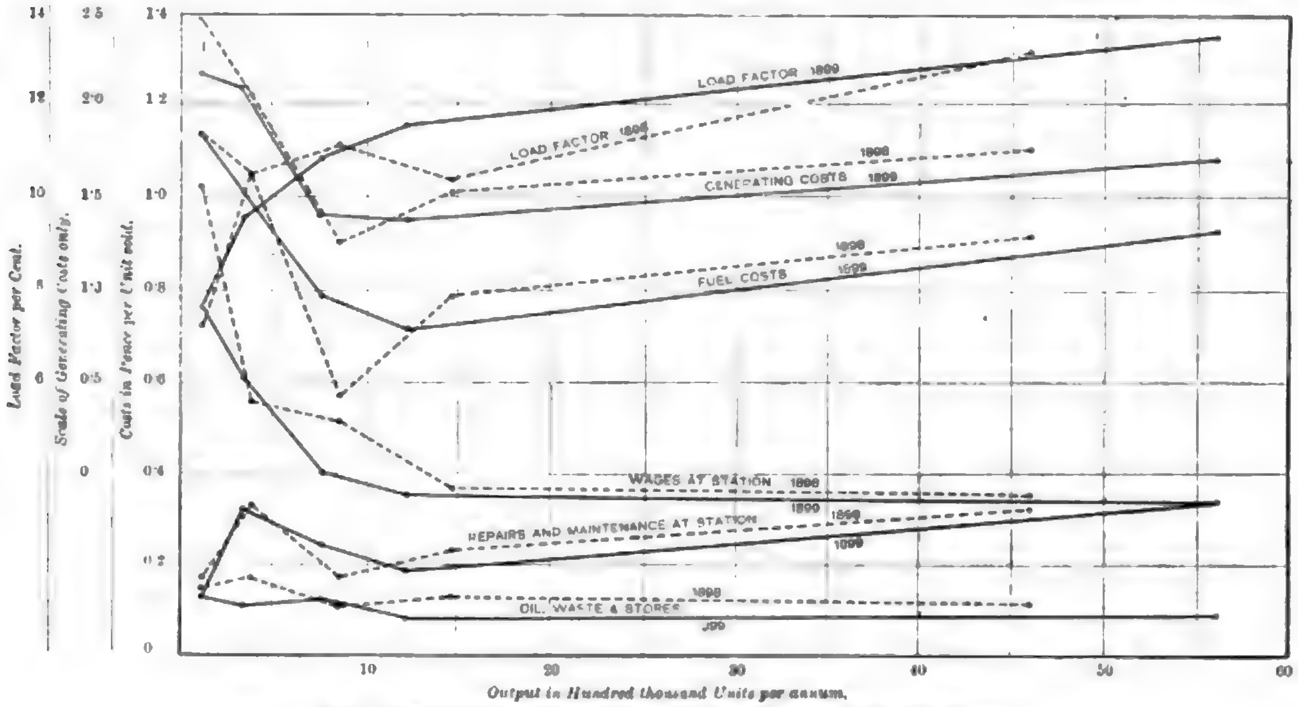


FIG. 9.—Company Undertakings. Curves relating Costs per Unit with Output. Dotted lines 1898, full lines 1899.

of the costs. It is only at outputs above a million units sold that the mean total revenue exceeds the mean values of the total costs plus 6 per cent. of the mean capital.

Figs. 5 and 6 derive interest from the fact that the output does not rise continuously with the load factor, thus permitting of some conclusions as to the effects respectively of output and load factor on the various items of expenditure. Thus, from Fig. 5 the sensitiveness of "Wages at station" to variations of output appears fairly evident. On the other

the list. Preston, with works costs at 1·02d. per unit and with generating costs at 0·91d., worthily succeeds Sheffield, which in 1898 stood with generating costs at 0·93d. and works costs at 1·02d. Notting Hill again is lowest in the item of wages at station having bettered its own record of 1898. Although advantageously situated in this respect it is highly creditable that the little station at Pontypool should exhibit the lowest fuel costs in the table for 1899. The Newcastle and District Company show the lowest total revenue. Dover

**TABLE III.**—*Electricity Works Costs for 1898 and 1899 of the Principal Company Undertakings for Electrical Supply in the United Kingdom.*

| Place. | Output in 1,000 units sold. 1898 | 1899 | Units sold per 8 c.p. lamp capacity. 1898 | 1899 | Load factor. units sold × 100 / max. dem. × 8760 1898 | 1899 | Total Revenue per unit sold. 1898 | 1899 | Fuel costs per unit sold. 1898 | 1899 | Oil, waste, water and stores per unit sold. 1898 | 1899 | Wages at generating station per unit sold. 1898 | 1899 | Repairs and maintenance at station per unit sold. 1898 | 1899 | Generating costs per unit sold. 1898 | 1899 | Works costs per unit sold. 1898 | 1899 | Manag'm'nt and property charges per unit sold. 1898 | 1899 | Total costs per unit sold. 1898 | 1899 | Working profit % to mean capital expended. 1898 | 1899 | Ratio of total costs to revenue (per cent.). 1898 | 1899 | Total costs plus 7 % of the mean ex. capital pr unit sold. 1898 | 1899 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birmingham | 1722 | ... | 26·3 | ... | 10·7 | ... | 4·66 | ... | 0·689 | ... | 0·120 | ... | 0·396 | ... | 0·219 | ... | 1·42 | ... | 1·46 | ... | 0·734 | ... | 2·20 | ... | 7·6 | ... | 47 | ... | 4·48 | ... |
| Bournemouth | 415 | 528 | 21·1 | 16·9 | 8·2 | 8·5 | 6·90 | 6·58 | 0·778 | 0·882 | 0·196 | 0·157 | 0·524 | 0·571 | 0·179 | 0·148 | 1·68 | 1·79 | 1·87 | 1·96 | 0·929 | ... | 2·80 | ... | 7·4 | ... | 41 | ... | 6·65 | ... |
| Bromley | ... | 111 | ... | 10·5 | .. | 6·3 | ... | 5·84 | ... | 1·188 | ... | 0·149 | ... | 0·818 | ... | 0·019 | ... | 2·17 | ... | 2·17 | ... | 1·108 | ... | 3·28 | ... | 2·7 | ... | 56 | ... | 9·81 |
| Brompton and Kensington | 975 | 1241 | 21·4 | 21·9 | 12·1 | 12·8 | 6·14 | 5·89 | 0·686 | 0·706 | 0·108 | 0·084 | 0·591 | 0·512 | 0·148 | 0·099 | 1·53 | 1·40 | 1·60 | 1·49 | 1·067 | 0·880 | 2·67 | 2·37 | 8·4 | 10·0 | 44 | 40 | 5·56 | 4·83 |
| Cambridge | 260 | 298 | 15·9 | 18·2 | 8·6 | 9·3 | 6·80 | 6·99 | 1·097 | 1·010 | 0·160 | 0·146 | 0·792 | 0·648 | 0·292 | 0·315 | 2·34 | 2·12 | 2·39 | 2·18 | 0·836 | 0·850 | 3·29 | 3·04 | 8·4 | 9·3 | 48 | 44 | 6·22 | 6·03 |
| Charing Cross | 3246 | 3862 | 33·3 | 34·2 | 17·1 | 17·5 | 4·44 | 4·40 | 0·988 | 0·856 | 0·089 | 0·058 | 0·374 | 0·349 | 0·194 | 0·262 | 1·65 | 1·52 | 1·81 | 1·72 | 0·512 | 0·459 | 2·33 | 1·18 | 7·5 | 7·9 | 53 | 50 | 4·31 | 3·16 |
| Chelsea | 1220 | 1423 | 17·3 | 14·7 | 10·0 | 10·3 | 6·17 | 5·88 | 0·884 | 0·698 | 0·130 | 0·100 | 0·345 | 0·287 | 0·240 | 0·218 | 1·64 | 1·40 | 1·94 | 1·70 | 0·953 | 0·803 | 2·89 | 2·50 | 5·5 | 5·6 | 47 | 43 | 7·03 | 6·75 |
| City of London | 6940 | 8549 | 19·1 | 19·7 | 10·2 | 10·7 | 5·84 | 5·05 | 0·939 | 1·236 | 0·129 | 0·127 | 0·348 | 0·362 | 0·305 | 0·414 | 1·74 | 2·17 | 2·10 | 2·49 | 0·852 | 0·695 | 2·96 | 3·18 | 6·3 | 4·6 | 51 | 63 | 6·18 | 6·02 |
| Clerkenwell | 447 | 920 | 8·0 | 10·0 | 10·5 | 8·1 | 6·03 | 4·97 | 1·423 | 1·071 | 0·300 | 0·185 | ... | ... | 0·583 | 0·512 | ... | ... | .. | ... | ... | ... | 4·76 | 3·22 | 1·0 | 2·2 | 79 | 65 | 13·93 | 8·80 |
| Dover | 423 | 524 | 25·8 | 31·9 | 13·6 | ... | 4·36 | 4·07 | 1·360 | 1·183 | 0·065 | 0·066 | 0·556 | 0·480 | 0·184 | 0·226 | 2·25 | 2·02 | 2·47 | 2·20 | 0·451 | 0·387 | 2·92 | 2·59 | 3·8 | 4·4 | 67 | 64 | 5·57 | 4·94 |
| Eastbourne | 308 | 358 | 19·4 | 15·1 | 11·3 | 11·8 | 7·35 | 7·62 | 1·336 | 1·386 | 0·213 | 0·204 | 0·740 | 0·736 | 0·195 | 0·124 | 2·48 | 2·45 | 2·96 | 2·78 | 0·830 | 0·754 | 3·79 | 3·54 | 8·2 | 10·1 | 52 | 46 | 6·82 | 6·38 |
| Folkestone | . | 303 | .. | 18·9 | ... | 6·5 | ... | 4·58 | ... | 0·902 | ... | 0·059 | ... | 0·443 | ... | 0·106 | ... | 1·51 | ... | 1·86 | ... | 0·889 | ... | 2·75 | ... | 4·0 | ... | 60 | ... | 5·64 |
| Guildford | 29 | 59 | 7·8 | 9·4 | 5·8 | 7·6 | 7·73 | 5·86 | 1·650 | 1·889 | 0·239 | 0·164 | 1·343 | 0·548 | 0·082 | 0·119 | 3·32 | 2·72 | 3·32 | 2·72 | 1·936 | 1·133 | 5·27 | 3·86 | 3·4 | 3·5 | 68 | 66 | 8·94 | 7·81 |
| Hastings | 364 | ... | 31·0 | ... | 12·7 | ... | 6·76 | ... | 1·912 | ... | 0·265 | ... | 0·638 | ... | 0·420 | ... | 3·24 | ... | 3·65 | ... | 0·929 | ... | 4·58 | ... | 6·0 | ... | 68 | ... | 7·11 | ... |
| Harrow | .. | 113 | ... | 17·9 | ... | 11·0 | ... | 7·98 | ... | 1·095 | ... | 0·093 | ... | 0·883 | ... | 0·402 | ... | 2·47 | ... | 2·64 | ... | 1·520 | ... | 4·16 | ... | 4·6 | ... | 52 | ... | 10·03 |
| Hove | 350 | 444 | 16·8 | 13·6 | 9·9 | 10·9 | 6·50 | 6·52 | 0·883 | 0·886 | 0·123 | 0·056 | ... | ... | ... | ... | ... | ... | 1·85 | 1·69 | 1·025 | 0·914 | 2·88 | 2·60 | 7·3 | 8·5 | 44 | 40 | 6·34 | 5·84 |
| Kensington and Knightsbridge | 2081 | 2464 | 34·1 | 33·5 | 12·6 | 12·2 | 5·34 | 5·17 | 0·760 | 0·639 | 0·093 | 0·088 | 0·368 | 0·304 | 0·685 | 0·609 | 1·95 | 1·64 | 2·08 | 1·94 | 0·961 | 0·864 | 3·04 | 2·81 | 7·7 | 9·0 | 57 | 54 | 5·12 | 4·64 |
| London (Metropolitan) | 6845 | 8328 | | | 12·0 | 12·5 | 5·32 | 5·16 | 1·592 | 1·601 | 0·194 | 0·167 | 0·381 | 0·340 | 0·359 | 0·433 | 2·69 | 2·61 | 2·77 | 2·66 | 0·664 | 0·589 | 3·44 | 3·25 | 5·8 | 5·9 | 65 | 63 | 5·70 | 5·51 |
| Newcastle | 804 | 967 | 19·8 | 22·6 | 10·8 | 10·6 | 4·38 | 4·33 | .. | 0·505 | ... | 0·081 | ... | 0·446 | ... | 0·137 | 1·18 | 1·17 | 1·35 | 1·32 | 0·594 | 0·676 | 1·94 | 2·00 | 9·1 | 8·4 | 44 | 46 | 3·82 | 3·96 |
| Newcastle and District | 743 | 964 | 18·7 | 19·3 | 12·7 | 14·6 | 4·46 | 3·97 | 0·590 | 0·615 | 0·168 | 0·172 | 0·407 | 0·361 | 0·175 | 0·095 | 1·34 | 1·24 | 1·53 | 1·42 | 0·495 | 0·573 | 2·02 | 1·99 | 9·1 | 7·4 | 45 | 50 | 3·90 | 3·87 |
| Norwich | 741 | 1028 | 21·6 | 26·0 | 9·7 | 11·6 | 4·55 | 4·22 | 0·705 | 0·751 | 0·050 | 0·060 | 0·300 | 0·271 | 0·214 | 0·250 | 1·28 | 1·33 | 1·57 | 1·64 | 0·657 | 0·800 | 2·23 | 2·44 | 8·1 | 7·2 | 49 | 58 | 4·24 | 4·17 |
| Notting Hill | 456 | 665 | 18·2 | 33·2 | 11·3 | 12·2 | 7·07 | 6·38 | 0·775 | 0·687 | 0·127 | 0·092 | 0·280 | 0·233 | 0·438 | 0·317 | 1·62 | 1·33 | 1·64 | 1·40 | 1·603 | 1·240 | 3·25 | 2·64 | 6·01 | 7·8 | 46 | 41 | 7·69 | 5·99 |
| Oxford | 374 | 427 | 19·0 | 21·7 | 12·2 | 10·2 | 5·99 | 6·01 | 0·652 | 0·634 | 0·054 | 0·057 | 0·552 | 0·494 | 0·595 | 0·743 | 1·85 | 1·93 | 2·03 | 2·07 | 0·961 | 0·899 | 2·93 | 2·97 | 5·4 | 5·8 | 50 | 49 | 6·86 | 6·63 |
| Pontypool | 52 | 58 | 10·2 | 12·3 | 6·5 | 6·7 | 6·16 | 6·16 | 0·560 | 0·429 | 0·117 | 0·274 | 1·212 | 1·143 | 0·056 | 0·124 | 1·94 | 1·97 | 2·34 | 2·26 | 0·779 | 0·689 | 3·12 | 2·95 | 7·2 | 7·2 | 51 | 48 | 6·06 | 6·08 |
| Preston | 444 | 602 | 26·7 | 18·3 | 8·5 | 9·7 | 4·90 | 4·60 | 0·346 | 0·447 | 0·089 | 0·071 | 0·381 | 0·313 | 0·129 | 0·080 | 0·95 | 0·91 | 1·15 | 1·02 | 0·927 | 0·697 | 2·07 | 1·72 | 7·1 | 8·4 | 42 | 37 | 4·85 | 4·11 |
| Reading | 160 | 232 | 13·7 | 9·6 | 6·0 | 6·4 | 6·17 | 6·49 | 1·296 | 1·046 | 0·172 | 0·080 | 1·220 | 0·692 | 0·180 | 0·080 | 2·87 | 1·90 | 3·03 | 1·91 | 0·907 | 0·832 | 3·94 | 2·74 | 3·1 | 5·6 | 64 | 42 | 9·02 | 7·44 |
| Richmond | 166 | 191 | 18·3 | 10·4 | 8·9 | 8·9 | 7·37 | 7·16 | 1·002 | 1·054 | 0·090 | 0·090 | 0·528 | 0·509 | 0·240 | 0·226 | 1·86 | 1·91 | 1·99 | 2·08 | 1·226 | 1·185 | 3·22 | 3·27 | 6·0 | 5·6 | 44 | 46 | 8·08 | 8·15 |
| St. James' | 3449 | 4201 | 28·7 | 35·0 | 13·9 | 14·9 | 4·89 | 4·47 | 0·509 | 0·545 | 0·066 | 0·066 | 0·378 | 0·350 | 0·164 | 0·181 | 1·13 | 1·15 | 1·24 | 1·32 | 0·740 | 0·638 | 1·98 | 1·98 | 16·2 | 15·0 | 40 | 44 | 3·24 | 3·14 |
| Scarborough | 217 | 257 | 10·3 | 12·2 | 9·1 | 8·6 | 5·97 | 5·79 | 1·194 | 1·224 | 0·112 | 0·118 | 0·811 | 0·751 | 0·275 | 0·331 | 2·46 | 2·49 | 2·67 | 2·59 | 0·763 | 0·740 | 3·43 | 3·33 | 6·1 | 6·2 | 58 | 58 | 6·36 | 6·10 |
| Sheffield | 978 | ... | 18·2 | ... | 10·4 | .. | 4·64 | .. | 0·302 | ... | 0·109 | ... | 0·368 | ... | 0·151 | ... | 0·93 | ... | 1·02 | ... | 0·503 | .. | 1·52 | ... | 6·0 | ... | 33 | .. | 5·15 | ... |
| Wandsworth | 471 | 846 | 16·8 | 30·1 | 8·2 | 12·4 | 5·62 | 5·31 | 1·019 | 0·922 | 0·259 | 0·203 | ... | ... | 0·346 | 0·432 | ... | ... | ... | ... | ... | ... | 3·00 | 2·60 | 2·3 | 3·1 | 53 | 49 | 10·85 | 8·79 |
| Westminster | 5065 | 6330 | 28·6 | 32·7 | 13·1 | 13·3 | 5·51 | 5·04 | 0·694 | 0·672 | 0·087 | 0·081 | 0·355 | 0·302 | 0·217 | 0·140 | 1·35 | 1·20 | 1·46 | 1·32 | 0·874 | 0·754 | 2·33 | 2·07 | 11·3 | 12·0 | 42 | 41 | 4·30 | 3·81 |
| Winchester | . | 57 | ... | 6·1 | ... | 7·3 | ... | 5·16 | ... | 1·220 | ... | 0·072 | ... | 0·855 | . | 0·004 | ... | 2·15 | ... | 2·24 | ... | 0·550 | ... | 2·79 | ... | 1·7 | ... | 54 | ... | 10·29 |
| Average | 1370 | 1545 | 19·9 | 19·8 | 10·6 | 10·5 | 5·80 | 5·59 | 0·950 | 0·933 | 0·140 | 0·114 | 0·568 | 0·519 | 0·269 | 0·246 | 1·87 | 1·80 | 2·05 | 1·96 | 0·881 | 0·819 | 2·99 | 2·75 | 6·80 | 6·68 | 51 | 51 | 6·36 | 6·16 |
| Per cent. increase | 12·78 | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | ... | | .. | | ... | |
| Per cent. decrease | ... | | 0·50 | | 0·94 | | 3·62 | | 1·79 | | 18·6 | | 8·63 | | 8·55 | | 3·74 | | 4·39 | | 7·04 | | 8·03 | | 1·77 | | 0·00 | | 3·15 | |

**TABLE II.**—*Six Municipal Works having Lowest Charges on Revenue.*

| 1898. Place. | Output in 1,000 units sold. | Units sold per 8 c.p. lamp capacity. | Load factor. | Total costs per unit. | Capital expenditure per kilo-watt capacity. | Total costs + 6 % of mean capital expended per unit | 1899. Place. | Output in 1,000 units sold. | Units sold per 8 c.p. lamp capacity. | Load factor. | Total costs per unit. | Capital expenditure per kilo-watt capacity. | Total costs + 6 % of mean capital expended per unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Edinburgh ... | 4,175 | 28·4 | 15·3 | 1·41d. | £84·0 | 2·59d. | Halifax ......... | 1,371 | 35·1 | 16·9 | 1·24d. | £72·8 | 2·28d. |
| Manchester ... | 4,773 | 31·4 | 12·8 | 1·56d. | 102 | 2·85d. | Bradford ...... | 2,416 | 24·2 | 13·7 | 1·18d. | 64·6 | 2·23d. |
| Brighton ...... | 2,649 | 26·5 | 15·4 | 1·68d. | 74·1 | 2·90d. | Edinburgh ... | 5,552 | 21·8 | 13·8 | 1·41d. | 73·2 | 2·70d. |
| Nottingham... | 895 | 17·6 | 9·3 | 1·38d. | 78·6 | 3·02d. | Nottingham... | 1,491 | 18·6 | 10·8 | 1·41d. | 64·6 | 2·83d. |
| Chester ...... | 474 | 25·5 | 15·4 | 1·52d. | 76·1 | 3·09d. | Brighton ...... | 3,207 | 24·4 | 16·6 | 1·80d. | 69·1 | 2·99d. |
| Halifax......... | 629 | 14·4 | 18·8 | 1·65d. | 51·8 | 3·14d. | Aberdeen...... | 846 | 23·4 | 12·6 | 1·51d. | 87·5 | 3·01d. |

**TABLE IV.**—*Six Company Works having Lowest Charges on Revenue.*

| 1898. Place. | Output in 1,000 units sold. | Units sold per 8 c.p. lamp capacity. | Load factor. | Total costs per unit. | Capital expenditure per kilo-watt capacity. | Total costs + 7 % of mean capital expended per unit | 1899. Place. | Output in 1,000 units sold. | Units sold per 8 c.p. lamp capacity. | Load factor. | Total costs per unit. | Capital expenditure per kilo-watt capacity. | Total costs + 7 % of mean capital expended per unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| St. James' ... | 3,449 | 28·7 | 13·9 | 1·98d. | £67·8 | 3·24d. | St. James' ... | 4,201 | 35·0 | 14·9 | 1·98d. | £81·8 | 3·14d. |
| Newcastle ... | 804 | 19·8 | 10·8 | 1·94d. | 75·5 | 3·82d. | Charing Cross | 3,862 | 34·2 | 17·6 | 1·18d. | 138 | 3·16d. |
| N'wc'stle & Dis. | 743 | 18·7 | 12·7 | 2·02d. | 70·1 | 3·90d. | Westminster.. | 6,330 | 32·7 | 13·3 | 2·07d. | 110 | 3·81d. |
| Norwich ...... | 741 | 21·6 | 9·7 | 2·23d. | 89 | 4·24d. | N'wc'stle & Dis. | 964 | 19·3 | 14·6 | 1·99d. | 79·2 | 3·87d. |
| Westminster | 5,065 | 28·6 | 13·1 | 2·41d. | 111 | 4·30d. | Newcastle ... | 967 | 22·6 | 10·6 | 2·00d. | 92·0 | 3·96d. |
| Charing Cross | 3,246 | 33·3 | 17·1 | 2·33d. | 131 | 4·41d. | Preston ...... | 602 | 18·3 | 9·7 | 1·72d. | 88·7 | 4·11d. |

comes out again with lowest management and property charges at 0·367d. per unit. The averages of the table indicate increased economy in all the items of costs, and, rather surprisingly, a diminution in the load factor and the ratio of the output to the plant capacity. These means are represented graphically in Figs. 7 and 8, the values from 1896 to 1899 being there shown.

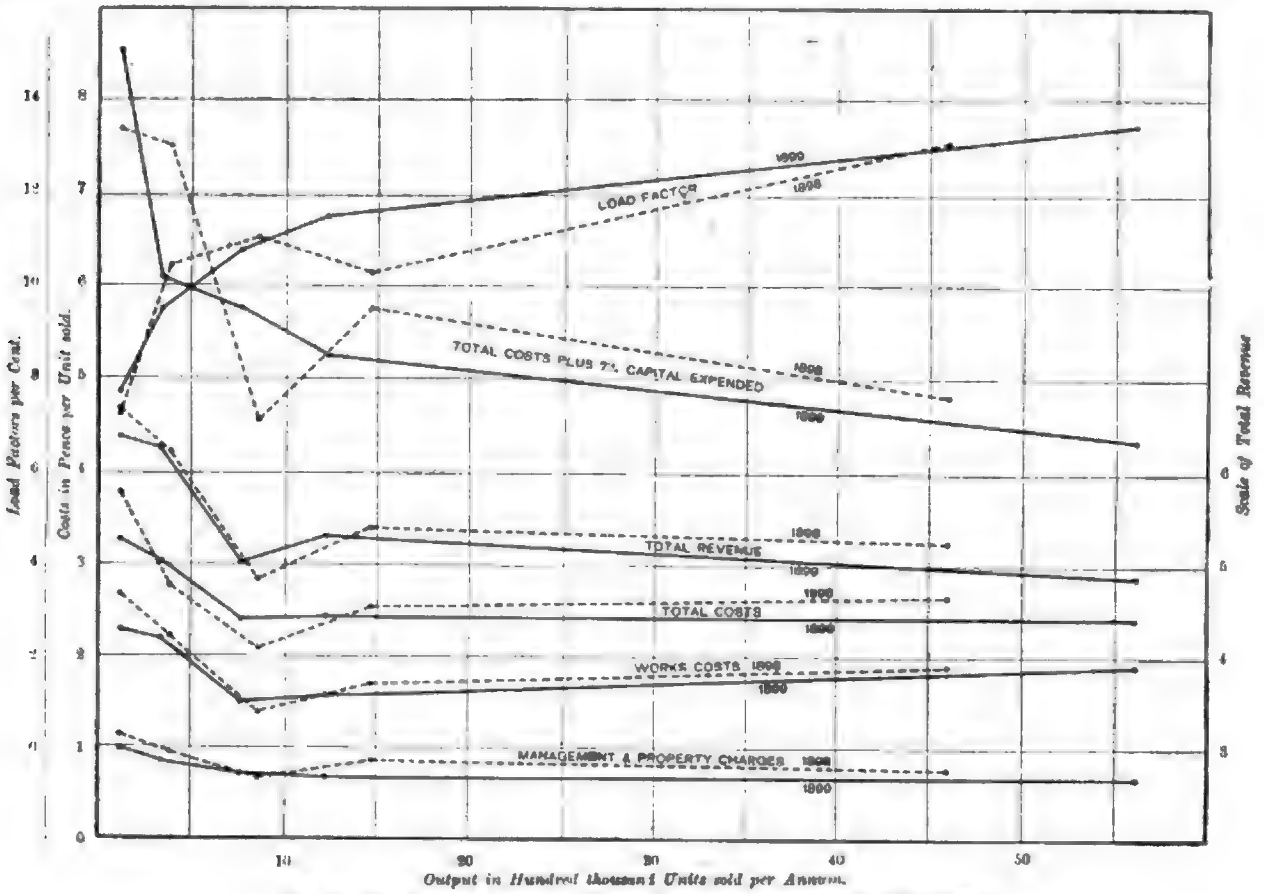


FIG. 10.—Company Undertakings. Curves relating Costs per Unit with Output.

Dotted lines 1898, full lines, 1899.

In Table IV. are given, in the order of merit, the six company-worked stations which, in 1898 and 1899, held lowest values for the quantity "Total costs plus 7 per cent. of the mean capital expended." With their necessarily high capital expenditure generally, in comparison with provincial stations, it is somewhat surprising to find three London stations at the head of this list in 1899. The St. James' station, while having total costs higher than the Charing Cross Company takes precedence by reason of lower capital expenditure—this being £81·8 per kilowatt of generating plant installed, as compared with £138 in the case of the Charing Cross Company. The two Newcastle companies have exchanged places in the list through the changes in their respective total costs. Preston occupies the sixth place with the low total costs of 1·72d. per unit, and the moderate

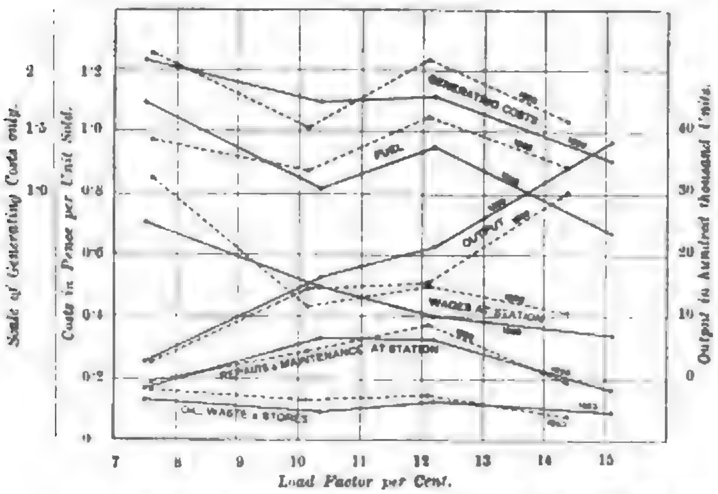


FIG. 11.—Company Undertakings. Curves relating Costs per Unit with Load Factor.

Dotted lines 1898, full lines 1899.

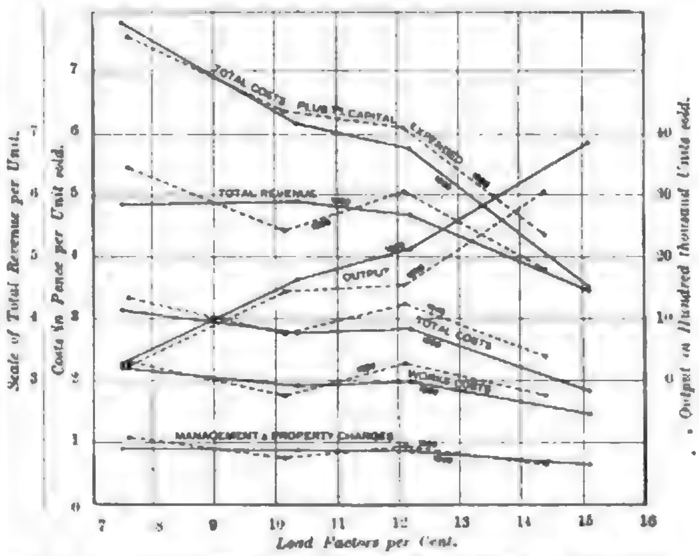


FIG. 12.—Company Undertakings. Curves relating Costs per Unit with Load Factor.

Dotted lines 1898, full lines 1899.

capital expenditure of £88·7 per kilowatt of generating plant installed. In Figs. 9 and 10 are plotted costs of working in relation to output. The mean values of the load factor have here again been included, and, as in the corresponding curves for municipal stations, high values for the load factor appear to be generally associated with the high outputs. Perhaps this is in large measure due to the fact that the high outputs are introduced by the London concerns, which also, in general, are characterised with high load factors. A point to be noticed in these curves is how apparently insensitive to variations either of output or of load factor are the items of "Oil, waste, water, and stores," "Repairs and maintenance at station," and even "Management and property charges."

It must be pointed out that the curves representing total revenue are not plotted on the same ordinate as the costs in either Fig. 10 or Fig. 12 in order to avoid the confusion which would otherwise occur through their re-crossing the curves of total costs plus capital charges. It may be mentioned that in the 1899 curves the total revenue obtained was generally under the total costs plus 7 per cent. of the capital expenditure for outputs under a million units in the year, and for load factors under 18 per cent.

As in the case of municipal stations it may be seen from Figs. 9 and 11 that, while the item of "Wages at station" depends on both conditions of output and load factor, it is particularly sensitive to variations in the former (viz., output).

## THE ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL INDUSTRIES IN 1900.

BY JOHN B. C. KERSHAW, F.I.C.

Introduction.—The past year has not been marked by any striking discoveries or developments in connection with the electro-chemical and electro-metallurgical industries. The processes for the manufacture of alkalies and bleach, of chlorates, and of hypochlorites, and for the refining of copper and bullion, all show progress during 1900. Development in two industries—namely, the ozone and aluminium industries—is retarded by the limited field of application for these products; but in the case of aluminium this is gradually being widened, and the consumption of the metal is increasing. The calcium carbide industry during 1900 has experienced the fall in prices long foretold by the writer, and for some months in the past year carbide could be obtained under cost price at several ports in Europe. This break in values has had serious effects upon the production. The processes for the extraction of zinc and copper directly from their ores, are still in the experimental stage of their development. Details of the various industries and processes are given under the respective headings below:—

I. Alkalies and Bleach.—The number of factories engaged in the production of alkalies and bleach by the electrolytic method has increased to 27 during 1900, this increase being due to the fact that some of those in course of erection a year ago are now operating. Two electrolytic alkali factories have, however, ceased operations during the past year—namely, at Les Clavaux, in France, and at Rumford Falls, in America. The cessation in the former case is due to financial difficulties; in the latter case the plant has been transferred to Berlin Falls, N.Y., where the products of the process are used in the manufacture of wood-pulp by the Burgess Sulphite Wood-Fibre Co. The process most widely adopted is that worked out originally by the "Elektron" Co., of Frankfort, and first operated by them at Griesheim in 1890. This company, two years ago, entered into a working agreement with the Elektrochemische Co, of Bitterfeld, and all the subsidiary companies promoted by these two pioneer firms are now operating under the technical supervision of the Frankfort company. Great secrecy is still maintained, and no official details have been published concerning the process used.

It was at one time reported to be a diaphragm process, but Ahrens has stated, during the past year, that it is a mercury process; that carbon anodes are used; and that a current of air is used to separate the amalgam from the unaltered mercury, as it passes from the cell. Works utilising this process are in operation at Griesheim, Bitterfeld (2), Rheinfelden, Ludwigshafen, Westeregeln, Lamotte, Monthey, Slaviansk and Flix. The parent company has been very successful from a financial point of view, and in 1898 and 1899 dividends of 16 per cent. upon its ordinary share capital were paid. Whether the subsidiary undertakings will prove equally remunerative remains to be seen; but the costs of power and the prices that can be obtained for the finished products, must necessarily vary in the different countries in Europe.

The process next in point of importance is the Castner-Kellner. This is now being operated at Weston Point, at Osternienberg and at Niagara Falls; while a modified form of the Castner cell has been devised by Solway & Co., of Brussels, and is being utilised at the works at Genappe, in Belgium, and at Donetz, in Russia. This process is also a mercury one. The pioneer works at Weston Point have been very successful; 4,000 H.P. is now utilised at this works, and dividends of 8 per cent. upon the ordinary share capital have been regularly paid since the works commenced full operations. The chief events of the past year in connection with this process have been the delivery of judgment in the appeal case, "Castner-Kellner Alkali Co. v. The Commercial Development Corporation" and the flotation of the Castner Electrolytic Alkali Co. in the United States. The appeal went against the Castner-Kellner Co. As the House of Lords has now given its decision, the case is finally settled, but the adverse judgment does not affect the position of the Castner-Kellner Company, for the whole fight has been over a patent which is not worked by that company.

The company flotation in America has been for the purpose of increasing the existing factory at Niagara Falls. The new company has a capital of £624,000. It pays two-thirds of this for the factory of the Mathieson Alkali Co., at Niagara Falls, where 2,000 H.P. is now utilised by the Castner process, and also obtains control of the Castner patents in the United States of America. £150,000 is to be expended upon increasing the capacity of the plant to 6,000 H.P., and £58,000 will remain as working capital.

The Hargreaves-Bird process is still only operated at two localities, namely, at Farnworth, and at Chauny, near Paris; but the first unit of plant in the large works at Middlewich, in Cheshire, is expected to be ready for operation early in 1901. A company has also been formed to purchase the patents and work the process in Spain, but no details of this new development have yet been published.

As regards the remaining processes, the Hulin process has been financially unsuccessful at Les Clavaux, and these works are now stopped: the Richardson and Holland process has passed through another year, chequered by the customary "temporary stoppages for improvements"; and the Rhodin process is about to receive trial on an extended industrial scale at Sault Sainte Marie, in America. It is in this quarter of the world, in fact, that the most important developments are now occurring in the electrolytic alkali industry; for, in addition to the enlargement, referred to above, of the Mathieson factory at Niagara, two electrolytic alkali works are in course of erection at Saulte Sainte Marie, and a third new works is being built at Niagara. At the latter the Ackers process is to be used, this being similar in principle to the Hulin process, and characterised by the use of fused salt as electrolyte, with molten lead as cathode material. These three new factories are expected to be in operation before the end of 1901. Other processes in actual use are the Le Sueur, at Berlin Falls; the Outhenin Chalandre, at Chevres, Montiers and St. Marcel; the Spilker and Lowe, at Leopoldschall; and the Oestr. Verein. f. Chem. Production process (a gravity process), at Aussig, in Austria. The total number of factories in operation and building at the end of 1900 is 30, distributed as shown in the following table.

*Electrolytic Alkali Factories, in Operation or Building, at the End of 1900.*

| Country. | In operation. | | Building. |
|---|---|---|---|
| | No. | Horse-power. | No. |
| Germany | 8 | 11,150 | 0 |
| France and Switzerland | 7 | 24,000 | 0 |
| United Kingdom | 3 | 7,020 | 0 |
| Russia | 3 | 3,500 | 0 |
| United States | 2 | 2,700 | 2 |
| Austria, Spain, Belgium, Italy | 4 | 4,000 | 1 |
| Totals | 27 | 52,370 | 3 |

**Aluminium.**—The European producers of aluminium still maintain their attitude of reserve with regard to their annual output of the new metal, and refuse to give any figures for publication. Unofficial estimates of the past year's production for the eight works now engaged in the industry range from 5,000 tons to 7,500 tons. The writer is inclined to regard the lower of these limits as nearest to the 1900 world production. The Pittsburg Reduction Co., of Niagara Falls, is still the largest single producing firm, the 1899 output of the two works located at this spot having been officially given as equal to 2,990 tons, while the 1900 output is expected to exceed this total by some hundreds of tons. The fall in the price of calcium carbide which has occurred during 1900 will, however, not be without its effects upon the aluminium industry, for all the European aluminium works have taken up carbide manufacture, and now that this has ceased to yield any profit, a larger proportion of their power will be devoted to the production of aluminium.

During 1900 the number of works producing aluminium has been increased by one—the works of the Société Anonyme pour l'Industrie de l'Aluminium, at Lend Gastein, Austria, having been started. A fall of 63 metres on the River Achen is utilised, and 5,000 H.P. has been developed. The original Neuhausen Aluminium Co. now controls three works—namely, at Neuhausen, at Rheinfelden, and at Lend Gastein; and if the whole of the 14,000 H.P. available in these works were devoted to the production of the new metal, the output would exceed that of the Pittsburg company. The latter company has, however, been extending its works, and it has now generating and tranforming machinery equal to 10,000 H.P. installed at Niagara Falls. The whole of this is to be devoted to aluminium production in the coming year.

With regard to new developments, the Pittsburg Aluminium Co. are building a factory at Shawinigan Falls, in Canada, which is expected to be ready for operation in 1901. A 5,000 H.P. plant is being installed, but it is doubtful whether the whole of this will be devoted to the manufacture of aluminium.

The total power now available for aluminium production is 56,000 H.P., but not more than one-half of this is at present utilised in the manufacture of the metal. The eight works engaged in the production are located as follows: Niagara Falls (2), Foyers, Neuhausen, Rheinfelden, Lend Gastein, Le Praz, St. Michel.

No new aluminium extracting process of any practical value has made its appearance during 1900; and all the factories engaged in the industry operate either the Herault or the Hall process. It is interesting to note that the English Herault patent expires in 1901, and that the British Aluminium Co. have filed an application praying for an extension of the life of this patent.* In America, judgment has been at last delivered in the protracted patent case concerning the Bradley patents. The Cowles Company, who own these patents, have been successful in their suit, and it is expected that all companies carrying on electric furnace operations will have to obtain licences from the Cleveland Electric Smelting Co. This may affect the position of the Pittsburg Reduction Co.

The selling price of aluminium in sheet, bar, or rod form, has undergone no material change during the past year. Aluminium for electrical purposes is being sold under cost price in America, viz., at 1s. 2½d. per pound at the point of consumption. In this country the charge for aluminium in the form of wire is 1s. 6½d. per pound for large orders. The applications of aluminium have not undergone any great extension during 1900, but the exhibits of this metal at the Paris Exhibition are expected to assist materially in the development of this side of the industry. Its use for electrical conductors is still chiefly confined to America. On this side of the Atlantic there is a disposition to doubt its durability when exposed to atmospheric influences. Reports upon the earlier overhead lines of the metal in California and elsewhere are beginning to appear; these are on the whole favourable to the new metal. Where breaks have occurred, they are generally traced to bad lengths of wire. In this country the only practical installation of aluminium is at Northallerton, in Yorkshire, in connection with a small lighting station.*

One of the most striking developments of the past year in connection with the utilisation of aluminium, has been the success of Heraeus, of Hanau, in Germany, in jointing the metal by a new method of autogenous soldering. For many years the difficulty of soldering aluminium by any of the ordinary methods has hindered the application of the new metal in the industries and the arts. Many solders have been invented, but with the exception of that of Richards', none of these have given strong and durable joints. Heraeus makes use of the fact that at a certain temperature, far below its melting point, aluminium becomes plastic and can be kneaded. The edges of the plate or ends of the wires to be joined, are raised to and maintained at this temperature, and are kneaded together until an homogenous mass of metal has been produced at the point of contact.

At the Paris Exhibition a wire 5ft. long, made up of 12 shorter pieces soldered together by the Heraeus method, attracted considerable attention.

It is expected by the inventor that the new method will prove servicable in manufacturing large vessels of aluminium for chemical purposes, and a vessel has already been constructed by the new method out of five separate pieces of aluminium plate 10mm. thick, with a capacity of 27 cubic ft. This vessel has stood a test of 5 atmospheres internal pressure without showing any leakage at the joints.

The interest in the various alloys of aluminium increases, as it becomes more and more apparent that the uses of the unalloyed metal are very restricted. In France separate companies have been floated to take up the manufacture of special alloys of the light metal, and "Partinium" and "Albradium"—two of these alloys—are expected to have a wide field of usefulness. The former is an alloy of aluminium and tungsten, and it is used in the motor car industry for portions of the structural work of the carriages. The latter is an alloy containing copper, nickel, zinc, phosphorus, and aluminium, and it takes a polish equal to that of silver. Another series of alloys of the light metal made in France contain tin, copper, zinc, and aluminium. The specific gravities of these alloys varies between 2·8 and 7·1. They are used for casting the more delicate parts of instruments and machines which have hitherto been made entirely by the lathe. Regarding other applications of aluminium—military outfits, boat building, printing, and metallurgical reductions—there is little new to report during the past year.

The campaign in South Africa gave a brief boom to the trade in aluminium camp outfits. The use of aluminium for printing purposes is slowly making headway in England; more quickly in Germany and in the United States. The Goldschmidt process for obtaining high temperatures for welding purposes, by means of a mixture called "Thermit" (aluminium powder and oxide of iron), has attracted much attention during 1900; but it was fully described two years ago and little has been added to the information then given. *The Times*, however, regarded it as a new invention, and devoted a column to its description in September last.

**Calcium Carbide.**—The chief event of the past year has been the heavy fall in the selling price of carbide—a fall which has put a sudden end to the "boom" in carbide commencing in 1897. This financial collapse had been foreseen by the

* *The Electrician*, November, 1900.

* *The Electrician*, October 26, 1900.

writer and by others who had made a special study of the growth of this new industry, and it is but the inevitable result of the over-speculation that attended the "boom," and of the over-production to which that speculation gave rise. At the commencement of the year carbide was selling for £15 to £20 per ton at the various localities in Europe where it was manufactured. Six months later carbide could be obtained f.o.b. at Hamburg or Rotterdam for £10. 10s. per ton, this price including packages and freight to the two ports named. The carbide factories cannot, in most cases, make any profit at this low price, and many of them have closed down for an indefinite time, while others are using their power for the manufacture of electro-chemical products. At the annual meeting of the German Acetylene Congress at Dusseldorf, in September, 1900, the future of the industry was the subject of a somewhat heated discussion. And Liebetanz stated his conviction that many of the recently-built carbide works run by water-power were badly placed, and would never pay. In his opinion carbide works deriving their power from blast-furnace gases, in the centre of manufacturing districts, will be built in the next few years, and will compete successfully with the water-power factories situated in remote corners of Europe. Dr. Munsterberg, of Berlin, objected to this threat of increased competition, and stated that every carbide works in operation was losing money at the prices ruling in September. In his opinion a price of £15 per ton would have to be regained before profits could be made by existing works. The writer doubts, however, whether the price of carbide can be restored to this figure now that the supply has overtaken the demand, and it is more probable that the future price will fluctuate between £10 and £12 per ton, and that those factories which cannot manufacture at this figure will devote their electrical power to other purposes.*

The fall in price of carbide is an undoubted gain to those interested in the acetylene lighting business, for it reduces by 30 to 50 per cent. the cost of their raw material, and will enable acetylene to compete as an illuminant on much more favourable terms with gas and oil. This view found expression in several speeches at the Dusseldorf Congress, and there will be a strong and interested opposition from this quarter to any attempt on the part of carbide manufacturers to restore the old level of prices.

There are already 34 central supply stations for acetylene gas in operation in Europe, and five in U.S.A. The use of the new illuminant for railway carriage lighting is also extending rapidly on the Continent. Dr. Rose estimates that the consumption of carbide by the Prussian State Railway in 1900 for this purpose will amount to 8,000 tons.

The number of acetylene supply stations now in existence has enabled reliable figures to be obtained for the actual cost of the gas, when generating, purifying and distributing charges have been met. Although carbide has been greatly improved in quality since the early days of the industry, purification of the acetylene gas is still *absolutely essential*; and on this account the use of small domestic generators is not extending in localities where central supply stations can be operated under favourable conditions. The prices charged by these central supply stations for acetylene gas in Europe have ranged from 49s. to 75s. per 1,000 cubic ft. In England the price charged at a central supply station in Kent is 60s. The fall in the price of carbide will, of course, be followed by a drop of from 20 per cent. to 30 per cent. in these charges for acetylene gas, but acetylene at 45s. per 1,000 cubic ft. is only equal to coal gas at 4s. 6d. per 1,000 cubic ft., and its use will therefore still be restricted to country districts where oil is its chief rival.

Owing to the unsettled state of the industry no estimate of the amount of carbide produced in Europe or America during 1900 can be relied upon.

The number of works built for manufacturing carbide now exceeds 100, but it is safe to prophesy that not one of these has been employing the whole of its available power for carbide production during the past year. Several companies have failed, others have undergone reconstruction (the modern method of escaping failure), and many works have temporarily suspended operations. A French authority has estimated that the world's production of carbide in 1900 would equal 256,000 tons. If one divides this total by three the quotient will, in the writer's opinion, be nearer the actual figure.

As regards the production of carbide in the United Kingdom, the British Aluminium Co. have now taken the manufacture into their own hands at Foyers, and, if required, can produce 3,000 tons of carbide per annum. The Acetylene Illuminating Co., who formerly rented the power, now confine their activity to distributing this carbide to the consumer. They have, however, taken up the installation of central supply stations as a branch of their business, and have made some progress in this direction during the year.

There have been one or two judgments of interest delivered during 1900 relating to carbide patents. In France, the Bullier patents have been upheld, and all companies which do not operate under these patents will now have to look forward to infringement proceedings. In this country, the Acetylene Illuminating Co. have won a similar case against the Midland Acetylene Co., but as the latter company is in liquidation, and did not defend the suit, the victory is not of much practical value. The United Alkali Co. have, however, now commenced to manufacture carbide in Lancashire, and it will be of interest to see whether the company claiming a monopoly of carbide manufacture under the Wilson patents will venture to fight this much more important and wealthy corporation.

Chlorates of Potash and Soda.—The number of works producing chlorates by the electrolytic method has been increased by one since the date of the last report, a small factory at Alby, in Sweden, having commenced operations towards the end of 1899. The total number of electrolytic chlorate factories is now 11, situated as follows: United States three, France two, Sweden two, Germany two, Austria one, Switzerland one. These 11 factories have about 40,000 H.P. available for the manufacture of chlorates, but the majority of them have produced carbide and other electro-chemicals in addition to chlorates during the past year, and it is impossible to give any reliable estimate of their output of chlorates during 1900. It is, however, probable that the proportion of the world's total consumption of chlorates supplied by the electrolytic works is gradually increasing, and that the old Liebig process is losing ground. Guillet in a recent survey of the French chemical industry, estimated the output of chlorates in France in 1899 at 3,850 tons, of which total 3,000 tons was supplied by the two electrolytic works at St. Michel and Chedde, in Savoy, and only 850 tons by the two older factories using the Liebig process. The discovery of Muller that the addition of a small quantity of potassium chromate to the electrolytic cell greatly increases the yield of chlorate per electrical horse-power hour (according to Hausserman this addition doubles the practical output) will no doubt be generally adopted in the electrolytic works, and it would therefore seem probable that before 1905 the Liebig process of chlorate manufacture will cease to be worked. Another improvement in the working of the chlorate cell, which may lead to important practical results, is that described in a recent German patent. This depends upon the use of a small quantity of alumina in the cell, in order to combine with the sodium hydrate as it forms at the cathode, and thus reduce the losses resulting from secondary electrolysis. The efficiency of the chlorate cell as originally worked was only about 20 per cent., so there is wide margin for improvement.

During the past year Carlsen has published some details of the process worked at Mansboe, in Sweden. No diaphragms are employed in the cell, which is charged with an alkaline electrolyte; and this claim in the original patent granted to Carlsen (Swedish patent 3,614 of 1890) is held to invalidate the later patents of Kellner and of Schuckert & Cie. relating to the addition of alkalies to a chlorate cell. As the writer has frequently pointed out, however, most chlorate patents are invalid, and Carlsen himself was anticipated by Charles Watt in his patent No. 13,755 of 1851.

* In this connection it is interesting to note that the Union Carbide Co., of U.S.A., are selling carbide packed for export at £12 per ton, and that large amounts have been exported by this company to Europe and to the Far East.

The price of chlorates has increased 20 per cent. during the past year. On December 31, 1899, chlorate of potash was selling for 3¼d. per pound in South Lancashire, and 12 months later it was quoted at 3⅞d., the rise of ⅝d. per pound being chiefly due to the advance in the cost of fuel.

The chief event of the year in the chlorate industry has been the trial of the law case St. Helens Corporation *v.* United Alkali Co., arising out of the disastrous explosion of a chlorate store at one of the works of the latter company at St. Helens in May, 1899. The Corporation claimed £5,000 damages for the destruction of a gas-holder at the Corporation Gas Works. The United Alkali Co. denied liability, asserting that chlorate of potash *per se* was not previously regarded as an explosive. After a lengthy trial the jury decided that the company ought to have known that chlorate of potash *per se* was an explosive under certain conditions, and that proper precautions ought to have been taken to prevent these conditions arising in their works. Judgment was given in accordance with this verdict; other claims for damages will now probably be settled by arbitration. The practical result of this explosion should be the banishment of all wood and other inflammable materials from the buildings in which chlorates are made or stored.

Copper.—The past year has been marked by a continuance of the high prices first obtained in 1899, for all classes and brands of copper. The control of the market by the Amalgamated Copper Co., of New Jersey, which seemed to be weakening towards the end of 1899, has been strengthened during 1900, and there appears to be little chance at present of copper sinking back to its former level of price—about £50 per ton.* The new mining companies which were floated during 1899 have not yet had much effect upon the visible supplies of the metal, and the world's output of copper for 1900 will not be greatly in excess of that for 1899, when 470,000 tons were produced.

Of this total it is now estimated that 44 per cent. is refined by electrolysis in the 42 refineries of Europe, America, and the Far East. These 42 refineries are situated as follows: America, 8; Germany, 9; France, 8; England, 7; Austria, 4; Russia, 3; Japan, 2; Australia, 1.

Only one of these — that at Papenburg, in Germany—starts with the ore as raw material; the remaining 41 use black or bessemerised copper for their anodes. The process used at Papenburg is that of Hoepfner, and is combined with a nickel-extracting process. Very few details have yet been published concerning the practical operation of this plant, and it is not yet proved that the process is a financial success. A similar works was to have been established at Hamilton, Ontario, but some hitch has occurred in this development, and for the moment the installation of the Hoepfner process at this place is suspended.

The latest estimates for the production of electrolytic copper by the American and European refineries give a total of 210,000 tons, divided as follows: U.S.A., 172,330 tons; Europe, 37,670 tons.

Several new copper refining processes have been described during 1900, but it does not appear than any of these are yet worked upon an industrial scale.

In America the "Arlington Copper Co." proposes to extract the copper from a poor ore—mined in New Jersey—by roasting, crushing and leaching with sulphuric acid, and electrolysing the resultant solution of copper sulphate. The ore contains 2 per cent. copper and a 90 per cent. extraction is expected. In England Cowper-Coles proposes to deposit tubes and other hollow articles, by means of a mandrel vertically placed in the depositing vat, and revolving at a high speed. The friction of the electrolyte is said to conduce to smooth and dense deposits of the metal, and agate burnishers—or strips of skin—are thus dispensed with. There would seem to be no doubt that this method yields satisfactory deposits, but the priority of Cowper-Coles' patent protecting this feature is disputed by Wilde; and, according to Lees, the method had been in use at Owens College for some years before Cowper-Coles' patent application was filed. Litigation may, therefore, be expected if Cowper-Coles attempts to enforce the claims of his patent No. 16,210 of 1899.

* As a result of the maintenance of copper at a price above £70 per ton, it is interesting to note that the Rio Tinto Co. paid an 80 per cent. dividend to its shareholders for the year 1899, and carried large sums forward and to reserve. This proves the correctness of the opinion that copper can be produced at present for about £40 per ton, and that the surplus is clear profit.

Hypochlorites.—The electrolytic methods of producing hypochlorite of soda solutions for bleaching wood pulp and textile goods are making progress; but it is exceedingly difficult to obtain any reliable information concerning the actual number of works and factories using these methods, or any accurate figures for the aggregate horse-power employed. The methods have been most widely adopted on the Continent of Europe; and in Germany, Austria and Russia a large number of the textile bleaching works are now using electrolysed salt solutions in place of bleaching powder. The latest available information relating to the various modifications of the original cell, described by Charles Watt in English patent No. 13,755 of 1851, is given below.

The Hermite form of cell is in use at Stjernfors, in Norway, for bleaching sulphite wood pulp. The daily output of this mill is 1,750kgs. pulp, using 187kgs. salt and 75 H.P. It is also in use for a similar purpose at Essonnes, and at a large number of other paper works in France. The use of electrolysed sea water prepared in the Hermite cell for sterilising or disinfecting sewage has not proved a success, and the installations at Worthing, Lytham, Ipswich, and other places are, the writer believes, all dismantled. At Havana, in Cuba, however, a similar process is stated to be working successfully. The Kellner hypochlorite cell is in use at Hallein, near Salzburg, in Austria, where 20,000kgs. of wood pulp is being produced per day. It is also used at the paper works near Gratz, in the same country, and at the Kellner-Partington Paper Pulp Co.'s new works in Norway. Gebauer & Co., of Charlottenburg, have undertaken the introduction of this cell in the textile industries of Europe, and it has already been installed in a large number of bleaching works in Germany, Switzerland, Holland, and Russia. With the latest form of Kellner cell a 10 per cent. salt solution is used, and a 50 per cent. current efficiency is said to be obtained.

The Vogelsang cell is in use in a large number of textile factories in South Germany, but no new facts have been published concerning its progress during 1900. The hypochlorite cell patented by Haas and Oettel differs from those named above in that carbon is used for anode material in place of platinum. This, of course, greatly reduces the original cost of the cell but it necessitates the settling or filtration of the electrolysed solution before use. A very full description of this cell has recently been published by Oettel, who claims that it is the most efficient of all the cells in use when producing hypochlorite solutions of high concentration. The cell is in practical operation at the wool-bleaching works of Wolle, at Aue, in Saxony.

Other hypochlorite cells, concerning which no fresh information has been published during 1900, are the Corbin, the Stefanow, and the Woolf. The first is in use at Nancy, the second at many places in Southern Russia, while the third is used for disinfecting purposes at Havana, in Cuba. No English bleaching firm has yet adopted the electrolytic method for preparing hypochlorite solutions; but the trials to which reference was made in the last report are being continued at Bradford, and doubtless the results obtained will be published during the present year.

*(To be concluded.)*

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.

"Dynamo-Maschinen ihre Berechnung und Construction durch praktische Beispiele erläutert." By J. P. Bradwell. 3 vols. (Potsdam: A. Stein.) 2m. each.

"Alphabetical Lists of United States Patentees and Inventions for the Quarter ending June 30, 1900."

## PATENTS EXPIRING IN 1901.

The following is a list of the patents of interest to electrical engineers which (unless specially extended by recommendation of the Judicial Committee of the Privy Council) will expire during the present year. The list includes only those patents of 1887 which have been kept in force up to date by payment of the renewal fees :—

| Date (1887). | No. | Name of patentee. | Subject of patent. |
|---|---|---|---|
| Jan. 4 | 123 | H. C. Sergeant ...... | Valve for direct-acting engines. |
| Jan. 7 | 254 | W. Chadburn ... .... | Elec. communicating apparatus. |
| Jan. 15 | 666 | Reinh'rd Mannesm'nn & Max Mannesmann | Tubes. |
| Jan. 15 | 683 | Alexander Siemens .. | Holophotes. |
| Jan. 15 | 701 | S. Z. de Ferranti..... | Electrical meters. |
| Jan. 15 | 702 | S. Z. de Ferranti... .. | Dynamo-electrical machines. |
| Jan. 26 | 1,201 | A. MacLaine ....... | Steam piston packing. |
| Feb. 7 | 1,904 | Gisbert Kapp, W. H Snell, and J. M. V. Money Kent | Transformers. |
| Feb. 7 | 1.914 | R. McLaren Young . | Lubricators. |
| Feb. 16 | 2442 | T. Tripp ............... | Metallic packing for pistons, &c. |
| Feb. 22 | 2,783 | J. H. Knight ......... | Oil engines. |
| Feb. 24 | 2.851 | T. Parker.............. | Automatic switch. |
| Mar. 11 | 3,744 | J. Richardson and B. R. Rowland | Valve gear for steam engines. |
| Mar. 16 | 3,989 | P. Brotherhood ...... | Three-cylinder steam engines. |
| Mar. 21 | 4,225 | G. Hookham ........ | Electricity meters. |
| Mar. 29 | 4,654 | E. H. Cowles and A. H. Cowles | Electric furnaces. |
| Mar. 29 | 4,676 | G. Westinghouse, jun. | Fluid pressure automatic brakes. |
| Apr. 12 | 5,312 | Hon. C. A. Parsons .. | Turbines. |
| Apr. 18 | 5,648 | J. H. Holmes ......... | Switches. |
| Apr. 20 | 5,730 | J. Metcalfe and E. Davies | Injectors for steam boilers. |
| Apr. 20 | 5,731 | E. Davies and J. Metcalfe | Injectors, &c., for steam boilers. |
| Apr. 23 | 5,951 | W. D. Priestman and S. Priestman | Oil engines. |
| Apr. 25 | 6,007 | J. and G. Weir ...... | Steam condensers. |
| May 4 | 6,555 | J. Allerton and F. Mori | Appliances for lighting safety (electric) lamps. |
| May 12 | 6,987 | A. Siemens ...... .... | Electric arc lamps. |
| May 25 | 7,618 | W. M. Mordey & Maj. Gen. C. E. Webber | Transformers. |
| May 25 | 7,625 | Sir E. Green, Bart.... | Fuel economisers. |
| June 8 | 8,228 | The Babcock & Wilcox Co. (N.Y.) & C. A. Knight | Boilers. |
| June 8 | 8,262 | W. M. Mordey......... | Dynamos. |
| June 20 | 8,856 | H. Aron .... ......... | Electric meters. |
| June 24 | 8,999 | W. Horsfall ..... ...... | Dust destructors. |
| July 12 | 9,725 | G. Westinghouse, jun. | Dynamo-electric machines. |
| July 12 | 9,726 | G. Westinghouse, jun. | Armatures. |
| July 12 | 9,727 | G. Westinghouse, jun. | Commutators. |
| July 12 | 9,728 | G. Westinghouse, jun. | Electric converters and boxes for same. |
| July 12 | 9,729 | G. Westinghouse, jun. | Electric converters. |
| July 12 | 9,730 | G. Westinghouse, jun. | Voltmeters. |
| July 12 | 9,731 | G. Westinghouse, jun. | Ammeters. |
| July 12 | 9,732 | G. Westinghouse, jun. | Electrical indicators. |
| July 12 | 9,733 | G. Westinghouse, jun. | Apparatus for regulating electrical circuits. |
| July 12 | 9,734 | G. Westinghouse, jun. | Means for transmitting electricity to a distance. |
| July 12 | 9,735 | G. Westinghouse, jun. | Electrical distribution apparatus |
| July 12 | 9,736 | G. Westinghouse, jun. | Connections between alternate current generators. |
| July 12 | 9,737 | G. Westinghouse, jun. | Apparatus for electrical distribution and conversion. |
| July 12 | 9,738 | G. Westinghouse, jun. | Apparatus for electrical distribution and conversion. |
| July 12 | 9,739 | G. Westinghouse, jun. | Automatic controlling apparatus for electrical circuits. |
| July 12 | 9,740 | G. Westinghouse, jun. | Apparatus for elec. distribution. |
| July 12 | 9,741 | G. Westinghouse, jun. | Apparatus for distributing electricity to railways, &c. |
| July 12 | 9,742 | G. Westinghouse, jun. | Apparatus for controlling electrical currents. |
| July 12 | 9,743 | G. Westinghouse, jun. | Incandescent lamp sockets. |
| July 12 | 9,744 | G. Westinghouse, jun. | Cables. |
| July 12 | 9,745 | G. Westinghouse, jun. | Transformers. |
| July 16 | 9,[illegible] | S. E. Howell ......... | Boiler tubes. |
| July 29 | 10,545 | A. Normand et Cie.... | Steam engines. |
| Aug. 13 | 11,065 | J. Jackson ......... | Belt fastener. |
| Aug. 23 | 11,502 | E. F. H. H. Lauckert | Dynamo-electric and electrodynamic machines. |
| Aug. 24 | 11.543 | H. Tudor ............. | Accumulators. |
| Sept. 13 | 12,132 | W. D. Priestman and S. Priestman | Hot air engines. |
| Sept. 26 | 12,986 | J. Vicars, T. Vicars, and J. Vicars, jun. | Mechanical stokers. |
| Sept. 27 | 13,092 | Société A. Cruto et Cie | Incandescent lamp filaments. |
| Oct. 15 | 14,024 | N. de Bernardo ...... | Accumulators. |
| Oct. 28 | 14,710 | L. Serpollet............ | Steam boilers. |
| Oct. 31 | 14,783 | J. C. Dobbie............ | Mariner's compass. |
| Nov. 8 | 15,232 | E. Berliner ............ | Apparatus for reproducing sounds. |
| Nov. 11 | 15,455 | W. S. Rogers ......... | Apparatus for connecting a number of electrical conductors to one main conductor. |
| Nov. 12 | 15,484 | Philip Cardew......... | Safety devices. |
| Nov. 26 | 16,258 | T. S. McInnes ......... | Engine indicators. |
| Dec. 10 | 17,047 | Frank King............ | Accumulators. |
| Dec. 24 | 17,768 | W. S. Smith, jun. ... | Apparatus for covering or insulating wire. |

## TROLLEY TRAMWAY v. MAGNETIC OBSERVATORY.

The present stage of the disagreement between the authorities of Kew Observatory and the London United Tramways Co. is well indicated in the following extracts from recent issues of *The Times*. Our first extract is from a communication printed in *The Times* on Christmas Day :—

Stretching westwards from Shepherd's Bush to Acton and from Hammersmith-broadway towards Kew and Brentford are several miles of tramway, which for some time have been completely equipped with everything necessary for electric traction. At Chiswick a large generating station, whose tall chimney is the most conspicuous object in the landscape of those parts, is ready to supply current to drive the cars along those tramways, and at the adjacent depôt the cars themselves—the most roomy and comfortable yet seen in the streets of London—are standing in scores, waiting to begin their work. The state of affairs, in short, is such that at a few minutes' notice, since the boilers are now constantly under steam, an efficient service of electric trams could be started on these lines. But, in fact, as yet not a single electric car has set out from the yard, and the people of West London are being debarred from enjoying the advantages of electric traction which Parliament has granted them. The reason for this delay in the opening of the first system of electric tramways seen in London is to be found in the action of the authorities who preside over Kew Observatory, combined with the inaction of the Board of Trade . . . . .
It is feared that the running of electric trams in West London will impair the scientific value of the magnetic observations at Kew, since it will be impossible to tell whether any particular indication recorded by the instruments is due to natural magnetic disturbances in the earth or to artificial disturbances proceeding from the tram lines. To prevent such a fate from falling upon magnetic observatories, Parliament has left it to the Board of Trade to see that adequate safeguards are provided by those who carry on electric tramway undertakings. In the present case the Board has for something like two years been engaged in negotiations with the parties concerned the West London and other electric tramway and railway companies and the scientific men who watch over the interests of magnetic observatories. The latter desired that the London United Tramways Co.'s lines should be installed in such a way that the difference in potential between any section of rail and the earth in its immediate vicinity should not exceed one-fifth of a volt, although 7 volts is the limit ordinarily allowed by the Board's standard regulations. They suggested that this might be ensured by the use of an insulated return, and a scheme of the sort was proposed, in which there were two trolleys on each car and two overhead wires above each track, the current being conveyed to the car by one and returning by the other. This plan minimised the chance of stray currents in the earth, but it had grave disadvantages of its own, from the point of view both of the company and the public, which seemed to render it undesirable, if not impracticable. Many people regard the two overhead wires required with the ordinary trolley system as a serious disfigurement to the streets, but with this plan the minimum number is four, and in places it would be necessary to have as many as 13, including guard wires. The tramway company looked askance at the heavy expenditure that would be entailed both in first cost and in maintenance, it considered that the frequency of the service it would be able to afford would be reduced, and it feared that for reasons of economical working a potential difference of 1,000 volts would be required between each pair of wires, in place of the 500 now prescribed, in the interests of public safety, as the *maximum* by the Board of Trade's regulations. It also pointed out, as an interesting commentary on the requirements of Kew, that at the present time, with none of its own generators at work, a difference of potential has been measured in the lines, amounting to as much as four-fifths of a volt presumably owing to stray currents from the Central London Railway or other electrical undertakings which are carrying on their business without interference. That is to say, the lines at Chiswick, quite apart from the operations of the tramway, are already the seat of electrical disturbances four times more intense than the *maximum* suggested by Kew as necessary for its own protection, and it need scarcely be remarked that this state of affairs, which, if Kew's own calculations are correct, should already have affected the instruments, would not be altered for the better, no matter what outlay on insulated returns were imposed on the London United Tramways.

In order to solve the difficulty the Board of Trade appointed a committee of representatives of the interest involved, and this last met on Oct. 21, when, after after a long discussion, it was unanimously agreed that the Board of Trade should draw up such regulations as appeared to meet the case. That decision was arrived at more than seven weeks ago, but the promised regulations have not yet been issued, and the matter remains unsettled. . . Those who appreciate the enormous services which have been rendered to the world by pure scientific research will regret the discontinuance of the Kew magnetic observations, if that be inevitable, but at the same time they may reflect that magnetic storms are not a local peculiarity confined to Kew, and that observations of them, which, after all, are only a small part of Kew's work, can quite well be made in other parts of the country where electric trams are not likely to penetrate. . . . The removal of the instruments elsewhere, which was suggested as a way out of the difficulty, and to the cost of which the tramway company has offered to contribute to a reasonable extent, would, it is true, mean interrupting the continuity of a long series of observations. But at many other observatories, Greenwich for example, even longer series are in existence, equally applicable to such a purpose as the establishment of a general connection between sun spots and terrestrial magnetism, which was specifically referred to by the Astronomer Royal at the last meeting of the committee. Kew, again, is conveniently near to town, and the possibility of combining enjoyment of its amenities with the pursuit of pure science is doubtless not without attraction even for the most purely scientific mind. If, however, personal considerations of this kind are to be taken into serious account, the decision must surely be in favour of the millions of Londoners who, in Sir Benjamin Baker's phrase, are longing to "taste the sweets of electric traction." The question, however, is wider than Kew, for the magnetic observations at Greenwich also are threatened by the spread of electric traction, and it may be argued that, if the interests of science at Kew are to give way to the convenience of a tramway company, the precedent will be binding in the case of Greenwich and other places. But that does not seem a necessary consequence; many people will feel that the antiquity and prestige of Greenwich entitle it to be protected by restrictions which would be out of place as regards Kew. It must be remembered, too, that Greenwich and Kew, electrically speaking, dominate a very large part of London, and that, if their maintenance absolutely unimpaired is to be insisted on as of paramount importance, the result will be to hamper, to a greater or less extent, practically all the numerous electrical tramways and railways now being projected in London.

**In reply to this communication, Prof. Rücker sent the following letter, which appeared in *The Times* of the 28th ult. The letter is of especial interest as disclosing the attitude of the Kew Observatory authorities on several important matters affecting the main question:—**

SIR:—The communication which appears in your columns to-day on "Electric Trams and Magnetic Observatories" must not be taken as giving an accurate account of the controversy to which it refers. I begin with the statement that "if the rails were perfect conductors of electricity, or if they were perfectly insulated from the neighbouring ground, there would be no trouble. But neither of these conditions can possibly be fulfilled." The question is not whether theoretically "perfect" insulation can be attained, but whether what is ordinarily called insulation should be insisted on. Some five or six electric railways and tramways originally accepted a clause compelling them to insulate their return conductors, among them being the company which has power to construct tramways in the neighbourhood of Kew. The experimental line which has been constructed at Kensington for the District Railway has an insulated return. It is intended to use a system satisfying the same condition whenever the Inner Circle is run by electricity. I believe that I am right in saying that the London County Council intend to employ an insulated return for their electric tramways. "Insulation" in the ordinary sense of the term is, therefore, possible. The scientific men who have been working in the interests of the observatories have never claimed to dictate how the insulation is to be secured. The double trolley system, described in your correspondent's letter, was that selected by the adviser of the tramway company. Apparently they did not, at that time, consider it to be "undesirable and impracticable." If it is so, several other methods of obtaining the required insulation are known. They are familiar to the engineer of the District Railway and to the adviser of the London County Council.

When it became evident that electric traction was to be developed on a large scale, the question as to the precautions to be taken to protect observatories was referred to the Board of Trade. This action was made retrospective, and the company, which had undertaken to insulate the part of the line for which it had then obtained powers, became free to argue against insulation. It is for the Board of Trade to decide whether the cost of insulation is more than the companies should be asked to bear, and I will not discuss it.

When the matter came before the Board of Trade a committee was appointed to investigate the amount of the magnetic disturbances produced by the tramways. In this investigation I took part, and at the special request of the engineers we tested, at Stockton, a plan for protecting observatories which they proposed and which did not involve insulation. Though doubtful as to the success of the plan, we finally assented to it, though the same arguments which proved that it was likely to be successful proved that precautions would have to be taken throughout a larger area than had at first seemed necessary. The stringent suggested regulation as to limiting the potential difference between the rails and the earth to one-fifth of a volt was proposed by the representatives of the tramways, not by us, and in agreeing to it we only accepted a condition which they had expressed their willingness to fulfil. Having first accepted and then abandoned insulation, they have now found, we are informed, that the method of protection which they suggested at Stockton, and the conditions which they proposed on July 20 last, and which were accepted by us within a fortnight, cannot be carried out. I do not wish to blame them for the delay which has thus been caused, but they certainly have no right to blame anybody else. It is not correct to say that the "maximum" potential difference was "suggested by Kew." It was suggested by the engineers. As to the alleged fact that the stray currents from the Central London Railway are producing currents in the London United Tramways Company's lines, which ought to affect Kew, I do not, of course, dispute the fact that measurements have been made to which the engineers of the company have, in good faith, given this interpretation. I will only say that I do not accept the result until I have had an opportunity of criticising the details of the experiment. The Kew authorities have offered every facility for experiments to test the matter and for the inspection of their records, but on every occasion on which a definite date has been fixed the interview has been postponed at the request of the representatives of the companies.

Finally, your correspondent displays a tender care for the interests of Greenwich, which is convenient when Kew is, for the moment, the more seriously assailed. I have been for some years both a visitor of Greenwich Observatory and a member of the committee by which Kew has been controlled, and I must decline to discuss their relative importance as magnetic observatories. It is sufficient to say that the work carried on at the two places has not been identical, and that the special work of Kew must either be destroyed or transported to some other place. Your correspondent states that it is impossible to produce "perfect insulation," which is either not *ad rem*, or means that it is impossible to produce insulation sufficiently perfect for the protection of observatories. If this is so, Greenwich is seriously threatened, in spite of the fact that the London County Council are prepared to insulate their tramways. Whether other companies which may construct lines within a dangerous distance of Greenwich will adopt the same plan I do not know, but I am quite sure that, under existing circumstances, it would be unwise to spend money on increasing the magnetic work of Greenwich.

If the Board of Trade decides that it cannot adequately protect the Kew Observatory, the only feasible plan is to remove the more delicate part of the work to some isolated spot where "stray currents" are not to be feared. Such a removal would be expensive, and the annual expenditure involved in maintaining a separate staff and in keeping up a second establishment in an out-of-the-way place will add seriously to current expenses. For this the electric tramways ought to pay compensation. The defence of Kew is the defence of a branch of science to further which the most enlightened countries in the world are willing to found observatories and to send expensive expeditions to the Arctic and Antarctic regions. It is also the defence of the British maker of magnetic instruments, which cannot be tested in disturbed situations. It is absurd to represent a defence of this sort as a mere blind opposition to a great and growing industry, which I, for one, believe will be of the greatest use to town and country alike. The question is not whether electric traction shall be developed, but whether a small share of future dividends is to be spent in compensation for the injuries done to science and to a small but highly skilled trade, which wants all the support it can get if it is not to be killed by German competition.

**This correspondence evoked a leading article on the subject, which appeared in *The Times* of the 29th ult. This leader may be taken as an expression of the views of the non-scientific and non-technical world on the question, and is, therefore, of interest to our readers as showing the attitude of the general community. Accordingly we reprint it *in extenso*:—**

The application of electricity on the largest scale to the satisfaction of the common wants of life is one of the most important questions with which the public and the Legislature have to concern themselves at the present day. Owing in part to a certain slowness in accepting innovations which is characteristic of us, and in part to legislation of a confused and discouraging kind, we are behind most other nations in electric lighting, electric traction, and the distribution of electric motive power for machinery. Obstruction similar to that with which railways had to contend now meets all who endeavour to remove the reproach of indifference to an agency which is destined to produce economic and social changes comparable to those brought about by steam traction. In some cases the generic resemblance of the objections made in the two cases is so close as to be almost ludicrous; and in the later case, as in the earlier, the science of yesterday is sometimes found pitted against the science of to-day and to-morrow. On Christmas Day we published an article from a correspondent who had taken some pains to get at the facts, pointing out the delay that has occurred in the opening of an important electric tramline built to serve a great and growing population to the west of Shepherd's Bush and Hammersmith. That delay is due, as he puts it, to the action of the authorities of Kew Observatory, and the inaction of the Board of Trade. The Board has been carrying on negotiations for some two years, but, although everything has been ready for many weeks to begin the running of tramcars, the Board has not yet been able to make up its mind. It should be explained that the Board of Trade, in addition to its ordinary powers, has been constituted in an especial manner the guardian of the interests of Kew Observatory. At that observatory certain magnetic observations have been carried on for some 40 years, and it is alleged that they will be seriously disturbed, if not rendered altogether worthless, by the magnetic disturbances set up by the escape of electricity from the tramlines in the vicinity. Therefore the Board of Trade has been insisting that this particular tramway system shall submit to regulations indefinitely more stringent than those by which other undertakings of the kind are bound. It is idle in a case of this kind to attempt to follow the course of negotiations. The two parties never agree as to how particular

suggestions originated, or why particular arrangements fell through. Prof. Rucker, whose letter on the subject we printed yesterday, does not admit on behalf of Kew that our correspondent's article gives an accurate account of the controversy, but his criticisms, however interesting to the controversialists themselves, do not affect the broad facts of the case as it concerns the public.

The whole difficulty arises from the escape of the return current from the rails, which the tramway company have formed at great cost into conductors as perfect as can be made. Prof. Rucker does not pretend that by any system escape of stray currents can be completely prevented. The company, on the other hand, maintains that it has reduced their escape, not only to a fraction of what is permitted in ordinary cases by the regulations of the Board of Trade, but also to a point far below the electrical disturbances already produced in the district by existing electrical installations, such, for example, as the Central London Railway. Prof. Rucker does not admit the accuracy of their measurements of such disturbances, but he does not offer to show that they are inaccurate. It would have been very much to the point could he have assured us that the instruments at Kew are not at present affected by magnetic currents due to other causes than the normal variations of terrestial magnetism which it is their function to record. But he does not do this. Therefore it must be held somewhat problematical whether Kew would really suffer at all by the very small escape of electricity which the tramway company's arrangements would permit. Again, Prof. Rucker does not make it clear that the Kew authorities have ever made up their minds as to what arrangements would satisfy them; and this is the more unfortunate because an impression prevails that these negotiations have been protracted by the uncertainty in which the company was always left as to whether any particular arrangement they might make would be accepted as satisfactory. Suggestions were no doubt made, but they generally imposed burdens which a commercial undertaking cannot bear, in order to secure a theoretical efficiency which is useless in presence of other and more powerful disturbing causes. Nor were the objections always merely commercial, since the public convenience would be seriously interfered with by some of the devices for procuring high perfection of insulation.

But the root of the whole matter is probably to be found in the concluding sentence of Prof. Rucker's lettter, in which he says that the question is whether "a small fraction of future dividends is to be spent in compensation for the injuries done to science and to a small but highly skilled trade." We may put aside the trade and the reference to its possible disappearance under German competition. We shall be surprised if Prof. Rucker can show that the trade is worth £500 a year; and in any case its requirements can be met elsewhere as well as at Kew. What is the injury to science, and what is the compensation that science demands? That is the first question, and the second is how far ought this particular company to pay compensation for an injury which must come from many other sources? The Kew Observatory is in any case more or less moribund, since it is being transferred to Bushey Park. The instruments affected by stray currents are few in number, and are too delicate to exist in the vicinity of a huge city. Justice forbids us to place all the burden of changes due to the growth of London upon the shoulders of a single company whose operations have not been proved to add appreciably to existing disturbances. Supposing that this tramway is the last straw, what is a fair compensation to demand for disturbance? There is a sort of precedent in Berlin, where magnetic instruments had to be moved to another site on account of the increase in electrical stray currents. In that case our impression is that the compensation exacted was something under £2,000. It cannot be supposed that if the Board of Trade had named any sum of corresponding magnitude as compensation to Kew—or even a sum five or six times as great—a company with a capital of three quarters of a million lying idle would not have closed with the offer. The public which is waiting for its tramway accommodation would like to get down to the cash basis. What will it really cost to move these particular instruments to another site, and what is the sum that Kew, through the Board of Trade, is demanding? "A small fraction of future dividends" may seem a trifle to Prof. Rucker, but, even supposing the dividends earned, which has yet to be ascertained, the scientific mind should not encourage the unscientific notion that compensation should be measured, not by injury, but by the means of those called upon to pay.

## PASTES FOR ACCUMULATOR PLATES.

Sulphuric acid was the first medium employed for making the lead oxide paste used for filling the grids and other forms of carriers used in accumulators, but it has been known for a long time that a paste possessing very considerable binding qualities can also be made by mixing the lead oxide with pure water, and to ascertain the relative advantages of the two processes Dr. Peters has carried out the following experiments, which he has described in the *Centralblatt für Accumulatoren und Elementenkunde*.

The sulphuric acid paste was made according to minute directions given by Stefan Farbaky and Dr. Stefan Schenek, who formed the lead oxide into a dry, crumbly paste with 25 per cent. sulphuric acid, which was then filled into grid frames so that it projected 3mm. to 4mm. beyond them. It was beaten until a distinct sweating took place, after which the superfluous portions projecting beyond the frame were shaved off with a long, sharp knife. The frame was then turned and the other side treated in the same manner. After drying the plate for two or three days in the air, it was dipped as rapidly as possible into a 25 per cent. solution of sulphuric acid, lifted out quickly, allowed to drip well, and put aside upright. After 24 hours the plate was again dipped into the acid, but this time until the evolution of gas almost entirely ceased. After a further 24 hours it was subjected to a third immersion, which lasted from 10 hours to 12 hours.

For making an aqueous paste Zacharias gives the following short directions: Stir the lead oxide with water into a paste of the consistence of gruel and press it into a frame or form it into small blocks. When the plates are dried they can be further treated. What is meant by this further treatment is not clear from the text, but Dr. Peters understands it to mean immediate formation, before which, however, a further acidifying is generally found necessary in practice. Silvey assumes this in his directions, which run: Lead oxide is stirred into distilled water so that a stiff paste is formed, free from lumps or particles of dry oxide, which is then spread on the frames, and while the plates are still moist, they are placed in sulphuric acid of a strength of 15°B to 25°B. There they remain for a longer or shorter time according to the amount of oxide, on an average from two to three days. Finally the plates are completely dried, or sufficiently so to enable them to be handled without injury.

Experimental plates were made according to these three processes in order to judge of their relative hardness in the unformed condition. The process of Farbaky and Schenek gave block plates whose hardness left nothing to be desired, but those made according to Zacharias' method were crumbly throughout their thickness. The trial plates obtained by the Silvey process were somewhat better, as they were at least superficially covered with a hard crust of about 1mm. in thickness, whilst all the inner portions remained crumbly, and therefore, as is well known in practice, a short acidifying is not sufficient if dilute sulphuric acid is employed, and plates which require hardening are left, not a few days only, but weeks and even months standing in weak sulphuric acid. From the results obtained by making plates suggested by Zacharias and Silvey, it is doubtful whether mere mixing with water alone, followed by a short drying, is sufficient to give a thorough cohesion throughout the mass of the plate. At any rate the formation of hydrates by those methods does not take place sufficiently quickly and thoroughly to give the desired result. If certain modifications are introduced into the process, an aqueous paste will harden sufficiently in time; and, in any case, the hardening takes place more rapidly when a basic lead sulphate is formed, and as the samples prepared according to Silvey and Farbaky and Schenek have shown, there must be a definite proportion of lead oxide to the sulphuric acid to obtain a good result rapidly. Dr. Peters hopes to find time shortly for a closer study of basic lead sulphate, whose properties are interesting, not only in this connection, but also on account of the bearing they have on Mr. E. J. Wade's theory of lead storage batteries.

On the conclusion of these preliminary experiments, a number of plates were made by each of the three processes, each plate having 140 sq. cm. surface on one side, and the plates were set up, in sets of five, in ribbed glass cells containing sulphuric acid of density 1·15, and connected in series, a constant current being passed through them for 14 days. The average current was 2·4 amperes (corresponding to a density of about 0·4 ampere per square decimetre), which fell more frequently during the night to 1 ampere. After this period the Farbaky-Schenek electrodes had a fairly thick membranous surface coating of sulphate which could be removed with a knife. This coating disappeared completely with the further use of the accumulator. The surface of the negative material in the Silvey cell had blisters formed on it, particularly on the middle plates. These were removed, but appeared again in smaller quantities on further employment of the accumulator. A similar bubbling up of the spongy lead was noticed in the case of the Zacharias accumulator. After removal from the forming bath, the plates were trimmed up, straightened where necessary, and washed in distilled water, and they were finally set up in sulphuric acid of density 1·15. To determine whether the electrodes were formed throughout, the cells were discharged 13 times with currents of 2·5 amperes to 3·2 amperes, and re-charged with currents of 1·2 ampere to 3 amperes, and in some instances with currents up to 5 amperes, until a series of successive discharges gave the same capacity. Then the series of six cells were charged and discharged, the specially characteristic results of which are recorded in the following tables. The discharges were taken under similar conditions for each of the three kinds of accumulators, and a Siemens voltmeter was employed to measure the potential difference. It was found that the two cells of the same type behaved in an almost identical manner, and therefore only the results obtained from one cell in each case have been given. The discharges were pushed as far as possible in each case.

Tables I. to V. show that the fall in potential in the Farbaky-Schenek accumulator takes place more slowly and regularly with the low and medium current densities than in the Zacharias and Silvey accumulators. The latter, when discharging with a current up to 6 amperes, is better in this respect than cells made according to Zacharias; up to 8·4 amperes it is about the same, but above 10 amperes it is worse. At 14 amperes a slight improvement is shown, which is, however, probably due to some accidental cause. The superiority of the Farbaky-Schenek accumulator, as shown in Table IV., must be attributed to the good qualities of their spongy lead electrodes

**Table I.**—*4 2-ampere Discharge.*

| Time in hours and minutes. | Farbaky-Schenek cell. | | Zacharias cell. | | Silvey cell. | |
|---|---|---|---|---|---|---|
| | Potential difference. Volts. | E.M.F. Volts. | Potential difference. Volts. | E.M.F. Volts. | Potential difference. Volts. | E.M.F. Volts. |
| $0^{0}$ | 1·980 | 2·016 | 2·138 | 2·167 | 2·080 | 2·120 |
| $0^{15}$ | 1·959 | 1·998 | 1·959 | 1·998 | 1·960 | 2·000 |
| $0^{30}$ | 1·958 | 1·998 | 1·958 | 1·997 | 1·960 | 1·999 |
| $0^{45}$ | 1·957 | 1·997 | 1·957 | 1·995 | 1·958 | 1·998 |
| $1^{0}$ | 1·952 | 1·995 | 1·949 | 1·990 | 1·954 | 1·936 |
| $1^{15}$ | 1·949 | 1·992 | 1·943 | 1·986 | 1·948 | [illegible] |
| $1^{30}$ | 1·943 | 1·983 | 1·940 | 1·981 | 1·941 | 1·962 |
| $1^{45}$ | 1·941 | 1·981 | 1·938 | 1·978 | 1·937 | 1·980 |
| $2^{0}$ | 1·939 | 1·978 | 1·923 | 1·972 | 1·924 | 1·975 |
| $2^{15}$ | 1·932 | 1·976 | 1·914 | 1·959 | 1·913 | 1·962 |
| $2^{30}$ | 1·923 | 1·968 | 1·895 | 1·942 | 1·898 | 1·946 |
| $2^{45}$ | 1·919 | 1·960 | 1·862 | 1·920 | 1·868 | 1·930 |
| $3^{0}$ | 1·907 | 1·956 | 1·821 | 1·893 | 1·839 | 1·905 |
| $3^{15}$ | 1·899 | 1·943 | 1·740* | 1·836* | 1·760 | 1·810 |
| $3^{30}$ | 1·882 | 1·937 | ... | ... | ... | ... |
| $3^{45}$ | 1·866 | 1·920 | ... | ... | ... | ... |
| $4^{0}$ | 1·843 | 1·900 | ... | ... | ... | ... |
| $4^{15}$ | 1·808 | 1·877 | ... | ... | ... | ... |

* These observations were taken at 3 hours 10 minutes.

**Table II.**—*6-ampere Discharge.*

| | | | | | | |
|---|---|---|---|---|---|---|
| $0^{0}$ | 1·980 | 2·023 | 1·946 | 1·987 | 1·960 | 2·002 |
| $0^{15}$ | 1·940 | 1·995 | 1·926 | 1·980 | 1·932 | 1·983 |
| $0^{30}$ | 1·940 | 1·993 | 1·923 | 1·979 | 1·930 | 1·982 |
| $0^{45}$ | 1·940 | 1·986 | 1·920 | 1·978 | [illegible] | 1·980 |
| $1^{0}$ | 1·928 | 1·980 | 1·912 | 1·966 | 1·919 | 1·977 |
| $1^{15}$ | 1·970 | 1·976 | 1·900 | [illegible] | 1·902 | 1·963 |
| $1^{30}$ | 1·903 | 1·960 | [illegible] | 1·943 | 1·884 | 1·952 |
| $1^{45}$ | 1·886 | 1·945 | 1·847 | 1·920 | 1·860 | 1·930 |
| $2^{0}$ | 1·860 | 1·928 | 1·760 | 1·858 | 1·795 | 1·886 |
| $2^{15}$ | 1·839 | 1·916 | ... | ... | ... | ... |
| $2^{30}$ | 1·778 | 1·862 | ... | ... | ... | ... |

**Table III.**—*8 4-ampere Discharge.*

| | | | | | | |
|---|---|---|---|---|---|---|
| $0^{0}$ | 1·942 | 2·018 | 1·940 | 2·000 | 1·940 | 2·000 |
| $0^{10}$ | 1·922 | 1·997 | 1·920 | 1·985 | 1·922 | 1·995 |
| $0^{20}$ | 1·921 | 1·996 | 1·919 | 1·982 | 1·919 | [illegible] |
| $0^{30}$ | 1·918 | 1·990 | 1·904 | 1·980 | 1·910 | 1·980 |
| $0^{40}$ | 1·906 | [illegible] | [illegible] | 1·962 | 1·899 | 1·970 |
| $0^{50}$ | [illegible] | 1·974 | 1·877 | 1·933 | 1·880 | 1·961 |
| $1^{0}$ | 1·862 | 1·960 | 1·842 | 1·932 | 1·849 | 1·940 |
| $1^{10}$ | 1·863 | 1·946 | 1·777 | 1·882 | 1·783 | 1·900 |
| $1^{20}$ | 1·842 | 1·935 | ... | ... | ... | ... |
| $1^{30}$ | 1·820 | 1·917 | ... | ... | ... | ... |
| $1^{40}$ | 1·777 | 1·880 | ... | ... | ... | ... |

**Table IV.**—*10-ampere Discharge.*

| | | | | | | |
|---|---|---|---|---|---|---|
| $0^{0}$ | 1·908 | 2·005 | [illegible] | 2·008 | 1·908 | 2·006 |
| $0^{5}$ | 1·900 | 2·002 | 1·901 | 1·985 | 1·901 | [illegible] |
| $0^{10}$ | 1·900 | 2·000 | 1·898 | 1·980 | 1·884 | 1·982 |
| $0^{15}$ | 1·898 | 1·998 | 1·896 | 1·978 | 1·879 | 1·979 |
| $0^{20}$ | 1·892 | 1·990 | 1·885 | 1·974 | 1·861 | 1·972 |
| $0^{25}$ | 1·883 | 1·984 | 1·880 | 1·968 | 1·840 | 1·958 |
| $0^{30}$ | 1·875 | 1·980 | 1·867 | 1·960 | 1·820 | 1·944 |
| $0^{35}$ | 1·862 | 1·976 | 1·860 | 1·957 | 1·798 | 1·928 |
| $0^{40}$ | 1·859 | 1·965 | 1·842 | 1·944 | 1·760 | 1·905 |
| $0^{45}$ | 1·843 | 1·960 | 1·827 | 1·937 | 1·674 | 1·858 |
| $0^{50}$ | 1·838 | 1·954 | 1·812 | 1·922 | ... | ... |
| $0^{55}$ | 1·822 | 1·942 | 1·779 | 1·903 | ... | ... |
| $1^{0}$ | 1·803 | 1·936 | 1·694 | 1·855 | ... | ... |
| $1^{5}$ | 1·782 | 1·918 | ... | ... | ... | ... |
| $1^{10}$ | 1·710 | 1·895 | ... | ... | ... | ... |

Their potential as given by the use of a cadmium auxiliary electrode is lower and more regular in the latter period of discharge than the corresponding potential in the other two accumulators. At the commencement of discharge the negative material of the Silvey accumulator gives better results than that of the Zacharias, but during the rest of discharge it deteriorates so rapidly as to become much worse than the latter. The Zacharias soon after the beginning of discharge resembles the Farbaky-Schenek, but towards the end falls off again very much, though not until the Silvey has been already fully discharged. The behaviour of the Zacharias lead peroxide plate is better, especially at the beginning of the discharge, than the Farbaky-Schenek, whilst the Silvey occupies the mean position during the first portion of discharge, but is surpassed by both the other two at the end. The cells were also short-circuited for equal periods, after which the Zacharias showed the highest potential, being followed by the Silvey and the Farbaky-Schenek, which order was afterwards changed to Farbaky-Schenek, Zacharias, Silvey, while after 10min. the original one was restored.

**Table IVA.**—*Measurements with Auxiliary Electrodes of Cadmium.*

| Time in hours and minutes. | Farbaky-Schenek cell. | | Zacharias cell. | | Silvey cell. | |
|---|---|---|---|---|---|---|
| | B'tw'n cadmium and | | B'tw'n cadmium and | | B'tw'n cadmium and | |
| | Lead peroxide. | Lead. | Lead peroxide. | Lead. | Lead peroxide. | Lead. |
| $0^{0}$ | 2·068 | 0·183 | 2·160 | 0·239 | 2·130 | 0·212 |
| $0^{5}$ | 2·087 | 0·194 | 2·120 | 0·231 | 2·120 | 0·222 |
| $0^{10}$ | 2·096 | 0·200 | 2·107 | 0·220 | 2·118 | 0·235 |
| $0^{15}$ | 2·096 | 0·202 | 2·102 | 0·219 | 2·102 | 0·238 |
| $0^{20}$ | 2·090 | 0·203 | 2·101 | 0·220 | 2·099 | 0·240 |
| $0^{25}$ | 2·085 | 0·208 | 2·100 | 0·223 | 2·083 | 0·252 |
| $0^{30}$ | 2·082 | 0·217 | 2·099 | 0·234 | 2·079 | [illegible] |
| $0^{35}$ | 2·080 | 0·220 | 2·097 | 0·240 | 2·062 | 0·277 |
| $0^{40}$ | 2·078 | 0·222 | 2·089 | 0·248 | 2·042 | 0·288 |
| $0^{45}$ | 2·067 | 0·228 | 2·083 | 0·262 | 1·998 | 0·319 |
| $0^{50}$ | 2·062 | 0·239 | 2·081 | 0·280 | ... | ... |
| $0^{55}$ | 2·060 | 0·241 | 2·078 | 0·300 | ... | ... |
| $1^{0}$ | 2·053 | 0·255 | 2·062 | 0·365 | ... | ... |
| $1^{5}$ | 2·040 | [illegible] | ... | ... | ... | ... |
| $1^{10}$ | 2·021 | 0·283 | ... | ... | ... | ... |

**Table V.**—*14-ampere Discharge.*

| Time in minutes. | Farbaky-Schenek cell. | | Zacharias cell. | | Silvey cell. | |
|---|---|---|---|---|---|---|
| | Potential difference. Volts. | E.M.F. Volts. | Potential difference. Volts. | E.M.F. Volts. | Potential difference. Volts. | E.M.F. Volts. |
| 0 | 1·862 | 1·973 | 1·883 | 1·985 | 1·899 | 2·000 |
| 5 | 1·864 | 1·976 | 1·888 | 1·993 | 1·893 | 2·000 |
| 10 | 1·860 | 1·968 | 1·880 | 1·985 | 1·882 | 1·995 |
| 15 | 1·843 | 1·960 | 1·875 | 1·981 | 1·873 | 1·923 |
| 20 | 1·838 | 1·957 | 1·860 | 1·977 | 1·858 | 1·978 |
| 25 | 1·823 | 1·946 | 1·844 | 1·963 | 1·841 | 1·967 |
| 30 | 1·807 | 1·940 | [illegible] | 1·957 | 1·822 | 1·960 |
| 35 | 1·798 | 1·934 | 1·816 | 1·940 | 1·802 | 1·947 |
| 40 | 1·775 | 1·919 | 1·780 | 1·922 | 1·780 | 1·936 |
| 45 | 1·764 | 1·905 | 1·743 | 1·900 | 1·736 | 1·904 |
| 50 | 1·720 | 1·883 | ... | ... | ... | ... |

The E.M.F. in volts was :—

**Table VI.**

| Minutes after removal of short circuit. | Name of cell. | | |
|---|---|---|---|
| | Farbaky-Schenek. | Zacharias. | Silvey. |
| 0 | 0·960 | [illegible] | 1·020 |
| 5 | 1·698 | 1·667 | 1·608 |
| 10 | 1·762 | 1·819 | 1·783 |

From Tables I. to V. the following discharge capacities are obtained :

**Table VII.**

| Discharge current in amperes. | Discharge capacity in ampere-hours. | | |
|---|---|---|---|
| | Farbaky-Schenek. | Zacharias. | Silvey. |
| 4 2 | 17·85 | 13 30 | 13·65 |
| 6·0 | 15 00 | 12 00 | 12 00 |
| 8·4 | 14 00 | 9·80 | 9·80 |
| 10 0 | 11·67 | 10 00 | 7·50 |
| 14 0 | 11·66 | 10·50 | 10 50 |

As the discharge current is increased from 4·2 amperes to 14 amperes the capacity of the accumulators falls to 6·19, 2·80, 3·15 ampere hours respectively in the case of the Farbaky-Schenek, the Zacharias, and the Silvey.

Now it has long been well known, and Mr. Wade has recently again called attention to the fact, that the less variation there is in the capacity of an accumulator when it is discharged with different current strengths the better the diffusion of the electrolyte in the active material, but this diffusion depends on the porosity of the active material, so that the figures given above and the accompanying curves give at the same time a gauge of the porosity of the pastes formed by the different methods.

A further proof of the porosity of the Zacharias plates was afforded by the readiness with which the dried plates absorbed the acid. Pastes made with distilled water give more porous active material than those made with sulphuric acid. The former pastes give better peroxide plates than the latter if they are dried before being placed in the sulphuric acid, but the spongy lead electrodes formed from them are not very satisfactory. The paste mixed with sulphuric acid shows a tendency to sulphate during the process of forming positive plates from it.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday. Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "Electrician Newspaper London.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "The Electrician," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "The Electrician" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* The Editor.

*All letters for insertion in* "The Electrician," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"The Electrician" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "The Electrician" are as under:—

| | Year | Half-Year | Quarter | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 15s. 0d. ... | 8s. 0d. | |

*New Volumes of* "The Electrician" *commence in April and October.*

## THE NINETEENTH CENTURY.

On the threshold of a new century we may fitly glance backward upon the century just brought to a close; and all the more appropriately does it become a scientific journal to do so, inasmuch as the nineteenth century in the Christian era stands out pre-eminently from among all the centuries of every historic era as the Scientific Century. Never, so far as available historic records reveal, have material civilisation and intellectual progress been so closely and markedly identified with the natural sciences—as distinct from purely mental and ethical sciences—as they have been from the dawning year of the nineteenth century continuously unto its close. And, to consider exclusively for the moment the particular science with which the electrical fraternity is most closely associated, we may recall to mind that it was in the recently departed century that the science of Electricity, as an exact science, had its origin; and in that same century all the practical applications of electrical science were commenced. So swift, indeed, has been the development of electricity, both in theory and in practice, and so complete has been the revolution in scientific ideas in almost every department of science, that it is not without considerable difficulty that we who live at the commencement of the twentieth century are able to form any exact mental picture of the corresponding conditions of theory and practice at the dawn of the nineteenth century. Yet there is probably no more striking mode of realising the immense change that has taken place in this comparatively short space of three generations, than by conjuring to the imagination the state of things when the century began.

Let us first describe the conditions of outward material civilisation in this respect, and afterwards contemplate the more subtle matter of scientific thought. In the year 1801, a world that knew no railway, tramway, steamship, telegraph, gas, or electric light, stood on the threshold of the discoveries and inventions that in the fulness of time would make all these things possible. James Watt's steam engines, gradually being improved by a busy host of inventors, were multiplying on the face of the land, and the stationary steam engine was thus becoming a somewhat familiar object. In the year 1784,

WATT had run a model locomotive on an ordinary road, but not until 1814 would STEPHENSON really inaugurate the steam railway. Late in the eighteenth century several engineers had attempted, but virtually failed, to run a steamboat; but when the nineteenth century dawned SYMINGTON was building the first successful steamboat, which, in the following year, would tow vessels on the Forth and Clyde canal. In 1800, VOLTA had presented his invention of the electric pile to a world that till then had known only of "frictional electricity"; and thus all the manifold usefulness of the electric current was inaugurated substantially at the commencement of the century. This invention not only startled theorists and made them busy in new fields of research, it also set practical minds to work: in a few months NICHOLSON and CARLISLE had discovered by its aid the phenomenon of electrolysis, and thus laid the foundation of electro-chemistry; three years later (1808) Sir HUMPHRY DAVY produced the first electric light, from a carbon arc, by means of a large voltaic battery. It is, by the way, worthy of note that a few years before the opening of the nineteenth century the manufacture of iron received an enormous impetus from the invention of the puddling hearth by HENRY CORT in 1784; and, indeed, we may observe that throughout the century the development of mechanical engineering—of which electrical engineering is a branch—proceeded parallel with improvements in the manufacture of iron and steel, and would seem in a great measure to have been dependent upon these.

Turning now to matters of theory, we may note that at the beginning of the last century scientists were still holding in preservation the doctrine, propounded by Dr. GILBERT of Colchester in 1600, of the essential distinction between electricity and magnetism. Permanent magnets and frictional electricity were their entire stock-in-trade—except for the quite recent discoveries of GALVANI and VOLTA; but with this comparatively limited material numerous workers in the seventeenth and eighteenth centuries had laid a good foundation of experimental work and a measure of tentative theory. The nature of this work is sufficiently indicated by the names of the workers: Sir ISAAC NEWTON, HAWKSBEE, Sir WILLIAM WATSON, BENJAMIN FRANKLIN, SYMMER, ÆPINUS, CAVENDISH and COULOMB. The materialistic fluid theory of electricity was generally accepted, with a similar hypothesis of magnetism; and the essential distinction between magnetism, frictional electricity and "galvanism" was universally believed. It was an epoch of materialistic theories in the sciences; and between each science and all the others a line of distinction was drawn, as rigid as that between electricity and magnetism. The physical forces had not been "correlated"—a task which was left to Sir WILLIAM GROVE, Dr. JOULE, and others 40 years later. Heat was commonly believed to be a fluid, termed "caloric"; chemical action to arise from the transference of another fluid, termed "phlogiston"; light, a stream of corpuscles emanating from radiant bodies. Energy—that supreme link between the sciences—had never been thought of; its existence had not been suspected.

Having glanced at the state of affairs at the beginning of the last century, we will now hastily review the development of electrical science and its applications during that period. Electrically speaking, the nineteenth century has been an era of electric currents, while the previous century was an era of electrostatics. Not that electrostatics have been entirely neglected in the past century; on the contrary, they have played an important part in the development of theory; but the discoveries of VOLTA and FARADAY have given electric currents a dominating position both in theory and practice; and, indeed, these discoveries lie at the foundation of every important branch of practice. Telegraphy, which had been suggested and experimentally tried in the age of frictional electricity, was rendered practically possible on a commercial scale by VOLTA's invention of the primary battery, combined with OERSTED's discovery of the deflection of a magnetic needle by a current, in 1820; and it was actually realised for the first time by COOKE and WHEATSTONE in 1836. This same discovery by OERSTED, moreover, opened out an entirely new field in electrical science, a field that has proved rich in practical results and in scientific suggestiveness. It directly traversed GILBERT's great dogma of the essential disconnectedness of electricity and magnetism. AMPÈRE's theory of magnetism was its offspring; and, as a consequence of OERSTED's discovery, STURGEON, in 1825, made the stupendously important invention of the electromagnet. FARADAY also, working along the same vein, discovered, in 1821, the rotation of a movable conducting wire around a magnet pole, and thus established the fundamental principle of the electric motor. The Faraday period, which had now commenced, was, indeed, even more brilliant and far-reaching in its consequences than had been the Volta period, some 20 years to 30 years earlier. It produced the splendid age of MAXWELL in electrical theory; and it gave to the engineer the fundamental clue to the invention of the dynamo, the transformer, the telephone and a host of other modern electrical appliances. In the domain of electrochemistry, also, FARADAY's influence was felt, principally in the researches which enabled him to enunciate his laws of electrolysis, in 1833. His discovery of electromagnetic induction was announced in 1831. To MAXWELL, the exponent of FARADAY in exact mathematical language, we owe the stimulus that led HERTZ in 1888 to discover the tangible reality of electromagnetic waves, a discovery that has given rise to the latest of electrical applications—wireless telegraphy. Returning to the time of FARADAY (1833) we may reflect with a considerable amount of surprise that discoveries and inventions such as were his and his contemporaries' could have been made at a period when there was no knowledge of the conservation of energy, nor any clear apprehension of the interchangeability of the so-called physical forces. It was not until 1840 that Dr. JOULE commenced his famous series of determinations of the mechanical equivalent of heat; announcing in 1841 the law of heating by electric current which is known as JOULE's law. Probably no single doctrine in physical science has had so great and widespread an effect as that of the conservation of energy, in consolidating and unifying the physical sciences on an exact basis, and in suggesting new modes of applying physical science to the practical needs of civilisation. Space does not permit of our following in detail all the commercial applications of the electrical discoveries we have just reviewed. With the exception of land telegraphy, they all belong to the latter half of the century; whereas, as we have seen, the fundamental discoveries on which they are based were made in the first half of the century. The dynamo is but 50 years old; submarine telegraphy dates from 1845-50; the first practical arc lamp was invented in 1857; only 20 years ago FAURE brought the secondary battery, or accumulator, into commercial use; electrometallurgy in commerce dates from 1840; EDISON and SWAN's inventions of the glow lamp date from 1879; the Bell telephone was invented in 1876, and the Hughes and Edison microphone in 1878; the first electric tramway was devised in 1879, and the overhead trolley dates from 1884; while wireless telegraphy—the latest arrival—is of quite recent birth, and has not yet been been weaned from the laboratory stage of its career. The popular dictum that "electricity

is still in its infancy" is ofttimes held in derision by the profession; but may not its phenomenally rapid growth suggest the vigorous infancy of a powerful giant rather than the stature of a full grown man? What will be the tremendous energy of the giant when fully matured the century just commenced may duly reveal; but our present task is to look backward—looking forward over a hundred years, however fascinating, we leave to more speculative minds, and to those better gifted with the spirit of prophecy.

Looking backward, then, upon the Scientific Century, as it may aptly be called, our minds are filled with one question above all others, viz., What are the causes which have constituted the nineteenth century an era of phenomenal progress in science? It is not merely in electrical matters that progress unique and stupendous has been made: the records of other sciences reveal advances not less rapid or remarkable. Chemistry, geology, biology have all been transformed within the century; mechanical science has developed enormously; even civil engineering, ancient as was its origin, has absorbed plentifully of the modern scientific spirit. In thought and in practice, science has been the dominating factor of the age. Why is this? Why, in other words, did not the century of science follow closely upon, say, the Elizabethan age of intellectual and literary brilliance; or, why was it not postponed indefinitely? The scientific conditions were ripe, indeed, in the Elizabethan age, for the immediate and rapid development of science, inasmuch as the inductive principle of research, upon which modern science is based, was as well enunciated then as it is now. There must surely have been a certain combination of social, intellectual, and material conditions which has stamped a scientific character upon the past century—a combination which did not occur in any previous historic age. What that particular combination may have been it must be left to the historian at a far later date to discover; at the present time we stand too close to the nineteenth century to be able to comprehend its true proportions—a distant perspective in time is necessary for such a gigantic task. But we may, perhaps, be permitted to hazard a few suggestions, which at any rate will serve to direct attention to certain salient characteristics of the century that may have assisted in the development of its scientific character. These, broadly speaking, may be classified as intellectual, social and political. Where the purely intellectual conditions are considered, it must be conceded that many times in the world's history circumstances have been favourable to a development of scientific inquiry and research, comparable with what has been achieved within the last hundred years. We have mentioned already that the Baconian system of inductive research might, were other circumstances favourable, have inaugurated a Scientific Century 300 years ago. Again, we may note that, intellectually speaking, the scientific methods of Sir Isaac Newton and of the leading scientists of the seventeenth and eighteenth centuries were not one whit inferior to those of the present day. Wherein the nineteenth century has differed, however, in this respect, has been in the much greater number of scientific workers, resulting in a greater body of intellectual activity being concentrated upon the task. The cause of this superior activity is to be found in the social conditions peculiar to the nineteenth century. The spread of education has been regarded by some as the dominant social factor; but, though widespread education has exerted a measure of influence, a much more powerful and radical cause is to be found in the increase and more favourable distribution of wealth. All the intellect of the best ages would never have created a practical scientific age under a feudal system, where the very few were very rich, and everyone else was very poor. The motive and the means would both have been absent. Indeed, the increased wealth of the middle class and the amelioration of the lower class of society have given to scientific research a commercial motive that has reacted upon the pursuit of pure science, and has greatly encouraged it. Some professors do not like to hear this truth; they prefer to emphasise the delights of seeking scientific truth for its own sake. This is admirable in its way; but these professors overlook the fact that their very professional chairs are endowed by the wealth of men who have made their money through the applications of science and who look to science for further favours. Commerce, in recognising the money value of science, has been a potent factor in the aiding of scientists and in making their paths straight and easy. The more favourable distribution of wealth has also assisted in another way in developing science—namely, by producing a larger and more lucrative market for the products of scientific application—thus encouraging, of course, the spread of scientific invention and industry. We may note, by-the-way, that, whenever science has in any measure flourished in an age of popular poverty or of political unrest, it has invariably partaken of an academic and strictly non-practical character. The political factor, indeed, is of great importance, especially with regard to the condition of peace or war. Great wars there have been in the last century, it is true; but these have, generally speaking, been short and decisive; and, since the close of the Napoleonic wars early in the century, war has not given rise to any widespread and continuous feeling of unrest, such as must have exerted a marked retarding influence upon the arts of peace in earlier centuries. In conclusion, and while still regarding the political aspect of the question, we would withdraw our gaze from the civilised world in general and concentrate it upon our own favoured country. For all truehearted Britons the scientific developments that have imparted its distinctive character to the nineteenth century will be indissolubly associated with the glorious reign of our revered and illustrious sovereign Queen Victoria. Long may she reign.

## OBITUARY.

### LORD ARMSTRONG.

It was with great regret that we announced in our last issue that Lord Armstrong died on Thursday morning the 27th ult. at his residence, Cragside, Rothbury, Northumberland. Though his health of late had not been of the best, not till within a week of his death did cause arise for anxiety. Inability to rally from the effects of fever and internal chill brought the end somewhat suddenly.

William George Armstrong was born on November 26, 1810. His father, Mr. W. Armstrong, was a merchant of Newcastle-on-Tyne; his mother, a daughter of Mr. W. Potter, of Walbottle Hall, Northumberland. He was educated at Bishop Auckland, and chose the law as his profession, notwithstanding a bias towards scientific and mechanical subjects. Later, while still a member of a firm of Newcastle solicitors, he commenced his career as an inventor.

In 1838, having long reflected on the enormous power available in the innumerable streams descending the hills of the north country, he devised a hydraulic rotary engine, which he hoped might utilise some of the energy running so freely to waste. But finding that for many purposes—such as the operating of cranes on wharves—the reciprocating principle was superior to the rotary, he designed a crane in which cylinders and pistons effected every required motion. It was

not till 1845, however, that opportunity arose for the realisation of his scheme; but before the end of 1846 the first hydraulic crane erected was at work on the quay at Newcastle. Meanwhile, in and about the year 1840, Armstrong published an account of his investigations on the "Electricity of Effluent Steam"—investigations which led to his invention of the "hydro-electric machine," which so greatly interested Faraday, and which remained for long the most powerful producer of electrification. Already, in 1846, his discoveries and applications had attained such importance that he was in that year elected a Fellow of the Royal Society. Armstrong continued to erect hydraulic plants at various places in the country, using in every case the pressure of the town mains or the head of special reservoirs. But in 1850 he introduced into his system the use of the well-known "accumulator," which made hydraulic power capable of vastly wider adoption.

At the Elswick works, now thoroughly established, but as yet wholly devoted to the creation of hydraulic machinery, certain experiments in gun-building were now inaugurated. As a result, in 1856 Armstrong's first gun was produced. It was built by shrinking on to a steel barrel successive iron tubular shells; it was a breech-loader, and possessed polygrooved rifling. It fired a projectile of elongated shape and with ogival head with unexampled accuracy over an unprecedented range; and so satisfactory proved its trials that Armstrong was appointed Engineer of Rifled Ordnance, was made C.B., and knighted. Within the seven years succeeding more than 3,000 similar guns were added to England's armament. Unfortunately the continual recurrence of certain difficulties in the breech mechanism impelled the Government in 1868 to return to muzzle-loading guns. Sir W. Armstrong resigned his official position simultaneously. The same year he was president of the British Association at its Newcastle meeting. His address dealt with the then already threatening depletion of our coalfields and with the extravagant methods of coal users. When the Royal Commission on this same question was shortly afterwards ordered, Sir W. Armstrong was nominated to sit as a member.

Various honours fell to him about this time. He was in 1862 made a LL.D. of Cambridge, in 1870 a D.C.L. by Oxford, and in 1873 the Albert medal of the Society of Arts was awarded him. But there came to him a greater triumph when, in 1880, the Government re-adopted the breech-loading and polygroove rifling principles of Armstrong.

The following year, in his capacity as president of the Mechanical Section of the York meeting of the British Association, he again called attention to the more efficient utilisation of natural sources of energy. He raised a hope that the development of the thermopile might lead to perhaps a wholesale utilisation of solar energy. He estimated that the heat received by an acre of ground in the tropics would, if wholly converted, yield mechanical energy at the average rate of 4,000 H.P. In 1882 he was elected president of the Civil Engineers, and was elevated to the peerage in 1887—the year after his unsuccessful parliamentary contest of Newcastle against Mr. John Morley. The Bessemer Medal of the Iron and Steel Institute was awarded him in 1891. In 1897, when in his 87th year, he published an elegantly illustrated book, entitled "Electrical Movements in Air and Water," which discussed certain phenomena he had observed in his electrical experiments conducted 50 years previously.

The funeral took place on Monday last at Cragside, the arrangements being all of the extremest simplicity. The remains were laid beside those of Lady Armstrong, whom he married in 1835, and who died in 1893.

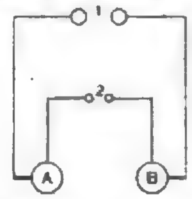
**Damage by the Recent Gale.**—Among the widespread disaster on land and sea created by the recent gale, damage to telegraph and telephone lines has been extensive and serious. The Post Office lines have greatly suffered, interrupting telegraphic communication over many parts of the country and with the Continent. Several of the submarine cable companies have also suffered through breakdown of their land lines.

## NOTE ON THE TRANSPARENCY OF METALS AND OTHER SUBSTANCES TO RADIUM RAYS.

BY T. MIZUNO.

While I was performing experiments on radium rays, I found that the transparency of metals and other substances to them could be easily and magnificently shown by means of a spark method. The usual method for studying the degree of transparency or, what comes to the same thing, the absorption of the rays by several substances is either a photographic or an electrometric one. The spark method to be described here is, of course, not quantitative like the electrometric one adopted by Meyer and Schweidler (*Phys. Zeitschrift*, No. 19), but it is very simple and highly advantageous when we want to show the experiment qualitatively to a large audience. So far as I am aware, no such spark method for the study of absorption is mentioned anywhere, and therefore it deserves, I think, a short account here. My experiment was conducted in the following way:—

To each of the poles A and B of an induction coil were respectively attached two wires forming the alternative spark-gaps 1 and 2, as shown in the annexed figure. These spark-gaps were formed by spark micrometers, so that the spark-lengths could be finely adjusted at will. Now suppose that one of the spark-gaps, say 1, is drawn apart just beyond its critical spark-length, that is to say, such a length across which the spark is just unable to spring, whilst the other spark-gap 2 is disposed just below its critical length. In this



sensitive state of the spark-gaps, if we bring the radium preparation into the neighbourhood of the gap 1 vivid sparks will take place there, while the sparks in the gap 2 will be either very much enfeebled or completely annihilated.

Setting the spark-gaps in such a sensitive state, I placed several substances under question, one after another, below the gap 1, and then brought the radium preparation just below those substances. In spite of the interposition of such substances, I still observed the sparks taking place in the gap. These sparks were evidently due to the action of some portion of the rays which passed freely through the substances. The substances thus investigated were:—

| | | | |
|---|---|---|---|
| Ebonite plate... | 1mm. in thickness. | Brass plate...... | 1mm. in thickness. |
| Glass plate...... | 2mm. ditto. | Copper plate... | 6mm. ditto. |
| Lead plate ...... | 2mm. ditto. | Nickel plate ... | 4·5mm. ditto. |

One of the striking properties possessed by the radium rays, namely, their power to pass through, though with some decided absorption, such thick metallic plates as mentioned above is thus qualitatively shown by means of a simple spark method.

## ON A PHASE-TURNING APPARATUS FOR USE WITH ELECTROSTATIC VOLTMETERS.*

BY ALBERT CAMPBELL, B.A.

For the measurement of alternating potential differences in many cases it is desirable or even essential to use electrostatic voltmeters. It is well known that these instruments are particularly unsensitive at the lower parts of their ranges, their scales closing in very much towards the zero point. When measurements of small direct-current P.D.s have to be made, it is an easy matter to add to $v$ (the small voltage to be measured) a constant voltage V, large enough to bring the deflection to an open part of the scale. When, however, the small voltage is an alternating one, the addition of a direct current V is almost useless, for the resultant effective† P.D. is only $\sqrt{V^2+v^2}$,

* Paper read before the Physical Society.

† As far as possible throughout this Paper I have used capital letters for *effective* (or root mean square) values.

*i.e.*, approximately $V\left(1+\frac{X^2}{2V^2}\right)$ when X is small compared with V.

But a satisfactory result is obtained if the auxiliary voltage V be of the same frequency as X and *in phase* with it; exact coincidence of phase is not absolutely necessary, as very little error is introduced by a lag of 5deg. or 10deg. between V and X.

When the phase adjustment is correct, the effective resultant is equal to V+X, and from this X can be immediately found. I have accordingly devised apparatus for the purpose of adding to an unknown voltage X a voltage V nearly in phase with X. Before proceeding to describe the apparatus a short digression on the theory of the subject seems desirable.

*Time Lag and Power Lag.*—In the first place let us consider the question of "difference of phase."

1. When the wave-forms of X and V (effective values) are sine curves

$$x = a \sin pt,$$
$$v = m \sin (pt + \phi),$$

then (*a*) the difference of phase between $x$ and $v$ is $\phi$, this angle being a measure of the actual *time lag* between $x$ and $v$. Also (*b*), if X and V are both voltages and P the effective value of their resultant $(x+v)$, and if (in Fig. 1) OXP is a triangle with sides X, V, and P,

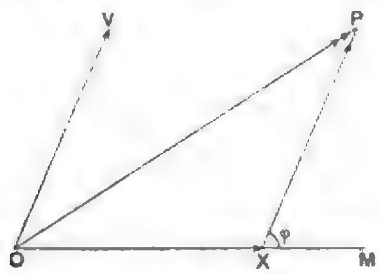


Fig. 1.

then the angle MXP is equal to $\phi$. (*c*) If X and V are the current and terminal voltage for a circuit, $\cos \phi$ is the power factor.

2. If the wave forms of $x$ and $v$ are not both sine curves, then, as Mr. Alexander Russell has already pointed out (*The Electrician*, November 3 and 10, 1899), the angle whose cosine is the power factor is in general not equal to the angle of *time lag* between $x$ and $v$. Indeed, when the wave forms of $x$ and $v$ are not similar, the time lag between them would have to be defined by some convention.

For practical purposes a sufficiently general case is

$$x = y + a \sin pt + b \sin 3pt + \ \ldots$$
$$v = e + m \sin (pt + \phi_1) + n \sin 3(pt + \phi_2) + \ \ldots$$

where $y$ and $e$ are direct-current components. Here the time lags $\phi_1, \phi_2 \ \ldots$ are not necessarily the same for the various harmonics, and to talk of the difference of (time-) phase is thus almost meaningless.

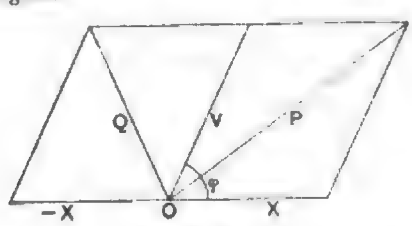


Fig. 2.

In the much simpler case when the wave forms are similar the time lag becomes a definable quantity—for example

$$x = a \sin pt + b \sin 3pt + \ \ldots$$
$$v = ak \sin (pt + \phi_1) + bk \sin 3(pt + \phi_1) + \ \ldots$$

where it is clear that there is at every instant an invariable time lag $\phi_1$ between $x$ and $v$.

But although the time lag seems to be of little importance in most cases, it will be found that the angle $\phi$, constructed as in Fig. 1 from three effective voltages (V, X, and their resultant, P), is a most useful quantity, no matter how complicated and different the wave forms of $v$ and $x$ may be.

As before let

$$x = y + a \sin pt + b \sin 3pt + \ \ldots \ \ldots \quad (1)$$
$$v = e + m \sin (pt + \phi_1) + n \sin 3(pt + \phi_2) + \ \ldots \quad (2)$$

and let X and V be the effective values of $x$ and $v$, and P and Q those of $(v+x)$ and $(v-x)$.

Then

$$2P^2 = 2y^2 + 2e^2 + a^2 + m^2 + b^2 + n^2 + \ \ldots \ + 4ye + 2am \cos \phi_1 + 2bn \cos 3\phi_2 + \ \ldots$$
$$= 2X^2 + 2V^2 + 4ye + 2am \cos \phi_1 + 2bn \cos 3\phi_2 + \ \ldots$$

and

$$2Q^2 = 2X^2 + 2V^2 - 4ye - 2am \cos \phi_1 - 2bn \cos 3\phi_2 - \ \ldots$$

Now, let $2ye + am \cos \phi_1 + bn \cos 3\phi_2 + \ \ldots = 2XV \cos \phi$. (3)

Accordingly,

$$P^2 = X^2 + V^2 + 2XV \cos \phi \quad \ldots \quad (4)$$
$$Q^2 = X^2 + V^2 - 2XV \cos \phi \quad \ldots \quad (5)$$

Hence, as in Fig. 2, P is the graphical resultant of X and V at an angle $\phi$ with one another. Similarly, Q is the resultant of X and V at an angle $(\pi - \phi)$.

Also, $$P^2 + Q^2 = 2(X^2 + V^2), \quad \ldots \quad (6)$$

and $$P^2 - Q^2 = 4XV \cos \phi \quad \ldots \quad (7)$$

It is easy to show that

$$\frac{p}{2\pi}\int_0^{\frac{2\pi}{p}} xv\,dt = ye + \frac{am}{2} \cos \phi_1 + \frac{bn}{2} \cos 3\phi_2 + \ \ldots$$
$$\therefore = XV \cos \phi \quad \ldots \quad (8)$$

Hence $$\cos \phi = \frac{p}{2\pi}\int_0^{\frac{2\pi}{p}} xv\,dt \div XV.$$

This last is the equation by which Mr. Russell (in the Paper mentioned above) proposes to define the "difference of phase" between $x$ and $v$. It is evident from equation (8) that, if X and V are respectively current and terminal voltage for a circuit, $\cos \phi$, as found from the triangle of X, V and P, is the power factor.

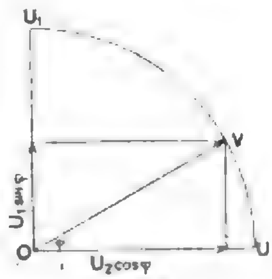


Fig. 3.

To avoid confusion with the *time lag* or ordinary phase difference, I would suggest that the angle $\phi$, whose cosine is the power factor, be named the "*Angle of Idleness*," and that $v$ and $x$ be said to have a "*power lag*" or difference of "*power phase*" of $\phi$. As shown above, when $x$ and $v$ are simple sine curves, the angle of idleness is equal to the time lag, but in the case of similar wave forms other than sinusoidal the time lag and the power lag are in general not equal to one another.

The apparatus which I now proceed to describe is for the purpose of turning the *power phase*, and, from what has been proved above, it will be found to be quite independent of wave form, not excepting those forms which contain a direct-current component. The general principle of the methods is to obtain two independent equal voltages $U_1$ and $U_2$, differing in power phase by exactly 90deg., and to add together suitable fractions of these voltages, such as $U_1 \sin \phi$ and $U_2 \cos \phi$, whose resultant (Fig. 3) is OV, *i.e.*, equal to $U_1$ but with the power phase turned through an angle $\phi$.

*First Method.*—In Fig. 4 is given a diagram of one way of doing this. A is a highly inductive resistance, and B a non-inductive one. They are placed in series across the source of supply from which X, the small voltage to be measured, is derived. The terminal voltage of A is applied directly to the primary coil of a small transformer M; the terminals of B are connected to a circuit containing adjustable inductance and resistance (at D and F) and the primary coil of a second small transformer N. G and H are reversing switches. The secondary coils of M and N are such as can give equal voltages $U_1$ and $U_2$. By adjusting A, B, D and F it is not difficult to obtain $U_1$ and $U_2$ equal and differing in power phase by exactly 90deg.*

The adjustment of the phases to exact quadrature is ensured in the following manner. The complete secondary coils of M and N are connected in series to an electrostatic voltmeter. D and F are then adjusted until the deflection of the voltmeter remains unchanged, when one of the switches H or G is reversed.

* By the combination shown a phase difference of considerably over 90deg. can be got.

As will be seen from Fig. 5, when the resultants OV and OV' are equal, $U_1$ and $U_2$ are in quadrature.

In order to be able to turn the power phase of the resultant voltage V, the secondary coil of the transformer M is sub-divided in such proportion that, by turning the sliding arm *m* to successive contacts, the voltages obtained are approximately

$$0,\ U_1 \sin 10°,\ U_1 \sin 20°,\ \ldots\ U_1 \sin 80°,\ U_1.$$

Similarly, N can give

$$U_2,\ U_2 \cos 10°,\ U_2 \cos 20°,\ \ldots\ U_2 \cos 80°,\ 0.$$

If the transformers are connected as in Fig. 4, and the sliding arms linked together, the resultant V will remain constant, but its power phase-angle $\phi$ (relative to $U_2$, say) will have the values

$$0°,\ 10°,\ 20°,\ \ldots\ 90°$$

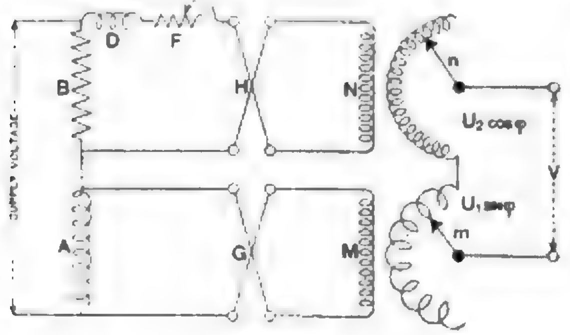


Fig. 4.

as the sliders are turned; by reversing $U_2$ (by switch H) and moving the sliders backwards $\phi$ is successively 100°, 110°, 120°, . . . 180°, and, similarly, may be carried on by steps of 10deg. to 360deg. Thus the power phase of the auxiliary voltage V may be brought quite close to that of X (the small unknown voltage), the closest position being found by connecting V and X in series to the voltmeter, and turning the phase of V till the maximum resultant deflection is got.

If the adjustment is not quite exact and a *small* angle of idleness $\phi$ be left between V and X, it can be shown that

$$P^2 - Q^2 \doteq 4XV\left(1 - \frac{\phi^2}{2}\right).$$

If X is small compared to V

$$P - V \doteq \frac{P - Q}{2} \doteq X\left(1 - \frac{\phi^2}{2}\right),$$

or,

$$X \doteq (P - V)\left(1 + \frac{\phi^2}{2}\right).$$

With regard to the actual transformers used, they both have closed magnetic circuits. M has 300 primary turns and 300 secondary, the latter being subdivided into coils of 53, 50, 47, 43, 37, 30, 22, 13 and 5 turns respectively. Transformer N has 300 primary turns and 600 secondary (subdivided in similar proportion to those of M).

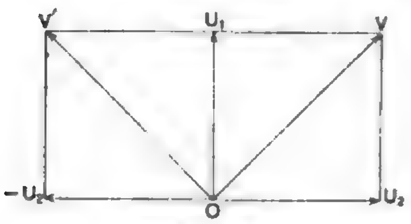


Fig. 5.

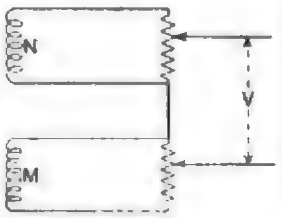


Fig. 6.

In subdividing the secondary coils it is impossible in any coil to have the number of turns other than a whole number, but it will be found that the above numbers give *very slight* variation in V, and that the successive values of $\phi$ are very close to 10deg., 20deg., 30deg., &c. With the supply P.D. at 100 volts (85 ∿ per second) V was 50 volts.

*Second Method.*—To obtain more continuous turning of the power phase of V, the above method may be modified in the following way: The secondaries of the transformers M and N are no longer subdivided, but, as in Fig. 6, have resistances in circuit with them, and from these resistances the proper voltage components are picked by sliders.

Two ways of obtaining the component voltages suggested themselves to me:—

1. The two secondary resistances ($R_1$, $R_2$, Fig. 5) were each evenly wound on a sheet with one edge cut to a sine curve, the covered wire being rubbed bare along the opposite edge, which was straight. A spring slider, *s*, runs between these bared edges, placed as in the figure. Since $\int \sin\theta d\theta = \cos\theta$, the components of V will be $U_1 \sin\phi$ and $U_2 \cos\phi$, the distance $\phi_0\,\phi_{90}$ being divided evenly from 0deg. to 90deg. I have tried this method roughly, and find it fairly accurate.

2. The secondary resistances may consist of long uniform straight wires $r_1$, $r_2$ connected as in Fig. 8. The sliders are drawn by strings passing round pulleys *e* and *f* to the end of the arm *gh* which can turn about the axle *g*. The angle turned through by the arm $gh = 2\phi - n\pi$ where $n = 0$, 1 or 2. I have as yet no practical experience of this method (2), but, where low values of V are sufficient, it is probably better than the two preceding methods.

*Third Method.*—Another way of sub-dividing the secondary voltages also suggests itself. The transformers M and N may be made in the form of rings with air-gaps in which are placed movable secondary coils which can be turned continuously into such positions that the induced voltages may be the components required.

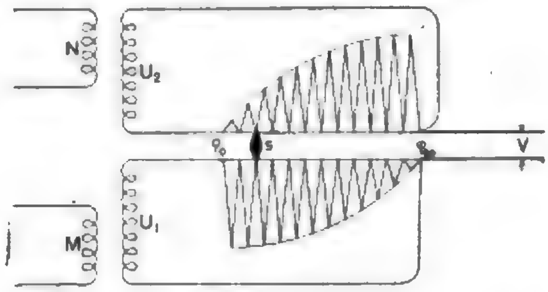


Fig. 7.

*Sample Experiments.*—The following experiments will serve as samples of the actual working of the first method. For ease of verification X was not chosen small:—

Experiment I.—A potential difference, X, was obtained from a non-inductive circuit connected with the supply. V had the value 70·0 volts. Its power phase was turned so as to give P and Q the maximum and minimum resultants with X, which occurred at $\phi = 310°$ and $\phi = 130°$. The observed values were $P = 103·8$, $Q = 36·7$. Hence $P - V = 33·8$, $V - Q = 33·3$; the mean of these last is 33·55, which agrees closely with 33·5, the directly measured value of X.

Experiment II.—In order to alter the wave form of X somewhat, X was taken from the ends of a non-inductive resistance in series with a highly inductive coil with an iron core. V was 71·5 volts. With $\phi = 0$, P was 109·0; with $\phi = 180°$, Q was 34·6. The mean $\frac{P - Q}{2} = 36·05$, while the actual value of X was 36·2 volts.

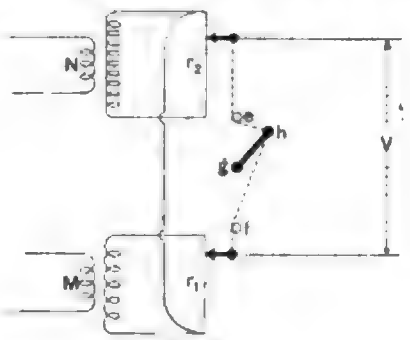


Fig. 8.

*Measurement of Power Lag.*—The apparatus of the second and third types may also be used to measure the power phase difference between two voltages $X_1$ and $X_2$. For this purpose $X_1$ is put in series with V, and the power phase of V turned until reversing V does not alter the resultant shown on the voltmeter; in this position V and $X_1$ are in exact power quadrature. Similarly, the phase turning required to bring V into quadrature with $X_2$ can be found, and hence we can find the power lag between $X_1$ and $X_2$ or its supplement. If there is any doubt as to which of these the result corresponds to, it can be at once determined by finding the positions of V which give the maximum resultants with $X_1$ and $X_2$.

To find the degree of accuracy of the method, let $\theta = \frac{\pi}{2} - \phi$, where $\theta$ is small.

Then

$$P^2 - Q^2 = 4X_1V \sin\theta \doteq 4X_1V\theta,$$

$$\therefore\ \theta \doteq \frac{(P+Q)(P-Q)}{4X_1V} \doteq \frac{P(P-Q)}{2X_1V}.$$

For example, if $X_1 = V$, then $P \doteq V\sqrt{2}$,

$$\therefore \theta \doteq \frac{P-Q}{V\sqrt{2}} \doteq \frac{P-Q}{P}.$$

Let $P \doteq Q \doteq 100$ volts, and suppose 0·1 volt can be detected at 100 volts reading—*i.e.*, $P-Q=0·1$ volt. This gives $\theta = 0·001$ radian, showing that the power phase of $X_1$ can be measured to within 0·06deg. By means of a suitable resistance in series with an unknown load this furnishes a method of measuring the power taken by the load, however inductive the load may be. If either of the voltages is not of such a size as to give good readings on the voltmeter, it may be raised or lowered by a suitable transformer for which the transformation ratio and the power lag between the primary and secondary voltages are known.

*Notes.*—In connection with my remarks on the time lag and power lag the following theorems may be of interest.

(*a*) For the wave forms—

$$x = a \sin pt + b \sin 3pt + \quad . \quad . \quad . \quad .$$

$$v = m \sin (pt + \psi) + n \sin 3\left(pt + \frac{\psi}{3}\right) + \quad . \quad . \quad . \quad .$$

let us find the conditions for which the power lag $\phi$ shall $= \psi$.

From equation (3) we see that

$$(am + bn + \quad . \quad . \quad . \quad .\ ) \cos \psi = 2XV \cos \phi$$

$$= \cos \phi \times \sqrt{(a^2 + b^2 + \quad . \quad . \quad . \quad .\ )(m^2 + n^2 + \quad . \quad . \quad . \quad .\ )}$$

Hence, if $\phi = \psi$, and $\psi \neq \frac{\pi}{2}$

$$a^2(n^2 + \quad . \quad . \quad . \quad .\ ) + b^2(m^2 + \quad . \quad . \quad . \quad .\ ) + \quad . \quad . \quad . \quad . = 2(abmn + \quad . \quad . \quad . \quad .\ )$$

$$\therefore (an - bm)^2 + \quad . \quad . \quad . \quad . \quad = 0$$

$$\therefore \frac{a}{m} = \frac{b}{n} = \quad . \quad . \quad . \quad .$$

Hence,

$$x = a \sin pt + b \sin 3pt + \quad . \quad . \quad . \quad .$$

and

$$v = qa \sin (pt + \phi) + qb \sin 3\left(pt + \frac{\phi}{3}\right) + \quad . \quad . \quad .$$

have a difference of power phase $= \phi$.

(*b*) Except in the case of sine wave forms, the existence of inductance or capacity in a circuit usually causes the wave form of the current to be different from that of the applied potential difference. Thus with resistance R, and self-inductance L, voltage

$$x = a \sin pt + b \sin 3pt + \quad . \quad . \quad . \quad .$$

gives current

$$c = a^1 \sin (pt + \phi) + b^1 \sin 3\left(pt + \tfrac{1}{3} \tan^{-1} 3 \tan \phi\right) + \quad . \quad . \quad . \quad .$$

If $\phi$ is small

$$c \doteq \frac{a}{R} \sin (pt + \phi) + \frac{b}{R} \sin 3(pt + \phi) + \quad . \quad . \quad . \quad .$$

*i.e.*, the current has a wave form similar to that of the voltage, with a time lag of $\phi = \tan^{-1} \frac{Lp}{R}$.

Similarly, with resistance and capacity, when $\phi$ is small,

$$c \doteq \frac{a}{R} \sin (pt - \phi) + \frac{b}{R} \sin 3\left(pt - \frac{\phi}{9}\right) +, \quad . \quad . \quad . \quad .$$

where $\phi = \tan^{-1} \frac{1}{KpR}$.

(*c*) In the phase turners described above both voltages are transformed, and hence no continuous component is present in the auxiliary voltage V. In the more general investigation (equations (1), (2), . . . . .), however, it should be remembered that *mixed* circuits (containing both alternating and direct components) are included. Some of the simpler cases of these are worth noticing.

1. When both voltages (V and X) are continuous, the angle of idleness, $\phi = 0$.

2. When X is purely alternating and V continuous, $\phi = \frac{\pi}{2}$.

3. When X is mixed and V continuous, *i.e.*,

$$x = y + a \sin pt + b \sin 3pt + \quad . \quad . \quad . \quad .$$

$$v = e,$$

then

$$\cos \phi = \frac{ye}{Xe} = \frac{y}{X}.$$

4. When X is mixed and V purely alternating, *i.e.*,

$$x = y + a \sin pt + b \sin 3pt$$

$$v = m \sin (pt + \phi_1) + n \sin 3(pt + \phi_2) + \quad . \quad . \quad . \quad . \ ,$$

then

$$2XV \cos \phi = am \cos \phi_1 + bn \cos 3\phi_2 + \quad . \quad . \quad . \quad .$$

Hence $\phi$ is independent of the direct-current component of X. This represents the case when the phase turner is used to measure a small mixed voltage X. It will be seen that the necessary condition ($\phi = 0$) can be here obtained.

## ELECTRIC LIGHTING AND TRACTION NOTICES.

During October and November we gave particulars of the notices regarding electric lighting and tramway provisional orders and bills for the 1901 session. A complete list of the applications for provisional orders which were deposited with the Board of Trade by Dec 21, is set out below, and it will be seen that the eliminating effect of the £50 deposit is inappreciable, only five proposals having been abandoned. Of the electric lighting provisional orders, 68 are being applied for by local authorities and 40 by companies, against 60 and 48 in 1900, when there were the same number of applications. Only five of the notices affect the metropolis, compared with six last year. There are 10 applications from Scotland and four from Ireland, a good increase in both cases.

### ELECTRIC LIGHTING.

#### LONDON.

| *Title of Electric Lighting Order and area.* | *Promoters.* |
| --- | --- |
| Deptford ........................ | County of London and Brush Co. |
| Lewisham and Penge (portion of Borough of Lewisham and Urban District of Penge) | Lewisham and District Electric Supply Co. (Ltd). |
| Marylebone ........................ | Marylebone Electric Supply Co. (Ltd). |
| St. Marylebone ........................ | Borough Council. |
| Stoke Newington ........................ | N. Metropolitan Elec. Power Dist. Co. |

#### THE PROVINCES.

| | |
| --- | --- |
| Aberavon ........................ | Corporation. |
| Abertillery ........................ | Urban District Council. |
| Alfreton ........................ | Urban District Council. |
| Alnwick ........................ | Northern Counties Elec. Supply Co. |
| Annfield Plain ........................ | Northern Counties Elec. Supply Co. |
| Ashton-in-Makerfield ........................ | Urban District Council. |
| Aspull ........................ | Urban District Council. |
| Atherton ........................ | Urban District Council. |
| Barry ........................ | Urban District Council. |
| Benfieldside ........................ | Northern Counties Elec. Supply Co. |
| Benwell and Fenham ........................ | Urban District Council. |
| Beverley (Corporation) ........................ | Corporation. |
| Birstall ........................ | Urban District Council. |
| Briton Ferry ........................ | Urban District Council. |
| Bromsgrove (Urban District of Bromsgrove, portion of Parish of Stoke Prior (Finstall) in Rural District of Bromsgrove and portion of Parish of Bromsgrove in Urban District of North Bromsgrove | G. G. Bodie, C. S. and W. Whitehouse |
| Burgess Hill........................ | Urban District Council. |
| Cannock ........................ | Urban District Council. |
| Carnarvon and District (Borough of Carnarvon and Rural District of Gwyrfai (except part in island of Anglesea | E. W. I. Peterson. |
| Chesham ........................ | Urban District Council. |
| Cheshunt ........................ | Urban District Council. |
| Consett ........................ | Northern Counties Elec. Supply Co. |
| Crieff ........................ | Burgh Commissioners. |
| Crompton ........................ | Urban District Council. |
| Dorchester Corporation ........................ | Corporation. |
| Dorking ........................ | County of Surrey Elec. Power Dist. Co. (Ltd.). |
| East Cowes ........................ | Isle of Wight Elec. Light and Power Co. (Ltd.). |
| Ebbw Vale ........................ | Urban District Council. |
| Faversham ........................ | Corporation. |
| Felling ........................ | Urban District Council. |
| Foots Cray (Contributory place of Foots Cray and portion of Urban District of Chislehurst | Bromley Rural District Council. |
| Friern Barnet ........................ | Urban District Council. |
| Frome (Urban District of Frome and portion of Parish of Selwood in Rural District of Frome) | Urban District Council. |
| Goole ........................ | Urban District Council. |
| Hampton ........................ | Urban District Council. |
| Handsworth ........................ | Northern Counties Elec. Supply Co. |
| Hindley ........................ | Urban District Council. |
| Hoddesdon ........................ | Urban District Council. |
| Honley ........................ | Urban District Council. |
| Ilkley (Urban District of Ilkley and Townships of Middleton and Denton in Rural District of Wharfdale) | A. H. Gibbings. |
| Ince-in-Makerfield ........................ | Urban District Council. |
| Isle of Thanet (Rural) Parishes of Garlinge, Northdown and St. Peter Extra in Rural District of Isle of Thanet) | I. of Thanet Elec. Tramways & Lgtg. Co. (Ltd.) |
| Lichfield Corporation........................ | Corporation. |

| *Title of Electric Lighting Order and area.* | *Promoters.* |
|---|---|
| Llandaff and Dinas Powis | Rural District Council. |
| Llangollen | Urban District Council. |
| Lyndhurst | Lyndhurst Elec. Lgtg. & Tract. Co. (Ltd). |
| Macclesfield | Corporation. |
| Macclesfield | Electrical Power Distribution Co. (Ltd). |
| Midland Electric Power Distribution and Lighting (Extension) Order. Urban Districts of Perry Barr, Tettenhall, Lye and Wollescote, and Stourbridge, and Parish of Great Barr in Walsall Rural District) | Midland Electric Corporation for Power Distribution (Ltd.) |
| Mitcham | Rural District Council of Croydon. |
| Mountain Ash | Urban District Council. |
| Neath Corporation | Corporation. |
| Neath Rural District | Rural District Council. |
| Neath, Briton Ferry, & Aberavon | Electrical Power Distribution Co. (Ltd.) |
| Newbury | Urban Electric Supply Co. (Ltd). |
| New Hunstanton | Urban District Council. |
| Northfleet | Urban District Council. |
| Northwood and Ruislip (Parish of Ruislip in Rural District of Uxbridge and portions of Parishes of Watford (Rural) and Rickmansworth (Rural) in Rural District of Watford) | Northwood Electric Light and Power Co. (Ltd). |
| Norton | Northern Counties Elec. Supply Co. |
| Pickering | Northern Counties Elec. Supply Co. |
| Pokesdown | Bournemouth and Poole Electricity Supply Co. (Ltd). |
| Pontypridd | Urban District Council. |
| Pudsey | Corporation. |
| Rhondda | Urban District Council. |
| Rickmansworth | North Metropolitan Electrical Power Distribution Co. (Ltd.) |
| Ripon | Corporation. |
| Rishton, Great Harwood, and Clayton-le-Moors. | C. Chadwell. |
| Roundhay and District | Roundhay & Dist. Elec. Lgtg Co. (Ltd.) |
| Royton | Urban District Council. |
| St. Austell | St. Austell and District Elec. Lgtg. and Power Co. (Ltd.). |
| Shildon | Northern Counties Elec. Supply Co. |
| Sittingbourne (Urban Districts of Sittingbourne and Milton-next-Sittingbourne) | County of Kent Elec. Power Dis. Co. (Ltd.). |
| Skipton | Urban District Council. |
| Standish-with-Langtree | Urban District Council. |
| Stratford-upon-Avon | Corporation. |
| Teddington | Urban District Council. |
| Teddington, Hampton, Hampton Wick, and Ham | Richmond (Surrey) Electric Light and Power Co. (Ltd.). |
| Thornhill | Northern Counties Elec. Supply Co. |
| Todmorden | Corporation. |
| Tredegar | Urban District Council. |
| Trowbridge | Urban District Council. |
| Ware Urban | Urban District Council. |
| Warwick | British Electric Traction Co. |
| Wellingborough (Public Purposes) | Urban District Council. |
| Wellington (Salop) | Urban District Council. |
| Whitley and Monkseaton | A. G. Robson, A. W. Dixon & J. A. Jeskell. |
| Widnes | Corporation. |
| Wisbech | Corporation. |
| Workington | Corporation. |
| Worsley Electric Supply Order | Urban District Council. |

### SCOTLAND AND IRELAND.

| *Title of Electric Lighting Order and area.* | *Promoters.* |
|---|---|
| Blackrock (Co. Dublin) | Urban District Council. |
| Clydebank | Burgh Commissioners. |
| Dalkeith | Crompton & Co. (Ltd.). |
| Dollar | Crompton & Co. (Ltd.). |
| Dungannon | Urban District Council. |
| Falkirk | Burgh Commissioners. |
| Galashiels | Corporation. |
| Gourock | Commissioners of Burgh. |
| Jedburgh | Crompton & Co. Ltd.) |
| Kildare | Naas, No. 1, Rural District Council. |
| Melrose | Crompton & Co. (Ltd.) |
| Oban | Burgh Commissioners. |
| Ross | J. Parker. |
| Waterford | Corporation. |

### TRAMWAYS.

There are only 24 applications for tramway orders, against 36 in 1900. These, however, constitute but a small proportion of the electric traction schemes as procedure by bill is usually adopted, except in simple cases, and where extensive powers are not sought:—

| *Order and District.* | *Order and District.* | *Order and District.* |
|---|---|---|
| Ashton-under-Lyne Corporation. | Glossop Electric. | Northampton Corp. |
| Birkdale. | Hopeman. | Pontypridd & Rhondda Valley. |
| Cheriton Urban District | Hyde Corporation. | Pontypridd Urban District. |
| Coatbridge. | Leamington. | Royton. |
| Colchester Corporation. | Littleborough Urban District. | Swindon Corporation. |
| Crompton. | Liverpool Corporation (Extensions). | Weston-super-Mare. |
| Denton Urban D. C. | Middleton and Chadderton. | West Riding. |
| Devonport Corporation. | | Wrexham District. |
| Folkestone Corporation | | |

## LIGHT RAILWAY SCHEMES.

*November Applications.*

During the month of November we gave some particulars of the applications made to the Light Railway Commissioners for authority to construct light railways, and we are now able to give a complete list of the new electric schemes. Electric traction is scheduled in all the new projects except two, for although eight steam lines figure in the list six have been already sanctioned by the Commissioners, and extensions of time, &c., are now sought. The following particulars of the total applications (A) together with the proportion of electrical schemes which have been presented to the Light Railways Commissioners since the passing of the Light Railways Act, may be of interest:—

| — | 1900. | 1899. | | 1898. | | 1897. | | 1896. |
|---|---|---|---|---|---|---|---|---|
| | Nov. | May. | Nov. | May. | Nov. | May. | Nov. | May. | Nov. |
| Total applications | 27 | 24 | 43 | 40 | 54 | 35 | 30 | 28 | 28 |
| Electric schemes | 19 | 17 | 32 | 21 | 32 | 18 | 16 | 10 | 14 |

| A Title. | Promoters. | Engineer. | Mileage. | Gauge. Ft. | In. | Agents. |
|---|---|---|---|---|---|---|
| Barton-on-Irwell | Barton-on-Irwell Rural District Council | C. C. Hooley | 1½ | 4 | 8½ | Baker, Lees & Co. |
| Bolton, Turton and Darwen | Lancashire Light Railways Co. (Ltd.) | Kincaid, Waller and Manville | 9¾ | 4 | 8½ | Sharpe & Co. |
| Canterb'ry, Whitst'ble & Herne Bay | O. W. Bowen | R. Henderson | 13½ | 3 | 6 | J. D. Tetley & Co. |
| Crewe | Crewe Corporation | C. Hopkinson | 8 | 3 | 6 | Sharpe & Co. |
| Dartford | Dartford Urban and Rural District Councils | W. C. C. Hawtayne | 5½ | 4 | 8½ | Baker, Lees & Co. |
| Halesowen | Halesowen Rural District Council | R. Wilson | 10¾ | 3 | 6 | Ditto. |
| Hayling Island | J. P. Bedson and T. Pollock | Knowles and Russell | 3¼ | 4 | 8½ | Angove, Bromwich & Yeo. |
| Isle of Thanet (extension of time, &c.) | Isle of Thanet Tramways and Lighting Co. Ltd.) | ...... | ... | ... | | Wm. Webb & Co. |
| Lyndhurst | Lyndhurst Elec. Lighting & Traction Co. Ltd.) | C. J. Wharton | 2¾ | 4 | 8½ | W. and W. M. Bell. |
| Mitcham | Croydon District Council | S. Stallard | 3½ | 4 | 8½ | Baker, Lees & Co. |
| Potteries (extensions) | Potteries Electric Traction Co. Ltd.) | S. Sellon | 5¾ | 4 | 0 | S. Morse. |
| Pwllheli, Nevin, &c. | North Wales and District Light Railway and Electric Power Syndicate (Ltd.) | Bennett & Ward-Thomas | 11 | 4 | 8½ | A. R. Roberts. |
| Rhondda Valley (extension | British Electric Traction Co. (Ltd.) | S. Sellon | ¾ | 3 | 6 | S. Morse. |
| Sandgate, Cheriton, & Folkestone | Sandgate and Hythe Electric Co. Ltd.) | Ditto | 4¾ | 4 | 8½ | Ditto. |
| Warrington and Northwich | Brunner, Mond & Co., J. H. Holden, and J. Hesketh | R. H. Scotter | 21¼ | 4 | 8½ | Baker, Lees & Co. |
| Welshpool and Llanfair (extension of time, &c. | Welshpool and Llanfair Light Railway Co. | A. J. Collins | ... | | | Barcham & Co. |
| West Cumberland | T. D. Lingard, A. L. Ormrod & T. S. Turnbull | A. Dickinson & Co. | 19¾ | 3 | 6 | Warwick Webb. |
| Worcester (extensions | Worcester Tramways (Ltd.) | S. Sellon | 1 | 3 | 6 | S. Morse. |

## RESULTS OF APPLICATIONS.

**We give below the results of the applications made to the Light Railway Commissioners in November, 1899 and May, 1900.**

*November, 1899.*

| Title. | Promoters. | Engineer. | Mileage. | Gauge. Ft. | Gauge. in. | Result. |
|---|---|---|---|---|---|---|
| Aldershot and Farnborough (ext.) | Power and Traction | G. Hopkins & Sons | ½ | 3 | 6 | Approved. |
| Barnsley and District (extension) | British Electric Traction Co. | S. Sellon | ½ | 3 | 6 | Ditto. |
| Blackpool and Garstang | Blackpool and Garstang Electric Light Railway Co. | J. J. Myres | 16¼ | 4 | 8½ | Ditto. |
| Blyth and District | British Electric Traction Co. | S. Sellon | 1½ | 3 | 6 | Withdrawn. |
| Cheltenham and District (exten.) | T. Nevins | T. Nevins | 2¼ | 3 | 6 | Approved. |
| Cinque Ports (Kent and Sussex) | D. Cook | D. Cook and J. T. Rossiter | 67¾ | 3 | 6 | Deferred. |
| City of Bath | Bath Corporation | C. R. Fortune and G. F. Metzger | 18 | 4 | 0 | Rejected. |
| County of Hertford, No. 1 | Hertford C.C. and the Metropolitan Tramways and Omnibus Co. | V. B. D. Cooper | 5¾ | 4 | 8½ | Approved. |
| Ditto No. 2 | Ditto | Ditto | 2 | 4 | 8½ | Withdrawn. |
| Ditto No. 3 | Ditto | Ditto | 9 | 4 | 8½ | Rejected. |
| Ditto No. 4 | Ditto | Ditto | 3½ | 4 | 8½ | Withdrawn. |
| County of Middlesex, No. 2 | Middlesex County Council | H. T. Wakelam | 12 | 4 | 8½ | Approved. |
| Gloucester and District | City of Gloucester Tramways Co. | J. Clifton Robinson | 8 | 3 | 6 | Ditto. |
| Hayling Island | W. Paynter, H. R. Trigg, and E. Belfield | Knowles and Russell | 4¾ | 4 | 8½ | Withdrawn. |
| Kingston, Surbiton and District | Greenwood and Batley | A. H. Rowan | 4¾ | 4 | 8½ | Rejected. |
| Llanelly and District | Llanelly and District Electric Light Co. | R. Wilson | 7¾ | 3 | 6 | Approved. |
| London County (Archway-road, Highgate) | London County Council | Sir A. Binnie | ¼ | 4 | 8½ | Not dealt with. |
| London County (Clapham, Wandsworth and Kingston-road) | Ditto | Ditto | 5½ | 4 | 8½ | Rejected. |
| London County (Deptford, Shooters Hill and Woolwich) | Ditto | Ditto | 5¾ | 4 | 8½ | Ditto. |
| London County (New Cross, Lewisham and Eltham) | Ditto | Ditto | 4¼ | 4 | 8½ | Ditto. |
| Loughborough and District | Loughborough & District Elec. Trac. Synd. | C. H. Gadsby | 8¼ | 3 | 6 | Approved. |
| Mansfield and District | J. Fell, J. Lewis, and W. J. Kershaw | Ditto | 5¾ | 3 | 6 | Ditto. |
| Morley and District | British Electric Traction Co. | S. Sellon | 10 | 4 | 8½ | Ditto. |
| Oldham, Ashton-under-Lyne, Hyde and District (extensions) | Oldham, Ashton, and Hyde Electric Tramway Co. | Ditto | 4¼ | 4 | 8½ | Rejected. |
| Peterborough and District (exten.) | British Electric Traction Co. | Ditto | 1 | 3 | 6 | Ditto. |
| Spen Valley (extensions) | Ditto | Ditto | 12 | 4 | 8½ | Approved. |
| Wakefield and District | J. Fell, J. J. Gittings, E. Horton, and W. J. Kershaw | Pritchard & Co. | 10 | 3 | 6 | Ditto. |
| Warrington and Northwich | A. Anderson, J. Hesketh, and A. Brown | R. H. Scotter | 13¼ | 4 | 8½ | Rejected. |
| West Hartlepool (extensions, &c. | Hartlepool Electric Tramways Co. | S. Sellon | 1¾ | 3 | 6 | Extensions withdrawn, deviation approved. |
| Wigan | Wigan and District Tramways Co. | Ditto | 7¾ | 3 | 6 | Approved. |
| Windermere and District | British Electric Traction Co. | Ditto | 6¼ | 3 | 6 | Withdrawn. |

*May, 1900.*

| Title. | Promoters. | Engineer. | Mileage. | Gauge. Ft. | Gauge. in. | Result. |
|---|---|---|---|---|---|---|
| Barnsley & District (extension) No. 2 | British Electric Traction Co. | S. Sellon | 4¼ | 3 | 6 | |
| Bath and District | Bath Corporation, Sir J. Sivewright and Leopold Hirsh | G. Hopkins & Son | 13½ | 4 | 8½ | Approved. Ditto. |
| Blackburn, Whalley and Burnley | Auxiliary & Light Railways & Tramways Co. | C. Chadwell | 14¼ | 4 | 0 | Ditto. |
| Durham and District | British Electric Traction Co. | S. Sellon | 2¾ | 4 | 8½ | Ditto. |
| Hayling Island | E. Belfield, T. Pollock, and J. P. Bedson | Knowles & Russell | 3½ | 4 | 8½ | Withdrawn. |
| Hyde and Dukinfield | Hyde Corporation and Dukinfield Corporation | J. Mitchell & S. Hague | 9¾ | 4 | 8½ | Approved. |
| Jarrow and South Shields | British Electric Traction Co. | S. Sellon | 3¼ | 4 | 8½ | Ditto. |
| Kidderminster and Bewdley | Kidderminster and District Electric Lighting & Traction Co. | S. Sellon | 4½ | 3 | 6 | Ditto. |
| Kingston, Surbiton and District (extension) | British Electric Traction Co. | S. Sellon | 7 | 4 | 8½ | Rejected. |
| Mansfield and District (extension) | J. Fell, J. Lewis, and W. J. Kershaw | C. H. Gadsby | 4½ | 3 | 6 | Approved. |
| Pwllheli and Nevin | North Wales and District Light Railway & Electric Power Synd. | Bennett & Ward-Thomas | 6½ | 3 | 0 | Withdrawn. |
| Rhyl and Prestatyn (extension) | Rhyl and Prestatyn Light Railway Co. | A. Dickinson & Co. | 2 | 3 | 6 | Approved. |
| Swansea and District | Swansea Corporation | Kincaid, Waller & Manville | 8 | 4 | 8½ | Ditto. |
| Sheerness and District | British Electric Traction Co. | S. Sellon | 2½ | 3 | 6 | Ditto. |
| Staines and Egham | Staines and Egham Light Railway Co. | V. B. D. Cooper | 3½ | 3 | 6 | Ditto. |
| Warrington & Northwich (extension) | A. Anderson and A. Brown | R. H. Scotter | 9¾ | 4 | 8½ | Withdrawn. |
| Warrington and Runcorn | International Electric Traction & Power Synd. | Bennett & Ward-Thomas | 8 | 4 | 8½ | Ditto. |

## ELECTRICAL JOINT STOCK COMPANIES OF 1900.

The following are the more important limited liability companies connected with the electrical and allied industries registered during the past year, with their capital :—

| | |
|---|---|
| Aberdare Electric Light Co. | £2,000 |
| Accumulator Industries | 10,000 |
| Adams Electrical Generator Co. | 5,000 |
| Adelaide Electric Tramways | 3,000 |
| W. H. Allen, Son & Co. | 200,000 |
| Anti-Collision Alarm Telegraph Co. | 1,500 |
| Babcock and Wilcox (re-registered) | 600,000 |
| Banbury and District Electric Supply Co. | 25,000 |
| John Bellamy | 40,000 |
| Brianne Electric Lamp Co. | £30,000 |
| Brisbane Electric Tramways Investment Co. | 750,000 |
| British Electric Car Co. | 50,000 |
| British Electric Plant Co. | 100,000 |
| British Electric Street Tramways | 300,000 |
| British and Foreign Electrical Vehicle Co. | 150,000 |
| British Power, Traction and Lighting Co. | 52,000 |
| British Motor Traction Co. | 1,000,000 |
| Brockie-Pell Arc Lamp (re-registered) | 80,000 |
| Cardwell-Boorman-Ford-Lloyd | 5,000 |
| Charing Cross and City Electric Co. | 300,000 |
| Cinque Ports Light Railways | 25,000 |
| Claud Hamilton (Aberdeen) | 5,000 |
| Colwyn Bay Electric Light and Power Co. | 3,000 |
| County of Kent Electrical Power Distribution Co. | 25,000 |
| County of Northampton Electric Power and Traction Co. | 25,000 |
| Cowper Inventions Development Co. | 50,000 |

| | |
|---|---|
| C.V. Lamp Syndicate | £14,000 |
| Crown Electric Heating Syndicate | 5,000 |
| Crowther and Co.'s Electrical Industries | 10,000 |
| John Davis & Son (Derby) | 35,000 |
| Dialene Rubber Co. | 12 000 |
| Doe Portable Electric Light and Power Syndicate | 40 000 |
| Donovan & Co. | 10,000 |
| Easton & Co. | 100,025 |
| Electric Incandescent Lamp Regenerating Syndicate | 7,500 |
| Electric Lighting Boards (British Manufacturing Co.) | 75,000 |
| Electric Railways Co. | 75,000 |
| Electric Supply Co. of Victoria | 200,000 |
| Electric Vehicle Co. of Great Britain | 1,000 |
| Electrical Navigation Protection Co. | 100,000 |
| Electrical Regulating and Lighting Syndicate | 75,000 |
| Electrical Testing Laboratories | 3,000 |
| Electrical Trades Supply Co. | 5,000 |
| Electrical Transport and Power Co. | 10,000 |
| Electro-Ceramic Syndicate | 2,000 |
| Electro-Chemical Co. (1900 (re-registered) | 200,000 |
| Electro-Magnetic Traction Co. | 1,500 |
| Finchley Electric Light Co. | 5 000 |
| Fireproof Electric Switchboard Co. | 1,000 |
| Fleet and District Electricity Co. | 5,000 |
| Founders' Syndicate | 60,000 |
| French Electric Lighting Boards | 4,000 |
| L. Gardner & Sons | 50,000 |
| Gardner Electric Drill and Hammer Co. | 40,000 |
| General Electric Co. (1900) (re-registered) | 800,000 |
| General Electric Co. of Ireland | 2,000 |
| General Tramways Construction Syndicate | 200,000 |
| H. and H. Accumulator Syndicate | 10,000 |
| Hands Limited | 50,000 |
| Harwich Electric Lighting and Tramways Co. | 50,000 |
| Hattersley Bros. | 50,000 |
| Higginbottom and Mannock | 60,000 |
| Hillgrove and Armidale Electrical Corporation | 70,000 |
| R. Hood Haggie & Son | 160,000 |
| Ernest Hutton & Co. | 5,000 |
| Imperial Electric Supplies Co. | 50 000 |
| Improved Electric Glow Lamp Co. | 40,000 |
| Ingleton Water Power Co. | 7,000 |
| Ingram and Kemp | 30,000 |
| International Electric Traction and Power Syndicate | 25,000 |
| Isidor Frankenburg & Co. | 250,000 |
| Johnson-Lundell Electric Traction Co. | 300,000 |
| Johnson Electro-Germicide Co. | 2,000 |
| Richard Johnson & Nephew | 200,000 |
| Johnstone, Benjamin & Co. | 15,000 |
| Kettle River Power Co. | 220,000 |
| King Arc Light Co. | 5,000 |
| Kingsburgh Motor Construction Co. | 50,000 |
| Lewisham and District Electric Supply Co. | 10,000 |
| London Electrical Warehouse Co. | 1,000 |
| Lyndhurst Electric Lighting and Traction Co. | 500 |
| McAlpine's Electrical Co. | 5,000 |
| Wm. M'Geoch & Co. (re-registered) | 100,000 |
| Mangano Electric Process | 50,000 |
| J. W. Manley & Co. | 3,000 |
| Marconi International Marine Communication Co. | 350,000 |
| Meldrum Bros. (re-registered) | 125,000 |
| Metropolitan Motor Manufacturing Co. | 10,000 |
| Meyra Electric Co. | 10,000 |
| Middlesex and Hertford Electric Lighting and Power Co. | 100 |
| Midland Electric Corporation (1900) | 200,000 |
| Miller & Sons | 30,000 |
| Monarch Motor Co. | 250,000 |
| Mordey-Fricker Electricity Co. | 20,000 |
| Motor Manufacturing Co. | 200,000 |
| National Construction Co. | 10,000 |
| New Century Arc Light Co. | 30,000 |
| North Wales and District Light Railway and Elec. Power Synd. | 1,200 |
| Northern Counties Electricity Supply Co. | 200,000 |
| Northern Counties Traction Co. | 5,000 |
| Northwood Electric Light and Power Co. | 15,000 |
| Paterson, Cooper & Co. | 20,000 |
| Perfect Light Co. | 25 000 |
| Premier Electric Lamp Co. | 100,000 |
| Railway and General Engineering Co. | 50,000 |
| Railway Construction and General Development Co. | 100,000 |
| Railway Equipment and Construction Co. | 1,000,000 |
| Rawlings Bros. | 100,000 |
| Reason Manufacturing Co. (re-registered) | 50,000 |
| Richardsons, Westgarth & Co. | 750,000 |
| Rosling, Appleby and Fynn | 100,000 |
| Ross Electric Light and Power Co. | 8,000 |
| Roundhay and District Electric Lighting Co. | 20,000 |
| Rowell, Stuart Kelman & Co. | 100,000 |
| St. Austell and District Electric Lighting and Power | 10,000 |
| St. Helens Electric Lighting Company | 10,000 |
| St. Stephen's Electrical Syndicate | 8,000 |
| Sandycroft Foundry Co. (re-registered) | 32 000 |
| Schattner Electricity Meter Co. | 50,000 |
| Scottish Electrical Luminiscriptor Co. | 10,000 |
| Sherard Cowper-Coles & Co. | 25,000 |
| South Lancashire Electric Supply Co. | £10,000 |
| South Lancashire Electric Traction and Power Co. | 850,000 |
| South Wales Electrical Power Distribution Co. | 30,000 |
| Staines and Egham Light Railway Co. | 1,000 |
| W. F. Stanley & Co. | 120,000 |
| Statters (Birmingham) | 10,000 |
| Sussmann Electric Miners' Lamp Co. | 30,000 |
| Taipo Accumulator Co. | 25,000 |
| Tangye Tool and Electric Co. (re-registered) | 100,000 |
| Taylor, Tunnicliff & Co. (1900) (re-registered) | 100,000 |
| Thames Valley Electric Supply Co. | 25,000 |
| Thomson-Davis Telephone System | 6,000 |
| Turner, Atherton & Co. | 175,000 |
| Typewriting Telegraph Corporation | 100,000 |
| Union Cable Co. | 25,000 |
| United Railway and Trading Co. | 500,000 |
| Universal Telephone and Electrical Co. | 10,400 |
| Volt Electrical Co. | 3,000 |
| Walker and Hodgetts | 5,000 |
| R. Waygood & Co. (re-registered) | 210,000 |
| Wear Electrical Engineering Co. | 5,000 |
| Welsh Electric Traction Co. | 25,000 |
| J. G. White & Co. | 100,000 |
| Whittaker Bros. | 7,000 |
| Williamson and Joseph | 4,000 |
| Wolverhampton District Electric Tramways | 200,000 |
| Yorkshire Electric Power Syndicate | 10,000 |

## PUBLIC COMPANIES WOUND UP, DISSOLVED, &c., IN 1900.

The following are the principal electrical and engineering limited liability companies which have been wound up (either voluntarily or compulsorily) or dissolved during the past year. The asterisk denotes that the company was wound up by order of the Court, and the † that the company has been struck off the register :—

Aluminium Co.
Andrews (J. D. F.) & Co. (voluntarily).
†Armstrong-Dove Motor Syndicate.
†Battery and Motor Co.
W. C. Bersey & Co.
*Birmingham Carbide Co.
†British Association of Medical Electricians.
British Blahnik Arc Light Syndicate.
Brockie-Pell Arc Lamp (for reconstruction).
†Canton (Waipori) Mining and Electric Power Co.
†Capital and Counties Electricity Supply Co.
Continental Water and Electrical Power Syndicate.
†Corbridge Electric Lighting Co.
Coventry Gas Fitting, Electrical and Engineering Co. (for reconstruction).
Crowdus Accumulator Syndicate.
†Cruto Incandescent Lamp Agency.
Cuttriss, Wallis & Co.
Dawson Gas Engines Syndicate.
Doe Portable Electric Light and Power Syndicate (for reconstruction).
Earle's Shipbuilding and Engineering Co. (for reconstruction).
Eastbourne Electric Light Co.
†Electric and General Contract Corporation.
Electric Automobile Syndicate.
†Electric Free Wiring Syndicate.
†Electric Meter Co.
†Electric Racing Horse Maze (Pioneer) Syndicate.
†Electric Steam Syndicate.
Electro-Chemical Co. (for reconstruction).
†Electrolytic Separation Syndicate.
†Elieson Lamina Accumulator Co.
†European Electric Finance Co.
Giffre Electro-Chemical and Power Co. (for reconstruction).
†Gravier Dynamo Syndicate.
*Gutta-Percha Corporation.
Howell's Anti-Inductive Telephone Syndicate.
Improved Electric Glow Lamp Co. (for reconstruction).
†Improved Incandescent Electric Lamp Syndicate.
*Isle of Man Tramways and Electric Power Co.
†Kerbey Bowen.
Land and Water Electric Power Syndicate.
†Langhans-Berrenberg-Chaplin Patents.
†Light Railway Contract Co.
†Llandudno Electric Supply Co.
London and Provincial Traction Co.
London Electrical Cab Co.
†London Electrical Carriage Co.
†London Electrical Coupé Co.
†London Electrical Van Co.
†London Health Electrical Syndicate.
Macroom and District Electric Lighting Syndicate.
†Maxim Motor Co.
Midland Electrical and General Engineering Co.
*P. C. Middleton & Co.

Motor Manufacturing Co. (for reconstruction).
Nalder Bros. & Co. (voluntarily).
New Electricity Supply Syndicate.
†New Power Syndicate.
†North London Electric Supply Co.
Nuneaton Electric Co.
Paris Singer (Ltd.).
†Peerless Accumulator Syndicate.
Perfect Arc Lamp and Accessories Co.
Premier Electric Lamp Syndicate (for reconstruction).
Printing Telegraph Recorder Co.
Reason Manufacturing Co. (for reconstruction).
†Recording Telegraphs.
Roller Bearings Co.
Sandycroft Foundry and Engine Works Co. (for reconstruction).
Scarborough District Lighting Co.
St. Stephen's Electrical Syndicate.
Sussmann Electric Miners' Lamp Co. (for reconstruction).
†United Inventions Syndicate.
Universal Electrical Advertising Syndicate.
West Kent Electricity Supply Co.
Western Counties Electric Light and Power Syndicate.
Woodlands Electric Co.

## CORRESPONDENCE.

### MAGNETIC OBSERVATORIES AND TRACTION DISTURBANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is, I think, agreed by both parties that the proper solution of the controversy between the London United Tramways Co. and the Kew Observatory is, that the Observatory should receive compensation and the magnetic recording instruments should be removed; and I do not wish to prolong the discussion. One new point, however, has been raised recently, which seems to me of some interest as bearing on the theory of the magnetic disturbance due to electric traction. The company state that they have made measurements, from which it follows that very large stray currents are already flowing in their lines—currents so large that they ought, it is said, to disturb our instruments, and they infer that if the instruments are not disturbed the precautions we have been asking for are excessive. Now, I express no opinion as to the amount of stray current which has been observed or which may be observed on the company's rails. I have not the material to criticise the experiments, but I do assert that, assuming the facts to be as they state, the deductions made from them are wrong. For the purposes for which our records are used they are not affected by existing leakage currents, and theory shows that they ought not to be affected.

Let us consider first the disturbance of the vertical component of the earth's magnetic force. Prof. Rücker has shown that, assuming the earth to be a homogeneous conductor, a system of leakage currents produces of itself no vertical magnetic force. A traction system in which the current returns through the rails does produce such a disturbance, for the vertical force at the observatory due to the current in the trolley wire is not balanced by that due to the current in the rails, since, in consequence of the leak, these two currents are not equal. The leakage currents themselves do not give rise to any resultant vertical force.

Consider, now, a limited portion of the earth at some distance from the observatory. The earth currents in this space will, in general, produce a vertical force at the observatory. Let us call this R. Then R is equal and opposite to the force due to the currents in the rest of the earth external to the limited space considered. If the observatory be at some distance R will usually not be large, though it might be readily detected by suitable instruments if we could get rid of the opposite force $-R$. This, however, we cannot do. Suppose now that a stream line enters this limited space at A and leaves it at B. We may clearly, within very considerable limits modify the path of the stream line between A and B without affecting the magnetic force at the distant observatory D. For, taking the case of a horizontal stream line, if $d\psi$ is the angle which an element of the line at P subtends at O, and $r$ the distance OP, then the magnetic force depends on the value of the integral $\int_A^B \frac{d\psi}{r}$, and, if OA and OB are both large compared with their difference $OA-OB$, the value of the integral is approximately equal to twice the angle $AOB\,(OA+OB)$ Thus the magnetic force at O due to the limited space will depend on its shape and position and on the current entering, but only to a secondary amount on the distribution of current within the space. Hence the resultant force at O due to the whole system of leakage currents may, in spite of changes in the distribution within a limited space, remain approximately zero.

Let us apply this to the disturbance produced by a rail. In its immediate neighbourhood the lines of flow of the leakage currents are modified by the presence of the rail, but the resultant vertical force from the area throughout which this modification takes place will only differ by a small quantity from its value before the introduction of the rail. The resultant vertical force therefore, due to the whole system of leakage currents, still remains approximately zero. The rail may carry a large current which before was distributed through the ground in its neighbourhood.

The force at the distant observatory, due to either the concentrated or the distributed current, may be quite appreciable, but each is balanced, in the one case approximately, in the other exactly, by the force due to the currents in the space which is undisturbed by the rail. Thus it does not follow, because currents may have been measured in the rail, which would be amply sufficient if they had been fed in from a trolley wire to disturb the records, that the vertical force instrument of the Kew Observatory must have been seriously affected.

The same is true with regard to the horizontal force. The horizontal disturbing force is entirely due to the vertical components of the leakage currents. The main currents of the original circuit have no effect on it.

Now a portion of the surface leakage current is disturbed by the introduction of the rail. Throughout the disturbed area the vertical component of the current must always be small. Hence, in any case the disturbed area contributes but a small amount to the small disturbance of the horizontal force caused by the whole system of leakage currents. A change, therefore, in the vertical distribution of current throughout the disturbed area will not appreciably affect the horizontal force at the distant observatory. The above conclusions will, of course, require modification if the source itself comes within the area disturbed by the rail, or is metallicly connected with the rail.

These considerations appear to me to reconcile the two series of observations. We certainly have noted no disturbance in the Kew magnetometer which could be attributed to large currents in the rails; the engineers of the company state that they have observed large leakage currents, and I believe the arguments I have adduced give the reasons why our instruments are not affected.—Yours, &c.,

Dec. 31. R. T. GLAZEBROOK.

### THE "DENSITY FACTOR."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your article on my Paper on the "Density Factor," in referring to the two-meter system, you state that the engineer is, presumably, to decide which lamps are to be on each meter. This is not my intention. The division of the lamps would be entirely at the option of the consumer. This method is in use in Manchester, and gives, I understand, most satisfactory results. Of course, the Manchester maximum demand system is not identical with that of Brighton, but there seems to be no reason why the second meter should not be as good with the one system as with the other. At the same time, when a means can be devised of getting over "the density of the consumer in appreciating the true value and importance of the maximum demand indicator"—that is, of making him face with equanimity a big electric light bill after he has had all of his lights on, say, for a dinner party, I will be glad to hear of it. The beneficient discoverer of such will earn the gratitude of the civilised world.

With regard to the position of Aberdeen, I find, on again looking into the statistics in Garcke's Manual, that I have

been led into an error, the units given for 1899 being for seven months only, and not for the complete year. While unable to give precise figures, I gather from later published results that Aberdeen must sell over 20 units per annum per £1 worth of mains laid. I deeply regret this unfortunate mistake, although naturally rejoicing to see that in this case my contention finds support instead of refutation.—Yours, &c.,

North Shields, Dec. 29. CHARLES TURNBULL.

## LEGAL INTELLIGENCE.

### Chloride Electrical Storage Syndicate (Ltd.) v. The Corporation of King's Lynn.

ARBITRATION.

In *The Electrician* for Dec. 7, p. 252, we published particulars of proceedings in arbitration before Major Cardew, R.E., at King's Lynn. The award in the arbitration has now been made.

The award orders the Corporation to pay the sum of £100 and the costs of the syndicate and of the arbitrator.

The amount claimed by the syndicate was £301. 1s. 7d. the principal part of which represented labour expended in erecting the storage batteries at the electric lighting station of the Corporation, it being claimed by the syndicate that they were entitled to charge for all labour at the rate fixed in the "Day Work" scale in the schedule of quantities, in addition to the prices quoted for materials; the contention of the Corporation was that such prices were intended to include all labour. The arbitrator was appointed by the president of the Institute of Civil Engineers on the application of the syndicate, the Corporation appearing at the hearing "under protest," on the ground that the matter was not one within the jurisdiction of the arbitrator, but one on which the decision of their engineer was intended by the contract to be final.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

London County Council require an electrical engineer to superintend, under the Council's chief engineer, the work of constructing or re-constructing for electric traction the Council's tramways, &c. Applications by Jan. 14.

Manchester Electricity committee require an electrical engineer for their electricity undertaking. An advertisement contains further particulars. Applications (addressed to chairman) must be in by 19th inst.

Manchester Electricity committee also require a deputy electrical engineer. An advertisement contains further particulars, and applications (addressed to chairman) must be in by 19th inst.

Manchester Tramways committee require an electrical engineer to act as chief engineer to the tramways department. An advertisement gives further particulars, and applications (addressed to chairman) must be in by Jan. 12.

West Ham Guardians require an expert to advise on the engineering work in connection with their new infirmary at Leytonstone. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. Fred. E. Hilleary), Union Workhouse Leytonstone, N.E., by 23rd prox.

The Council of the Foreign Community, Shanghai, require a municipal electrical engineer. Further particulars from Messrs. John Pook & Co., 53, Leadenhall-street, London, E.C., to whom applications should be forwarded before Jan. 12. See advertisement.

A smart draughtsman is required as evening instructor in the drawing office at the Northampton Institute, Clerkenwell, E.C. Forms of application from the principal (Dr. R. Mullineux Walmsley). See advertisement.

Rotherham Corporation invite applications for the post of borough electrical engineer. Applications to town clerk by Jan. 14.

Burnley Corporation require a general manager for their tramways. Applications by Jan. 19.

The Governors of Sir John Cass's Technical Institute, Jewry-street, Aldgate, E.C., require a principal. Applications to clerk, 10A, Idol-lane, Eastcheap, E.C., by Jan. 26.

An assistant lecturer in physics is required for the Technical College, Huddersfield. An advertisement gives further particulars.

A large Continental manufacturing firm require a manager and engineer to take charge of the business in the United Kingdom and British colonies. See advertisement.

The Bromley (Kent) Electric Light and Power Co. (Ltd.) require a secretary. Applications to the engineer and manager (Mr. R. L. Gamlen), West-street, Bromley, by January 7th. See advertisement.

Huddersfield Tramways committee requires a lineman. Applications to town clerk by Friday, 11th inst. See advertisement.

A switchboard attendant is required for the Motherwell Corporation electricity works. Applications to the electrical engineer (Mr. S. E. Britton) by 9th inst. See advertisement.

Mr. C. T. R. Wilson, F.R.S., Fellow of Sidney Sussex College, has been appointed lecturer in experimental physics at the University of Cambridge.

Mr. W. J. Wood has been appointed assistant electrical engineer at the Bolton Corporation electricity works.

**Alleged Injury from Electrolysis.**—An action brought by the Manufacturers' Natural Gas Co., of Indianapolis, against the Indianapolis Street Railway Co. to recover $50,000 damages for deterioration to gas pipes caused by electrolysis is pending in the Superior Court at Indianapolis. According to the *Street Railway Review* the Gas Company complains that disintegration of pipes has been caused by inability of the Street Railway Company's conduits to carry the return current back to the power house, as a consequence of which employés of the Gas Company have received shocks and burns when the gas has been ignited by electricity. It was argued for the defence that the Street Railway Company's rights to use the streets were prior to those of the Gas Company, and that the latter was not entitled to recover because it made no pretence that its property rights had been damaged.

**Alleged Receiving.**—At the Westminster (London) Police Court on Wednesday, before Mr. Horace Smith, Albert Henry Ashford, marine store dealer, was charged, on remand, with feloniously receiving, among other things, a large quantity of solder, the property of Mr. Wm. Beattie, of Victoria-street, S.W., and new electric cable and fittings, the property of the Chelsea Electric Supply Co. (Ltd.). The police removed two large van loads of property (all of which was alleged to have been stolen) from the prisoner's shop and stable. Prisoner was further remanded on £200 bail.

**Asuncion (Paraguay).**—The Paraguay Development Co. (a U.S. joint stock concern) has secured a valuable concession for the electric lighting of this city, and for the construction and equipment of electric tramways. The concession is for 25 years, and both lighting and traction services must be working by Aug. 30, 1902.

**Belfast.**—At a meeting of the Electric Committee last week the city electrical engineer (Mr. Victor A. H. McCowen) submitted a statement as to the progress of the electricity undertaking during the past twelve months:—On Dec. 31, 1899, there was an equivalent of 51,500 8 c.p. lamps connected to the mains, and there were now 73,500, an increase of 43 per cent. There were also applications for a further 10,000 8 c.p. lamps. The output for the year 1899 was 622,500 units sold. The estimated output for 1900 was 875,000 units, an increase of 40 per cent. The average price obtained for current supplied during 1899 was 4·36d. per unit; for 1900, owing to the reduction in price introduced at the beginning of the year, the average price would work out at about 3½d. per unit. The National Electric Wiring Co. had obtained for them during the year a connection of over 2,000 8 c.p. lamps. The advantages of electrical driving were at last being recognised, and they had now about 120 electric motors, aggregating 450 H.P., connected to the mains, and applications for a further 160 H.P. The system of letting out motors on hire was being appreciated by small users of power, and they had about 150 installed, driving various types of machinery, including hoists, sewing machines, linen finishing machines, printing machines, dairy machines, ventilating fans, grain crushers, &c. The average price obtained for current supplied for motors during the year worked out at about 2½d. per unit, while several long-hour consumers obtained it as low as 1·6d. per unit. Notwithstanding the greatly increased cost of coal during the year, the cost of production would not be increased, but would actually be reduced owing to other economies being introduced and to increased output. The maximum load on the station was 955kw., and for 1900 1,307kw., an increase of 37 per cent.

**Blackburn.**—On the introduction of electric traction two years ago the tramway fares were reduced 50 per cent., and at the end of the first year's working the receipts were over £4,000 more than in the previous year, representing an increase of 2,000,000 passengers. Last year the increase over 1899 was £2,500 in receipts, and 600,000 in passengers.

**Bolton.**—Tramway matters occupied the attention of the Council on Wednesday. The Tramways committee proposed to establish a circular system of electric tramways in the centre of the town, cars running every 2½ minutes and collecting and depositing passengers at the starting points of the various tramway routes. Mr. Tootill said this would involve a change of cars to all passengers who desired to go to the railway station. He did not know of any town where such a system was in successful operation, and as the committee

had no experience in that matter it was unwise to launch upon the experiment before they had perfected their system in other directions. Ald. Miles admitted that the proposed system had disadvantages, but it would solve the congestion difficulty in the centre of the town due to all cars starting from the same point. They would have specially light cars for the circle service. The traffic manager estimated that the scheme would not only give them a quicker all-round service, but would result in a saving of nearly £11,000 per annum. Mr. Smith (vice-chairman of the Tramways committee) maintained that the block in the centre of the town must be relieved. He added that they were reducing the fares along with the adoption of this new system. Ald. Nicholson (chairman of the committee) said at the beginning he was emphatically opposed to the circular system, but he desired the Council to try it as an experiment. Passengers would not have to pay extra fares for the town circle when it formed part of their journey to or from the route on which they desired to travel. The recommendation was adopted.

**Buxton.**—The electrical engineer (Mr. E. Calvert) has reported that 500 lamps have been connected since the previous meeting, and that it was absolutely necessary to place an order for additional plant, to be delivered before June, at a cost of between £4,000 and £5,000; and Mr. Calvert anticipates that by next season there will be 12,000 lights on the books. The town hall is to be wired for the electric light at a cost of £550.

**Calcutta.**—The demand for electric current continues to increase at a steady rate. The Calcutta Electricity Supply Corporation started operations in April, 1899, with 700 8 c.p. lamps connected, but by April, 1900, there were 14,000 lights, and at the end of November 27,000. The machinery installed or on order is capable of supplying current to 60,000 lights, but, in view of the increasing demand, additional plant capable of supplying another 100,000 lights will be obtained. The engineer to the company (Mr. K. A. Scott-Moncrief) has recently been in England where he has arranged for the purchase of two 750kw. steam dynamos. Mains are being laid in additional streets. New works are being built and will supply electricity to the suburban districts of Alipore, Ballygunge, &c.

**Cardiff.** The ceremony of laying the first rail and fixing the first bonds in connection with the Corporation's electric tramway scheme was performed by the mayor (Councillor T. Andrews) on Tuesday.

**Cleckheaton.**—Application has been made for sanction to borrow £25,000 for electric lighting and refuse destructor works.

**Crewe.** Electric current is being supplied to 42 consumers, representing an equivalent of 1,100 8 c.p. lamps, and 90 applications for supply have been received, equivalent to 3,500 lamps.

**Dawson City (Yukon).**—The streets of this city are now lighted by electricity, and a number of the business premises, and especially the well-equipped stores, have the electric light. Electric tramways are to be running early in 1901.

**Derby.**—The salary of the borough electrical engineer (Mr. T. P. Wilmshurst) has been increased from £350 to £400 per annum, with further annual increments of £50 until a maximum of £500 is reached.

**Dunstable.**—Ald. Garrett has succeeded in his endeavours to get the Council to obtain a provisional electric lighting order, and his consistent advocacy of electric lighting is about to be crowned with success. He is a member of the firm of F. T. and A. Garrett, who had given notice of intention to apply for an order, but in his opinion the lighting of the town and the supply of electric energy should be in the hands of the local authority. The resolution in favour of applying for the order has been carried unanimously.

**East Grinstead.**—The Council have decided to expend £25 in obtaining expert advice on the proposal to establish electricity works.

**Electric Lighting at Gasworks.**—Electric lighting plant has just been put down at the Broughty Ferry gasworks, all departments except the retort house having been wired, and lamps have been suspended round the gasometers. Last week the commissioners visited the works, and the gas manager (Mr. Forbes Waddell) pointed out that now any necessary work could be attended to at night with far greater facility and safety than could otherwise be the case.

**Electric Traction in the Lake District.**—A committee has been formed to oppose this scheme. The guarantee fund has reached £1,300.

**Electricity Supply in Lancashire.**—The Lancashire Electric Power Co. have approached several local authorities in Lancashire as to the supply of current in bulk, and especially the smaller districts. The following terms, which are 20 per cent. below the maximum rates fixed in the company's bill, have been offered: For a supply averaging 300 hours per quarter 1·87d. per unit, 400 hours 1·60d., 500 hours 1·44d., and 600 hours 1·33d.

**Epsom.**—An inquiry was held here last week into the application of the Council to borrow £2,793 additional for electricity supply works. Already £10,100 has been sanctioned, and the extra loan is required chiefly to meet the extra cost of buildings. The consulting engineer (Mr. W. C. C. Hawtayne) stated that the Council purchased a station site on his advice in December, 1898, and he was instructed to prepare plans for carrying out the electric lighting scheme. 131 tenders under the various sections were sent in, and the amount of the contracts recommended for acceptance was £10,894. The increase in the amount of the building contract was largely due to the considerable rise in the price of material and labour. There was no opposition.

**Faversham.**—The consulting electrical engineer (Mr. H. Talbot, of Nottingham) recommends the Council to adopt the continuous-current three-wire system of distribution with a pressure of 230 volts at consumers' terminals. The total estimated cost is £13,450. The Council are applying for a provisional order, and the capital sum to be expended has been fixed at £20,000.

**French Cable Projects.**—In connection with the paragraphs going the round of the papers concerning big schemes originating in Paris for the laying down of submarine telegraph cables under French auspices, we would refer our readers to *The Electrician* for Aug. 10 last, pp. 593-595. On p. 594 a complete map is given, showing the routes of the cables proposed in the earlier scheme. Also for Aug. 17, p. 625. It is stated that the scheme set out as above mentioned is too modest for some of the more militant French legislators, and that 40 deputies have been found who have signed another *Proposition de Loi*, by the terms of which a vastly increased network of submarine telegraph cables and overland connecting lines is scheduled. This bill provides for the construction of the following lines:—

*Atlantic.* A cable from Rochefort to Dakar, 2,224 miles, cost 20,210,717f.; Dakar to Buenos Ayres, 3,874 miles, cost 44,702,871f.; Dakar to Kotonou and Libreville, 2,168 miles, cost 13,284,036f.; Libreville to Mossamedes, 1,074 miles, cost 7,535,628f. Total for the Atlantic (with 100,000f. for a cable steamer to effect repairs) of 86,733,252f.

*Indian Ocean*: Tamatave to St. Denis, 381 miles, cost 2,332,418f.

*Chinese Seas*: Saigon to Shanghai, and Port Arthur and Taku, 2,865 miles, cost 20,004,843f.; Saigon to Batavia, 1,291 miles, cost 9,453,497f. Total for the Chinese Seas (with 700,000 for a cable steamer) of 30,158,340f.

*Levant*: Bizerta to Sebastopol and Bayrouth, 2,173 miles, cost 9,804,941f. with cable ship costing 700,000f.), a total of 10,504,941f.

The *land lines* comprise lines from Macao to Canton, Taku to Tientsin, and Ergasteria to Athens—total cost estimated at 124,728,591f. In the future the bill foreshadows establishment of other lines, especially between Mossamedes and Fort Dauphin, Fort Dauphin and Lourenço Marques, Dakar and Cayenne, St. Denis and Reunion Island, and Batavia, and Saigon and Manila, to cost an additional 106,000,000f.

By the bill the State is to have the advantage of constructing these lines. There are those among the deputies who think that France will have her work cut out to establish the smaller of these schemes.

**Gillingham.**—Following the example of the neighbouring councils, Rochester and Chatham, the District Council have decided to approach the Chatham, Rochester and District Electric Light Co. with a view to the purchase of so much of the company's undertaking as lies within the Gillingham district.

**Gomersal.**—The District Council have given notice to purchase so much of the undertaking of the Dewsbury, Batley and Birstall Tramway Co. as lies within the district, in order to grant a lease of this portion to the British Electric Traction Co., in connection with their Spen Valley electric tramway service.

**Grimsby.**—The electricity works were formally opened on the 1st inst., current being switched on by the chairman of the Lighting committee, Ald. Dobson.

**Halifax.**—On the recommendation of the Tramways committee the salary of the tramways manager (Mr. F. Spencer) has been increased from £300 to £350 per annum, with a further increase of £50 a year from 1902.

The electric tramways from Cote Hill to Tuel-lane and from Boothtown to Catherine Slack were officially inspected by the Board of Trade last week, and are now open for traffic.

**Hebden Bridge.**—The Council, who have decided to apply for a provisional electric lighting order, have instructed Mr. Walter Emmott, of Halifax, to prepare a full report on electric lighting.

**Huddersfield.**—The Linthwaite electric tramway route is ready for official inspection. The first trial trip took place on Thursday evening last.

**Imperial Penny Post.**—On April 1 next, Imperial penny post will be extended to Victoria (Australia).

**Lancaster.**—The question of the appointment of an electrical engineer to take charge of the tramway scheme and electricity supply works during the absence of Mr. W. A. Fraser in South Africa was discussed by the Council on Wednesday. It had been decided that the engineer appointed should act under the surveyor until Mr. Fraser returned. It was now stated that the selected candidates had refused to accept appointment under another official. Ultimately the matter was left over to next meeting, when notice is to be given to rescind the former resolution.

There were 34 applications for the position of temporary borough electrical engineer, and the following were selected to meet the committee:—Messrs. E. A. Browning (London), A. R. Dayson (Plymouth), and W. A. Tester (London).

**Leeds**.—The receipts of the Corporation tramways department during 1900 totalled £168,005. 11s. 6d. against £123,937. 0s. 6d. in 1899, an increase of £44,068. 11s. The gradual extension of the electric system is responsible for the swelling of the receipts. Within the past year electric has supplanted horse and steam haulage on different routes, and the work of complete transformation is to be hurried on. The committee have instructed the engineers to get out specifications for the electrical equipment of the few sections remaining, and it is expected that the work will be completed before the close of 1901.

**Leeward Islands**.—Telephone systems are in operation in Antigua and St. Kitts, the expenditure of the former island being £927, receipts £704. For St. Kitts the expenditure was £533, receipts £337. There are 275 and 204 miles of line respectively erected in the islands.

**Light Railways**.—Owing to delay in delivery of rails by the Lorain Steel Co., U.S.A., the work of constructing the Cheltenham-Cleeve Light Railway has not been commenced, but the promoter (Mr. T. Nevins) expects to start work in February.

Owing to the refusal of the Light Railway Commissioners to vary their order for the construction of electric tramways in Worcester to include agreements made with the local tramways company and the British Electric Traction Co., considerable delay has been caused, and a supplementary agreement is to be entered into between the parties.

**Manchester**.—The electricity department have issued a statement of the progress made during the past year. In December, 1899, there were 3,014 consumers, representing the equivalent of 328,696 8 c.p. lamps, and there are now 3,646 consumers, with an equivalent of 362,464 lamps, an increase of 33,786. When the installation of the four 1,800kw. Westinghouse generators is completed at Bloom-street this station will have a total capacity of 12,000 H.P., and will be rather larger than the Dickinson-street works, which has taken seven years to attain its present maximum. At the latter station two new 1,000 H.P. Ferranti generators were erected during the year, and both machines will shortly be ready to assist with the load. They are intended to supply the energy required for working the tramways on the three routes first to be taken over by the Corporation (Cheetham Hill, Rochdale and Bury New Roads). With the completion of these two generators the whole of the space apart for machinery at Dickinson-street will be fully occupied. The provision of arc lamps for many of the principal thoroughfares was sanctioned by the City Council three years ago, but this work was deferred, it being considered that it would be advantageous to combine it with the overhead equipment for the tramways. The arc lamp lighting will be started on the three roads through which the tramcars pass.

**Metropolitan District Railway and Electric Traction**.—Mr. J. S. Forbes, chairman of the District Railway Co., has issued a circular describing the financial condition of the company. Mr. Forbes points out that the traffic on the underground railways has been seriously affected by the new Central London Railway, and by the severe omnibus competition. The success of the adoption of uniformity of class and fare on the Central London line is described as contrary to all previous London railway experience. The dearness of Welsh smokeless coal has driven the companies having running powers over the underground lines to use inferior fuel, leading to a further deterioration of the atmosphere, and reducing the popularity of the underground system. Mr. Forbes states that there is only one possible remedy—electrification. Recent experiments have proved that with the adoption of electric traction the vitiated atmosphere will disappear and a more economical and effective working of the trains will be secured. The tenders for the equipment of the line electrically recently sent in are (Mr. Forbes states) undergoing careful examination, and show that the line can be converted to electric working at a moderate outlay and in a comparatively short time. In view, therefore, of the adverse change in circumstances referred to, the directors of the District Company have decided to ask the shareholders to consent to the raising of the moneys already authorised by Parliament for effecting this object.

**Nottingham**.—The Sherwood Market-place electric tramway route was opened for traffic on Tuesday.

**Private Bill Legislation**.—In order to meet the demand for electric current within the parish of St. Mary Abbots, Kensington, the Notting Hill Electric Lighting Co is promoting a bill for powers to acquire land in Napier-road and Holland-mews, Kensington, for an additional generating station.

The bill of the South Yorkshire Electric Power Co. seeks powers to supply electric energy in bulk to authorised undertakers, and for providing power to any person. The energy supplied to "authorised undertakers" may be used for lighting, and that supplied to any person for power may be used for lighting any premises on any part of which the power is utilised. The area of the company's operations is set out in a schedule, but they are specifically prohibited from exercising powers in Bradford, Leeds and Sheffield; and, except for obtaining access to some other district, a similar restriction is placed upon the company in Halifax, Huddersfield, Wakefield, Dewsbury, Batley, Morley, Brighouse, Keighley, Doncaster, Barnsley, Rotherham, and Todmorden. The capital will be £2,000,000 in £10 shares, with the right to borrow not more than one-third of the issued capital. The shares will be divided into preferred and deferred half-shares. The first directors are Sir R. Mottram, Sir W. Agnew, Mr. H. A. Earle, and Mr. W. P. J. Fawcus. The dividend payable on the capital is to be on a sliding scale based on a standard price of 2½d. per unit. Subject to this condition the dividend is to be at a standard rate of 8 per cent.

In the bills of the London County Council for tramways and street improvements the capital expenditure is put at £2,145,200. Of this sum £957,200 is put down for the construction of new tramways and reconstruction of existing tramways, land for generating station, &c. The length of tramways proposed is upwards of 28 miles.

This company will, next session, apply to Parliament for power to lay a second trunk main as an alternative route for the supply of current from Willesden to the areas embraced in the company's system of supply—i.e., Paddington, St. Marylebone, St. Giles, Holborn and the Strand. It will be remembered that the Board of Trade, in granting the company permission to supply at high pressure, recommended that, if possible, a second trunk route would be advisable. The new mains will take an entirely different route to that of the existing main, and if the bill passes the company will be in a still better position than at present to ensure a regular and uninterrupted supply.

**Ross**.—Mr. John Parkes' application for a provisional electric lighting order has been unanimously approved by the Council.

**St. Helena**.—Governor Sterndale in a report upon the trade of St. Helena for 1899, just published, refers to some public works in course of construction. Amongst these are the new barracks, and the belief is expressed that when these are finished it will pay a small company to erect and equip a station for lighting Ladder Hill and the town by electricity, generated by windmills. There is always a steady wind from the south-east Trades. During the year 1899 there were only nine days calm. The lighting at present is by kerosene oil of a very indifferent quality.

The telephones on the island, which connect east, west, and central points, have been constructed by the Royal Engineers, and are used solely for military and official purposes. The Colonial Government grants an annual subsidy of £45 and Lloyd's £30.

**St. Lucia**.—A telephone system, completed in 1896, connects Castries with the small towns and villages of the islands; 120 miles of trunk line are open for traffic. The chief exchanges are worked by paid operators and the village exchanges by the police. The revenue for the year 1899 was £526 and the expenditure £443. The Government owns the lines.

**Salford**.—On the presentation of the minutes of the Electric Light committee at the Corporation meeting on Wednesday, Mr. Jackson raised an objection to the manner in which, he alleged, the committee had gone about the preliminaries for the appointment of a borough electrical engineer, at a salary of £700 a year. He declared that members had gone to other towns trying to induce the electrical engineers of those places to send in applications. He condemned that policy, and he also questioned the necessity for paying so high a salary. The committee's minutes were approved.

**Sheffield**.—An analysis of the receipts of the tramways department for 1900 appeared in a recent issue of the *Sheffield Daily Telegraph*. The quarterly totals were: First, £23,606. 13s. 6½d.; second, £29,503. 0s. 4d.; third, £33,094. 16s.; and fourth, £34,922. 12s. 3½d. The total for the year was £121,127. 2s. 2d., and the average for each week £2,329. 7s. The electric cars to Heeley, Brightside, and Harcourt Road all commenced running during November.

**Siam**.—The Siam Electricity Company has decided to acquire the undertakings of the Bangkok Tramways Co. and of the Siam Electric Railway Co.

**Spain**.—Information concerning the electrical industries of Spain has just been published by the Government, and it appears there are at present 443 electric power stations in Spain, of which 12 are in the city of Madrid. Two of these supply power for street railways, nine for lighting, while the twelfth, still under construction, will be the largest of all, and will supply power for both purposes. Electric light is now to be found all over the city of Madrid, and its application is steadily increasing. Three companies—the Compania General Madrilena de Electricidad, the Compania Inglesa de Luz Electrica, and the Sociedad de Electricidad de Chambin—chiefly supply electric current for the Spanish capital. The first two companies are owned by French, German, and English capitalists. The Madrilena Company has a capital of 10,000,000 pesetas (about £400,000), and in 1899 paid 23½ per cent. dividend. The third company, with a capital of £200,000, is entirely Spanish. A few months ago a com-

pany (capital £20,000) was formed, with headquarters in Madrid, to manufacture electrical apparatus and appliances.

**Stourbridge.**—The Board of Trade are to be asked to extend the period of the Council's provisional order by two years; and the application of the Midland Electric Corporation for electric lighting powers is to be opposed by the Council.

**Sutton Coldfield.**—The Council have acquired a site for electricity works at £2,625.

**Swansea.**—At present the electricity department have in hand applications for the equivalent of 7,500 8 c.p. lamps. With regard to the proposal to supply electric current to the docks, the electrical engineer (Mr. J. H. Cawthra) reported to the Electric Lighting committee on Wednesday that at the price suggested current could only be supplied at a loss to the Corporation.

**Theatre Français.**—It is stated that the inauguration of the new Théâtre Français, Paris, narrowly escaped postponement in consequence of serious defects in the wiring arrangements for the electric light at the theatre.

**Water Power Utilisation in Spain.**—Application has been made for a concession for the utilisation of the waters of the River Saja for the generation of electric power for the supply of current to Los Tojos.

**West Australia.**—A correspondent writes that there is an opening for the introduction into Western Australia of railway and mining material generally, high-class electric lamps, fittings, motors, &c., for 200 volts and upwards. Much German and American electrical material is being sold in Western Australia at the present time. The policy of the country is to deal with local agents, and Perth or Fremantle are suggested as centres where profitable agencies could be established.

**Wigan.**—The Council on Wednesday approved the municipal bill for the construction of electric tramways and for authority to supply electricity in bulk beyond the limits of the borough.

**Willesden.**—Voting papers are to be issued to-day (Friday), returnable on the 8th inst., for the poll which ratepayers of the district are taking on the subject of the proposed tramway scheme of the Willesden District Council. Willesden is claimed to be the largest urban district council in the country, with a population of 120,000 persons, and covering an area considerably over 4,000 acres. The total capital outlay involved in the carrying out of the Council's proposed tramway undertaking is over £73,000 (including £20,000 for road widening).

**Worcester.**—The Council have authorised the Electricity committee to proceed with the scheme for the extension of street lighting by electricity.

**Workhouse Lighting.**—The Kensington Guardians have applied for sanction to borrow £13,300 for the electric lighting scheme prepared by Prof. H. Robinson.

**Worthing.**—The charge for electric current has been fixed at 6d. per unit for lighting and 3d. for power, with sliding discounts when the consumption exceeds 1,000 units per annum.

**Annual Dinner.**—The seventh annual dinner of the cable companies' staffs was held on New Year's Day, at the London Tavern, Fenchurch-street, E.C., when 107 guests assembled. Mr. Vigge Jensen (Great Northern Company) presided, and Mr. W. James (Commercial Company) occupied the vice-chair. A smoking concert followed.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers' or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

"The Art of Electrolytic Separation of Metals."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Electrical Testing for Telegraph Engineers."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"Wireless Telegraphy: Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"The Manufacture of Carbons for all Electrical Purposes."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"Armature Winding of Electric Machines."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full page tables, 30s. post free.

"Temperature Coefficients of 'Conductivity' Copper." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 84·9°F. Printed on strong cardboard, 6d. net.

"Laboratory Notes and Forms."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

**NOW READY.**—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"Drum Armatures and Commutators," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil-armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"The Steam Engine Indicator and Indicator Diagrams."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

Digitized by Google

# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Canterbury* Lighting committee invite tenders for boiler and engine-house plant, condensing apparatus and pipework, and extension of switchboard. An advertisement contains further particulars, and specification may be obtained by manufacturers at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria street, Westminster, London, S.W., after 9th inst. An advertisement contains further particulars, and tenders must be sent in to the town clerk (Mr. Henry Fielding), Town Hall, Canterbury, before 4 p.m. on 30th inst.

The Council of the Metropolitan Borough of *Fulham* require tenders for the supply of materials and goods required in connection with their electric light and dust destructor station. Further particulars are set out in an advertisement, and tenders must be sent in to the acting town clerk (Mr. W. J. H. Denselow), Town Hall, Walham Green, S.W., by 5 p.m. January 9th.

*Ilford* District Council invite tenders for work in connection with the electric lighting of the town hall and public offices. An advertisement contains further particulars, and specifications may be obtained from the clerk to the Council (Mr. John W. Benton). Tenders, addressed to chairman, must be sent to Mr. Benton not later than 31st inst.

*Oldham* Corporation require tenders for two 600 I.H.P. engines and four 1,200 I.H.P. engines, each direct coupled to a continuous-current dynamo. Specifications may be obtained from Mr. A. Andrew, Gas and Water offices, Oldham, and can also be seen at (but not obtained from) the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, London, S.W. An advertisement gives further particulars, and tenders must be sent to Mr. Andrew by Jan. 29.

*Southport* Tramways committee require tenders for material for electric tramways, including poles, brackets, and scrolls, bases, trolley wire, trolley wire attachments, galvanised steel wire, and section boxes. Specifications and forms of tender may be obtained from the borough electrical engineer (Mr. Charles D. Taite), and tenders must be delivered at the offices of the town clerk, Town Hall, Southport, by 21st inst. An advertisement gives further particulars.

*Sunderland* Corporation invite tenders for the supply of (*a*) condensing plant and cooling tower, (*b*) secondary battery, (*c*) main switchboard, (*d*) travelling crane. Specification obtained from the borough electrical engineer (Mr. J. F. C. Snell), and tenders (addressed Chairman of Lighting committee) must be delivered to the town clerk (Mr. Fras. M. Bowey), by noon Feb. 1. An advertisement contains additional particulars.

*Rathmines* District Council require tenders for boiler-house and engine-house plant, condensing apparatus and pipework, switchboard extension, mains, and public incandescent lighting. Tenders to clerk by 4 p.m., Jan. 10.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal Buildings, Lavender-hill, S.W., before noon Feb. 1.

*Poplar* Borough Council require tenders for an electric crane for a maximum load of 5 tons. Tenders to acting town clerk, 117, High-street, Poplar, E., by Jan. 16.

*Farnworth* District Council invite tenders for eight 66-passenger tramcar bodies, motors, undertrucks, controllers, &c. Tenders by Jan. 10.

*Southampton* Corporation require tenders for overhead equipment of about 1¾ miles of tramway route. Tenders to town clerk by noon Jan. 7.

*Sheffield* Tramways committee invite tenders for a slow-speed vertical engine for driving a 1,000kw. tramway generator. Tenders to General Manager by Jan. 21.

*Partick* Burgh Commissioners require tenders for steam dynamos, battery-charging motor, booster and balancer. Tenders to town clerk, 97, West Regent-street, Glasgow, by noon Jan. 7.

*Glasgow* Corporation require tenders for telephone apparatus in connection with their tramways. Tenders to town clerk by Jan. 18.

*Rotherham* Corporation invite tenders for electricity meters. Tenders to town clerk by Jan. 19.

*Manchester* Waterworks committee require tenders for wiring and fittings at their hydraulic pumping station. Tenders by 8th inst.

*Wolverhampton* Corporation require tenders for materials and labour for constructing tramway track, &c. Tenders by Jan. 15.

*Ayamonte* (Spain) Municipal Council require tenders for an electric lighting concession for 20 years. Tenders to el Secretario del Ayuntamiento by Jan. 12.

## TENDERS RECEIVED AND ACCEPTED.

At the Stockport Corporation meeting on Wednesday the following tenders were accepted:—

| | |
|---|---|
| British Insulated Wire Co. (overhead equipment and rail bonds) | £6,981 |
| Leeds Steel Works (rails, fishplates, &c.) | 10,045 |
| Hadfields Steel Foundry Co. (points and crossings) | 3,408 |
| Macartney, McElroy & Co. (laying permanent way) | 5,796 |

Bristol Corporation have placed a contract with Messrs. Siemens Bros. & Co. for the supply of two 165kw. Siemens-Willans steam dynamos for £4,390. 16s. 6d.

Crewe Corporation have accepted the tender of Messrs. Dorman and Smith for the supply of 500 incandescent lamps and fittings.

Tunbridge Wells Town Council have accepted the tender of the Baltic Saw Mills Co. for the supply of 20 45ft. square pitch pine poles, and that of Messrs. Wells & Co. (Ltd.) for 10 40ft. and 6 50ft. poles for the telephone department.

Croydon Corporation have accepted the tender of the Wheeler Condenser and Engineering Co. for an additional Barnard cooling tower for the electricity works at £758.

Wrexham Town Council have accepted the tender of Messrs. Brook, Hirst & Co. for wiring the markets for the electric light. The tenders sent in varied from £259 to £363. 10s.

## BUSINESS NOTICES.

The business which has been carried on for the past 11 years at Prudential-buildings, 36, Dale-street, Liverpool, by Mr. Lester Taylor and Mr. Archie Kelly will in future be continued by them in partnership with Mr. Walter J. Hide under the style of Lester Taylor, Kelly and Hide.

Messrs. Robert W. Blackwell & Co. have opened branch offices at 7, St. Mary's-street, Cardiff, which will be under the control of Mr. B. Phillips-Smith.

Messrs. H. G. Massingham and C. Lopdell (carrying on business as Massingham, Lopdell & Co.), electrical engineers, 23, Victoria-parade, Torquay, have dissolved partnership. Debts by Mr. Massingham.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 5s. 7$\frac{1}{16}$d. will be payable on 16th inst. at 71, Cross-lane, Earlestown, Lancs., in the bankruptcy of G. H. Bentley, electrical engineer, Earlestown.

It has been decided to wind-up voluntarily the Automobile Association (Ltd.), and Mr. H. M. Gowar, 23, College-hill, London, E.C., has been appointed liquidator.

J. D. F. Andrews & Co. (Ltd.) is to be wound-up voluntarily, and Mr. W. H. King, 13 and 14, Basinghall-street, E.C., is liquidator.

H. Jackson, electrical engineer, 12, Margaretta-terrace, London, S.W., has arranged a composition with his creditors under which he is to pay, in four instalments, 10s. in the £. The unsecured liabilities are returned at £969, assets £330. Mr. C. F. Oughton, Moorgate Station-chambers, London, E.C., is trustee. The following are the principal creditors:—

| | | | |
|---|---|---|---|
| Veritys Limited | £264 | Accessories Manufacturing Co. | £29 |
| Edison and Swan Co. | 129 | Vigers Bros. | 21 |
| W. T. Henley's Co. | 56 | Evered & Co. | 15 |
| Westminster Engineering Co. | 54 | Hands Limited | 14 |
| General Electric Co. | 41 | Hodges & Todd | 13 |

**Plant, &c., for Sale.**—As announced in our advertisement columns, Messrs. Wheatley Kirk, Price & Co. have received instructions from Messrs. Laing, Wharton and Cunnington to sell by public auction at an early date a large quantity of surplus stock, including valuable electrical fittings, cable, general stores, machines, tools, &c. Catalogues are in course of preparation, and will be obtainable from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

The electricity department of the Nelson Corporation have for disposal a storage battery of E.P.S. central station K type cells. Particulars are given in an advertisement. Tenders have to be sent in to Mr. R. M. Prescott, town clerk, Town Hall, Nelson, by Jan. 23.

An advertisement gives particulars of an extensive engineering workshop in the London suburbs which is for sale with or without machinery.

**B.T.H. Plant.**—A well-got-up pamphlet, No. 82, issued by the British Thomson-Houston Company, contains a complete description and a number of excellent illustrations of the Sheffield electric tramways.

**Calendars, &c.**—From the Electrical Power Storage Co. we have to welcome the well-known blotting-pad, calendar, diary and price list which the company have sent out for some years past to their customers. The pad is well got up and forms an admirable advertisement without being unduly aggressive. There is a £500

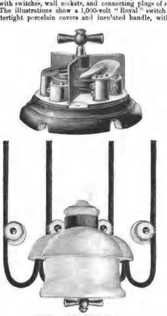
railway accident coupon attached. If any customer has been overlooked in the distribution, he is invited to notify the company.

Messrs. Cole, Marchent and Morley (Ltd.), Bradford, are sending out a well-got-up showcard, illustrating a 800kw. standard slow-speed coupled compound horizontal Corliss engine for electric traction. These engines are also made vertical, and the horizontal sets have been standardised in various sizes.

The Brush Co. have just issued a well-arranged price list of alternators, dynamos, motors, steam engines, transformers, switches and fuses, lightning arresters, arc lamps (ordinary, inverted and enclosed types), incandescence lamps, and other items of "Brush" plant apparatus and accessories. The list is well illustrated.

A useful date remembrancer is to hand from Messrs. W. H. Willcox & Co., each monthly sheet containing illustrations of the goods supplied by Messrs. Willcox.

**Price List**—We have received from the Electrical Co. (Ltd.) 122 to 124, Charing Cross-road, London, W.C., price list No. 8, dealing with switches, wall sockets, and connecting plugs of several types. The illustrations show a 1,000-volt "Royal" switch made with watertight porcelain covers and insulated handle, with trip motion. A number of switches of special design are also shown in addition to many of the regular stock designs manufactured by the company. The list includes a number of diagrams and connections of the "Royal" switches, which are sent out with coloured insulated covers where ordered.



1,000 volt "Royal" Switch.

**Exports of Electrical Apparatus and Material**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Dec. 22 to Jan. 1, with the ports of destination :—

*Africa*—Beira, £320 ; Cape Town, £294 ; Durban, £249. *Argentina*—Buenos Ayres, £2,000 (telegraph material) ; Rosario, £456. *Australasia*—Adelaide, £82 ; Christchurch, £39 ; Melbourne, £1,315 (including £1,200 telegraph wire) ; Sydney, £3,355 ; Wellington, £1,886 (including £1,241 telegraph material). *Belgium*—Ghent, £19. *Ceylon*—Colombo, £45. *Channel Islands*, £689. *Chili*—Valparaiso, £523 (telegraph material). *China*—Shanghai, £173. *Denmark*—Copenhagen, £238 (telegraph wire). *Egypt*—Alexandria, £20. *Germany*—Hamburg, £219. *Holland*—Amsterdam, £35 ; Flushing, £20. *Hong Kong*, £110. *India*—Bombay, £429 (including £46 telegraph material) ; Calcutta, £1,400 ; Madras, £20. *Mauritius*, £117. *St. Helena*, £1,946 (telegraph material). *Straits Settlements*—Singapore, £17. *West Indies*—Trinidad, £26. *Zanzibar*, £88. Total £16,130, against £19,278 for the corresponding 11 days last year (Dec. 23 to Jan. 2).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

October 26, 1900.

19,213. L. B. Atkinson. London. Improvements in dynamo-electric machines and motors, and in means for regulating the same.

19,220. H. Hirst and J. H. Collings. London. Improvement in unions or connections for electric light pendants and other fittings.

19,223. Z. Wirt. London. Improvements in or relating to electrical ignition devices for explosion engines.

October 27, 1900.

19,227. C. Adams-Randall. London. Aerial or wireless telephony.

19,238. J. L. Berridge and B. Kerr. London. Improvements in or relating to machinery or apparatus for re-covering electric cables, wires, and other cores.

19,251. A. De Puydt. Liverpool. Improvements relating to arc lamps. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 22, 1900, being date of application in Belgium.)*

19,263. L. Kamm. London. Improvements in rheostats.

19,280. The Jandus Arc Lamp and Electric Co. (Ltd.), J. G. Gorham, and A. D. Jones. London. Improvements in electric arc lamps.

October 29, 1900.

19,294. H. K. P. Barham and E. U. Bambury. Portsmouth. The "B B" improved semi-dry storage battery or accumulators for storing electrical energy.

19,321. G. Roselieb and B. Dellagana & Co. (Ltd.). London. An improved process and means for the reproduction of electro-depositing of high relief and undercut designs.

October 30, 1900.

19,371. E. Norris. Lincoln. Improvements in starting switches for electric motors.

19,383. F. R. Boardman. London. Improvements in and connected with electric arc lamps.

19,386. C. H. Offord and S. Jevons. Birmingham. Improvements in automatic time switches.

19,393. R. J. Yarnold. London. Improvements in apparatus for electrically treating air, gases and gaseous mixtures.

19,394. G. H. Chard. London. Improvements in lamp holders, switches for electric lighting.*

19,395. G. Middleton. London. An anti-vibration base frame for motors, dynamos, and other machinery.

19,416. H. D. Stroud. London. Improvements relating to telephone call recorders.*

19,438. C. Schuster. London. Improvements in electric arc lamps.

19,444. G. C. Marks. London. Improvements in arc lamps. (Continentale Jandus Electricitats, A.-G., Societe Anonyme, Belgium.)

19,448. C. A. Carus-Wilson. London. A new or improved method of controlling the action of electromotors.

19,449. C. A. Carus-Wilson. London. A new or improved method of controlling the action of electromotors.

19,451. G. F. Mansbridge. Improvements in and relating to electrical condensers.

October 31, 1900.

19,470. Crompton & Co. (Ltd.) and S. L. Brunton. Chelmsford. Improvements in electric switches.

19,471. Crompton & Co. (Ltd.) and H. W. W. Dix. Chelmsford. Improvements in electrical switches.

19,482. W. J. Crossley and C. J. Atkinson. Manchester. Improvements in electric ignition for internal combustion motors.

19,486. F. W. Leake. London. Improvements in electric clocks.

19,494. The British Thomson-Houston Co. (Ltd.) London. Improvements in slot wedges for dynamo-electric machines. (H. G. Reist, United States.)*

19,495. The British Thomson-Houston Co. (Ltd.) London. Improvements in systems of electrical distribution. (W. Le R. Emmet, United States.)*

19,496. The British Thomson-Houston Co. (Ltd.) London. Improvements in induction electric motors. (C. P. Steinmetz, United States.)*

19,497. The British Thomson-Houston Co. (Ltd.) London. Improvements in automatic circuit-breakers for electric circuits. (E. M. Hewlett, United States.)*

19,498. The British Thomson-Houston Co. (Ltd.) London. Improvements in circuit-breakers for electric currents. (E. M. Hewlett, United States.)*

19,499. The British Thomson-Houston Co. (Ltd.) London. Improvements in systems for controlling electric motors and electrically propelled railway trains. (F. E. Case, United States.)*

19,500. The British Thomson-Houston Co. (Ltd.) London. Improvements in electric switches. (E. M. Hewlett, United States.)*

19,506. F. J. Green. London. Improvements in electric arc lamps.*

19,511. J. H. St. Hill Mawdsley. London. Improvements in dynamo-electric and electro-dynamic machines.

19,512. H. H. LAKE. London. Improvements relating to electric circuit-breakers or switches. (McElroy-Gruno Electric Railway System, United States.)*

19,516. J. R. FRIKART. Liverpool. An improved device for regulating engines for driving electrical dynamos and the like.

November 1, 1900.

19,539. A. J. IRELAND and C. W. G. LITTLE. Kew. Improvements in trolley poles and standards.

19,564. C. E. LJUNGMAN. London. Improvements in and relating to combined telephone and sound telegraph apparatus.*

19,570. A. W. HANCOCK, J. LEIGHTON, and R. HACKING. London. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like.

19,576. A. L. A. C. D'ARLINCOURT. London. Improvements in electric switches and in ships' telegraphs, railway signalling apparatus and the like.

19,588. J. BOOKER and P. SUMNER. London. Improvements in automatic electrical switches and circuit breakers.

19,594. J. L. DAVIES. London. Improvements in alternating-current transformers or economy coils.

19,595. J. L. DAVIES. London. Improvements in or connected with arc lamps.

19,612. A. J. BOULT. London. Improvements in or relating to the renovating of electric incandescent lamps. (La Saymar Omnium Industriel d'Electricité Société Anonyme, France.)

November 2, 1900.

19,616. G. PRESCOTT. Liverpool. Improvements in electric railway car or vehicle trollies.

19,623. P. J. E. KENNEDY and H. C. READING. Burton-on-Trent. An improved gas light fuse and junction box for electric cables.

19,658. M. HANKIN. London. A new and improved process of insulation of electric wires or cables.

19,672. E. PILSOUDSKY. Liverpool. Improvements in wireless telegraphy and in apparatus therefor.

19,674. H. H. LAKE. London. Improvements relating to electric railways working on the surface-contact system. (W. M. Brown, United States.)*

19,686. G. DE ROUSSY DE SALES and F. GUEUGNON. London. Improvements in accumulators.*

November 3, 1900.

19,736. J. ZENNECK and THE PROF. BRAUN'S TELEGRAPHIE GESELLSCHAFT MIT BESCHRÄNKTER HAFTUNG. London. Improvements in decohering apparatus for wireless telegraphy.

19,737. J. ZENNECK and THE PROF. BRAUN'S TELEGRAPHIE GESELLSCHAFT MIT BESCHRANKTER HAFTUNG. London. Improvements in signalling by means of electric waves.

19,754. O. D. LUCAS, T. H. MARSH, and A. VANDAM. London. Improvements in and relating to key sockets for incandescent electric lamps.*

19,759. W. AITKEN. London. Improvements in electric traction systems.

19,765. W. PITT. London. Improvements in electric resistances.

19,766. W. E. ROWLANDS. Liverpool. Improvements connected with overhead trolley poles used in electrical traction.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

20,493. BERRY. Electrical signalling systems for railroads.

21,650. BRITISH THOMSON-HOUSTON CO. (LTD.) (Potter and Case). Systems of control for electrically-propelled vehicles and trains.

21,655. BRITISH THOMSON-HOUSTON CO. (LTD.) (Garfield). Systems of controlling electric motors.

21,660. BRITISH THOMSON-HOUSTON CO. (LTD.) (Buck). Electric circuit-breakers.

21,662. BRITISH THOMSON-HOUSTON CO. (LTD.) (Stevens). Electric arc lamps and magnets therefor.

24,594. GREENSTREET and SELBY. Automatic electrical cutouts.

25,746. BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz). Alternating current electric meters.

# COMPANIES' MEETINGS AND REPORTS.

## Pearson Fire Alarm System (Ltd.).

The second ordinary general meeting of this company was held in London, on Friday last, Mr. Richard Pearson (chairman) presiding.

The CHAIRMAN said: We have decided, seeing that so many of our shareholders would be away during the Christmas holidays, that it would be better to adjourn for one month, so I propose to move a resolution to that effect. I think that a review of this company should be given to-day, and I propose to state what we have done, what the system really is, and what it has done for London and the provinces. In the first place we own the entire rights of the District Messenger wiring system for London for automatic fire alarms. This cost the company a considerable sum of money, and may be a very valuable asset, as the District Messenger Co. have spent £140,000 in bringing out their system. The whole of that, with 22 offices, is, so far as automatic fire alarms are concerned, our joint monopoly. We have also from the Post Office a practical monopoly in a licence to work automatic fire alarms throughout Great Britain and Ireland—after a test for over eight months by the engineers and technical advisers of the Post Office. Most people associate fire alarms with fire-alarm posts. That is the difference between our system and many so-called fire alarms. What I consider our greatest accomplishment is that the Corporation of London, after a thorough examination by their electrical engineers and others, have allowed us to open up the streets of London wherever we wish to for the purpose of our work, in just over a year. Our mains run for more than a mile through the streets of the City of London. The heads of the fire brigades of Manchester, Leicester, Birmingham, Sheffield, Liverpool and many other large towns have also thoroughly examined our system. We have been approached from over 20 provincial towns desirous of bringing out our system as subsidiary companies. We have also been approached by persons in Russia and France. In Russia we are already protecting the Imperial Palace of the Czar and the national galleries. The money is already subscribed for a parent syndicate for France. At the adjourned meeting we shall be able to give you a statement of accounts together with our report, which I believe will please you.

Mr. HENRY GAMMAN said, as formerly the largest shareholder in the company and as a late director, he wished to detail the circumstances under which he parted with the bulk of his shares and retired from the board. It might be said that it was not a matter of public interest when an ordinary private individual retired from a board of directors. That was so ordinarily, but when the shares of a company rose in a very short time from 12s. 6d. or 15s. up to £4. 12s. 6d. or £4. 15s., the matter became one of public interest, more especially when the company had had for months past an average bank balance of £150, and which at that time had not £50 to its credit at its bankers. He had not retired from the directorate of the company because he had lost faith in the novelty and validity of Mr. Pearson's patents or in the reliability of the system. If the large fire insurance offices would give a rebate of 7½ per cent. or 10 per cent. for the installation of this system, then the fortune of the company was made and the shares worth even their present inflated price. Even if the great tariff offices did not give way, they had expected that with the aid of rebates on non-tariff risks, and by what Mr. Pearson's railway signal apparatus might bring in, the company might pay a small dividend on their original capital of £140,000. But none of these hopes had been realised. They started the company with energy, and endeavoured to get the system taken up in France and in Germany. They even sent a clever electrician to the United States and introduced the system there to all the chief offices. Mr. Pearson had told them how they got the licence from the Postmaster-General, but he had not told them how they got it, in spite of the opposition of Sir W. H. Preece, who disbelieved in the system. Mr. Pearson had told them that they got permission from the City of London to go under certain streets, and that they had protected a large amount of most valuable property in the Cripplegate district; but he had not said that they got that in spite of the opposition of Commander Wells. They introduced the system in English country towns, and Mr. Pearson himself went down to Liverpool. He interviewed the managers of the two biggest insurance companies in England, and tried everything to make the system go; but they could not make any headway. All this cost money; in fact, they spent money right and left. About a year ago they had to issue their remaining 10,000 £1 shares. It was hopeless to go to the shareholders and ask them to subscribe at par for shares which were then standing at 12s. 6d. or 15s. He had himself bought some at 13s. 1½d. He recommended that the directors endeavour to get someone to subscribe the necessary 10,000 £1 shares, and as an inducement let them have a large block of the directors' own shares at a very low price—5s. was agreed upon as the price. Mr. Pearson came forward with some few thousands of these shares, and he (Mr. Gamman) sold between 20,000 and 30,000. In the spring of 1900 Mr. Pearson introduced a solicitor—a Mr. C. M. Trevor, who said he had clients who could advance the £10,000 on the terms mentioned, and after a certain amount of negotiation the first cheque for £1,000 was produced, signed by a firm very well known on the Stock Exchange. They got another £1,000, and then Mr. Trevor's clients became apparently very poor. Mr. Trevor, by agreement, was to pay £100 per week for 10 weeks. [There was considerable interruption at this point.] Mr. Gamman, however, referred his interrupters to the secretary as to whether the £10,000 had ever been paid. He proceeded to make charges in regard to a very much vaunted contract for the supply of millions of thermostats, and roundly asserted that the company had no money at the present time. He was continually interrupted, and compelled to resume his seat.

The CHAIRMAN said Mr. Gamman had made £20,000 or more out of the company, while he (Mr. Pearson) had never sold a share. Mr. Gamman to-day held 25 shares.

Mr. ALFRED STROVER WILLIAMS, late chairman of the company, said the company might be a brilliant success, but in his view the high price to which the shares had been lifted had effectively discounted success. Everything Mr. Gamman had said as to the financial position was absolutely correct. So far as he was concerned, he had parted with a number of his shares when he considered the right moment had come for doing so.

The meeting was then adjourned for a month.

**BRITISH ELECTRIC STREET TRAMWAYS (LTD.)**—The statutory meeting was held on Monday. Sir J. Kenneth D. Mackenzie, Bart., the chairman, said the meeting was called to lay before the shareholders the company's exact position, and to notify them of the important concessions they had been able to obtain from the vendors. The prospectus called

attention to the various patents that the company owned, and the multitude of improvements that would result were they to be adopted generally. Undoubtedly a great future lay before the company. Attached to the notice convening the meeting was a copy of an agreement which the board had entered into conditionally. Mr. T. Parker had consented to accept £300 per year as consulting engineer to the company, instead of £500 provided by the first contract made with him, and also to forego the sum equal to one-tenth of the dividends paid to the shareholders by way of commission over and above his salary. Mr. Parker thinks he can be of much more service to the company by having a freer hand as consulting engineer for the Midlands districts than by remaining on the board as a director only, and he will thus continue to act for the company in the same way as will Sir William Preece and Major Cardew, their consulting engineers and electricians. The vendor company had consented to allow the shares received by them in part payment of the purchase money to be deferred as regards dividends until a dividend of 5 per cent. had been paid upon the shares publicly subscribed and paid for; and had also agreed to allow the company to retain 170,000 shares in its hands, which would only be released to the vendors pari passu as and when the remainder of the company's capital was issued. With regard to the prospects of the company it was early yet to say much, nor ought he to divulge information which could be easily turned to their disadvantage. With the clear working capital they had in hand and which they intended to husband and guard carefully, the company ought to make a good start and do well. He had connected himself with the largest of the new electrical railway schemes now before Parliament solely to be able to influence its being brought into the hands of the company, as its financial backing was all that could be desired; and if everything went well with the bill, as they anticipated, the company ought to make a very good thing out of it. He asked them to approve the new agreement with Mr. Parker. The motion was carried.

**MAXIM ELECTRICAL AND ENGINEERING EXPORT CO. (LTD.)**—The second annual general meeting was held on Monday. The chairman (Mr. Jules de Meray) said that since the closing of the accounts on Nov. 30, the activity in their engineering department had been such that they had received firm orders amounting to £3,930, and they had sent in tenders for £21,510 worth of work, and, as a good deal of those tenders were for goods of their own specialities, they must secure a fair share of them. The productions of another department—the specialities manufactured by Messrs. J. F. Pease & Co.—had been received with favour, and they had supplied them to the Board of Trade, Government railways in Australia and New Zealand, and orders were in hand for New South Wales. With regard to their lamp department, they had only shipped 6,368 lamps; but this number might have been largely increased if the Hiram S. Maxim Corporation had been ready for them. They had been passing through a time of trouble inherent to the early stages of manufacture, consequent upon the education of a new staff of employés, and therefore for some time they ceased to push the lamp trade. He was informed those difficulties were over, and that the Hiram S. Maxim Corporation were now prepared to give prompt delivery of a very superior lamp, and therefore they should recommence to push the business. The recent independent tests they had made showed the Maxim lamp was, indeed, a marvellous one and must command a large sale. They were sending out a trial shipment to an Australian corporation with a tender and a cable code for them to order 10,000 lamps per annum for three years, which they hoped to secure, while they were in treaty with several agents at different ports to take from 5,000 to 30,000 lamps per annum, and were it not for the difficulties already alluded to, many of those would have been fixed up. In addition to the Maxim incandescent lamp they had in active progress the production of an arc lamp that for price, efficiency, and simplicity would beat anything hitherto known to the electric world. It was a combination of two American and one English patents, and their representative was now in the States arranging for the amalgamation of those patent rights, while some 1,500 lamps were in course of manufacture in this country. He expected they would put an arc lamp on the market about the midsummer of 1901 that would be a potential revolution, and must secure the bulk of the arc lamp trade. Negotiations were in progress for the acquisition of another important business, which would probably necessitate an increase of capital. The report and accounts were adopted.

**OKONITE CO. (LTD.)**—The annual meeting of shareholders in this company was held on Monday, and, in the absence of every one of the directors, Mr. A. Vaughan-Stevens (a trustee for the debenture-holders) presided. Answering a shareholder, the solicitor to the company (Mr. Holmes) said the directors were on the other side of the Atlantic, and would not attend that day. The meeting was called by the directors in accordance with the articles of association. Mr. Vaughan-Stevens said Mr. S. Pope, Q.C., was a trustee for debenture holders, but he had resigned. He, however, quite agreed with the schemes of reconstruction about to be submitted. The debenture holders had held a meeting, and were not satisfied with the security they held on the properties in Birmingham and Manchester, and they also agreed to reconstruction, because it was thought impossible for the concern to go on with such a loadstone of loss around its neck. He could offer little explanation of the accounts submitted. A profit of £3,032 had apparently been made, but he could offer no explanation as to its disposal. The whole debit balance to last year was £66,557 19s. 9d., and the assets being taken at the amount originally valued, the share capital should be written down to that amount. There had been a plant in Manchester for making the wire, but it had been sold and the proceeds paid to the trustees for the debenture holders. (A Mr. Chapman asked if there were any of the vendors and of the original shareholders left, and the chairman said they still formed the directorate. He did not think the directors had tried to wreck the company, and pointed out in answer to some acrimonious remarks by Mr. Hawkins, that Mr. Pope had lost over £10,000 in litigation in connection with the company. There were also other heavy losers in this country; in fact, the only person who made anything out of the concern was Baron Grant, who netted £60,000. The preference shares were chiefly held in America, but there were 32,000 ordinary shares held in England, and of these 21,072, favoured reconstruction. Ultimately the accounts were adopted, and the reconstruction scheme approved.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**CROWTHER & CO.'S ELECTRICAL INDUSTRIES LTD.**—Registered Dec. 21, with a capital of £10,000 in £1 shares, to acquire the business of Crowther & Co., and to carry on the business of an electric supply company in all its branches. The subscribers are: E. R. Crowther (electrical engineer and contractor), C. A. Lockby, jun. (electrical engineer), J. Stewart, M. Culverwell (contractor), C. A. de B. Copinger (electrical engineer), S. Saunders (heating engineer) and W. H. Whittaker. E. P. Crowther is first managing director.

**ELECTRICAL TRANSPORT AND POWER CO. (LTD.)**—Registered Dec. 19, with a capital of £10,000 in £10 shares, to apply for parliamentary or other powers to construct tramways or light railways and a bridge and works appurtenant thereto in South Hayling and elsewhere, to carry on the business of tramway, light railway, &c., constructors and proprietors, electrical engineers, electricians, suppliers of electricity, &c. The subscribers include J. W. Haynes (civil engineer), J. M. Hewitt (engineer), T. Pollock (engineer) and J. P. Bedson, M.I.C.E.

**ST. HELENS ELECTRIC LIGHTING CO. (LTD.)**—Registered Dec. 21 with a capital of £10,000 in £5 shares, to carry on the business of electricians, electrical, mechanical and chemical engineers, &c. The subscribers are F. E. Gripper (electrical engineer), J. C. Wigham (engineer), H. J. Read, H. L. Butcher, L. A. Hards (engineer), W. Christmas and G. F. Barrow.

**WILLIAMSON AND JOSEPH (LTD.)**—Registered on Dec. 19, with a capital of £4,000 in £1 shares, to take over a business mentioned in an agreement with the Consolidated Telephone Construction and Manufacturing Co. (Ltd.), and to carry on the business of electricians, electrical and general engineers, suppliers of electricity, telegraph, telephone and electric light contractors, &c. The first directors are H. F. Jackson, C. Woolley, F. W. Kerr and C. H. Reynolds.

## CITY NOTES.

**MEMORANDA.**—Bank rate 5 per cent. (Jan. 3, 1901). Price of silver 29⅛d. per oz. (Dec. 27). Consols (2¾ per cent.) 96⅞—97 for money, 97⅞—98 for account; 2½ per cent. 97—97½ (Jan. 3). Stocks and Shares Continuation Days, Jan. 14 and 29; Ticket Days, Jan. 15 and 30; Pay Days, Jan. 16 and 31; Mining Share Carry-over Days, Jan. 11 and 28.

**BLACK SATURDAY.**—Amongst the enterprises probably involved in the downfall of the London and Globe Finance Corporation is the Baker-street and Waterloo Railway, the prospectus of which recently appeared. The

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | .. | ... | ... |
| *Birmingham Tramways. | Dec. 29 | 4,360 | + 649 | 25 | 113,365 | + 4,793 |
| Blackpool Corporation... | „ 27 | 265 | + 110 | 39 | 28,196 | + 7,503 |
| Blackpool and Fleetwood | „ 29 | 221 | + 3 | 26 | 20,395 | + 88 |
| Bolton Corporation ...... | „ 30 | 1,395 | ... | 39 | 52,840 | ... |
| Bradford Corporation... | „ 30 | 1,057 | + 714 | 39 | 22,535 | + 7,283 |
| Brisbane Trams ......... | Nov. 14 | 2,157 | + 492 | 19 | 35,691 | + 6,840 |
| *Bristol Trams & Carriage | Dec. 28 | 4,970 | + 1,921 | 26 | 88,678 | + 3,393 |
| *Buenos Ayres & Belgrano | „ 2 | 2,735 | - 367 | 22 | 54,696 | + 5,223 |
| Central London Railway | „ 29 | 4,911 | ... | 22 | 116,479 | ... |
| City & South London Ry. | „ 30 | 1,704 | + 733 | 26 | 43,273 | + 17,291 |
| Cork Elec. Trams ......... | „ 27 | 450 | + 40 | 52 | 21,198 | + 1,577 |
| Dover Corporation ...... | „ 29 | 185 | + 27 | 39 | 8,760 | + 551 |
| Dublin & Lucan Rly. | „ 29 | 89 | + 28 | 26 | 2,456 | + 435 |
| Dublin United ............ | „ 28 | 3,762 | + 653 | 26 | 105736 | + 13,103 |
| Dublin Southern Dist.... | „ 28 | 817 | + 152 | 26 | 25,307 | |
| *Dundee Corporation ... | „ 26 | 595 | + 125 | ... | ... | ... |
| *Glasgow Corporation ... | „ 29 | 9,530 | + 1,024 | ... | ... | ... |
| Hull Corporation ......... | „ 29 | 1,883 | + 1,112 | 26 | 36,811 | + 19,783 |
| *Liverpool Corporation... | „ 22 | 9,053 | + 1,840 | 51 | 406,243 | + 55,089 |
| Liverpool Overhead Rly. | „ 30 | 1,397 | + 92 | 26 | 42,571 | + 916 |
| *Sheffield Tramways ...... | „ 30 | 3,338 | + 1,248 | 52 | 131,127 | + 42,194 |

* Partly electrical.

share capital of this undertaking was £2,385,000. Report has it that the flotation was not a success. The construction is, however, we understand, progressing.

**CONSOLIDATED KENT COLLIERIES CORPORATION (LTD.).**—At a general meeting on Monday a shareholder (Col. Stuart Harrison) suggested the advisability of establishing electricity works in order to utilise the waste fuel at the collieries. In reply, the chairman (Mr. F. O'Driscoll) said the matter was one which would receive the attention of the directors.

**ELECTRIC AND GENERAL INVESTMENT CO. (LTD.).**—Warrants for the dividends on the 6 per cent. cumulative preference shares and the interim dividend of 10 per cent on the ordinary shares have been posted.

**ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.).**—A petition has been presented to the High Court of Justice to confirm a special resolution reducing the capital of the company from £100,000 to £5,000, and will be heard on the 16th inst.

**LONDON ELECTRIC OMNIBUS CO. (LTD.).**—The fourth ordinary general meeting was to have been held on Monday. As there were not sufficient shareholders present to form a quorum the meeting was adjourned for a week. The chairman (Lieut.-Col. T. T. Turnbull) said a number of replies had been received to the circular sent out by the board, and it was probably owing to that fact that more shareholders had not considered it necessary to attend.

**MARCONI'S WIRELESS TELEGRAPH CO. (LTD.).**—An extraordinary meeting to confirm the resolution altering the articles of association passed on the 18th ult. will be held at the offices of the company on the 9th inst.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed Jan. 9 a special settling day in the provisional certificates for £100,000 4½ per cent. first debenture stock of the *Blackheath and Greenwich District Electric Light Co. (Ltd.)*, and Jan. 15 for the provisional certificates for £328,744 4 per cent. first mortgage debenture stock of the *London United Tramways (Ltd.)*, and the stocks have been ordered to be quoted in the official list. The committee has also been asked to appoint a special settling day in and to grant a quotation to £75,000 4 per cent. debenture stock of the *Kensington and Knightsbridge Electric Lighting Co. (Ltd.)*, and the *Notting Hill Electric Lighting Co. (Ltd.)*, and the further issue of 13,769 £10 shares (£5 paid, and numbered 85,001 to 98,769) of the *Metropolitan Electric Supply Co. (Ltd.)*.

**UNITED RIVER PLATE TELEPHONE CO. (LTD.).**—An interim dividend on the ordinary shares at the rate of 5 per cent. per annum has been declared.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 24. | | Price Wednesday, Jan. 2. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Jan. 2. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'kh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅞ | ⅞ | ⅞ | ⅞ | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13½ | 13½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ... xd | 102 | 105 | 100 | 103 | 4 7 5 | ... | ... | ... |
| 19,661 | 5 | 2/0 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 2 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9¾ | 8¾ | 9¾ | 3 18 6 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 60,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9¾ | 10¼ | 9¾ | 10¼ | 4 8 1 | February and August | 9¾ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¾ | 6 | 5¾ | 5¾ | 3 16 3 | " " | 5¾ | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | ... | ... |
| £180,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) ... xd | 111 | 114 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,570 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 | 10 | 9 | 10 | 4 0 0 | February and August | 9¾ | 9¾ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | 13¾ | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ... xd | 125 | 130 | 122 | 127 | 3 18 9 | June and December | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. (all pd.) (red.) ... xd | 109 | 111 | 106 | 108 | 4 2 7 | ... | 108 | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ | 12½ | 11½ | 12½ | 4 1 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,640 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 99 | 101 | 99 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 6 7 | April and October | 12½ | 12½ |
| £330,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage xd | 112 | 115 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £360,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) ... xd | 98 | 101 | 96 | 99 | 3 10 8 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | 14½ | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅞ | ⅞ | ⅞ | ⅞ | 12 16 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate E. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 75 | 85 | 75 | 85 | 5 18 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 171 | 180 | 170 | 180 | 4 9 11 | April and October | ... | ... |
| £115,800 | 100 | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 6 | February and August | ... | ... |
| 30,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) ... xd | 100 | 103 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | 2 | ... |
| £50,000 | Stock | 6% | Do. 6% Debentures | 85 | 95 | 85 | 95 | 6 6 3 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,000 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12½ | 13½ | 12½ | 13½ | 4 13 4 | March and September | ... | ... |
| 29,015 | 5 | ... | Do. Do. | 12 | 13 | 12 | 13 | ... | ... | 12½ | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 2 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 14 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 13 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 | 120 | 118 | 120 | 3 6 1 | February and August | ... | ... |
| 13,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 13½ | 14 | 13 | 14 | 6 1 5 | ... | 13¾ | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 5 9 | February and August | 12¾ | 12¾ |
| £310,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 121 | 121 | 123 | 4 1 4 | ... | 122 | 121 |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ | 4½ | 4½ | 4½ | ... | ... | ... | ... |
| £350,000 | Stock | 5% | Do. 5 per Cent. Debentures ... xd | 104 | 107 | 102 | 105 | 4 15 2 | ... | ... | ... |
| £120,000 | Stock | 5 | Do. 5% 2nd Deb. St'k Prov. Certs (all pd.) xd | 96 | 99 | 94 | 97 | 5 3 1 | ... | ... | ... |
| 266,287 | 10 | 3/0 | Central London Ordinary | 9¼ | 9¾ | 9¼ | 9¾ | 3 1 6 | June and December | 9½ | 9½ |
| £656,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 64 | 66 | 64 | 66 | 2 9 7 | February and August | 64 | ... |
| 57,500 | 10 | 1/3 | Do. Ordinary (Nos. 22,501 to 80,000) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 135 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £300,000 | Stock | 5% | Do. (1898) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £241,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 115 | 120 | 115 | 120 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896), Ltd., Ordinary | 17 | 18 | 17 | 18 | ... | ... | ... | ... |
| 54,487 | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £200,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 21½ | 23½ | 21½ | 23½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 13 5 | " " | ... | ... |
| £200,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture ... xd | 113 | 115 | 112 | 114 | 3 17 11 | January and July | ... | ... |
| 20,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'c'n 6% Pref. | ... | | 9½ | | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8¼ | 8¾ | 8¼ | 8¾ | 4 9 8 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13¼ | 13¾ | 13¼ | 13¾ | 3 14 1 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 16 10 | January and July | ... | ... |
| $[illegible] | $1,000 | [illegible] | London Street Railway (Toronto) Mort. Gold Bonds (red.) | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| [illegible] | 100 | 5% | Montreal Street Railway [illegible] (red.) | 101 | 103 | 101 | 103 | 4 16 0 | ... | ... | ... |
| £[illegible] | 100 | 4½% | Do. [illegible] Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 0 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | 4 13 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 10½ | 11½ | 10½ | 11½ | ... | ... | ... | ... |
| [illegible] | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 3½% | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 103 | 105 | 4 5 9 | ... | ... | ... |
| £40,000 | Stock | 5% | Waterloo and City Ordinary | 95 | 97 | 95 | 97 | 5 3 0 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Dec. 21. | Price Wednesday, Jan. 2. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Jan. 2. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,800 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) .. x 1 | 99 103 | 99 103 | 3 18 5 | January and July... | ... | ... |
| 26,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December ... | ... | ... |
| £119,100 | 100 | 5% | Do. 5 per Cent. Debentures | 86 90 | 86 90 | 5 11 1 | ... | ... | ... |
| £827,720 | Stock | 16/0 | Anglo-American | 52 55 | 52 55 | 6 11 10 | Feb., May, Aug., Nov. | ... | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 97 99 | 97 99 | 6 2 5 | " " | 94½ | 97½ |
| £3,088,640 | Stock | 27/0 | Do. Deferred | 10 10½ | 10 10½ | 11 17 2 | " " | 10½ | 10¼ |
| 13,333,300 | $100 | $2½ | Commercial Cable Capital Stock .. x 1 | 170 180 | 170 180 | 4 8 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,500,075 | Stock | 4% | * Do. 4 per Cent. Debenture Stock .. x 1 | 102 104 | 101 103 | 3 17 8 | " " | 103½ | 102½ |
| 15,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ 7½ | 6½ 7½ | 7 6 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 16 | 15 16 | 6 5 0 | " " | ... | ... |
| 13,100 | 5 | 2/0 | Direct Spanish Ordinary | 3½ 4½ | 3½ 4½ | 4 8 10 | April and October.... | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference .. | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures .. x 1 | 100% 104% | 100% 104% | 4 6 7 | January and July.... | ... | ... |
| 60,710 | 20 | 8/0 | Direct United States Cable .... x 1 | 10 10½ | 10 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10¼ | 10¼ |
| £144,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Do. [illegible] | 99 102 | 98 101 | 4 9 1 | June and December .. | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary | 138 141 | 138 141 | 4 13 3 | Jan., Apr., July, Oct. | 138 | 135 |
| £1,639,660 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 96 99 | 95 97 | 3 11 1 | " " | 95 | 96 |
| £1,633,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) .. | 110 111 | 110 111 | 3 10 4 | May and November ... | 110½ | ... |
| 250,000 | 10 | 2/6 | Eastern Extension | 13½ 14½ | 14 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14¼ | 13½ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) [illegible] at £3pm. all p [illegible] | 9½ 9½ | 11½ 11½ | ... | ... | 9½ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 115 | 113 115 | 3 8 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 .. | 100 103 | 100 103 | 3 17 9 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) .. | 99% 101% | 99% 101% | 3 19 5 | May and November ... | ... | ... |
| 180,227 | 10 | 1/0 | Globe Telegraph and Trust | 10½ 10½ | 10½ 10½ | 4 17 8 | Jan., Apr., July, Oct. | 10½ | ... |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 15½ | 15 15½ | 3 17 5 | " " | 15¼ | 15¼ |
| 160,000 | 10 | 5/0 | Great Northern of Copenhagen .. [illegible] (red. x 1 | 31 33 | 30 32 | 3 19 3 | January and July .... | ... | ... |
| £82,000 | 100 | 4½% | Halifax & Bermuda Cable 4½ 1st Mort. Deb. [illegible] | 99 102 | 99 101 | 4 9 1 | June and December ... | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 45 53 | 45 53 | 4 16 2 | May and November .. | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1906 | 104 107 | 104 107 | 5 13 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) .. x 1 | 101 104 | 99 104 | 3 19 5 | June and December .. | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 8 | 7 8 | 5 0 0 | April and October.... | ... | ... |
| 3,351 | £100 Cert. | 6% | Submarine Cables Trust | 123 125 | 123 125 | 4 11 6 | " " | ... | ... |
| 15,609 | 10 | ... | West African Telegraph | 2½ 3½ | 2½ 3½ | 4 0 3 | December and July .. | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 102 | 99 102 | 4 19 3 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ½ ¾ | ½ ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures .. x 1 | 100 103 | 100 102 | 3 14 5 | January and July .... | ... | ... |
| 63,321 | 10 | 6d. | West India and Panama | ¾ 1 | ¾ 1 | ... | May and November .. | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 6 7 | 8 11 6 | " " | 6¼ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures .. x 1 | 103 105 | 103 106 | 4 15 4 | January and July... | ... | ... |
| 217,930 | 10 | 5/0 | Western Telegraph (late Brazil'n S'bm'rine) .. x 1 | 14 14½ | 13½ 14½ | 4 14 3 | Mar., June, Oct., Dec. | 14¼ | 13½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1903) .. x 1 | 103 104 | 103 104 | 4 17 1 | June and December ... | ... | ... |
| £311,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) .. x 1 | 103 105 | 103 105 | 3 15 6 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 3½ | 3 3½ | 5 14 4 | August | ... | ... |
| 224,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. .. | 3/3 4/3 | 3/9 4/3 | ... | January and July .. | ... | ... |
| 72,690 | 1 | 2½% | Monte Video Telephone Ordinary | ¾ 1 | ¾ 1 | 5 0 0 | November | ... | ... |
| 34,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | " | ... | ... |
| 690,000 | 5 | 3/0 | National | 4½ 4½ | 4½ 4½ | 6 3 11 | February and August | 4½ | 4½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference . | 13 14 | 13 14 | 4 5 9 | " " | 13¼ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference . | 11 13 | 11 13 | 4 12 4 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 5 5½ | 5 5½ | 4 15 3 | " " | 5 | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) .. x 1 | 93 95 | 95 97 | 3 13 2 | June and December ... | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) .. x 1 | 101 104 | 99 101 | 3 14 5 | ... | 100½ | ... |
| 171,504 | 1 | 0/5 | Oriental | ¾ 1¼ | ¾ 1¼ | 5 3 0 | April and October..... | ... | ... |
| 54,000 | 5 | 2/6 | United River Plate | 4½ 5 | 4½ 5 | 7 0 0 | July | ... | ... |
| 14,839 | 5 | 3/6 | Do. 5% Cumulative Preference (fully paid) .. | 5 5½ | 5 5½ | 4 10 11 | June and December ... | ... | ... |
| 23,361 | 5 | 1/3½ | Do. do. (£1 10s. paid) | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| £170,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 104 107 | 104 107 | 4 13 6 | June and December .. | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 8d. | Alliance Electrical Co. 5% Cum. Pref. | ¾ 1¼ | ¾ 1¼ | 4 8 11 | ... | ... | ... |
| 135,000 | 1 | 7½d. | Avon Electricity Meter 6 per Cent. Cum. Pref. | ¾ ¾ | [illegible] | 7 8 4 | March and September | ... | ... |
| 65,000 | 1 | ... | British Electric Works Co. Ordinary | ... | ¼ ½ | ... | ... | ... | ... |
| 30,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ... | ¼ ½ | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | ... | 97 99 | ... | ... | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 11 12 | 10½ 11½ | 5 13 11 | July and February .. | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference .. x 1 | 6¼ 6½ | 5¾ 6¼ | 4 16 0 | January and July .. | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ 5 | 4½ 5 | 6 0 0 | ... | ... | ... |
| 93,050 | 2 | 1/1½ | Brush Electrical Engineering | 1½ 1¾ | 1½ 1¾ | 6 8 4 | September | 1½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2 2½ | 2 2½ | 5 0 8 | ... | 2½ | 2¼ |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | " | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock .. | 108 111 | 108 111 | 4 0 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock .. x 1 | 103 105 | 101 103 | 4 7 5 | January and July ..... | 102½ | 102 |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 12½ 13½ | 12½ 13½ | 5 11 1 | " " | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference .. x 1 | 5½ 5¾ | 5½ 5¾ | 4 6 11 | " " | 5½ | ... |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) .. | 111 115 | 109 113 | 3 19 10 | November and May... | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 1½ | 1 1½ | 6 8 0 | ... | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 100 | 97 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Clarke's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 19 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1¼ | ¾ 1¼ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 2/4½ | Crompton and Co., Nos. 1 to 54,000 | 3½ 4 | 3½ 4 | 5 12 4 | January and July... | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) x 1 | 99 102 | 98 101 | 4 13 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1¼ | ¾ 1¼ | 5 6 8 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) .. | 1½ 2½ | 1½ 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ 4½ | 3½ 4½ | 6 13 4 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) x 1 | 90 92 | 88 90 | 4 5 11 | June and December ... | ... | ... |
| £[illegible] | Stock | 2% 4½ | Do. 3½ [illegible] Participating [illegible] (all pd) | 93 100 | 93 100 | ... | ... | ... | ... |
| 36,500 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. .. | 4½ 5 | 4½ 5 | 8 0 0 | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) .. | 102 105 | 101 104 | 4 6 8 | ... | ... | ... |
| 112,100 | 2 | 1/1½ | Electric Construction Co. Limited | 2 2½ | 2 2½ | 5 6 2 | January and July .... | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference .. | 3½ 3¾ | 3½ 3¾ | 4 4 2 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) .. | 103 101 | 103 106 | 3 16 11 | January and July.... | ... | ... |
| 110,000 | 1 | ... | [illegible] | ¼ ¾ | ¼ ¾ | ... | ... | ... | ... |
| 50,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ 14 | 13 14 | 6 7 4 | February and August | 13½ | 13 |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 5¾ | 5½ 5¾ | 4 15 4 | " " | 5½ | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 104 112 | 108 112 | 4 0 4 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works .. x 1 | 21 22 | 21½ 21½ | 6 13 0 | " " | 21½ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) .. | 101 104 | 101 104 | 3 17 5 | March and September | ... | ... |
| 37,963 | 12 | 11/0 | Telegraph Construction and Maintenance .. | 39 42 | 39 42 | 4 5 9 | March and July .... | 40 | 40 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1910 .. x 1 | 101 104 | 100 103 | 3 17 8 | January and July .. | ... | ... |
| 1,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 11 | 10 11 | 5 15 2 | ... | ... | ... |
| 3,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference .. | 5½ 6½ | 5½ 5½ | 4 6 11 | ... | ... | ... |
| 10,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ 11½ | 10½ 11½ | 6 1 9 | April and October .... | ... | ... |
| 4,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference .. | 6¾ 7½ | 6¾ 7½ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures x 1 | 101 105 | 103 105 | 4 0 11 | May and November .. | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
‡ The London Stock Exchange Committee refuses to quote these.

// THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,182. [No. 12. Vol. XLVI.] FRIDAY, JANUARY 11, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

# NOTES.

The sheet table, which we publish as a supplement to our present issue, gives a complete account of the present state of electricity supply in the United Kingdom. Year by year the number of supply stations increases, and those already in existence continue to develop at an enormous rate, so that, with the co-operation of the large power distribution schemes, it will probably not be long before almost every village will be blessed with electric light and power. This year the direction of progress, apart from mere increase in lamp and motor connections, which is represented graphically in an article in this issue, is apparent in the steady growth of the employment of continuous-current for distribution, and in a gradual settling down to standard lines of design in the case of new stations. It is also satisfactory to note considerable reductions in the price now charged for current. The engineers of the stations in operation and the consulting engineers who are responsible for the erection of new ones have given us every assistance in the preparation of the supplement, and we desire here to tender to them our sincere thanks.

It has been our practice to publish at this time of the year a map of the United Kingdom showing all the towns where electricity supply works are in operation or in progress. Latterly this map had become very much overcrowded; and, owing to the continued extension of electricity supply, the printing of any intelligible map of the kind has now become practically impossible. We are, therefore, reluctantly compelled to discontinue it—a course which we had to adopt, for similar reasons, in the case of our map of electricity supply mains in London some time ago.

Particulars are given in another column of an important arrangement, almost amounting to what Americans term a "combine," between the British Electric Traction Co. and the Brush Electrical Engineering Co. The agreements which have been drawn up and signed between these two companies provide, on the one hand, for the absorption of Brush capital into the British Electric Traction Co., and, on the other hand, for the placing of orders for electric tramway equipment and plant with the manufacturing company. We regard this *rapprochement* as being highly favourable to the promotion of British interests in electrical engineering, and it has our best wishes for a prosperous issue.

"A wonderful invention, but don't bring it down our way!" Such was the attitude of our grandparents towards the steam railway; and such, it would seem, is the attitude of the public to-day towards underground electric railways. Stephenson and Brunel were belauded for their genius, but were urged to put their railways as far away from towns as possible; and, in more recent times—in fact, only last Tuesday—a meeting of Paddington householders decided that, while "no one who had enjoyed the quickness and cleanliness of these new underground electric railways would wish to oppose the multiplication of them, in order that the interests of residents in Paddington might be heard in Parliament it was necessary that they should technically oppose" the Bill for the construction of an underground electric railway in their neighbourhood. Nor is this delicately-expressed aversion merely formal, for a committee has been formed for the purpose of raising funds for active opposition. Meanwhile we await the decision of the committee recently appointed by the Board of Trade to enquire into the alleged vibration troubles from this type of railway. Exaggerations there undoubtedly have been, in the statements in the newspapers, with regard to the extent of the disturbances; but it is important that if any serious vibration does occur the conditions should be determined, in order that a suitable remedy—for a remedy is undoubtedly available—may be applied. Nothing is more foolish than the popular supposition that the vibration troubles alleged to occur along the route of the "Tube" are *inherent* in either electric traction or the Greathead system of tunnel construction.

The quite erroneous idea has got about in the public press that the return currents of deep-level electric railways, such as the Central London and the South London Railways, are fraught with fearful danger to gas and water pipes. The idea appears to have been started in the columns of a scientific but non-technical contemporary, wherein an article set forth in professorial mathematics the alarming rate at which these metal pipes are dissolving away. As so often happens, the mathematics were built on an airy foundation of impossible assumptions. The expression "earth return" is only by the greatest courtesy to be applied to the return path of the electric currents on these railways. For the major portion of the return current there is ample pathway through the carefully-bonded track rails; for any leakage from these rails there is the massive iron tubular sheathing by which the entire railway is surrounded. There must be, it is true, a certain amount of external leakage into the subsoil where the conductivity of the tube is interrupted by imperfect electrical contact between the iron flanges. But, having regard to the manner in which these Greathead tunnels are put together, we cannot conceive that any considerable break in conductivity can occur in any part of them. However, even if we accept the assumption that leakage currents do stray beyond the outside of the tunnels, we are puzzled to know what gas or water pipe they can encounter at a depth of 60ft. or more below the surface. Can it be that the critics believe these already enfeebled stray currents have enough vitality left in them to push their way through clay and gravel to the surface, and work serious mischief there? The danger, in such circumstances, is reduced to a quantity of such infinitesimal magnitude as to be observable only by a mathematician.

When an engineering structure has been designed and built on a narrow margin of safety, it is highly dangerous to try to remedy any unforseen defect by boring holes in it. Through the neglect of this generally obvious truism a serious accident occurred last June to one of the passenger lifts at the London-bridge Station on the City and South London Railway. The report of the Board of Trade inspector, Colonel Yorke, has just been issued, and is an instructive document. It appears that the pulley shaft supporting the lift cage was originally designed with a factor of safety of under 5, a sufficient margin—as the inspector observes—for the mere dead load, but not a liberal allowance for the alternating live load imposed during the revolution of the shaft. To make matters worse, however, when it was found that the pulley would not keep its place on the shaft, the already heavily strained metal of the shaft was still further taxed by having two holes drilled into it and tapped for a couple of set screws to be placed on either side of the pulley. This looks, indeed, like dreadful bungling. Cracks naturally sprang up inside the shaft along the sharp lines of the screw threads and with the creation of these the end was inevitable. The shaft snapped and down came the pulley and tackle; but even then the cage would not have fallen had there been a properly constructed safety gear ready to act. The gear, however, had been thrown out of action in order to effect certain repairs; so the question whether it would have effectively prevented the accident remains unsolved. But, in the opinion of Col. Yorke, it would not have been effective, inasmuch as to put it into action a rope must actually break or slacken sufficiently to release the safety cams. In the actual conditions of the accident the friction of the ropes on the sheaves would probably have held them too strained to permit of this release. Accordingly, the report embodies a recommendation that passenger lifts should be provided with an additional rope passing direct from the safety clutches over the pulley to the counterweight, a modification which would provide against the repetition of such an accident in the future.

**Pacific Cable.**—The Agents-General of New South Wales and Victoria have been appointed representatives of Australia on the Pacific Cable Board.

**Lecture.**—Prof. Silvanus P. Thompson delivered an evening lecture on Wednesday, at the "Urania," Berlin, on "Faraday and the English School of Electricians." The lecture was delivered in German.

**The Electrical Standardising, Testing, and Training Institution.**—Yesterday, the 10th inst., Prof. C. A. Carus-Wilson, M.A., commenced a course of lectures to the senior students of this Institution on "Dynamo and Motor Construction."

**Personal.**—Capt. F. L. Lloyd, R.E., who before going to South Africa with the Electrical Engineers (R.E.) Volunteers served at Plymouth, has been appointed secretary of the committee appointed to consider the question of mechanical transport for military services.

**Electrical Engineers (R.E.) Volunteers.**—The Secretary of State for War has approved of another detachment of this corps being raised for service in South Africa. It is to consist of one field officer, four company officers and 100 non-commissioned officers and men.

**Salford Royal Technical Institute.**—A special course of 10 lectures will be delivered by Mr. W. B. Burnie, A.I.E.E., commencing January 24th, on "Central Stations and Electrical Distribution." Mr. John Morris, M.I.M.E., will lecture on "Engineering Estimates and Specifications."

**Finsbury Technical College.**—At the Technical College, Finsbury, Prof. P. Silvanus Thompson will lecture on Wednesday evenings during the Lent term on Magnetism and Electromagnetism. The Monday lectures during January will be by Dr. E. W. Marchant on Alternating Currents; andlater, Prof. Thompson will resume the subject of Dynamo Design.

**Submarine Signalling.**—It is announced that Prof. Elisha Gray has perfected an apparatus for submarine signalling. With this apparatus he has succeeded in transmitting the sound of a bell under water for a distance of 12 miles. Prof. Gray claims that the use of the invention will minimise danger from submarine torpedo-boats, and will also protect vessels from the danger of collision during a fog.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | — |
| Pernambuco—Ceara | Nov. 22, 1900 | — |
| Bolama—Bissao | Dec. 23, 1900 | Jan. 6, 1901 |
| Falmouth—Bilbao | Dec. 28, 1900 | — |
| Marseilles—Barcelona | Jan. 7, 1901 | — |

**Swedish Telegraphs.**—An official report just issued shows that in 1899 the Swedish telegraph service dealt with 2,644,000 messages, of which a little over one-half were foreign, 3,650 being press telegrams. The correspondence was greatest with Germany, Great Britain coming next with 7,000 messages less. The increase in the receipts was 134,000kr. There were in the country 178 stations under the Government service, 810 railway telegraph stations, and 894 stations belonging to private companies.

**The Patent Laws Committee.**—We learn from a well-informed source that the report of the Departmental Committee of the Board of Trade on the Patent Laws is now complete, and has been presented to the President of the Board. It is a very comprehensive report, and it is believed that it will make some very drastic recommendations as to the proper carrying out of the patent laws, and how they ought to be amended. The report will be presented to Parliament on the opening of the next Session.

**Tesla's Experiments.**—The *New York Herald* published in a recent issue an interview with Dr. Tesla, in which the inventor replies to certain of his critics. He denies that the mysterious signals he has at times received are atmospheric in origin, and states his conviction that they are due to causes heretofore unknown. Atmospheric electricity, he admits, produces in ordinary Hertzian systems effects which have made him always doubt the practical value of those systems, but his apparatus is entirely different from the Hertzian and is actuated by the electrical conditions over a stretch of land 2,200 miles in length and breadth.

**Vibration and the Central London Railway.**—After communication with and on the invitation of the Central London Railway Co. and a committee representing the owners of houses in the vicinity thereof, the Board of Trade have appointed a committee, consisting of Lord Rayleigh, F.R.S. (chairman), Sir John Wolfe-Barry, K.C.B., F.R.S., and Prof. J. A. Ewing, F.R.S., to consider to what extent the working of the traffic on the Central London Railway produces vibration in the adjacent buildings, and what alterations in the conditions of such working or in structure can be devised to remedy the same, and to report to the Board of Trade.

**Falmouth Observatory.**—A circular signed by the Bishop of Truro, as president of the Royal Cornwall Polytechnic Society, has been issued to bring under favourable notice the need which has arisen for financial assistance in order that the magnetic observations at the Falmouth Observatory may be continued. The circular points out that now that electric trams have seriously interfered with the magnetic observations at Greenwich, and those at Kew are threatened in like manner, additional importance is attached to the maintenance of magnetic records at Falmouth. A remedy that might be suggested would be that the Kew authorities should buy the Falmouth Observatory and remove their instruments thither.

**Development of the Swedish Telephone System.**—The telephone system in Sweden is being developed at a rapid rate. During the three years 1900-2 a sum of no less than £200,000 is to be expended upon the extension of the State telephone system alone. The following table shows the development in the period 1896-1900:—

| | Length in kms. | Number of apparatus. |
|---|---|---|
| 1896 | 62,666 | 25,911 |
| 1897 | 75,300 | 32,892 |
| 1898 | 97,692 | 46,381 |
| 1900 | 110,000 | 52,500 |

At the same time the gross receipts rose from 2,306,000kr. in 1896 to 4,100,000kr. in 1900, the cost of working and maintenance advancing at the same time from 1,037,000kr. to 2,100,000kr.

**A Large Canadian Light and Power Plant.**—Our contemporary *The Electrical World* of New York states that the Cataract Power Co. at De Cew Falls, Ontario, has just completed the installation in its power-house of one of the largest electric generators for light and power purpose built in Canada. The generator has a capacity of 2,000kw. with a large overload capacity. The weight of this generator, complete, is about 100 tons, and is similar in design to the 1,000kw. machine, two of which the Cataract Company now has in its power station. The capacity of the Cataract Power Co.'s electric plant is now over 10,000 H.P. and its station is one of the most complete in Canada. The two lines from De Cew Falls to Hamilton, Ontario, a distance of 35 miles, are now in successful operations.

**French Submarine Boats.**—A popular account of some of the recent submarine boat experiments at Cherbourg was published in yesterday's *Figaro*. General André was present at one of the trials of the "Morse," when a two hours' submarine excursion was accomplished. According to the account of this excursion, the motive power is wholly electric. The boat as a whole is divided into three parts above the water-ballast chamber, a fore-part, middle-part, and stern-part. In the bow section the torpedoes and their launching machinery are stationed, in the central section the accumulators are kept, and in the stern section the motors are situated. Alluding to the possibility of disaster consequent on exhaustion of the accumulators, the article states that a "combination of motors has been in course of construction for some months so that the accumulators may be charged afresh on the spot."

**The Institution of Junior Engineers.**—The Council of the Institution have had their attention drawn to the increasing importance of the subject of works management and the absence of facilities for its study. In view of the great value to young engineers of a knowledge of the methods of economical manufacture and the commercial conditions prevailing in modern engineering establishments, they have arranged for a course of six lectures on works management to be given by Mr. A. H. Barker, Wh.Sc., B.A., B.Sc. (who is himself manager of an engineering works), at the Westminster Palace Hotel, Victoria-street, Westminster, commencing on Tuesday, February 5th. The proprietors of the *Engineer* consented to assist the Institution in arranging for the delivery of these lectures, and have made a handsome donation towards meeting the expense entailed. The fee for the course is 12s. 6d., and a reduction of 2s. 6d. will be made to members of the Institution. Further particulars, including a syllabus and time-table, can be had from the secretary.

**A Safe Lift.**—The following interesting letter from Sir Frederick Bramwell appeared in *The Times* yesterday:—

SIR: I saw in your edition of Tuesday an account of an inquest upon a man who was killed by taking great pains to open the well-guarded door of a lift (instead of easily opening another door through which he really wished to pass), and who succeeded in killing himself because, when he had opened the lift door, the lift was not opposite the opening, and he fell down into the lift hole and was killed.

About 10 or 12 years ago I caused to be designed in this office, and to be executed by different contractors, a small hydraulic lift to carry one person, for use in my house in Hyde Park Gate. It was guided up the well hole of the ordinary staircase without anything surrounding it, and access was obtained by making a gateway in the hand-rails on each landing and by fitting to each opening a spring gate. The lift itself was fitted with a gate so that the occupant might not tumble out as he went up from floor to floor. I caused to be arranged (not as any matter of invention, but more as a common precaution) a simple device by which none of the spring gates could be opened unless the lift was opposite to the opening, and I also had another arrangement by which the doors of the lift itself could not be opened unless the lift was opposite to a spring gate. This thing has worked perfectly for the 10 or 12 years it has been in existence; I came down by it this morning, and I hope to go up by it to-night.

It appears to me that if an arrangement of this kind, by which it would be rendered impossible to open any lift door on any floor unless the lift were there, were in general use, it would prevent such an accident as that which you recorded.

**Institution of Electrical Engineers.**—At the meeting of this Institution last night, Prof. Perry, President, in the chair, it was announced that a Calcutta local section had been formed—the first in the Indian Empire. It was also announced that Dr. Oliver Lodge had been elected chairman of the Birmingham local section, the other members of the committee being:—Vice chairman, Henry Lea; Committee: F. Brown, Alfred Coleman, Alfred Dickinson, G. S. Ram, Dr. W. E. Sumpner, Prof. R. Threlfall, W. Wyld and J. C. Vaudrey; Hon. Sec., Dr. D. K. Morris.

Delimitations of the various local sections were announced as follows: Newcastle—the counties of Northumberland, Durham and Cumberland, with Middlesbrough and Cleveland district; Birmingham—the town district, with the counties of Warwick, Stafford and Worcester; Dublin—a circle of 25 miles radius around the city. The delimitation of the Glasgow section has not yet been settled.

Contrary to the published arrangements, Mr. J. B. C. Kershaw's Paper on "Aluminium as an Electrical Conductor" was read *before* the Paper on "Capacity in Alternate Current Working," by Mr. W. M. Mordey.

**The Hargreaves-Bird Electrolytic Alkali Process.**—We are informed that the large works at Middlewich for the operation of this process will be ready for the commencement of manufacture in April next. Owing to the overcrowding of all electrical engineering works with orders, some delay has occurred in obtaining the generating machinery for the Middlewich plant, and the date of starting has been more than once postponed. The Farnworth experimental plant is still running with satisfactory results, alkali equivalent to 57½ per cent of soda ash being obtained direct from the cell liquors by boiling these down. The current efficiency of the cell averages 93½ per cent.

At the St. Gobain Co.'s works at Chauny, near Paris, the small installation of the Hargreaves cell has ceased running, since it has been found that the cells were too small for economic manufacturing operations, and the generating machinery has also been giving some trouble. The plant at this works was erected before the large experimental cell at Farnworth had yielded such favourable results, and it is now intended to enlarge the plant at Chauny, and to erect cells five times the size of those originally put down. This enlargement is, however, postponed until after the commencement of manufacturing operations at Middlewich in order to profit by the experience gained with this large industrial plant.

**The Cost of Establishing Municipal Telephone Systems.**—A specially appointed telephone sub-committee of the Portsmouth Town Council recently reported as to the establishment of a municipal telephone service in that town. This report, embodying a report and estimate by Mr. A. R. Bennett, was discussed by the Council last week, and was ultimately sent back to the sub-committee for further report. ——At a meeting of the Portsmouth Ratepayers' Association a report from Sir William Preece on the subject of the cost of establishing telephonic communication in Portsmouth was discussed. Replying to the question whether Mr. A. R. Bennett's estimate of £19. 10s. per subscriber was a reasonable figure for the construction of exchange connection, provision of instruments, &c., to form a complete telephonic service, Sir William Preece says:—

It is no secret that I am entirely opposed to the municipalisation of telephones. It is an imperial business, and should be in the hands of the Post Office. No municipality is justified in entering a business so very speculative and subject to such severe competition. I gave estimates before the Parliamentary Committee of 1895, but I declined to do so before the Committee of 1898 on public grounds of policy. My estimates of 1895 were £55 per subscriber in London, and £45 in the provinces. These estimates were in the days of iron pipes and gutta-percha wires. Now paper cables and earthenware conduits have been introduced, and prices are lower, although materials in general have gone up.

My estimate for Portsmouth is £35 per subscriber; £19. 10s. can only be for something very cheap and very nasty.

**Wireless Telegraphy.**—It is reported in several of the American periodicals that the Congo Free State has agreed to adopt the Marconi system of wireless telegraphy for communication between the military stations. The trials will be made, it is said, between Boma and Matadi. It is, besides, widely stated that a project is on foot to establish stations along the route from Great Britain to Australia to maintain communication with the vessels in that trade route. Various other rumours are current in the English press. The *Daily Chronicle* stated the other day that Mr. Marconi has purchased some land at Mullion, near the Lizard, where buildings have been erected and heavy machinery installed. The greatest secrecy is observed regarding the experiments being carried on, but local report avers that Mr. Marconi is hoping to send, within three months, wireless messages to America. The charge for transmission of messages has already been fixed: "Atlantic 'cablegrams' at a halfpenny a word," says the *Birmingham Post*.

It is stated that M. Popoff, the well-known Russian authority on wireless telegraphy, has received a definite proposal from a syndicate of English capitalists inviting him to London to negotiate the sale of his patents, or to join them in exploiting his system on a large scale. M. Popoff is reported to have responded favourably. It is, in fact, confidently stated that the syndicate concerned is the International Marine Communication Co. (Ltd.)—an offspring of the Marconi Wireless Telegraph Co. (Ltd.)

**British and Continental Generating Plant.**—Mr. Victor A. H. M'Cowen, the city electrical engineer of Belfast, has presented to his committee a report of his visit to the Paris Exhibition. After a brief description of the salient features of the plant exhibited by some of the larger manufacturers, Mr. M'Cowen draws the following conclusions:—

Looking at the electrical exhibits as a whole, one is impressed with the very great difference between British and Continental practice—the large slow-speed steam generators, so generally used, taking up a very considerable amount of floor space as compared with the compact high speed sets so largely adopted in this country; the extent to which polyphase plant is employed, and the number of firms that manufacture this type of plant. No doubt, as soon as the demand for such arises at home, our electrical firms will be prepared to manufacture it, but just at present the Continental firms are ahead of us in this line, and will probably supply a good deal of this type of plant to our country for some time . . . . The standard pressures and periodicities of the exhibition polyphase machines, with a few exceptions, were 5,000 volts, 2,200 volts, and 50 cycles per sec. respectively, the speed being anything between 70 and 100 revs. per min., the sizes of the sets mentioned ranging from 800kw. to 3,000kw.

A number of large power (1,000 H.P.) *single cylinder* engines were shown direct-coupled to three phase generators—indeed, all types of engines, single, two, and three-crank, vertical and horizontal, were direct-coupled to three-phase generators, and it would have been very interesting to see how the generators, driven by the different types of engines, would have behaved when connected in parallel. The exhibition authorities, however, made no provision for this, it being only possible to run the three-phase machines on separate circuits . . . .

Although one is bound to admire the massive appearance of some of the large slow-speed engines so much in evidence, the complications of valve gears, and the number of men, apparently necessary, employed in connection with the running, impressed me with the simplicity and the small amount of attention required in operating our own plant; and so far I have seen nothing which I would put before the high-speed engines in our own station for electric lighting or traction purposes.

As far as continuous-current dynamos are concerned, I believe there is very little to choose between Continental and British. There is no doubt that the commutation on the Continental slow-speed machines seen running was practically perfect; whether they can obtain such good results with large size high-speed sets is another question. As a rule, the design and finish of the machines compared favourably with the best British make. Offers from Continental firms for this type of plant should be carefully considered. In polyphase work Continental manufacturers are undoubtedly before us, and when we require plant of this type, either "generating" or "transforming," for giving a supply in some of the distant outlying districts, it will certainly be desirable to obtain tenders from some of the firms mentioned.

With regard to boilers, there were a number of very interesting types exhibited. The "Niclausse" water tube was well to the front, and will be worth considering when installing new plant. I believe, however, there will be no necessity to go far afield for boilers when we have the Babcock and other well known types manufacted at home and giving every satisfaction. British boilers were well represented in the "Babcock" and "Galloway," which supplied a very large proportion of the steam required in the exhibition.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**MONDAY, January 14th.**

INSTITUTION OF ELECTRICAL ENGINEERS.—NEWCASTLE-ON-TYNE SECTION. Ordinary Meeting.

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Special Lecture to the Graduates' Section, by Prof. J. A. Ewing, F.R.S., on "Structure of Metals," illustrated by lantern slides. All classes of members invited.

**TUESDAY January 15th.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture I., by Prof. J. A. Ewing, F.R.S., on "Practical Mechanics: First Principles and Modern Illustrations."

**WEDNESDAY, January 16th.**

ROYAL MICROSCOPICAL SOCIETY.

*8 p.m.* Meeting at 20, Hanover-square, W.

INSTITUTION OF MINING AND METALLURGY.

*8 p.m.* Ordinary General Meeting at the Geological Museum, Jermyn-street, S.W. Among the Papers to be read is "Electro-Silvered *versus* Plain Copper Plates," by E. Halse.

**THURSDAY, January 17th.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting.

**FRIDAY, January 18th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Annual General Meeting at Storey's Gate, when the adjourned discussion on Mr. H. A. Humphreys' Paper on "Power Gas and Large Gas Engines for Central Stations," will take place.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. Dewar F.R.S., on "Gases at the Beginning and End of the Century."

# SOUTHAMPTON CORPORATION ELECTRIC TRAMWAY AND LIGHTING SYSTEM.

BY H. G. NICHOLSON.

Southampton, which has come prominently before the public within recent years on account of its important geographical situation as a shipping centre in easy communication with London, early saw the necessity of reconstructing the old horse tramway to electric traction, when the Corporation acquired, in 1898, the undertaking then belonging to the Southampton Tramways Co. In a very short while Messrs. Kincaid, Waller and Manville, who are the engineers to the Corporation for both lighting and traction, had the work in hand, which has now taken the lead of the southern towns in the matter of an efficient system of electrical tramways. The electricity works, which were formerly put down for lighting purposes only, have been adapted for supplying the necessary power to the tramways; and as there are a number of towns of about the same size as Southampton, and placed under very similar circumstances, a description of how this change was effected, with particular reference to the more unusual features of the installation, should prove of interest.

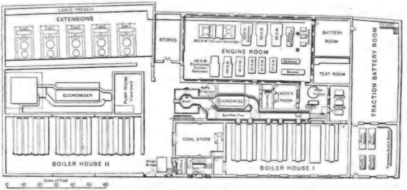


FIG. 1.—PLAN OF SOUTHAMPTON ELECTRIC SUPPLY AND TRAMWAY POWER STATION.

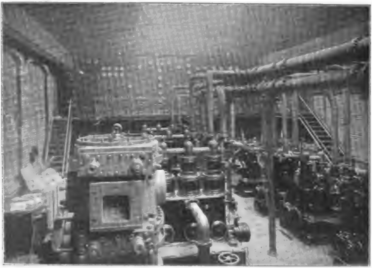
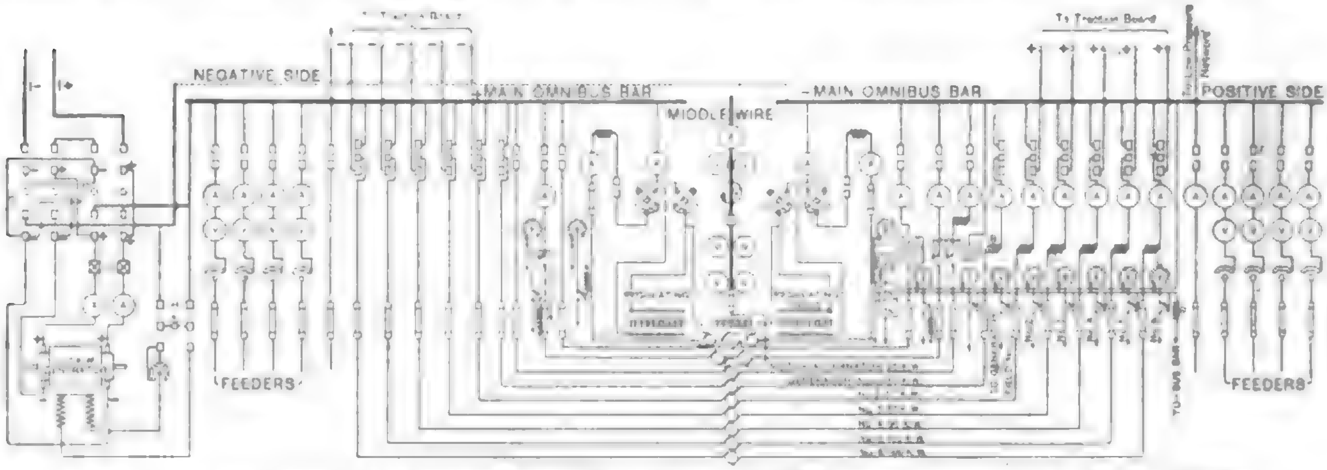


FIG. 2.—INTERIOR OF MACHINERY ROOM.

The electricity works are situated in the heart of the town, and are in a suitable position for the distribution of energy for lighting and traction, and there can be no doubt that for undertakings of this size, a combination of the station for

both purposes is the most desirable and efficient in working. It will be seen from the accompanying plan of the power station (Fig. 1) that there are six units of continuous current machinery of the Crompton-Willans type, varying from 100kw., which generate current at 200 volts for lighting and 240 to 250 volts when used for traction purposes; and it is this plant, with the aid of a large battery of Tudor accumulators, that supplies the current to the tramways. A Ferranti engine, of the latest pattern, direct-coupled to a British-Schuckert dynamo of 300kw. capacity will shortly be running, which

The steam-raising plant consists of seven B. & W. boilers and one Lancashire boiler, four of which are fitted with Vicars stokers and two are of the B type. A coal elevator and conveyor is supplied to feed the hoppers with fuel of small slack. The coal-handling gear is driven by a duplicate set of 9 H.P. Lundell motors, with worm gears. Economisers are used and effect a considerable saving in the coal consumption. The feed pumps, which are of the three-throw type, are driven by steam engines and one by a Lundell electric motor. The feed pipes are in duplicate, and can pass the feed water either



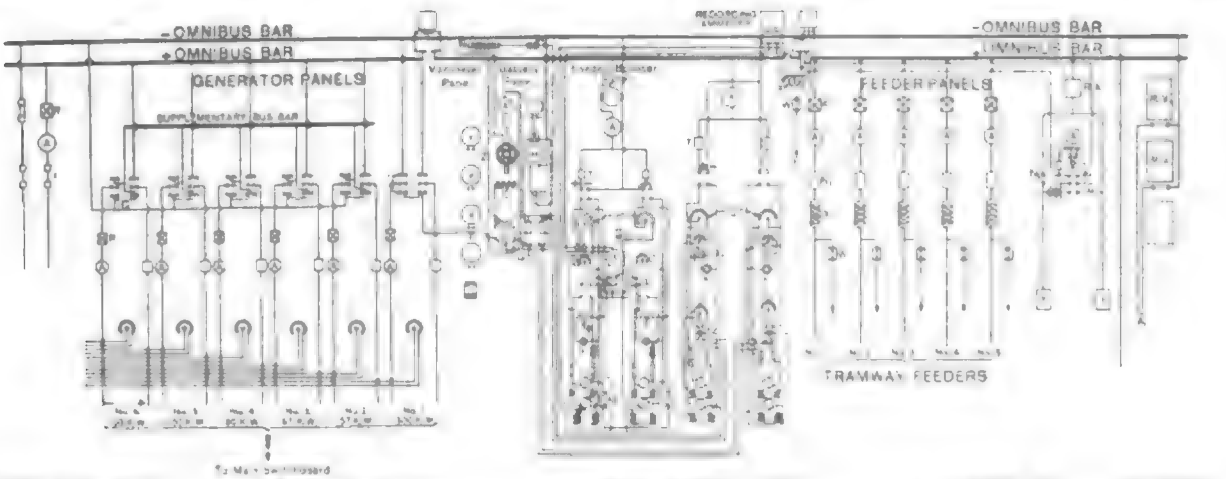
A, Ammeter. B, Starting Switch. C, Field Regulating Switch. D, Circuit Breaker.
E, Four-pole Change-over Switch. F, Main Switch. G, Two-way Main Switch.
H, D.P. Field Switch. I, Current Direction Indicator. J, Six-way Regulating Switch.
K, Discharge Resistance. L, Auto-Minimum Cutout. R, Resistance.

FIG. 3.—DIAGRAM OF CONNECTIONS OF MAIN LOW TENSION SWITCHBOARD.

then can be utilised to generate current at 500 or 600 volts for the tramways and at 200 volts for lighting. This has a double-wound armature with two independent commutators for this purpose. It will be noticed that there is also a balancer and a lighting battery of Pritchetts & Gold's make, either or both of which can take care of the unbalanced current on the three-wire network. This battery also assists on the peak of the lighting load. A Crompton motor booster

through the economisers or direct to the boilers. The steam piping is also arranged in duplicate, of which a good view is shown in Fig. 2. One of the new B. & W. boilers of the double-drum type has already been erected on the new site for extension, and some of the new generating plant will also be shortly put in hand.

Reference to the diagram (Fig. 3) of the low tension switchboard will be sufficient to explain the general arrangement;



B, Five-contact Battery Switch. C, Maximum Cutout. D, Three-way Switch. G, D.P. Change-over Switches. H, Aron Meter. I, D.P. Switch. J, Copper 'Bus Bars.
K, Discharge Resistance. L, Main Fuses. M, Equalising Switch. N, D.P. Field Break Switch. O, Field Resistance Switch. P, Starting Switches.
Q, Motor Starting Switches. R, Circuit Breaker. S, Two-way Voltmeter Switch. T, Magnetic Blow-out Fuse. U, Field Break Switch. W, Lightning Arrester.
X, Kicking Coil. Y, Earth Plate. $N_1$, S.P. Switch. R.A., Recording Ammeter. R.V., Recording Voltmeter. $D_1$, Two-way Switch. $A_1$, Test Wires.

FIG. 4.—DIAGRAM OF CONNECTIONS OF TRAMWAY SWITCHBOARD.

of the double type is provided for charging this battery. There are three sets of Crompton-Brunton alternators of 120kw. capacity, each driven by a Willans engine, which are used for the lighting of the outlying districts; also a motor alternator takes care of the day and night alternating load, rendering it unnecessary to run any of the steam alternating plant on the light load.

and it will be seen that the positive and negative connections are kept quite apart with the middle wire in the centre, this being for protection against fire on the switchboard. Two-way switches are provided, so that any of the generators can be paralleled on the main omnibus bars for lighting, and the lower position makes connection with the tramway switchboard. From these main lighting bars there are five positive

and negative feeders which deliver current to the low tension network on the three-wire system, which for the best part is bare copper strip carried on porcelain insulators with 200 volts across the outers, and 100 volts on each side. The unbalanced current, which is usually not more than about 80 amperes at a maximum, is taken care of by the "balancer" or from the lighting battery. All new consumers on the low tension network are now being connected direct across the 200-volt outers. The alternating current is generated at a pressure of 2,000 volts, and is transformed down to 200 volts on the network by transformers placed in pits. There are four high tension feeders, the longest being about 8¼ miles, and the drop of volts on some about 50 at maximum load.


FIG. 5.—TRAMWAY BATTERY ROOM.

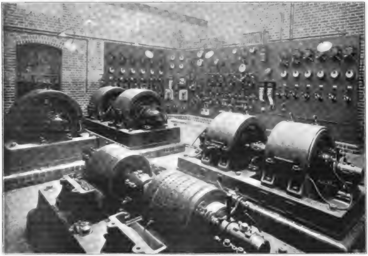


FIG. 6.—INTERIOR OF BOOSTER ROOM, SHOWING TRACTION SWITCHBOARD.

The main switchboard was built by Messrs. Crompton & Co., and is seen in the view of the engine-room. The high-tension switchboard is of the Ferranti outer earthed type with nine panels.

From the diagram of the tramways board (Fig. 4) it will be seen that any pair of the five generators when delivering current at 250 volts can be put in series across the main omnibus

bars, also that any of the three remaining machines can be paralleled with either of these machines, or any other desirable combination effected to supply current at 500 volts to the main omnibus bars. For raising the pressure to 550 volts on the feeder 'bus bar a feeder booster can be interposed, the generating side of which has a compound winding, so that at "no load" the boosted volts are about 15, which increases to 50 at "full load" to allow for the drop of volts on the feeders, and by this means a very constant potential is obtained on the trolley line. There is a duplicate set of feeder boosters, which can be run in parallel if desired. These machines also serve the purpose of regulating the pressure on the line, to compensate for the variation in the voltage while the battery is being discharged. For charging the tramway battery, a view of part of which is given in Fig. 5, consisting of 236 cells of the Tudor type, a duplicate set of charging motor boosters are provided, which can generate 140 volts, and so make up 600 volts, which pressure is required when the battery is nearly fully charged. The booster of each of these sets is provided with double-wound armatures and two independent commutators, which, when put in series by that of the battery when used as a feeder booster, and oppose the battery when used for charging, which is really the same thing as assisting the pressure of the generators. The direction of pressure of this booster is altered as desired by means of a double pole change-over switch for the fields. Number 3 way places the 300kw. generator direct on the battery terminals, for charging it at 600 volts without the aid of a feeder booster. The feeder panels, of which there are five, are each provided with a B.T.H. circuit breaker as well as a switch, the object of the latter being to prevent interference with the action of circuit breaker when putting current on the line. Should any of the circuit breakers open, an electric bell instantly starts ringing, both in the engine room and the booster room, this being done by means of a contact actuated by any of the circuit breaker handles. The power circuit panel is provided for supplying current to the electric cranes used at the docks. The Board of Trade panel is of Elliot Bros. make, the drop of volts to the ends of the track at Portswood and Shirley being 4 and 4·5 volts respectively at a maximum. The testing ammeter can be placed in circuit with the positive 'bus bar by means of a plug board instead of the alternative

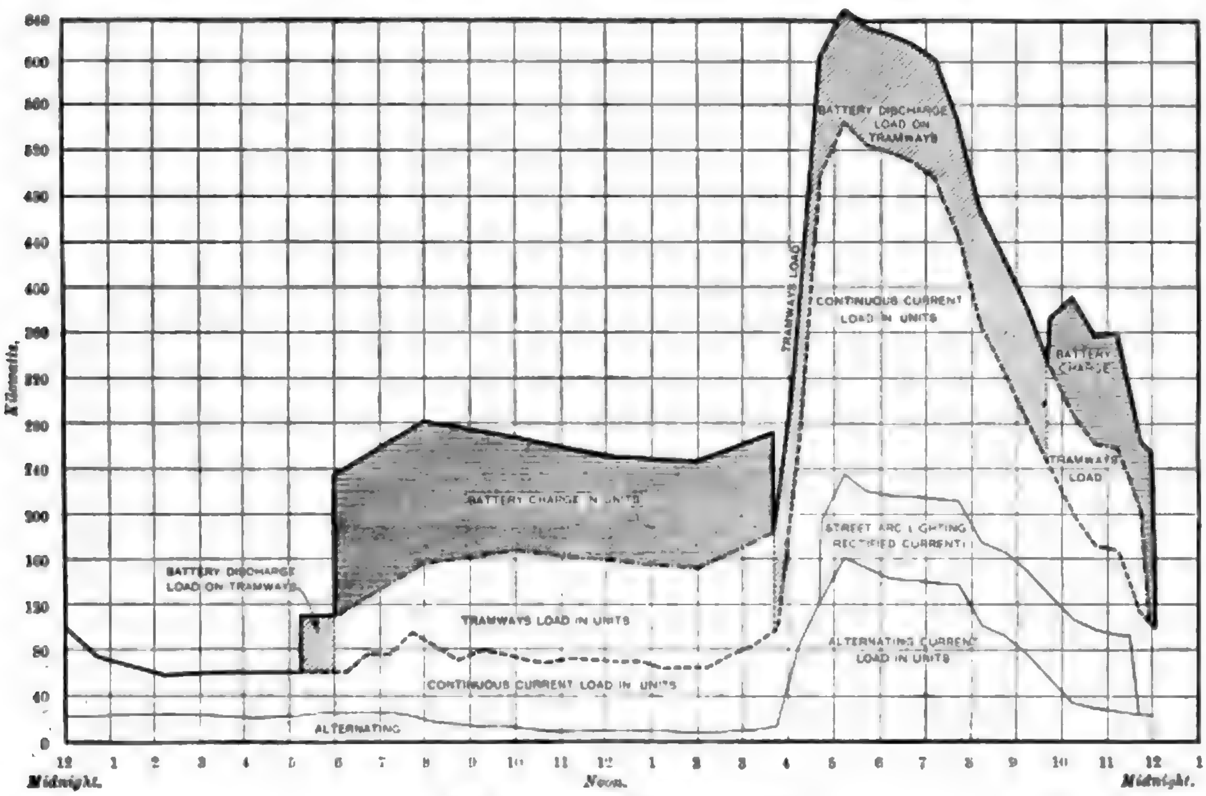


FIG. 7.—A SAMPLE DAILY LOAD CURVE.

means of a switch by the side of the machines, gives 140 volts, and when in parallel 70 volts; and in this latter case it is used as a feeder booster, with large current capacity, the object of this arrangement being not to unduly weaken the fields and so to prevent sparking at the brushes. The motor sides of these four booster sets are driven from the main 'bus bars, and are shunt-wound, the fields being separately excited from a pair of 'bus bars direct from the battery. This ensures that the fields of same are never broken except when desired. It is a peculiar fact that a double-pole switch is necessary to effectually dissipate the self-induced spark through the discharged resistance whenever one pole of the system is earthed These machines are built by Messrs. D. Bruce Peebles & Co., and run sparklessly at all loads without shifting the brushes, which is an important matter for tramway work.

On the battery panel a three-way switch is provided. No. 1 way puts the battery direct across the main 'bus bars; No. 2 way inserts the charging motor booster in series with the negative pole of the battery and the negative 'bus bar; and it should be here pointed out that the booster pressure assists multiple way switch connected to the generators; and the leakage current on the overhead lines is usually about ·05 amperes. A Thomson-Houston wattmeter is provided for each of the generators, as well as a total input meter, which checks the sum of these meters, and the total output meter registers the units used by the tramways. A meter supplied by the General Electric Co. registers the ampere hours put in and taken out of the battery, which works very reliably.

The tramway switchboard was built by Messrs. Fowler, Lancaster & Co. and is of handsome appearance, a view being shown in the photograph of the booster-room (Fig. 6).

Before considering the load curves of the station, it should be added that the tramway battery consists of 286 Tudor cells of 1,900 ampere-hours capacity, when discharging for five hours at 380 amperes. The maximum discharge rate is 570 amperes, and the normal charging rate 320 amperes. The usual conditions of working for 24 hours can be readily seen from the curve of the load on the station (Fig. 7), and on Thursday, November 8 of last year, it will be seen that a very considerable day-load was obtained, due to the tramways. At 5 a.m.

the battery took over a load for the workmen's cars to the docks; at 6 a.m. charging was commenced with two 100kw. steam generators, these also supplying energy to the tramways, the charging current varying with that used for traction, while the amperes and volts on the generators remained fairly constant, as the battery acts as a very good regulator for the varying tramway load. At 4:40 the battery took over the traction load till 9:55 while the 100kw. generators were used on the peak of the lighting load, and charging was again commenced at 9:55 continuing till 11:50 p.m. It will also be seen by comparison of the different areas of load, which are shown shaded in the figure, that the number of units put into the battery and the number taken out is very favourable.

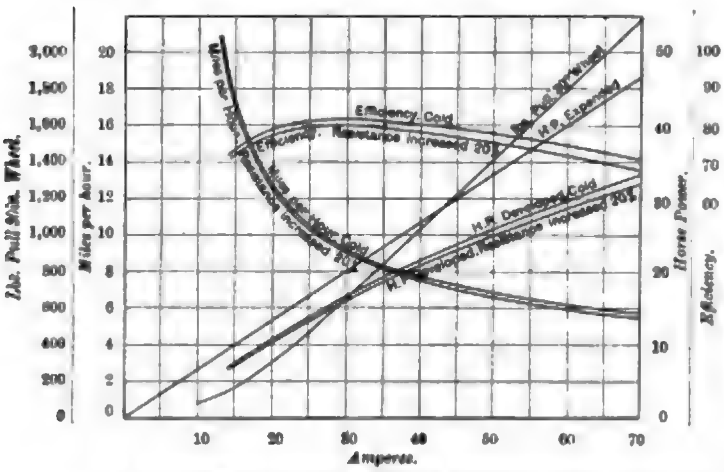


Fig. 8.—Efficiency Curves of No. 46 (500-Volt Railway Motor). Gear Ratio, 14 : 68.

Besides the very economical conditions of working, the reliability of this system speaks for itself, from the fact that since the commencement of supply the tramways have not stopped in one instance for want of current from the station. It may be thought perhaps, that the capital charges due to the storage system are greater than that for the generating plant which would be otherwise necessary; but the actual figures relating to the Southampton tramways system show that this is not so in the present instance.

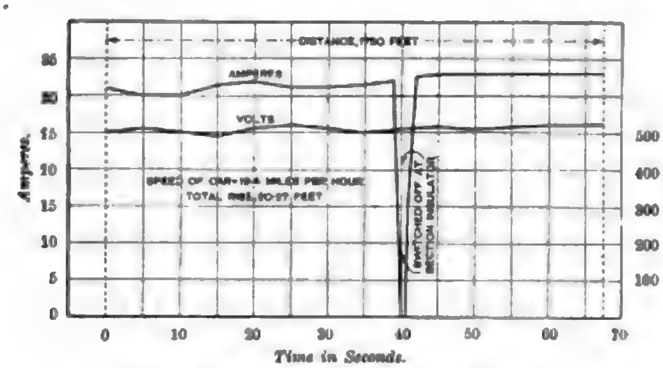


Fig. 9.—Car Test Curve on a Trial Run.

There are 20 cars at present in use on service which are of the double-deck, single-truck type, provided with Westinghouse double motor equipments and series parallel trolleys, with emergency rheostatic brakes. The cars have a seating capacity for 22 persons inside and 24 persons outside, the seats on the top being placed longitudinally back to back owing to the limited head room at the Bargate. As the rails become in wet weather very greasy where wood paving is used, flats on the car wheels are not an infrequent occurrence, although there are not many steep gradients. Instead of averaging 60,000 car miles, a number of flats have formed at about 10,000 miles. The depth of chill on the wheels is about 1⅛in. It is really a matter for consideration whether it would not be better to use wheels with a steel tyre, which would probably last 300,000 car miles; and I look for an improvement in this direction on the present chilled wheels in the near future.

An efficiency curve taken from one of the Southampton motors is given in Fig. 8, and it should be pointed out that no particular motor was selected, and that the Westinghouse Company would probably be able to show a more accurate and perhaps better curve; but the fact I wish to emphasise is that besides the American-built tramway motors being thoroughly mechanical in design, they are also highly efficient at practically all loads. Not one of the motors in Southampton has ever given any trouble, which is sufficient to show the state of perfection of these motors. It would be perhaps interesting to those who are not familiar with such curves to explain how this one has been plotted out. The horse-power expended is a straight line, as the volts are constant at 500; and, for example, 37·5 amperes multiplied by 500 volts gives just over 25 E.H.P. The curve for the horse-power developed is plotted from the weight in pounds hung on the brake wheel multiplied by the distance travelled by the wheel in one minute, giving foot pounds, and this factor divided by 33,000, the numerical equivalent of English horse-power, gives the curve for the horse-power developed on the shaft, which is in this case the car axle. The efficiency curve is then plotted by the relationship of these two horse-power curves. For example, looking up the lines at 37·5 amperes, horse-power expended equals approximately 25·2 and horse-power developed 19·6, which gives 75 per cent. efficiency as shown.

A curve Fig. 9 of the test taken from one of the Southampton cars up a slight incline shows that the car attained a speed of 19·4 miles per hour, and as all particulars are given it may be of interest for comparison.

The charge for lighting is 6d. for the first two hours and 4d. afterwards, and power is supplied at 2d. per unit up to the tramway switch pillars by the Lighting committee to the Tramways committee.

(*To be continued.*)

## A 1000-KILOWATT STEAM TURBINE-ALTERNATOR.

The accompanying illustration (Fig. 1) shows one of two steam turbo-alternators, each of 1,000kw. capacity, built by Messrs. C. A. Parsons & Co. for the Elberfeld electric supply works. These sets are now running at these works in conjunction with the original Brown-Boveri alternators driven by Sulzer engines. The illustration is from a photograph taken when the set was on the testing bed at Messrs. C. A. Parsons & Co.'s works, at Newcastle-on-Tyne. Tests of an elaborate and exhaustive nature were undertaken by Mr. W. H. Lindley, M.I.C.E., Prof. Schröter and Dr. H. F. Weber; and the results of these trials are embodied in a report, extracts from which we give below. Our first extract describes the arrangements for the trials:—

These tests were made on Jan. 5, 6, and 7, 1900. Jan. 8 was devoted to making sundry checks upon the measurements and readings, and to a joint comparison of independent calculations, and to subdividing the observations in coincident groups . . . . . The turbo-alternator was erected in the large testing house of the firm, upon a wooden framework made to replace the foundation in the permanent installation, which will be 4 metres high, in such a manner that the turbine, piping, condenser, air pump, &c., in fact, occupied exactly the same relative position as they will in their final arrangement . . . . The steam was taken from the following boilers, and at the normal pressure of about 10 atmospheres absolute:—

| | | | |
|---|---|---|---|
| One Babcock & Wilcox boiler of about... | 227 | sq. metre heating surface. | |
| Two marine boilers, each of about ...... | 550 | ditto | ditto |
| One locomotive boiler of..................... | 67 | ditto | ditto |

A Babcock and Wilcox superheater, with independent firing, was introduced in the main steam pipe. It should be here mentioned that the boilers in the works had to be used, as it was manifestly impossible to procure an entirely new boiler plant for the purpose of testing a machine of such great power. The boilers having been in use at the works for a long time were not quite tight, and their condition did not permit of an exact measurement of the *feed-water consumption* when the turbine was running at *full* load. As the results of the preliminary tests had shown

that it was permissible to determine the steam consumption by a direct measurement of the steam condensed in the surface condenser—*i.e.*, of the discharge of the air-pump, it was decided to adopt this method. Thus it was possible simply to take the steam for the tests from the various boilers and mains already existing in the works. For testing at *half* load, however, the Babcock and Wilcox boiler was available, and, being in thoroughly good order, permitted of an absolutely trustworthy measurement of the *feedwater* consumption at that load. In order to fix the relation between the steam condensed or discharge of the air-pump and the feedwater consumption a trial at half-load was made with this boiler alone, during which both *feedwater and air-pump discharge* were carefully measured during a fixed period. For this purpose the steam main was cut off by blank flanges from all other connections, except that which led directly from the boiler through the superheater to the steam turbine. It should be at once observed that, in accordance with results previously obtained by the preliminary tests, this trial revealed a very slight difference between feedwater and steam condensed. This difference was due to two trifling leakages in the steam main. The determination of steam consumption, from the measurement of air-pump discharge, was, therefore, in the present case proved to be trustworthy. The cooling water for the condenser was taken from a large cooling water pond. The delivery was effected by means of a helical pump driven by an electric motor. This pump forced the water through the tubes of the surface condenser in precisely the same way as will be the case in the station at Elberfeld, where centrifugal pumps driven by electric power are to be used. Arrangements were made to measure the temperature of the cooling water at the inlet and outlet of the surface condenser. The cooling water pond was so arranged that the cooling water was always taken from the coldest level. The pipe connections to the machine were most carefully examined before commencing the trials, with the object of securing absolute trustworthiness in the measurements. The same precautions were adopted in regard to the changed. . . . . The temperature of the steam on its admission to the turbine was taken immediately behind the stop valve by a mercurial thermometer. This thermometer was inserted into a small steel tube, closed at the bottom and filled with mercury, and extending to the centre of the steam pipe. The number of revolutions was determined by calculation from the revolutions of the air-pump crank, geared down from the main shaft of the steam turbine in the proportion of 8 : 1. It was found impracticable to utilise an ordinary revolution counter with centre point, and a stationary counter was not available. Therefore the time taken by 100 revolutions of the air-pump crank was observed by means of a chronometer divided into [illegible] seconds, and thence the revolutions per minute of the air pump, and, by multiplying these by 8, the revolutions of the turbine were obtained. Besides these observations the potential and strength of the entire exciter current were measured with instruments belonging to Messrs. Parsons. In order to determine the various electric properties of the turbo-alternators, in the first place, an instrument for measuring the *electrical output*, and, secondly, an instrument for measuring the voltage of the dynamo, viz., about 4,000 volts, were required. In accordance with the contract, the output of the dynamo was to be measured on an inductive load with cos $\phi = 0{\cdot}80$; consequently, in addition to the wattmeter and voltmeter, an ammeter was required to determine the amount of the lag between the potential and current phases. A standard wattmeter, in combination with a non-inductive resistance of 40,000 ohms, was used to measure the output. The fixed coil of this wattmeter consisted of three windings of bare copper 1cm. in diameter, capable of carrying a current up to 400 amperes. The constant of this wattmeter was determined in the laboratories of the Electrotechnical Institute in Zurich two days before it was packed. The test was made with the greatest care under an alternating current of 50 complete cycles per second. Seven series of observations were made at the wattmeter angles of about 52deg., 106deg., 149deg., 211deg., 264deg., 311deg., and 339deg.

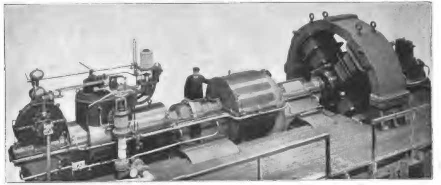


Fig. 1.—One of the 1,000 k.w. Parsons Turbo-Alternators for the Elberfeld Electric Supply Works.

leads of the main current circuit and the exciter current circuit. Pressure gauges and vacuum gauges were fitted to the steam turbine at every point of importance for observing the steam pressure; also thermometers for measuring the temperature of the steam, and arrangements for determining the number of revolutions.

The firm had arranged a water resistance for loading the machine, consisting of four electrodes, which were immersed in four iron vessels fitted with water coolers, representing respectively the four graduations of the normal load of the alternator—viz., $\frac{1}{4}$, $\frac{2}{4}$, $\frac{3}{4}$, and $\frac{4}{4}$. The vessels were filled with water and furnished with a continuous supply. They were insulated from the earth. The sides and bottoms of the vessels formed the second electrode, and these in turn were each connected by a further lead to an auxiliary electrode immersed in the cooling water pond, where it could be raised or lowered for purposes of regulation. The earth plate was immersed in the cooling water pond itself, and was directly connected with the earth lead of the second pole of the alternator. Regulation of the load could be effected by raising or lowering the four electrodes immersed in the pond, or by the withdrawal of one or other of the same. The instruments for the electrical observations, consisting of a standard wattmeter with the necessary resistance, and a static voltmeter, as well as an ammeter from the laboratory of the Federal Electrotechnical Institute in Zurich, were fitted up in immediate proximity of the alternator, in a small chamber specially separated from the test-house by glazed partitions.

In order to determine the steam consumption from the air pump discharge, the latter was conveyed through a special pipe into two wrought-iron vessels. A three-way cock was arranged in this pipe in such a way that at a given signal the connection with the one vessel could be instantly cut off, and diverted to the other. . . . . The observations made on the steam turbine in the testing house consisted of noting the steam pressure at different points, the temperature of the steam on admission to the steam turbine, and the revolutions, and, finally, during the governor tests, speed diagrams were taken while the load was being suddenly

The value of the constant was found equal to 0·09011, so that the effect E to be measured was obtained from the wattmeter angle $x$ and with the shunt resistance of 40,000 Ω by means of the following equation:—

$$E = 0{\cdot}09041 \times 40{,}000 \times x \text{ watt} = 3{\cdot}6044 \times x \text{ kilowatt.}$$

Three days after the return of the wattmeter from Newcastle, the constant of the instrument was determined afresh for an angle of about 147deg., in order to ascertain whether it had undergone any change in value during transport. The result showed that the constant was [illegible]th part of its value less than it had been when the instrument was gauged prior to its despatch to Newcastle. As this difference is so small and almost within the range of errors of observation, the constant of the watt-

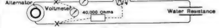


Fig. 2.

meter may be regarded as not having been influenced by the transport of the instrument. The voltmeter used for the measurements was an electrostatic instrument of the Lord Kelvin type, which permitted the voltage of about 4,000 volts being read off accurately to 5 volts directly, *i.e.*, without the necessity of transforming the voltage. . . . . The ammeter employed, beside the wattmeter and voltmeter, for ascertaining the lag of phase between potential and current, was a hot wire ammeter with a range from 50 amperes to 350 amperes, which permitted reading exactly to 1 ampere.

For the purpose of measuring the output of the dynamo, and for deducing the other electric values under consideration, the wattmeter, ammeter, and voltmeter were placed and connected as shown in Fig. 2.

In order to obtain the total output of the dynamo with the wattmeter in this position, the power absorbed by the shunt winding of the wattmeter $= P^2 \div 40,000$ watt (P denoting the voltage of the dynamo) has to be added to the energy given by the wattmeter (in accordance with the formula $E = 0·09011 \times 40,000 \times x$ watt). This implies only a small correction of 0·4kw. when $P = 4,000$ volts, and it may therefore be regarded as constant for all the voltages observed during the tests. As Messrs. Parsons desired to determine the output of the dynamo independently a wattmeter—a Kelvin balance—belonging to Messrs. Parsons, was placed in series with the fixed coil of the above wattmeter, the resistance in the shunt winding of the balance (which was likewise 40,000 ohms) being connected in parallel to the resistance in the shunt winding of the wattmeter. Under these circumstances the correction of 0·4kw. above mentioned had to be increased to 0·8kw. It may be here mentioned that this balance had been adjusted and its scale verified at the Kelvin laboratories shortly before the present tests, and that its readings corresponded *almost exactly* with those of the wattmeter. For example, in the series of tests at the normal load of the dynamo at 11 a.m. the wattmeter indicated 1,004·4kw., whilst the Kelvin balance gave 1,000kw. to 1,002kw.

No less than 12 lengthy series of tests were undertaken, with the plant in different conditions as to load and method of governing. In the determination of steam consumption at different loads, in order to obtain as accurate values of the output as possible, in spite of fluctuations in the water resistance and the consequent fluctuations in the strength of the current and in the potential, observations of the wattmeter were taken twice in every minute throughout the whole duration of each series of tests, one made with the torsion spring turned to the right, and the other with the spring turned to the left, so that the average value of output for a period of one hour could be deduced from 120 separate observations. The voltage of the dynamo was recorded by a second observer as frequently as the output. Although a very exact determination of the voltage was not necessary for fixing the relation between steam consumption and output, still it was desirable to carry on a continuous measurement of the potential so as to maintain it in the neighbourhood of its normal value of 4,000 volts by regulating the water resistance. This was, on the whole, well attained during each series of tests. The following tables, with the remarks of the experts upon them, sufficiently indicate the general results of the tests of steam consumption :—

| No. of series. | Amount of load. | Exact value of output in kw. | Steam consumption per kw. hour. In lb. | In kg. | Steam consumption in one hour. |
|---|---|---|---|---|---|
| | | | | | kg. |
| A. | Preliminary trial.................. | 1,172·7 | 18·22 | 8·26 | 9,689 |
| II. | Overload ........................... | 1,190·1 | 19·43 | 8·81 | 10,465 |
| I. | Normal load........................ | 994·8 | 20·15 | 9·14 | 9,092 |
| III. | Three-quarter load ............... | 745·3 | 22·31 | 10·12 | 7,542 |
| IV. | Half load ........................... | 498·7 | 25·20 | 11·42 | 5,696 |
| V. | Quarter load ....................... | 246·5 | 33·76 | 15·31 | 3,774 |
| VI. | No load with alternator excited | 0 | — | — | 1,844 |
| VII. | No load without excitation ... | 0 | — | — | 1,183 |

A direct comparison of these results is not possible, because the measurements have not been made at one and the same steam pressure, and, above all, not with exactly the same amount of superheating. Therefore, on the basis of the results of the measurements the steam consumption has been calculated at the average superheating recorded in the observations—viz., 14·3°C., corresponding to a steam temperature of 197·3°C. These corrected results will be found in column 12 of the following table. Further, to enable a comparison to be made with the steam consumption of reciprocating engines, working with saturated steam, the equivalent steam consumption, calculated as saturated steam at 11 atmospheres, are given in column 13 of the same table :—

The relation between the steam consumption per hour D (expressed in kilogrammes) and the output N is in the first place obtained from the quotient

$$\frac{D_N - D_0}{N}$$

in which $D_N$ = steam consumption per hour at output N,
$D_0$ = steam consumption per hour at no load with excitation.

This quotient gives the following values :—

7·846 for N = 246·5kw.
7·840 for N = 498·7 „
7·601 for N = 745·3 „
7·261 for N = 994·8kw.
7·214 for N = 1190·1 „

It will be seen that the relation cannot be expressed by a simple proportion ; therefore, for the purpose of determining the steam consumption per hour, at an output of 1,250, 1,000, 750, 500, and 250kw., a formula has been worked out, based upon the figures in column 12 of the preceding table, giving the relation between steam consumption and output within the limits of the present tests with an accuracy sufficient for all practical purposes. If the output be taken as the abscissæ, and the corresponding steam consumption (calculated for 11 atmospheres absolute and 14·3°C. superheating) be plotted as the ordinates, a curve is obtained which differs in a marked manner from a straight line and has its concave side turned towards the line of the abscissæ. But as the deviation of this curve from the straight line is not very considerable, the relation between D and N may, for the above purpose, be expressed as follows :—

$$D = D_0 + aN - bN^2,$$

$D_0$ representing the observed value of 1,840kg. The values for the coefficients $a$ and $b$, calculated from the results of the five series of observations, by Gauss' method of the smallest sum of the square of the errors, are—

$$a = 8·1178, \qquad b = 0·000769.$$

The following table may serve to judge how accurately the above formula represents the results. The steam consumption per hour D is :—

| According to the corrected observations in column 12 of table. | | According to the formula. | Difference in per cent. of the observed values. |
|---|---|---|---|
| For N = 1,190 | D = 10,425 | D = 10,411 | −0·13 |
| 995 | 9,063 | 9,157 | +1·04 |
| 745 | 7,505 | 7,460 | −0·60 |
| 498 | 5,750 | 5,692 | −1·01 |
| 246 | 3,774 | 3,790 | +0·43 |
| 0 | 1,840 | 1,840 | 0·00 |

For the following outputs, in round numbers, this formula gives the steam consumption per hour as follows :—

| Output. | Steam consumption per hour. | Steam consumption per kilowatt hour. |
|---|---|---|
| kw. | kg. | kg. |
| 1,250 | 10,786 | [illegible] |
| 1,000 | 9,189 | 9·19 |
| 750 | 7,496 | 9·99 |
| 500 | 5,707 | 11·41 |
| 250 | [illegible] | 15·28 |

**Tests were made to determine the variation in the number of revolutions between zero load and full load. These showed an average variation of 8·6 per cent. Other tests were made for the purpose of ascertaining the change in the speed with sudden changes of load. In order to carry out these tests the water resistance was divided into four sections. A separate lead from each section was carried into the test room, and was there provided with a switch arrangement, which, on a given signal, permitted of suddenly switching on or off the corresponding section which had previously been regulated to approximately 25 per cent. of the load. The switching on or off could accordingly be effected with a quick jerk and without**

| No. of series. | Load in kw. | Average observed steam pressure in kg./cm.² absolute. | Corresponding temperature of saturat'd steam. | Average observed t'mperat're of superheated steam at inlet valve. | Superheating (Col. 5—Col. 4). | Observed steam con-'mption per kw. hour. | Total heat contained in 1kg. of steam at observ'd st'm pressure. In saturated condition. | In superh't'd condition. | Measured consumption of heat per kw. hour (Col. 9 × Col. 7). | Corresponding consumption of saturated steam per kw. hour (Col. 10 ÷ Col. 8). | Corresponding consumption of steam at 11kg. abs. and at 14·3° superheating. (1kg. of steam = 669·2 cal.). | Corresponding consumption of sat. steam at 11 atms. absolute (1kg. of steam = 662·3 cal.). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kw. | kg./cm.² | °C. | °C. | °C. | kg. | Calories. | | Calories. | kg. | kg. | kg. |
| II. | 1,190·1 | 10·11 | 179·3 | 189·5 | 10·2 | 8·81 | 661·1 | 666·0 | 5,867 | 8·87 | 8·76 | 8·86 |
| I. | 994·8 | 10·47 | 180·9 | 192·0 | 11·1 | 9·14 | 661·7 | 667·0 | 6,096 | 9·21 | 9·11 | 9·20 |
| III. | 745·3 | 10·76 | 182·0 | 190·0 | 8·0 | 10·12 | 662·0 | 665·8 | 6,738 | 10·18 | 10·07 | 10·17 |
| IV. | 498·7 | 10·40 | 180·6 | 209·7 | 29·1 | 11·42 | 661·6 | 675·6 | 7,715 | 11·66 | 11·53 | 11·66 |
| V. | 246·5 | 10·14 | 179·4 | 196·4 | 17·0 | 15·31 | 661·2 | 669·4 | 10,248 | 15·50 | 15·31 | 15·47 |
| | | | | | | per hour. | | | per hour. | per hour. | per hour. | per hour. |
| VI. | * | 10·34 | 180·3 | 193·0 | 13·3 | 1,844 | 661·5 | 667·8 | 1,231,423 | 1,861 | 1,840 | 1,859 |
| VII. | † | 10·49 | 181·0 | 194·5 | 13·5 | 1,183 | 661·7 | 668·2 | 790,481 | 1,194 | 1,181 | 1,194 |

* No load with excitation. † No load without excitation.

transition. When making tests at the smaller loads the careful preliminary regulation of the load to be switched on or off was omitted; consequently, the variations in load in these cases often exceeded ± 25 per cent. The average variation of speed in these latter tests corresponded to a change of 1·1 per cent. in the voltage.

Tests made to determine the drop of voltage between no load and full load, with constant speed and constant excitation, showed the following very satisfactory results. With a non-inductive load, the voltage at no load "with exciter current 111·0 amperes and with 1,476 revs." was 8,955·5 volts; and with a load of 984kw. "with exciter current 111·0 amperes and with 1,477 revs." the voltage was 8,918·0 volts. This indicates a potential drop of 0·95 per cent., with the load increased from 0 to 984kw., or 1·02 per cent. at 1,000kw. To produce an inductive load a large hollow coil, with its core partly filled with iron plates, was inserted in the lead which had been used in the previous tests. The core was so adjusted that the angle of the difference of phase of voltage and current was approximately 38deg., the cosine of this angle being, therefore, about 0·78. For a change of load from 0 to 1,000kw. the inductive drop was about 11 per cent.

## THE ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL INDUSTRIES IN 1900.

BY JOHN B. C. KERSHAW, F.I.C.

(*Concluded from page 391.*)

**Nickel.**—The increasing use of nickel in the steel industry has caused electro-metallurgists to devote considerable attention in recent years to the problem of extracting and refining this metal by electrolysis, and many electrolytic methods have been patented.

The total world-production of nickel in 1899 was estimated to amount to 7,350 tons, the New Caledonian mines, in the Southern Hemisphere, and the Sudbury mines, in Canada, being the chief sources of ore supply. The bulk of this ore is still treated for extraction of the metal by purely metallurgical methods; but the crude nickel is being electrolytically refined in England, Germany, and in Canada, and Hoepfner claims to have worked out a process by which the nickel is extracted direct from the ore by electrolytic means. This process is now operating upon an industrial scale at Papenburg, in Germany. The ores used are roasted, crushed, and leached with a mixed solution of cuprous and calcium chlorides. This solution is electrolysed with carbon anodes and copper cathodes to remove the copper. After the nickel in solution has risen to 10 per cent., the copper, iron, and lead remaining in solution are removed by chemical methods, and the resultant pure solution of nickel chloride is then electrolysed with nickel cathodes in order to obtain the nickel. The writer is informed by Dr. Hoepfner that the Papenburg works are operating successfully, but it is yet too early to judge of the financial success of this method of nickel extraction.

At Hamilton, Ontario, the Frasch process of electrolytic extraction is about to receive trial. In this process the crushed ore is directly used as anode material, in a cell containing brine as the electrolyte. Chlorides of the soluble metals are produced at the anode, and a solution of sodium hydrate at the cathode. The solution of chlorides is then electrolysed to separate the copper, and the other metals present are obtained by a later chemical treatment. The practical success of this method is not yet proved.

The electrolytic methods of refining crude nickel in use by the Balbach Co. in the United States, by Messrs. T. Bolton & Sons in England, by Messrs. Gustav Menne & Co. in Germany, and by Nikolajev in Russia, resemble those used for copper refining, the chief difficulty being that nickel has a tendency to "foliate" when thick plates are electro-deposited. This difficulty, according to Foerster, can be overcome by working with the electrolyte at an elevated temperature.

The Mond process of nickel extraction, which is about to be worked upon a large scale at Clydach, in South Wales, is not an electro-metallurgical process, but depends upon the formation of a volatile compound called nickel carbonyl when carbon mon-oxide gas is passed over the heated ore containing the metal in the reduced state.

At Saulte Sainte Marie in Canada, ferro-nickel alloys are said to have been produced direct from the ores of the Sudbury district, by treatment in the Clergue electric arc furnace. The alloys produced contain 7 per cent. nickel, but silicon and other impurities are present, and it is not yet proved that the alloys obtained in this comparatively simple way are sufficiently pure to be used for the manufacture of nickel steel. Should this be the case, the process will have a great future.

**Ozone.**—There is little to report in connection with the ozone industry during the past year.

The Commercial Ozone Syndicate, formed to exploit the Yarnold ozoniser in this country, has gone into voluntary liquidation, and the writer has not heard that any new company has been floated to carry on its work. The proposed application of this ozoniser to the refining and bleaching of oils is still unrealised, although two years ago very favourable experts' reports were published concerning the value of this process.

The question of water sterilisation by means of ozonised air still attracts much attention, and the exhibit of the Sociéte Industrielle de l'Ozone at the Paris Exhibition, showing the Marmier and Abraham process as worked at Lille, was much commented on. According to Borchers this process is now in use at Lille, and at Boléo, in Mexico. There is some doubt whether these installations are merely experimental, or whether they are running on a commercial basis; and it is perhaps yet too early to speak of this method of water purification as a definite success. It is significant that similar installations at Blankenburg, at Oudshoorn, and at Paris are reported to have been dismantled.

The practical value of these processes is dependent upon the cost, and as the water requires filtration before treatment with the ozonised air, the ozone treatment is certainly unnecessary for ordinary drinking waters, such as those supplied by most of the water companies in this country. In France, where less attention is paid to sanitary matters, the potable waters are notoriously bad, and there may be a necessity for further purification after the water has passed through the sand filters. According to M. Abraham the cost of sterilising an average water by the Marmier and Abraham process is 0·0045fr. per cubic metre (equal to 1½d. per 1,000 cubic ft.), but at the Paris Exhibition the much higher estimate of 1 centime per cubic yard was given. The only other practical applications of ozone known to the writer at the present time, are in Silesia for bleaching textile goods, and in France, where it is used in the manufacture of artificial perfumes. The Siemens and Halske form of ozoniser is used in the former case, and the Verley ozoniser in the latter.

**Zinc.**—There are no startling developments to report in connection with the electro-metallurgical processes for zinc extraction during 1900. In this country the only process being operated upon an industrial scale is that of Hoepfner.

Great reticence is displayed concerning the details of this process. It is believed that it depends upon the electrolysis of zinc chloride solution, using carbon anodes and diaphragms. Electrolytic zinc produced by this process at their Winnington works, in Cheshire, and testing 99·5 per cent. zinc, was exhibited by Brunner, Mond & Co. at the Paris Exhibition. The zinc plant at Winnington has been extended during the year, so the process appears to be a financial success.

The Cowper-Coles process, to which reference was made in the last report, is not yet operating upon an industrial scale, and the Swinburne-Ashcroft process—which differs from the two preceding ones in being a fusion process—has also not yet emerged from the experimental stage of its development.

Improvements have, however, been effected in the last-named process, and £10,000 is to be expended upon trials with the mixed sulphide ores of the Tasmanian Copper Co. The modified process is carried out as follows: The pulverised ore is mixed with fused zinc chloride, chlorine gas is blown through the fused mass, and the molten zinc and lead

chlorides obtained by this treatment are decanted from the insoluble gangue, &c., and electrolysed in a separate vessel.

The mechanical difficulties in carrying out such a treatment would appear to be great, but possibly they may be surmounted. Chlorine gas is certainly not a pleasant gas for pumping operations.

At Ellesmere Port, near Manchester, the Fry process is now in successful operation, but the electrolytic treatment of the zinc oxide obtained, has not yet been carried beyond the experimental stage of its development. The process as at present worked is therefore wholly metallurgical in character, the final products being lead, silver, and zinc oxide. The recovery of zinc from the latter is based upon feeding it into a bath of molten zinc chloride, and electrolysing the molten mass with carbon anodes and molten zinc as cathode material.

The Ellerhausen process is another purely metallurgical process for treating mixed sulphide ores, which was worked out at Llanelly, in South Wales. The process is based upon direct smelting of the ores. Lead, zinc, and silver are volatilised and recovered by churning up the resultant gases with water. These metals are obtained partly as sludge and partly as solutions of their salts; but a portion of the silver, with the copper and gold, remains in the matte.

The British Sulphides Smelting Co., who own the Ellerhausen patents, have increased their capital to £800,000 during the past year, and have bought up the French company. The Llanelly works have been closed, and the smelting operations have been concentrated at the French works in Angoulême. No details have been published as to the method adopted for treating the metallic salt solutions obtained by this process, but probably electrolysis is used to separate the zinc.

In Germany, the Dieffenbach process, which was at one time reported to be a success, is no longer operated upon an industrial scale; and though much has been written concerning the electrolytic process of Hoepfner, it is not clear that this is in use in Germany. The latest definite information the writer has received relating to the progress of this process abroad, was that the electrolytic works at Hruschau in Austrian Silesia, and in Canada were expected to be started in 1900; but in electro-metallurgical developments, as in other branches of industrial progress, expectation is usually months ahead of realisation.

During the past year, Rontschewsky has been carrying out experiments to determine the influence of oxidising agents in the anode chamber of a zinc depositing cell. He has found that using lead anodes and a small percentage of chlorates, he could obtain lead peroxide at the anode without diminishing the quality of the zinc deposit at the cathode. Substituting sodium chromate for sodium chlorate, and using a tripartite cell, he obtained lead chromate of any desired tint at the anode, in conjunction with metallic zinc at the cathode. These modifications of the usual zinc depositing process may become of industrial importance, if a market can be found for these lead by-products.

As regards the electro-galvanising industry, there is nothing new to report during 1900.

Conclusion.—This review of the position of the various electro-chemical and electro-metallurgical industries at the close of the year 1900, shows that while advance in some directions is slow, yet on the whole progress is visible. The aggregate number of works and factories in which electricity is used for carrying out chemical or metallurgical operations continues to increase from year to year, and the writer now estimates it to be over 230.

The majority of these works employ water-power for generation of the electrical energy, but, as the remarks upon the present condition of the calcium carbide industry show, water is not always the most economical source of power, when the correct test of economy is applied—namely, ability to earn profits. The position of Germany and England with regard to these new industrial developments is therefore not so hopeless, as some are disposed to imagine, and the use of blast-furnace gases for power generation in connection with electro-chemical and electro-metallurgical manufactures, may prove in the future a wide and profitable outlet for capital and ability in both countries.

With regard to the aggregate power utilised in the electro-chemical and electro-metallurgical industries, Borchers' estimate in 1898 of 418,000 H.P. is still in excess of that actually employed, and this total must be taken again as representing the power *available* for these manufactures, rather than as the power at present utilised.

For the four industries with which the writer is specially acquainted the latest reliable figures are given in tabular form below.

*Power used in 1900 in the Four Chief Electro-chemical and Electro-metallurgical Industries.*

| Manufacture. | United Kingdom. | | All countries. | |
|---|---|---|---|---|
| | No. of works. | H.P. | No. of works. | H.P. |
| Alkalies and bleach ............ | 3 | 7,020 | 27 | 52,000 |
| Aluminium ........................ | 1 | 2,000 | 8 | 28,000 |
| Chlorates of potash and soda | 0 | — | 11 | 24,000 |
| Copper............................ | 7 | 1,500 | [illegible] | 16,000 |
| Totals ............................ | 11 | 10,520 | 88 | 120,000 |

The calcium carbide works, as already explained, have been seriously affected by the fall in value of their only product, and the writer estimates that their output for the year 1900 will not exceed 85,000 tons. This represents about 85,000 H.P. The remaining industries do not any of them utilise power on a large scale, and probably 10,000 H.P. is an ample estimate for the power employed in the hypochlorite, ozone, bullion, nickel, and zinc industries during 1900.

Adding these various figures together, we obtain a grand aggregate of 215,000 H.P. for the total actually utilised in the electro-chemical and electro-metallurgical industries of the world during 1900.

The place occupied by the United Kingdom in connection with these new industries is not very flattering to our self-esteem as a manufacturing nation. Only 21 electro-chemical and electro-metallurgical works are operating in this country, compared with 220 in the remaining countries of the world.

Limits of space will not allow any lengthened discussion of the various causes which have contributed to this result, but three may be named :—

1. Lack of natural water-power capable of cheap developments for industrial purposes.

2. Ingrained conservatism on the part of the financiers directing our industries.

3. Want of knowledge on the part of chemists and electrical engineers.

The writer has already stated his belief that the first of these is not so serious as some are disposed to imagine, and in a Paper published in September, 1900, he gave grounds for that belief. The second and third of these causes are more serious, and can only be removed by education. Upon our success or non-success in providing such education will depend the position which our country is finally to take in the electro chemical and electro-metallurgical industries in the century which has just dawned.

---

Water Power Utilisation in Norway.—The *Engineer* states that the largest turbine installation of its kind in Scandinavia is now being constructed on the river Glommen, in Norway, which flows through the central and south-western parts into the Christiania Fjord. The object of the undertaking is to supply Christiania and adjacent parts with electricity for lighting and motive purposes. Up till now several huge dams have been built at two waterfalls, with a canal for feeding the turbines 1,100yds. in length. The falls are estimated to yield 16,000 and 10,000 effective H.P. respectively. They are situated about 25 miles from the capital, and close to the Trunk Railway, which is naturally a great advantage. The capital of the concern is £5[illegible],000, most of which has been taken up in England.

## SWEDISH TELEPHONE OPERATIONS IN RUSSIA.

As the result of the tendering just decided for the telephone concessions in the five Russian cities of St. Petersburg, Moscow, Odessa, Warsaw, and Riga, two concessions for the working of the systems in Moscow and Warsaw have been given to Swedish companies, at the head of which is Herr H. T. Cedergren, director of the Stockholm General Telephone Co., &c., and who has just returned after concluding the negotiations. In an interview he has made the following interesting statements :—

In the Russian cities named the well-known American Bell Telephone Co., or, rather, the European branch at Antwerp, has hitherto held the concessions, which were granted for 20 years, to expire on November 1, 1901 ; and the present competition has been held in order to settle the concessions for a period of 18 years from that date, the competition having been the keener as the Russian towns still offer a wide field for telephonic operations, the use of the telephone not having advanced appreciably during the working by the present concession holders. In St. Petersburg, for instance, there are only 27 subscribers per 10,000 inhabitants, as against no less than 900 in Stockholm to the same number of persons. *En passant* it may be mentioned that Stockholm in this respect takes first place by a long way over the principal cities of the world, San Francisco coming nearest, but with only 485 apparatus per 10,000 inhabitants, then Berlin with 218, New York with 150, Chicago with 100, Paris with 74, London with only 47, and St. Petersburg (as stated) with only 27 per 10,000.

The cause, continued Herr Cedergren, of the very limited use of the telephone in Russia is chiefly that the lines are old-fashioned single overhead ones, and because the subscription is rather high—viz. : in St. Petersburg, Warsaw, and Moscow, 250 roubles, and in Riga and Odessa, 150 roubles a year per apparatus. One of the conditions in the concessions of the Bell Company was that on their expiry the plants, &c., should revert to the Russian State, and all these, which the new concessionaires have to take over, have been valued at 1,000,000 roubles—viz., St. Petersburg, 358,000 roubles ; Moscow, 271,000 roubles ; Warsaw, 157,000 roubles ; Riga, 114,000 roubles ; and Odessa, 100,000 roubles.

Besides the conditions respecting the taking over of the old Bell installations, and one granting three years only from November 1st next year for the reconstruction of the systems, there were others in the concessions prepared by the Chief Russian Post and Telegraph Administration, as, for instance, insistence upon the new systems answering all modern requirements, the lines to be subterranean, most improved apparatus only to be used, and others. The concessions were granted for 18 years, when the Russian State would have the privilege of taking over the systems, and the price of redemption should be fixed by arbitrators appointed by each party. Everything was thus fixed by the State so that the only bone of contention was really the price of the annual subscription. As regards the latter, it was stated that it should apply to transverse apparatus, with a small advance for apparatus frequently used and a slight reduction for those less in use, whilst the subscription was to apply to all apparatus within 3 kilos from the central station, but for longer distances there should be an extra charge. In the competition the Administration invited 10 tenders for St. Petersburg and Moscow, 8 each for Warsaw and Odessa, and 12 for Riga, and the two mutually-interested Swedish companies, represented by Herr Cedergren, and of which he is managing director, were invited to tender for all the towns named, which was done. Besides the municipal bodies in the towns, the only other tenderers were the Western Electric Co., of Chicago, and in Riga and Odessa five others for each town.

Naturally the labour of inspecting the work prior to the tendering took much time. Thus Herr Cedergren, with a staff of assistants, spent the whole summer in going over them, and in preparing elaborate calculations. As an illustration of the extent of the businesses concerned may be mentioned that the Swedish estimates forming the basis for their tenders fix the cost of the installations in St. Petersburg at 16,700,000kr. (18kr. = 20s.), in Moscow at 15,400,000kr. (the number of subscribers in each city being estimated at 20,000), in Warsaw (10,000 subscribers) at 6,800,000kr., and in Riga and Odessa (6,000 subscribers each) at 4,000,000kr. per town. These estimates apply to the whole time of concession—18 years—irrespective of the cost of the site for the new central stations required.

As already stated, the two Swedish companies tendered for two cities—viz., for Moscow with 79 roubles per apparatus, and for Warsaw with 69 roubles. In addition a tender was made for St. Petersburg, but the municipal council there tendered lower with 55 roubles, but as it is considered that this figure is far too low for an effective service it may be rejected and the Swedish tender, which stands next, may be accepted. In Odessa the Raffalovitch firm obtained the contract with 48 roubles, and in Riga Messrs. Rucker & Co. with 57 roubles. As an example of neat calculation may be mentioned that Herr Cedergren's tender for the Warsaw service was but one rouble below the next one. Therefore if the Swedish companies did not succeed in every case they have captured two of the biggest contracts, and have a fair chance of obtaining the third, and that the most important of all. The two concessions obtained alone cover some 23,000,000 roubles, besides the cost of the sites, which is a considerable amount for Swedish enterprise. The initial outlay during the first three years will, of course, be the heaviest, as the maximum net of underground mains will then have to be laid down. As regards technical difficulties, the soil of Moscow and Warsaw afford none, but in St. Petersburg they would be very great, owing to the marshy nature of the soil there. It is the intention to employ almost exclusively Swedish engineers on the new works ; but when they are completed in accordance with the terms of the concessions, all chief posts must be held by Russian subjects. During the progress of reconstruction, however, Swedes may be employed on the works. The promoter and his concerns are backed by a strong body of Swedish and Danish bankers.

## ELECTRICITY WORKS ACCOUNTS.

### Cardiff Municipal Electric Supply Works.

As the net result of its fifth year of working the Cardiff undertaking has found itself in the unfortunate position of having to meet a deficit of £1,794. Perhaps still more unfortunate is the fact that this position marked a retrogression on previous results. Most of the several items of cost show increased values for 1899-1900. The two exceptions are oil, &c., and wages at the station. The reduction in these charges more than neutralise the advance which has taken place in the other items of works costs, with the result that the aggregate generating and works costs have slightly diminished, although, owing to increased management and property charges, the total costs have risen. We learn that, included in "Repairs and renewals of mains, &c.," £150 was expended in the renewal of rubber arc light cables.

In a comparison of the financial results the moderate character of the total revenue must not be overlooked. Indeed, we understand that the committee found that the charges for public lighting were, at 1·52d. per unit, below what they could afford to do it at, and decided that a higher rate be credited the undertaking for public lighting supply in subsequent accounts.

Although the Corporation was awarded damages, the net proceeds of which amounted to £1,106, as the result of their action against the contractors for delay in the delivery of plant, yet this amount was not applied to repair the loss of revenue occasioned by the delay. The amount, in the present accounts, appears in the general balance sheet.

Both the lamp connections and the output show advances of a little over 26 per cent., while the load factor was 11·8 per cent. in 1899-1900 as compared with 11 per cent. in 1898-9.

### Newport Municipal Electric Supply Works.

The results recorded in the Newport accounts for the year to March 31 last are, on the whole, most satisfactory. With unimportant exceptions a general and consistent reduction took place in the costs. Thus, although there also occurred a diminution in the total revenue per unit, the ratio of the costs to the revenue materially fell, the working profit rose from 3·99 per cent. to 5·02 per cent. on the mean capital, and a small surplus of £415 was left after paying capital charges amounting to 4·53 per cent. on the mean capital. The undertaking thus, for the first year in its existence, was self-supporting.

The value 0·565d. per unit for fuel is most creditable, even considering Newport's position in respect to coal supply. The average fuel costs in municipal stations in 1899-1900 was 0·73d. per unit, but associated with a mean output of over a million units sold and an average load factor higher than that at Newport. The item of oil, &c., dropped to a very fair figure, but wages at the station, although much reduced, were still rather too high. The repairs at the station were, as usual, less than half the average in other stations.

An excellent rate of advance is noticeable in the business done and acquired. The year's output was over 45 per cent. higher than in the preceding year, while additional lamps connected rose the total by 26·6 per cent. Although the load factor at 10·6 per cent. is still below the average, it is a decided improvement upon the 9·4 per cent. load factor which obtained in 1898-9.

| | CARDIFF. | NEWPORT (MON.). |
|---|---|---|
| *Undertaking Worked by* | Cardiff Corporation. | Newport Corporation. |
| *Date of Commencement of Supply* | December, 1894. | October 14, 1895. [2 and 3 wire. |
| *System of Supply* | Alternate current transformer sub-stations. | Alternate-current transformer sub-stations, |
| *Chief Engineer* | N. Appelbee. | C. D. Copland. |

| YEAR ENDED | CARDIFF MAR. 31, 1899. | | CARDIFF MAR. 31, 1900. | | NEWPORT MAR. 31, 1899. | | NEWPORT MAR. 31, 1900. | |
|---|---|---|---|---|---|---|---|---|
| **QUANTITIES—** | | | | | | | | |
| Units generated | 522,040 | | 673,633 | | 451,560 | | 602,822 | |
| „ SOLD (TOTAL) | 405,234 | | 511,300 | | 322,638 | | 469,204 | |
| „ sold to consumers | 305,534 | | 389,336 | | 218,034 | | 324,728 | |
| „ sold for public lighting, &c. | 101,700 | | 121,964 | | 104,604 | | 144,476 | |
| „ used on works | 21,274 | | 25,838 | | 14,836 | | 34,974 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 12·5 | | 15·7 | | 22·9 | | 14·3 | |
| Maximum supply demanded | 420 kilowatts | | 495 kilowatts | | 393 kilowatts | | 506 kilowatts | |
| Number of public lamps | 61 arc, 12 glow[a] | | 64 arc, 12 glow | | 42 arc | | 76 arc, 6 (16 c.p.) glow | |
| Number of consumers | 251 | | — | | 237 | | 371 | |
| Connections to mains in 8-c.p. lamps | 21,498 | | 27,250 | | 24,707 | | 31,273 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 32,500 | | 32,500 | | 14,060 | | 32,800 | |
| CAPACITY OF PLANT IN KILOWATTS | 1,040 | | 1,040 | | 450 | | 1,050 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | £91,660 | £88·0 | £95,228 | £91·6 | £80,815 | £180 | £80,815 | £76·9 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 91,660 | 88·0 | 95,228 | 91·6 | 80,815 | 180 | 80,815 | 76·9 |
| RECEIVED (TOTAL) | 32,500 | 31·3 | 49,325 | 28·2 | 43,181[a] | 96·0 | 84,996[a] | 81·0 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 32,500 | 31·3 | 49,325 | 28·2 | 39,000 | 86·6 | 80,815 | 76·9 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | 59,160 | 56·9 | 45,903 | 44·1 | 41,815 | 92·9 | nil | — |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | 59,160 | 56·9 | 45,903 | 44·1 | 41,815 | 92·9 | nil | — |
| REPAID (TOTAL) | — | — | 4,653 | 4·47 | nil | — | nil | — |
| RESERVE OR SINKING FUND | 3,529 | 3·39 | 4,492 | 4·32 | — | — | — | — |
| DEPRECIATION FUND | — | — | — | — | nil | — | nil | — |
| EXPENDED (TOTAL) | 71,018 | 68·3 | 85,718 | 82·4 | 69,880 | 155 | 92,983 | 88·8 |
| Lands and buildings | 15,241 | 14·7 | 16,792 | 16·1 | 17,102 | 38·0 | 19,905 | 19·0 |
| Plant | 26,223 | 25·2 | 32,048 | 30·8 | 30,441[b] | 67·7 | 39,379[h] | 37·5 |
| Mains | 22,620 | 21·7 | 26,401 | 25·4 | 18,261 | 40·6 | 24,247 | 23·1 |
| Miscellaneous | 6,925 | 6·66 | 8,477 | 8·15 | 4,076 | 9·06 | 9,452 | 9·00 |
| BALANCE OF CAPITAL ACCOUNT | -38,518[b] | -37·0 | -36,393[b] | 35·0 | -26,699[c] | -59·4 | -7,987[c] | 7·61 |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
| TOTAL | £7,056 | 4·179d. | £8,512 | 3·997d. | £6,135 | 4·563d. | £8,711 | 4·458d. |
| Revenue from supply | 5,927 | 3·501d. | 7,188 | 3·374d. | 4,813 | 3·580d. | 6,804 | 3·480d. |
| „ meters, &c. | 140 | 0·083d. | 164 | 0·077d. | 187 | 0·139d. | 249 | 0·127d. |
| „ public lighting | 987 | 0·585d. | 1,160 | 0·545d. | 1,083 | 0·806d. | 1,553 | 0·795d. |
| „ sale of lamps, &c. | — | — | — | — | 52 | 0·039d. | 57 | 0·029d. |
| „ miscellaneous sources | 2 | 0·001d. | 1 | — | — | — | 48 | 0·025d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £5,088 | 3·014d. | £6,573 | 3·085d. | £3,790 | 2·820d. | £4,619 | 2·364d. |
| WORKS COSTS | 3,918 | 2·321d. | 4,877 | 2·289d. | 2,837 | 2·112d. | 3,486 | 1·784d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 1,100 | 0·652d. | 1,721 | 0·808d. | 897 | 0·668d. | 1,104 | 0·565d. |
| Oil, waste, water, stores | 482 | 0·285d. | 322 | 0·151d. | 293 | 0·218d. | 307 | 0·157d. |
| Wages at station | 1,403 | 0·831d. | 1,341 | 0·630d. | 1,227 | 0·913d. | 1,419 | 0·726d. |
| Repairs and maintenance at station | 322 | 0·191d. | 475 | 0·222d. | 45 | 0·034d. | 159 | 0·081d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 47 | 0·028d. | 122 | 0·057d. | 43 | 0·032d. | 73 | 0·037d. |
| Repairs, renewals of mains, &c. | 215 | 0·127d. | 415 | 0·195d. | 83 | 0·062d. | 54 | 0·028d. |
| *Public lighting* | [illegible] | [illegible] | 384 | [illegible] | [illegible] | [illegible] | 371 | [illegible] |
| Attendance | 178 | 0·105d. | 271 | 0·127d. | 249 | 0·185d. | 371 | 0·190d. |
| Renewals | 86 | 0·051d. | 113 | 0·053d. | | | | |
| MANAGEMENT AND PROPERTY CHARGES | 1,170 | 0·693d. | 1,695 | 0·796d. | 953 | 0·709d. | 1,132 | 0·580d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | 371 | 0·174d. | 182 | [illegible] | 188 | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | 0·622d. | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | 701 | 0·415d. | 797 | 0·374d. | 610 | 0·454d. | 694 | 0·355d. |
| Stationery, &c. | 97 | 0·057d. | 78 | 0·037d. | 36 | 0·027d. | 54 | 0·028d. |
| Establishment charges | 47 | 0·028d. | 262 | 0·123d. | 45 | 0·033d. | 103 | 0·053d. |
| Law charges, &c. | 107[c] | 0·063d. | 187[h] | 0·088d. | 81[d] | 0·060d. | 88[d] | 0·045d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £1,967 | 2·95% | £1,939 | 2·47% | £2,344 | 3·39% | £4,092 | 5·02 |
| Sum carried to Depreciation Fund | — | — | — | — | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 845 | 1·27% | 1,019 | 1·30% | 1,076 | 1·03 | 1,115 | 1·37 |
| Net interest on loans (incl. Debenture charges) | 2,166 | 3·25 | 2,715 | 3·47 | 1,560 | 2·56 | 2,573 | 3·16 |
| BALANCE FROM LAST ACCOUNT | 227 | 0·34% | 190 | 0·242% | 305[e] | 0·52% | 12 | 0·015 |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | — | — | — | — | 12 | 0·02 | 415 | 0·510 |
| *Deficit* | 841[d] | [illegible] | [illegible] | 2·53% | — | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | — | — | — | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 72·1% | | 77·2% | | 61·8% | | 53·0% | |
| Expenditure per kilowatt capacity | £4. 17s. 10d. | | £6. 6s. [illegible] | | £8. 8s. 5d. | | £4. 8s. 0d. | |
| REVENUE PER KILOWATT CAPACITY | £6. 15s. 7d. | | £8. 3s. 10d. | | £13. 12s. 7d. | | £8. 5s. 10d. | |
| Expenditure per 8-c.p. lamp capacity | 3s. 1½d. | | [illegible] | | 5s. 4½d. | | 2s. [illegible] | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 4s. 4d. | | 5s. 2½d. | | 8s. 8½d. | | 5s. 3½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 6s. 6½d. | | 6s. 3d. | | 4s. 11½d. | | 5s. 6½d. | |
| Price charged for lighting, per unit | 6d. to 3d.[e] | | 6d. to 3d.[e] | | [illegible] | | [illegible] | |
| Price charged for power, per unit | 2½d. to 2d. | | 2½d. to 2d.[e] | | 2d.[f] | | 2d. to 1½d. | |
| Price charged for public lighting | £18 per arc per ann. | | — | | £25 per arc per ann. | | £[illegible] per arc per ann. | |

CARDIFF.—REMARKS.—a The glow lamps are of 32 and 50 c.p. capacity. b Over-expended. c Includes insurance £45 and certification of meters £[illegible]. d After adding £24 management of stock and composition duty. e Maximum demand system [illegible] scale. f For the rectified current area. Alternating current arcs are shut down at 12 p.m. and glow lamps then put on and charged for at £[illegible] per lamp per annum. [illegible] per unit if consumption is below [illegible] per annum, if over [illegible]. h Includes insurance £31, certification of meters £40 and management of stock and duty £24. [illegible] Met to the extent of £[illegible] by general district rates.

NEWPORT (MON.).—REMARKS.—a Includes £4,181 value of lands appropriated. b Includes £[illegible] on arc lamps. c Over-expended. d [illegible] e From the rates after meeting [illegible] deficit. f Less 5 per cent. discount. g By scale as follows:—Up to [illegible] units per quarter, [illegible] per unit; [illegible] to [illegible] units per quarter [illegible]; [illegible] units per quarter, [illegible]; above [illegible] units per quarter, [illegible] per unit. For motors, 2d. per unit to [illegible] units per quarter; over [illegible] units per quarter 1½d.; 5 per cent. discount if paid within a month. h Includes £[illegible] on arc lamps.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 0d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 16s. 0d. ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## ELECTRIC TRACTION ON THE "UNDERGROUND" RAILWAY.

With quite startling swiftness electric traction on the "Underground" railway has been transformed from a matter of almost idle speculation into an affair of the most vital and pressing moment. From an attitude of airily toying with the latest scientific development in railroading, the directors of the Metropolitan and Metropolitan District Railway Companies have suddenly been compelled to recognise in electric traction the only means of salvation from impending ruin. What has produced this remarkable and complete *volte face?* Only last May we felt it incumbent upon us, when announcing the starting of the first "experimental" electric train on a portion of the "Underground," to express our opinion that there was nothing in this event "more than an attempt to put off the day when the entire Inner Circle system must be electrically equipped." Electric traction on the Inner Circle has been for many years past talked of by shareholders and the general public, and written about in the daily press, as a wonder of the distant future. Now and again the suffocating fumes of Gower-street and Portland-road stations have goaded the public into clamouring for the supersession of steam by electric locomotives; but the directors were deaf to every cry, and electric traction rose into greater and greater fame in the outside world unheeded by them. Then the Board of Trade stepped in and, in February, 1897, reported that "by far the most satisfactory mode of dealing with the ventilation of the metropolitan tunnels would be by the adoption of electric traction." The directors were given three years in which to take the proper steps; and almost the whole of this period ran out before anything tangible was done. Even then only a short length of line was electrically equipped. There was, in fact, every indication of a persistent policy of dawdle and delay; and so, we believe, it would have remained to the end of the chapter, had not a new and formidable factor forced itself into the question—the competition of the Central London Railway. While the Metropolitan and District Railway Companies were supinely ignoring the new method of traction

that was making by force its merits known all over the world, a rival company was formed and commenced to build and equip the now famous "Tube," practically straight across the most important diameter of their Inner Circle. Even when thus palpably menaced they refused to regard the matter seriously, and proceeded with their futile "experiment" to demonstrate the obvious and the already universally proved. The rival electric line was jeeringly referred to as a "tramway," because, unlike the "Underground" railways, it did not carry luggage or heavy goods, the inference being that it was a much more serious problem to run by electricity an Inner Circle than a "Twopenny Tube." Within six months, nevertheless, of the first running of the once-despised new rival, Mr. J. STAATS FORBES, the chairman of the Metropolitan District Railway Co., announced at a special—and urgency—meeting of the shareholders, that "the position had become desperate," and called for "prompt remedies" in order to "pull the company out of a great dilemma." These urgently needed remedies consisted, he declared, in the electric equipment of the railway; and the meeting had been called for the purpose of sanctioning the creation of £500,000 new share capital and raising additional £166,000 loan capital in new debenture stock, for the purpose of carrying out this scheme.

Judging from the published figures, the effect of the competition by the "Tube" on the receipts of the Metropolitan and District railways is amply sufficient to fill the shareholders of these two railway companies with alarm. It appears that their returns for the 25 weeks ended on December 22nd last show a reduction amounting to £10,856 for the Metropolitan and £16,940 for the District, or an aggregate of £27,796. Commenting upon this, *The Times* calls attention to the fact that for the first five weeks of this period there was no Central London Railway competition; so that, assuming the decline to have taken place in the remaining 20 weeks, it represents a decrease of £1,390 per week. Mr. FORBES significantly reminded the shareholders that the adoption of remedial measures was urgent, otherwise the situation "would daily become worse than it was even now." In this he judges the position rightly, though with lamentably belated acumen. Of foresight we discover not a single trace in the whole history of the attitude of the directors of the two "Underground" systems towards electric traction. On the contrary, there is exhibited nothing but reluctant capitulation to the force of circumstances. In our comments upon Mr. W. LANGDON'S Paper on "The Supersession of the Steam by the Electric Locomotive" (see *The Electrician*, December 14, 1900, p. 281) we observed that "it will not be the mere question of cheapening the cost of the present service that will impel, and indeed compel, railway directors to abandon steam locomotion; but it will be the ever-increasing pressure of competition by rival electric lines, running a much faster and more frequent service of trains than can be done by steam." These words were prophetic; the now precipitate action of the Metropolitan District Railway Co. is their first fulfilment. It is to be hoped that other British railway companies will take heed from the misfortunes of that company, and will not, like them, turn a deaf ear to the claims of electric traction until it is almost too late.

Almost, if not quite, too late. We are by no means certain that the psychological moment is not gone by, and that the creation of the Central London Railway has not introduced new conditions that even the best electrical equipment in the world will not entirely nullify. Had the Inner Circle been converted to electric traction before the Central London Railway Co. obtained powers to construct its rival line, there would have been a stronger ground for opposing the granting of those powers, and possibly Parliament would have refused to grant them. Moreover, had the Inner Circle been thus equipped, its much enhanced popularity would have told seriously against subscription of capital for the new venture, even when powers had been granted. We will not go so far as to assert that the "Twopenny Tube" would never have come into existence; but we do believe that its advent might have been retarded for several years. Now that the "Tube" is an accomplished fact, it offers to a large section of the former patrons of the Inner Circle a much more direct route between home and business, and it would be foolish to suppose that electric traction will tempt these back to their abandoned route. In fact, the topographical advantages of the "Tube" are almost if not quite as readily appreciated by the travelling public as are the comforts attendant upon its electrical equipment. Nevertheless, there is room in London for both railways, and if the reconstruction of the Inner Circle and its rolling stock is promptly effected in a liberal and enlightened manner, according to the best modern practice, we believe and hope that it will receive a new lease of life.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Torsional Magnetostriction.*—In 1885 Kirchhoff published his remarkable research on the effect of stress upon magnetisation. This is the most comprehensive treatment which the problem has received, and it agrees in its applications with the deductions of Lorberg and of Korteweg for the analogous case of electrostriction. Maxwell's original stresses refer to a medium without structure. Helmholtz makes the stresses in the electric or the magnetic field depend on changes of density in the medium, while Kirchhoff's stresses allow for a dependence both on bulk and on elongation, and thus involve three constants, viz., permeability, bulk expansion, and elongation. The experiments of Nagaoka and Honda show an imperfect agreement with theory both for iron and for nickel. C. Barus has, therefore, devised a statistical treatment of the subject, such as was suggested for viscosity by Maxwell. He illustrates his theory by means of a model consisting of two circular plates joined by a number of elastic bands, and held apart by a rod pivoted at the centres of both. He finds that the effect of longitudinal magnetisation is an increment of rigidity in all paramagnetic metals, whereas the permanent effect of a transverse or a circular field is relatively inappreciable so far as rigidity is concerned.

[C. BARUS, *Am. Journ. of Science*, December, 1900.]

*Remanent Magnetism.*—The magnetisation remaining after the magnetising force has been removed has been already studied in a variety of specimens and shapes. P. Holitscher has studied the same matter in one and the same iron ellipsoid, with especial reference to the duration of magnetisation and to the number of magnetic impulses applied He finds that the remanent magnetic moment is distinctly dependent upon the time during which the magnetising force is applied. It takes from one minute to three minutes to have its full effect in the case of fields varying from one unit to six units. This is all the more strange as the temporary magnetisation is practically independent of the duration of magnetisation. When the direction of the field is kept constant, successive impulses increase the remanent magnetism, the increase becoming slow after the first 10 impulses, but continuing to be perceptible until some 100 impulses have been given. On the other hand, when opposite magnetisations are induced in succession, the remanent magnetism remains sensibly the same. During the first few impulses there is some variation, but that is probably due to incomplete previous demagnetisation, and steady values are always obtained after the first six reversals.

[P. HOLITSCHER, *Ann. Physik*, No. 12, 1900.]

*Air Ionised by Röntgen Rays.*—E. Villari has made a careful study of the manner in which *aria ixata* is discharged, and how the discharging bodies take up the charge. He finds that bent tubes absorb the charge more quickly than straight tubes, whether they consist of copper, lead, glass, or indiarubber. A tube of flexible copper 8in. or more in length and 1cm in diameter, twisted into 8 or 10 turns, and well insulated by paraffin and a glass tube, charges itself to a potential of some 80 volts when traversed by ionised air. Similar charges, though not quite so high, may be obtained by sending the Röntgenised air through "filters" of fine brass wire gauze contained in brass tubes. Even when the gauze is not very fine, several pieces superimposed and mounted in glass tubes take charges of from 15 to 20 volts, Under similar circumstances, however, metallic films take a corresponding negative charge. This was observed in the case of copper, iron, zinc, brass, platinum, aluminium, and tin. The author is led to the conclusion that the same metal will require a negative or a positive charge accordingly as it is struck forcibly or softly by the ionised air. A negative charge may be converted into a positive charge by simply lengthening the tube.

[E. VILLARI, *Nuovo Cimento*, August, 1900.]

*Pressure and Temperature in the Electric Spark.*—E. Haschek has supplemented his own and Mache's experimental work on the pressure and temperature within the electric spark by a theoretical treatment based upon the conceptions of Schuster. It is supposed that at the beginning of the discharge certain minute particles, whether of air or of electrode material, are projected with a great velocity from both electrodes. Their initial velocity between zinc poles would be about 8,000m. per sec., but owing to the resistance of the gas traversed, this velocity would fall to about 400m. per sec. by the time the particles are 4mm. away from the electrodes. The collisions which bring about this retardation also produce a rise of temperature, and the retardation itself produces an accumulation of particles which gives rise to an increase of pressure. Both pressure and temperature show a strictly corresponding distribution. With five large Leyden jars and a spark-gap of 8mm. the maximum temperature would be some 1,000deg. in the centre, and the maximum pressure would amount to some 28 atmospheres. This is of the same order as the pressure determined experimentally.

[E. HASCHEK, *Ann. Physik*, No. 12, 1900.]

## CONNECTIONS TO ELECTRICITY SUPPLY WORKS.

According to our annual custom, we publish a series of diagrams showing the extent of the connections to electricity supply works in the United Kingdom. The figures are compiled from the large table presented as a supplement with this week's issue. In the case of the London stations, traction and other applications of electric motors still form an almost insignificant proportion of the whole load, but several large provincial stations now supply electrical energy both for lighting and tramways, and the effect of the tramways motor load is already noticeable in the diagrams below. Except in diagram 1, therefore, an even scale of kilowatts has been adopted this year instead of a scale based on the power taken by the 8 c.p. lamp as a unit.

An important alteration is noticeable in diagram 2. While electricity supply in the provinces has increased in popularity at a greater rate than ever before, the total of lamp connections in London, although still growing rapidly, has not maintained last year's rate of increase. However, as the additional connections in London have amounted to over 10,000kw., there is no cause for alarm, especially as the enormous increase in the provinces much more than compensates the London figures. Thus the grand total for London and provinces is nearly 800,000kw., or about 10 million 8 c.p. lamps—more than 3 million greater than last year, the increase in 1899 and 1898 having been 1½ mil-

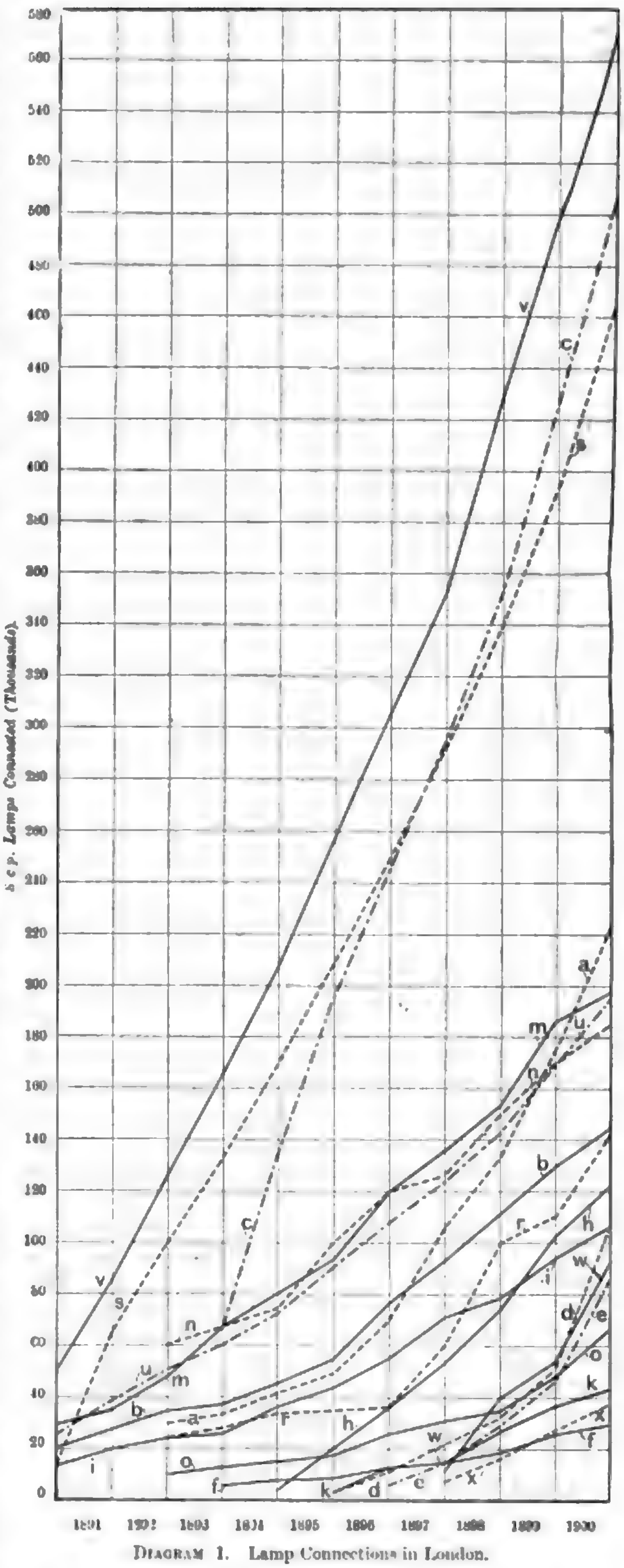


DIAGRAM 1. Lamp Connections in London.

a Charing Cross Co.
b Chelsea Co.
c City of London Co.
d County of London and Brush Provincial Co. (Clerkenwell).
e County of London and Brush Provincial Co. (Wandsworth).
f Crystal Palace Co.
h Hampstead Borough Council.
i Brompton and Kensington Co.
k Islington Borough Council.
m Kensington & Knightsbridge Co.
n London Electric Supply Corporation.
o Notting Hill Co.
r St. Pancras Borough Council.
s Westminster Electric Supply Corporation.
u St. James' and Pall Mall Co.
v Metropolitan Co.
w Shoreditch Borough Council
x Hammersmith Bor.' Council.

14. Seating Capacity of Cars.
15. Weight on Driving Wheels of Cars.
16. Method of Coupling Motors to Axles.
17. Number of Motors on each Car or Locomotive.
18. H.P. of each Motor.
19. Drawbar Pull in lbs. of Motor Car.
20. Method of Controlling Motors.
21. Type and Number (per car) of Brakes.
22. Number and Position of Power Houses.
23. Type, Number and H.P. of Boilers.
24. Type, Number and H.P. of Engines.
25. Type, Number and Capacity in kilowatts) of Dynamos.
26. Method of Coupling Engines to Dynamos.
27. Number and Capacity of Boosters.
28. Details of Power House Equipment.
29. Type, Size and Number of Batteries.

h make the information and data nical uses.

TIONS BY LOCAL AUTHORITIES.
lations for.
ND REGULATIONS RELATING TO
IETER TESTING.
LASH AND SEARCH LIGHTS.
TIONS.
LECTRIC LAMPS, &c.
OPTED SYSTEMS OF CHARGING
ES, AND LAMP CONNECTION
OF ELECTRIC INSTALLATIONS.
PREVENTION OF FIRE ARISING
S (BRITISH AND FOREIGN).
AND LIGHT RAILWAY ORDERS
ACTION AND LIGHT RAILWAY

# DIRECTORY

**BRITISH, COLONIAL, AND FOREIGN GOVERNMENT DEPARTMENTS: CHIEF OFFICIALS.**

These lists of the principal British, Colonial, and Foreign Government Departments, with the chief officials in any way connected with Telegraphy, Telephony, Electric Lighting and Tramways, &c., have been revised by the various Departments and brought up to date.

An Official List of the Representatives of Foreign Countries to Great Britain, Consuls and Consulate Offices, and Agents General, &c., of the Colonies, is also given.

**LOCAL AUTHORITIES.**

This list includes the names of the chief officials of every important local authority in Great Britain, the populations, and the price of gas to private consumers and for public purposes; whilst it can be seen at a glance whether the Board of Trade have granted a Provisional Order (to the local authority or a company) for any locality, if so, in what year, and whether the gas works are the property of the local authority or of a private company. These tables have been compiled with the view of assisting Manufacturers and Dealers in Electric Light and Power Plant and Apparatus, &c., to introduce their Supplies to municipal authorities all over the country. A list is also given of the names and addresses of Chairmen of the Electric Lighting and Tramway Committees of the Local Authorities of the country.

**SCIENTIFIC AND OTHER INSTITUTIONS**—Full particulars relating to.

**TRADE SOCIETIES**—Full particulars relating to.

**UNIVERSITIES, COLLEGES, SCHOOLS, AND TECHNICAL INSTITUTIONS.**—Full list and particulars.

*ter, most of which is specially prepared for the "Big Blue Book," and which goes to make t. reference in the English language.*

, PRINTING AND PUBLISHING OFFICES,

**URT, FLEET STREET, LON**

**SUPPLEMENT T**

**JANU**

## *Copyright*

| — | Name of Town o (Figures in bracke estimated popu |
|---|---|
| 1 | **Aberdeen** .. [150,000] |
| 2 | **Aberystwith** [8,725] |
| 3 | **Alderley Edg** [2,470] |
| 4 | **Altrincham** .. [12,424] |
| 5 | **Ashton-unde** [45,000] |
| 6 | **Ayr** .......... [28,000] |
| 7 | **Bangor**........ [11,000] |
| 8 | **Barnsley** ..... [35,427] |
| 9 | **Barrow-in-Fu** [60,871] |
| 10 | **Bath** ........... [52,600] |
| 11 | **Bedford** ....... [35,500] |
| 12 | **Belfast** ........ [380,000] |
| 13 | **Bexhill** ...... [5,089] |
| 14 | **Birkenhead**... [115,164] |
| 15 | **Birmingham** [514,956] |
| 16 | **Blackburn** ... [137,000] |
| 17 | **Blackpool** ... [18,000] |
| 18 | **Bolton** ......... [162,000] |
| 19 | **Bootle** ......... [53,544] |
| 20 | **Bournemouth, and Christc** |
| 21 | **Bradford** ...... [288,402] |
| 22 | **Bray (Ireland** [8,000] |
| 23 | **Brighouse** ... [20,005] |
| 24 | **Brighton** ...... [124,000] |
| 25 | **Bristol** ......... [325,000] |
| 26 | **Buckingham** [3,400] |
| 27 | **Burnley** ....... [104,000] |
| 28 | **Burton-on-Tre** [58,000] |
| 29 | **Bury** ........... |

# 1900–1901.

**PUBLISHED ANNUALLY SINCE 1889.**

| METERS. | PRICE PER UNIT. Small figs. (1) indicate first hour, (2) first two hours, &c. Lighting. | Power. | TARIFF SYSTEM. W. indicates the Wright system of charging. D. indicates Discounts. | Price of Gas in District. | Gasworks owned by. L.A. = Local Auth. Co. = Company. | | REMARKS. |
|---|---|---|---|---|---|---|---|
| Ferranti and Thomson | 6d.(1)—3d. | 3d. & 1d. | W. | 3/2 | L.A. | 1 | Newton forced draught. Hand stoking. Worthington feed-pumps. Duplicate feed ranges. Current supplied for traction. Motors heating and cooking apparatus hired, and lamps sold. |
| Hookham & Thomson | 6d. | ... | ... | 3/6 | Co. | 2 | Steam draught. Hand stoking. Worthington pump and injectors. Town water supply. Alternators not paralleled. |
| Hookham, Watson, Thomson, and Longhattner prepay. | 7d.(1)—4d. | ... | W. | 2/11 | Co. | 3 | Berryman feed water heater. Worthingham feed pumps. Hand stoking. 4s. per quarter charged for consumers' meters &c. |
| Hookham, Shallenberger and Thomson | 6d. | ... | ... | 2/10 to 3/4 | Co. | 4 | Induced draught (Sturtevant) fan on trial. Two additional Lanc. boilers being erected. |
| Hookham ... | 4½d. | Not decided | ... | 2/4 | Co. | 5 | Refuse destructors in addition. 300 H.P. to be supplied for tramways. 320 tube Green economiser. Natural draught. Hand stoking. Motor-driven three-throw pump and Holden and Brooke injector. Jackson 15-kilowatt motor generator, for small lighting or traction loads. |
| Hookham and Thomson | 5d. | 3d. | ... | 3/9 | 2 Co.'s | 6 | 96-tube Green economiser. Natural draught. Vicars stokers. Worthington horizontal feed pumps. Alternators paralleled. Free or municipal wiring just adopted. |
| ... | 5d. | 2½d. | Not yet in use | 3/6 | L.A. | 7 | Meldrum forced draught. Hand stoking. Duplicate Weir feed-pumps working through exhaust steam heater, and 96 tube Green economiser. Berryman feed-water heaters. Meldrum refuse destructor. No traction. Free wiring by Co. |
| Hookham ... | 7d.(1)—2d. | 1½d. | W. | 2/10 to 2/4 [illegible] for cash | Co. | 8 | Royle exhaust steam feed heater. 192-tube Green economiser. Vicars stokers. Worthington feed pumps. Town water. Boosters, 130 amp. at 95 volts. One 300 kw. Willans-Peebles set on order. Motors on hire. |
| Ferranti and Hookham | 6d.(1)—3d. | 3d.(1)—1½d. | W. | 2/6 | L.A. | 9 | 168-tube Green economiser. Natural draught. Hand stoking. Two 3-throw B. & W. steam-driven feed pumps and one injector. |
| Hookham and Shallenberger | 4½d. | 3d. | D. | 2/8 to 2/4 | Co. | 10 | No economisers. Natural draught. Hand stoking. Alternators not paralleled. Street lamps are alternating arcs. Eighty additional arcs now being installed. |
| Hookham and Shallenberger | 4½d. | 3d. | D. | 2/10 | Co. | 11 | Green economisers. Natural draught. Mechanical (Vicars) & hand stoking. Worthington & Weir feed pumps. Water from river. |
| Ferranti and Hookham | 6d. (1)—2d. | 3d.(1)-1½d. | W. | 2/3 less discounts to 1/9 | L.A. | 12 | 8—Gas-engine sub-station. 96-tube Green econr. Steam blast, forced draught under bars. Proctor & Bennis stokers on Lancs. Chain grate on B. & W. Duplex steam feed pumps and 3-throw electric. Boosters 100amps at 0 to 120 volts. Free wiring. Motors on hire. |
| Hookham & Thomson; Reason prepayment | 7d. & 3d. | 3d. under 6 H.P. 2½d. over 6 H.P. | W. | 4/9 | Co. | 13 | No economiser. Natural draught. Hand firing. Two Smith and Vaile pumps. Two feed mains. Town water. No traction. Superheaters. Exhaust steam feed water heater. Condensing plant about to be erected. Well sunk at station for feed and condensing purposes. Free wiring to be adopted. |
| Ferranti ... | 6d.(1)—3d.(2)—1½d. | 4d.(1)—3d.(2)—1½d. | W. | 3/2 | L.A. | 14 | 324-tube Green economiser. Natural draught. Vicars stokers. Worthington feed pumps and injector. Separate traction stations in progress. |
| Hookham and Ferranti | 7d. to 4½d. | 4d. to 2d. | ... | 2/7 | L.A. | 15 | ...... |
| Aron, Bastian, Ferranti, Hookham and Thomson | 6d.(1)—3d. | 2½d. & 1½d. | W. | 3/0 | L.A. | 16 | 288-tube and 192 tube Green economiser. Meldrum forced draught on two boilers. Proctor stokers. Two steam pumps; one electric 3 throw. Alternators paralleled. 90kw motor alternator. Traction. Motors and arcs on hire and maintained. |
| Shallenberger, Thomson, & Aron | 7d.(1)—2d. Churches 5d. | Tramw'ys 2d. Private 2½d. | W. | 2/4 | L.A. | 17 | From same station 500 H.P. at 500v. cont. by separate plant to local tramway. Plant capacity column inclus. of tram plant. Further ext. of 1,200 kw. now in progress. 480-tube Green econ'r. Wilton's induced draught. Hand firing and mechanical stokers. Mumford feed pumps and injectors. Alternators par. Cowans boosters and balancers. Accumulators as stand-by for exciting, and to run motor-alters at light loads. 288-tube Green economiser. Meldrum and Bennis stokers. Worthington and electric feed pumps. Alternators paralleled. 112 kw. positive and negative booster. About 30 miles of tramways, requiring 1,500 H.P. |
| Ferranti, Hookham, Shallenberger and Thomson | 6d.(1)—3d. or 5d. all r'd. | 5d.(1)—1d. traction 1½d. | W. & D. | 2/6 | L.A. | 18 | |
| Hookham ... | 5d.(1)—3d. | £1. per H.P. per quarter, 1d. per unit or 5d.(1)—1½d. | W. | 2/9 | Co. | 19 | 192-tube Green economiser. Natural draught. Bennis mechanical stokers. Worthington feed pumps. Parker boosters. An "Easy" wiring system adopted. Traction commenced May, 1900. |
| Thomson and Aron | 7d.(1½)—3½d. | 4d. | W. | 3/4 | Co. | 20 | Two 120-tube Green econ'rs. Sturtevant induced draught. Hand stoking. Super'hrs. Water soft'rs. 3-throw pumps g red to high-sp'd eng's. Hire-purchase wiring financed by the Co. Cont. cur. plant to supply tramways |
| Aron, Bastian, Ferranti, Hookham and Thomson | 4½d. | 2d. & 1d. | 2½% dis. within 2 months | 2/6 | L.A. | 21 | Two stations. Free lamps. 240-tube Green econs. Marine boilers induced draught, Lancs. natural. Hand stoking. Water-tube mech. me stoking. Electric and steam-driven feed pumps. Current supplied for traction. |
| Hookham and Shallenberger | 6d.(1½)—3½d. | 6d.(1½)—3½d. | W. | 4/6 | Co. | 22 | Alternators run on separate circuits. Hand stoking. Green economisers. Natural draught. |
| Bastian, Ferranti and Hookham | 6d. | 5d. | ... | 2/9 | L.A. | 23 | ...... |
| Ferranti, Reason and Thomson | 7d.(1)—1d. | 7d.(1)—1d. | W. | 3/3 | Co. | 24 | 288-tube and 300-tube Green economisers. Natural draught. Steam and electrical feed-pumps. Current supplied for traction. Alternating current supply discontinued since introduction of 440-volt 3-wire system |
| Shallenberger, Thomson, Aron, and Hummel | 5d. (3½d. day) | 1½d. | D. up to 25% | 2/3 | Co. | 25 | Mechanical stokers. Arcs run in 20 circs of 12 lamps. Two 196 tube Green econ. Meldrum furnaces 2 boilers. Remainder natural. B. & W. chain grate. 2 duplex steam and two 3-throw motor driven pumps. Duplex feed pipes. Alternators paralleled. No traction. Three steam-driven exciters. |
| Ferranti, Hookham & Schattner | 8d. | ... | ... | 5/0 | Co. | 26 | Street lighting, 25 and 32 c.p. incan. lamps. No econs. Nat. draught. Hand stoking. Inject. feed. River water. |
| Ferranti, Hookham & Thomson | 6d., or 2d. + £8 per ann. per kw. demanded | 2d. for 48 hrs. week, 3d. if under | W. | 2/6 | L.A. | 27 | Charge for gas also subject to discount. Green economiser. Proctor and Leache stokers. Natural draught. Bailey feed pumps and Parker motor-driven pumps. River water. |
| Shallenberger & Hookham | 6d. and 3d. | 2½d. | W. | 2/10 to 3/0 | L.A. | 28 | Green economisers. Perret furnaces. Hand stoking. Pearn feed pumps. River water. Alternators parallel. Free wiring. |

lion and 1½ million respectively. It should be added that, for the purpose of these figures, only the actual metropolitan supply undertakings are included in London; the various neighbouring boroughs and urban districts have been considered as provincial. The new London Government Act (1899) may be taken to define the boundary.

Turning to diagram 1, it is seen that the Metropolitan Company and the City Company still lead the way in London

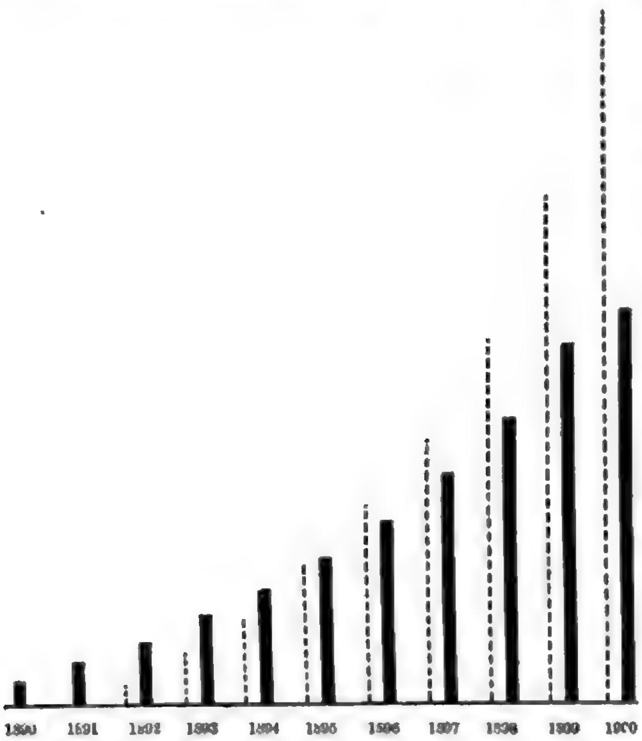


DIAGRAM 2.—Connections to Electricity Supply Mains in London and Provinces.
London (————————). Provinces (- - - - - - - - - -).
Scale: 1in. = 50,000 kilowatts.

so far as lamp connections are concerned, the latter undertaking in spite of the competition which it will soon have to undergo with the Charing Cross and Strand Company. The Westminster Company is a good third in point of lamp connections, and in its case the number of additional lamps connected during the year is greater than in any previous years, while the City and Charing Cross Companies maintain

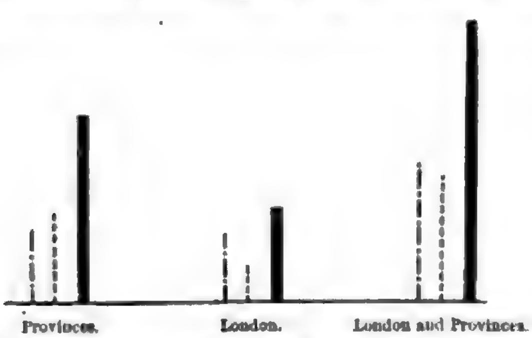


DIAGRAM 3.—Connections to Continuous and Alternating Current Stations.
Alternate current (— — — — —). Continuous current (——————).
Alternate and Continuous (—· —· —· —).
Scale: 1in. = 100,000 kilowatts.

about the same rate of increase as last year. The cause of the decrease in the total number of lamps added during the year is, therefore, to be sought among the lower bunch of curves, and it is seen that Kensington and Knightsbridge, Hampstead, Islington, and the Crystal Palace Companies all show distinct signs of bending over. We trust that this is only a temporary phase, as in the case of St. Pancras last year. The disastrous fire early in the year at the Maiden Lane station of the Charing Cross Company seems to have made no difference to its capacity of acquiring new consumers, and its curve of connections is rising rapidly. The addition of the City area will no doubt have a further stimulating effect.

Diagram 3, when compared with the corresponding diagram published last year and in previous years, shows that continuous current distribution is steadily superseding single-phase alternating. Where the latter system has been retained, moreover, it has to a large extent been supplemented by continuous current distribution, and thus there is a further increase in the number of stations supplying both continuous and alternating currents. This year the figure representing provincial companies has not decreased as it actually did last year, but its increase is slight compared with the enormous growth both in number and size of municipally-

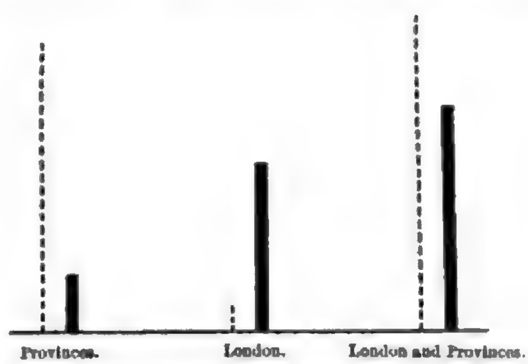


DIAGRAM 4.—Municipal and Company Connections.
Municipal (— — — — — — — —). Company (——————————).
Scale: 1in. = 100,000 kilowatts.

controlled provincial undertakings. This is set forth in diagram 4. Diagrams 3 and 4 are drawn to a smaller scale than diagram 3.

To complete these data, we give below in tabular form the figures from which the diagrams have been plotted:—

**Table I.**—*Details of Connections in London and Provinces.*

| | | | |
|---|---|---|---|
| LONDON (105,400kw.) | Municipal (14,200kw.) | — | 8,000kw. |
| | | ∽ | 6.200kw. |
| | | ≂ | none. |
| | Companies (91,200kw.) | — | 41,600kw. |
| | | ∽ | 13,400kw. |
| | | ≂ | 36,200kw. |
| PROVINCES (186,700kw.) | Municipal (155,700kw.) | — | 85,100kw. |
| | | ∽ | 42,700kw. |
| | | ≂ | 27,900kw. |
| | Companies (31,000kw.) | — | 15,200kw. |
| | | ∽ | 5,700kw. |
| | | ≂ | 10,100kw. |

**Table II.**—*Connections to Alternating and Continuous-Current Stations.*

| — | ≂ | ∽ | — | Totals. |
|---|---|---|---|---|
| London ......... | 36,200kw. | 19,600kw. | 49,600kw. | 105,400kw. |
| Provinces.... ... | 38,000kw. | 48,400kw. | 100,300kw. | 186,700kw. |
| Totals ...... | 74,200kw. | 68,000kw. | 149,900kw. | 292,100kw. |

**Table III.**—*Municipal and Company Connections.*

| — | Municipal. | Company. | Totals. |
|---|---|---|---|
| London ............ | 14,200kw. | 91,200kw. | 105,400kw. |
| Provinces ...... ... | 155,700kw. | 31,000kw. | 186,700kw. |
| Totals ...... | 169,900kw. | 122,200kw. | 292,100kw. |

## PRACTICAL NOTES ON WATER POWER FOR ELECTRICAL PURPOSES.*

BY F. R. YORKE.

The utilisation of water power is one of the most interesting subjects with which an engineer can have to deal, and to electrical engineers especially it appeals very strongly. There exists a great similarity between the laws governing the use of water and those governing the use of electricity. Lord Kelvin, in describing and explaining electric phenomena when referring to this similarity, has termed it the "Hydraulic Analogue," and the analogy crops up frequently in various ways. Water power is also interesting from the fact that no two schemes for its development are exactly the same. Every scheme, therefore, must be carefully considered on it own merits, as the local conditions themselves vary so greatly. At one time it may be the utilisation of a large river with only a few feet fall, and another time a small burn with a fall of several hundreds of feet. With such a great difference in water-power problems it is obvious that the methods of developing them must also differ. It need hardly be said that in order to obtain the best results, it is of the utmost importance to provide the right plant to suit each particular locality. It is impossible in the space allotted to this Paper to go into the whole question of the utilisation of water power, embracing as that would do the construction of dams, reservoirs, and the construction of all the various types of turbines, &c. So it is proposed, therefore, only to discuss some of the principal types of plant used in this country, and to indicate the particular conditions for which they are most suited; and also to deal with some practical details which experience has shown to be useful, and concerning which information is not readily obtained from ordinary sources.

*Water Wheels.*—Before the advent of the turbine the water wheel was the recognised method of obtaining power, and there are still a great number of these scattered over the country driving mills, saw benches, &c. For electric lighting and power, however, unless the local conditions are extremely favourable, water wheels labour under many disadvantages, where continuous running at all times and seasons is a necessity. In the first place their use is limited to moderate falls, and in flood time, unless a considerable drop is allowed in the tail race, the wheel becomes drowned. In heavy frosts also the wheel is liable to become stopped through ice. The speed of a water wheel is also very slow, and considerable gearing is required before the dynamo can be driven at the required number of revolutions. Still, where it is desired to utilise existing water-wheels, they may, by taking the necessary precautions, do good work. The author has found that many water-wheels in this country are run at too high a speed, and by changing the gearing increased power and efficiency have resulted. The author has, however, at present two installations worked by means of water-wheels. In one case the electric light is only required during the summer and autumn; and in the other case there is a lake 15 miles long at the back of the river, so that there is always a large and certain supply of water at all times of the year.

*Turbines.*—There is no single or universal type of turbine which is applicable to all and every form of water-power. Each one has to be designed for its own particular purpose. They may be distinguished under two principal classes: first, "Impulse" wheels, and secondly, "Pressure" or reaction wheels. For high falls, say over 200 feet, wheels of the "Impulse" type are the most advantageous. The best known in this country are the Girard and Pelton wheel type. The Girard is especially applicable where the power has to be varied, as the efficiency is high for small loads, and also when the supply of water is variable it can be utilised to the best effect. The Pelton wheel is the simplest and cheapest form of turbine there is, and where the supply of water is regular and the load constant, such as when charging accumulators, this type gives excellent results. I have sometimes employed two wheels on one shaft, each wheel being fitted with a separate nozzle. With these forms of impulse wheels, the effect of suction below the turbine cannot be utilised, as the wheels must run perfectly free. However, as they are only used on high falls, the few feet lost in this way are of no great consequence. For medium falls, below 200ft. and above 50ft., the author's experience has chiefly been with reaction wheels of the "Vortex" type invented by Prof. James Thomson. One of the very first that was made is in use at the present time, working under 80ft. head. Its age must be at least 42 years, so that it has done well. With this type on a good fall it can generally be managed that the speed of turbine and dynamo can be arranged to coincide, so as to admit of direct coupling. One advantage of the Vortex turbine is that the wheel is balanced. The water entering the circumference of the wheel divides into two and escapes at either side of the centre. This necessitates two suction pipes, but where the length of suction pipe is long the two pipes may be led into one by means of a Y piece. If the fall is under 50ft. turbines of the "reaction" type, such as the "Vortex" or such as the "Waverley" type, may be employed. In the former the speed will be slower, and belting or gearing will have to be used. With the latter (the Waverley) the speed is much higher, owing to the small diameter of the wheel, which is constructed on the principle known as that of "mixed flow." It is, therefore, possible by using this form of turbine to couple the dynamo and turbine together, even in the case of comparatively low falls. On the other hand, this type of turbine can only be used with advantage when the head remains constant. Should this vary from floods or any other cause, the speed of the turbine is at once reduced. When it is important to maintain the speed constant under varying conditions of supply and head the "Jonval" type of turbine is the one recommended. In this case the flow of water through the turbine is parallel with the axis, and considerable variation in the speed can be permitted without greatly affecting the efficiency. This form of turbine has already been adequately described by Mr. A. Steiger in a Paper read before the Institute some four years ago; and I will, therefore, only say that the Swiss engineers have achieved some remarkable results, in maintaining the constancy of the speed under greatly varying conditions. At Chevres, for instance, by fixing two turbines on the same shaft and constructing the wheels in the form of a cone, they have been able to maintain a constant speed of 80 rev., with as large a variation of head as 50 per cent.—viz., 20ft. in winter and 15ft. in summer. As a contrast to this the author recently had occasion to inspect an installation where turbines were working under a similar low fall. In slight floods, when the head was reduced only 10 per cent., the power available fell off very rapidly; and when it was reduced by 20 per cent. no power could be obtained at all. Such cases show it may happen that where water-power has been condemned for being unreliable, it is the engineering that is at fault and not the water-power.

*Suction.*—In every form of reactance wheel the suction principle can be employed. This is a most valuable property, as the turbine can be fixed well above flood level, although it is not advisable to exceed 25ft. The suction pipe or pipes are carried down into the suction well, sufficient depth of water being allowed below the bottom of the pipes, and the outlet to the tail race should be constructed so that the bottom of the pipe or pipes may always be submerged. As a rule suction pipes are carried vertically downwards; but in some cases it is not possible to do this without going to great expense. With regard to suction pipes the author has had some unique experiences which are worthy of notice. In many cases it would be extremely convenient to lay these pipes on the slope; but it is found in practice not to answer, as the vacuum under this condition cannot be maintained. The cause of this the author attributes to the dissolved air in the water being set free under the diminished pressure, and the bubbles of air rising to the top of the pipe on the slope, the air will gradually run up to the top of the pipe and accumulating there destroy the vacuum. The effect will be readily seen by opening, say, a bottle of soda water and holding it at the angle of 45deg. To meet this difficulty in practice, where a vertical pipe cannot be used directly under the turbine, the suction pipe or pipes must be taken out horizontally, *then* vertically downwards. It will be readily understood that the air bubbles in the horizontal part of the pipe cannot accumulate, as, when the turbine is working, the flow of water sweeps them onwards. The author has used this arrangement of suction pipes in several cases with success, and it has now been adopted by leading turbine manufacturers in this country.

*Lades.*—It is only in exceptional circumstances that the actual vertical fall of a river or stream can be obtained. As a rule it is a series of falls distributed over a considerable distance that have to be utilised. This necessitates the construction of a head, race, or lade, carried along on the contour till the desired difference of level between it and the river is obtained. In designing the lade the principal factors to be determined are the size and the gradient, so that the volume of water required may possess the requisite velocity. In practice the velocity should be as a rule from 2½ft. to 3ft. per second, which is sufficiently low to prevent scouring, and yet sufficiently high to prevent the water freezing too quickly in winter.

*Pipes.*—An important detail with regard to water-power work is the size of the pressure pipes to be used. This is the usual stumbling block with those who have not had much experience in water-power work, the tendency being to put down pipes of insufficient size. The quantity of water yielding power for a given fall is easily calculated, but the size of pipe is often taken from tables giving simply the free discharge of water. This table is useless where the water is required for power purposes, because not only is it necessary for a certain quantity of water to pass through the turbine, but there has to be a certain amount of pressure at the back of it. This pressure can only be maintained by allowing the water in the pipe to flow through comparatively slowly. With a turbine of a given size, if the pipe be too small the velocity of the water will become too great, and the result will be to set up friction producing a back pressure, which is equivalent to a reduction of the working head. There must be, of course, some amount of friction even

* Paper read before the Glasgow Section of the Institution of Electrical Engineers on Monday.

with a moderate velocity, but in practice, for small pipes, say up to 10in., the velocity should not exceed 2½ cubic feet per second. For large pipes, say 20in., the velocity may be, say, 5ft. to 6ft. per second, without involving too great a loss of pressure. The length of pipe, of course, must also be taken into consideration, and from tables the loss of head due to friction in the pipes can be calculated. The actual horse-power, of course, delivered by the turbine depends on the working head after the loss has been allowed for.

*Water Power.—Intakes.*—In utilising mountain streams it is necessary to make special provision at the intake. Perhaps at the first visit it may look extremely simple to build a small dam and take a pipe from it; but after heavy rain, or a spate produced by melting snow, these usually clear mountain streams become wild torrents carrying down sand, stone and other debris. If this sand is allowed to pass through the strainer into the pipe it will play havoc with the turbine wheel, cutting it to pieces in a very short time. To meet this difficulty a method which the author has adopted, and which works well, is what may be termed the "Level tank" system. A tank is constructed of stone or cement in the usual way, of sufficient size to receive the strainers, and it is built on a level with the dam across the burn. A large pipe protected by a coarse strainer is taken from the dam to the tank, and this latter must be at a sufficient distance from the burn in order to be out of the way of floods. By this arrangement only the quantity of water required for the turbine passes into the straining tank, the surplus which is not required continuing its usual course. The connecting pipe being very large, the velocity of water is too slow to allow of any sand or debris being washed along into the tank, and in this way the turbine is only fed with clean water. In addition to a water supply for power, this system has also been successfully adopted for purely domestic purposes. Water-power schemes may be divided under three headings: First, those which are obviously insufficient, or which it certainly would not pay to utilise; secondly, those which require careful estimating and consideration as to whether the outlay would be warranted; and, thirdly, those cases in which the local conditions are so extremely favourable that there is no question as to the advantage to be gained. It is the business of the engineer to discriminate between these varying conditions and advise accordingly. Only lately the author had to reject a most tempting water-power scheme on account of the heavy outlay which its utilisation would necessitate. When all is said and done the capital outlay to provide an efficient and reliable water power is practically the sole factor in determining its adoption. If the first cost is not too great, water as a source of power is superior to every other. From a mechanical point of view the movement is purely rotary, which is naturally more efficient and steady than the reciprocating action of a steam or gas engine. The attendance required is less, the cost of all fuel and cartage is saved, and the depreciation of pipes and turbines is certainly lower than with engines and boilers. No ugly chimney stacks are required, and the buildings altogether are of a much simpler character. There is also an entire absence of steam, noise, and smoke. On the Continent there may be seen rows of turbines of 800 H.P. to 1,000 H.P. working at full power in almost perfect silence. In this Paper the question of water-power governing has not been touched upon. In America, say at Niagara, and also in Switzerland, this difficult question has been most successfully tackled. In the author's own practice it has not been found necessary to use automatic regulation as with every turbine put down electric storage has invariably been employed; and under these circumstances a governor is not required; in fact, its absence is an advantage. The combination of an ungoverned turbine and dynamo with electric storage is a very strong and effective one. When the water is turned on at first the full charging current is obtained, but as the pressure in the cells rises, the current automatically decreases and when the cells are full this decrease is very marked indeed. The striking feature of water-power plant is its simplicity, and the great thing to do is to utilise this to the fullest extent by adopting automatic lubrication throughout, such as ring lubricators for the dynamo and turbine bearings, and water lubrication for the stuffing glands. It is then quite easy to arrange the plant to run day and night. The author has several installations where this continuous system is in vogue, and it is especially advantageous where the electric current is used for power purposes as well as electric lighting. The reason for this is that where electric motors are used for sawing or threshing, the power is frequently required early in the morning, but in ordinary circumstances this is just the time when the accumulator is at its lowest, and to take a heavy discharge from it under these conditions is disastrous. On the other hand, by charging at a low rate day and night by the morning the cells are fully charged, and heavy currents may be taken from them for motive purposes without damage. Also the regulation is simplified, the charging and discharging switches are put on the same contact and there they stop. Under these circumstances it becomes a matter of interest to enquire after the voltage, but as a matter of fact, working at a low rate in this manner, the variation is not found in practice to be great—perhaps a few more lamps per annum may have to be replaced. As far as the accumulator is concerned this is the most efficient way of working, and the lifetime of cells worked by water power under these conditions is distinctly longer than in the case where the current is kept constant. In those cases where steam or gas engines are employed, the author tries as far as possible to achieve the same conditions, by reducing the current as the charging progresses. The best results of all have been obtained when the accumulator cells have been charged with a current far below the list rates. In many cases the lifetime of the accumulator has been doubled by charging at half rate, and as the man in charge has not to be in constant attendance, in many cases it does not matter whether the cells take five hours or 10 hours per day to fill.

*General Remarks.*—In this country up to the present time there is not a single instance of water power being used on a large scale, such as is found abroad, for the purpose of electric generation and transmission. It must be recollected that the local conditions are not the same. On the Continent—for instance, in Switzerland—the price of fuel is very high indeed, ranging in many cases from £2 upwards. It therefore pays in these circumstances to utilise the water power at command to the fullest extent. There is no doubt whatever that the statement which we hear so frequently made concerning the enormous amount of water now running to waste in this country is perfectly true, but until its utilisation can be shown to pay from a commercial point of view, the water will remain unutilised. The tides also which ebb and flow in our rivers and estuaries will not be taken advantage of until it can be shown that the interest on the capital required for their utilisation is less than the cost of fuel required to generate the same power. The author's own feeling is that, as regards the development of water power on a large scale in the future it will be on the lines of electric generation and transmission to the nearest sea-board, where convenient sites for harbours and works can be obtained. A scheme of this kind has the advantage of offering cheap sites for works and power at a moderate cost, and in the most efficient form, and also that the raw material and finished products can be cheaply conveyed to and from the works. Water power, however, is extensively used in this country for private works and installations, such as driving mills, saw-benches, farm machinery, and other similar purposes, and also for driving dynamos for the supply of electric light and power. Of these latter applications, the author has had no inconsiderable experience, and in one district alone in the West of Scotland he has had 15 working with the most excellent results, some for 10 or 12 years. In these private installations it is of great advantage, when a sufficient supply of water has been obtained, to utilise it not only for electric lighting, but for other domestic purposes. In many cases a threshing mill or a saw-bench can be driven direct off the turbine itself, by fixing an extra pulley on the shaft, or it may be necessary to employ electric motors at a distance. The value of these subsidiary applications is often very great. To take a single instance: The proprietor of an estate of considerable size with plenty of timber (which only realised a small price when sold) was in the habit of buying finished wood for fencing and other estate purposes. However, a sawmill was built at a convenient site, some half a mile distant from the turbine, and provided with a motor of 15 H.P. to 20 H.P. The result is that now the whole of the timber of the estate is used for home purposes, and a cross-cut saw in a few days provides enough fire-logs for the winter's use. The saving effected by this arrangement is sufficient to pay for the interest on the cost of the whole installation, including the lighting of the mansion-house. The turbine in this case was 30 H.P., working under a head of 8ft. It is certainly remarkable at the present time to witness the many uses to which electricity is applied. As an example of the various applications of electricity, the author may mention those in connection with one of his recent installations: (1) Electric lighting, 200 lamps; (2) electric bells; (3) telephones connecting house, stables, and farm; (4) electric clocks, controlled by standard clock in hall; (5) electric heating by means of radiators; (6) electric cooking; (7) pumping water required for house and farm; (8) driving farm machinery, consisting of corn mill, turnip pulper, and chaff cutter. The two difficulties met with in water-power practice are—(1) during the autumn through leaves gathering on the strainer and stopping the flow of water to the turbine; and (2) snow and ice in winter. The first difficulty can best be dealt with by fixing strainers of very large size at the mouth of the pipe, so that frequent journeys by the attendant may be avoided; the second (snow and ice in winter) can only be dealt with by breaking up the ice in order to clear the lade, and providing for the disposal of the broken ice. At Fort William, for instance, where there is an exposed lade for three-quarters of a mile, it is necessary, as a rule, after two or three weeks prolonged frost, to engage an extra man to assist in keeping the lade clear. The lade at the lower end is broadened out to form a catch-pit, on the river side of which a long overflow is provided. There is a very steep fall from the overflow, and the broken ice is hauled out and over it by means of rakes. Sometimes it is also necessary to open the side sluice for the quicker disposal of the broken ice.

*Towns.*—There are many towns in Scotland where water power is available, which will be taken advantage of when the members of urban councils realise the economic advantages for electric lighting and power which lie at their door. If the present high price of fuel is maintained, the more marked will be the advantage to be derived from using water power. In conclusion, one further consideration may be submitted. Whether coal or water power is used, the power of both is obtained from the sun; but there is this distinction—in the case of coal the potential energy of the sun stored up in countless ages past is being utilised; whereas, in the case of water power, the energy of the sun exercised only yesterday in evaporating the water of the ocean is perhaps being used by us to-day for driving our turbines and dynamos.

## RECENT TESTS OF AMERICAN IRON AND STEEL.*

BY J. WALTER ESTERLINE AND ROBERT B. TREAT.

Marked improvements in the methods of electrical design and the wide range of variation of the magnetic quality of the material used in the construction of electrical machinery, have created a demand for definite, accurate knowledge concerning the quality of the iron and steel used. The magnetic properties must be known in order to closely predetermine the operation of a machine to be constructed; a point especially important in the design and construction of large, special machines built on guarantee contracts.

The fact that the product of different makers of commercial irons, as well as the output of the same manufacturer, varies greatly in its magnetic quality, makes it imperative that the builder of the machines make frequent tests in order to detect and exclude the poor grades of material. The authors have been, for several years, making tests of iron for manufacturers of machinery, foundries and rolling mills. In comparing the results of some of these tests, which were made on material coming from all parts of the country, a wide variation in magnetic quality was apparent and it was thought that perhaps a more extended and thorough series of tests, sufficient to give an accurate notion of this variation, might be interesting and profitable.

To this end, letters were addressed to nearly all of the important companies manufacturing electrical machinery in this country, requesting them to furnish samples of cast iron, cast steel, wrought iron, sheet iron and sheet steel they were using at that time. The response was more than liberal, and may perhaps be taken as a measure of the interest taken in this subject, some manufacturers sparing no pains and expense to furnish suitable specimens. Twenty companies sent more than one hundred samples of material, the preparing and testing of which was a task of a little greater proportions than was apprehended at the time of writing the letters.

The samples were all in the form of bars, and were tested in a special apparatus designed and made by the authors. Care was taken to exclude sources of error, and all the bars were tested under similar conditions. This is done in the tables, and the densities at different values of H, as well as the history of the iron, is given. The curves of cast iron, cast steel, and wrought iron were carried to a value of H = 150, which exceeds the limit reached in practice, but gives a better opportunity for comparison. The density in the teeth of armature cores being sometimes very high, it was deemed advisable to run the curves of sheet metal to a value of H = 450; this was done, but the curves only show the relation up to H = 150. The values of B for H = 450 are given in Table IV.

The samples coming from so many and such varied sources, little can be said of the physical treatment to which the material has been subjected, but where known it has been indicated in the tables.

Of 13 samples of cast iron tested, eight are tabulated; the cast iron curves show a wide variation throughout the useful range, but rather more uniformity at the higher values of B and H. The wrought-iron bars tested were few in number, but gave by far the greatest uniformity. By comparison with Tables II. and III. it is noticeable that in every case the wrought iron is more susceptible at the low values of magnetic force, but is excelled by cast steel at the higher values. The samples of cast steel shown in Table III. are representative, being the product of eight different furnaces. For H = 10, B varies from 6,400 gausses to 13,200 gausses, too great a difference when it is known that all these materials are made especially for the electrical trade. No. 26 in finishing appeared to be a superior piece of metal, being tough and uniform, but on being tested gave a very low curve at the start; from the data furnished by the maker this poor quality is supposedly due to an excess of sulphur. It serves to show that the metal which works the best in the lathe, and has apparently the finest structure, is not always the best magnetically.

No. 2 is known by the makers as "Semi-steel." The metal is very uniform, is tougher than cast iron, and more brittle than cast steel. At densities up to 4 kilo-gausses or 5 kilo-gausses it compares

* Abstract from the *Electrical World* of New York.

**Table I.**—*Cast Iron.*

| No. | B H = 10. | B H = 100. | Remarks. |
|---|---|---|---|
| 27 | 2,300 | 9,340 | Soft grey iron used in the field yokes of large alternators. |
| 18 | 2,100 | 8,880 | Ordinary scrap cast iron, a jet of steam forced in cupola before drawn. |
| 12 | 2,100 | 8,570 | Soft iron, large coarse crystals. |
| 39 | 4,200 | 9,450 | Curve very good for low values of B. |
| 47 | 4,800 | 9,180 | The best grade. |
| [illegible] | 3,800 | 9,250 | ...... |
| 46 | 4,000 | 9,600 | ...... |
| 1 | 4,360 | 9,380 | Soft grey iron, good quality. |

**Table II.**—*Wrought Iron.*

| No. | B H = 10. | B H = 100. | Remarks. |
|---|---|---|---|
| 25 | 13,200 | 17,320 | Common refined iron. |
| 5 | 12,550 | 17,300 | ...... |
| 40 | 12,800 | 17,000 | ...... |
| 37 | 13,200 | 17,450 | Sample cut from the forging of small motor field. |

**Table III.**—*Cast Steel.*

| No. | H = 10. | H = 100. | Remarks. |
|---|---|---|---|
| 41 | 13,200 | 17,500 | Unannealed "Dynamo steel," 0·12% car. |
| 38 | 12,600 | | Sample cut from pole casting. |
| 36 | 14,250 | 18,000 | Special "Dynamo steel," car. 0·11%, man. less than 0·05%, silicon 0·02%. |
| 35 | 12,100 | 18,300 | Curve by Ewing, metal same as No. 35. |
| 33 | 11,150 | 17,400 | Common machinery steel, car. 0·21%, man. 0·61%, silicon 0·2%, phosphorus 0·04%. |
| 26 | 6,400 | 17,550 | Metal rich in sulphur. Curve too low for low values of H. |
| 10 | 10,000 | 17,400 | Unannealed cast steel. |
| 4 | 10,000 | 17,000 | ...... |
| 21 | 11,600 | 17,700 | Open hearth steel. |
| 2 | 8,000 | 12,500 | "Semi-steel," quality very uniform, very good for low densities. |

**Table IV.**—*Laminated Metal.*

| No. | B H = 10. | B H = 100. | B H = 450. | Remarks. |
|---|---|---|---|---|
| 34 | 13,350 | 17,150 | 21,150 | Sheet steel, specimen annealed in air-tight compartment. |
| 23 | 12,150 | 16,850 | 20,850 | Same as 34, but unannealed. |
| 15 | 11,900 | 16,420 | 20,600 | Same as 23 and 34, but annealed in open air. |
| 9 | 13,400 | 17,650 | ... | Sheet steel unannealed. |
| 17 | 12,800 | 17,170 | ... | Same as No. 9, but annealed in open air. |
| 8 | 9,800 | 16,400 | ... | Same as Nos. 9 and 17. |
| 29 | 13,350 | 18,000 | 21,420 | Sheet steel unannealed, cut from armature punching. |
| 0 | 13,350 | 17,880 | 21,700 | Sheet steel annealed in open air fire. |
| 31 | 11,950 | 16,440 | 19,400 | Unannealed sheet steel. |
| 3 | 11,700 | 15,750 | 19,450 | Same as 31, but annealed in an air-tight compartment. |
| 44 | 12,500 | 17,000 | 20,600 | Same as 31, but annealed in open air fire. |
| 6 | 14,100 | 18,200 | 22,100 | The best specimen. Same as 29, but annealed in air tight compartment. |
| 22 | 14,000 | 17,840 | 21,550 | Unannealed. |
| 16 | 15,000 | 18,040 | 21,620 | Same as 22, but annealed in air-tight compartment. |
| 30 | 13,300 | 17,250 | 21,000 | Same as 16 and 22, but annealed in open air fire. |
| 45 | 12,800 | 17,100 | 20,800 | Transformer iron. |
| 24 | 10,800 | 15,260 | 19,300 | Sheet iron. |
| 11 | 12,700 | [illegible] | 20,850 | Sheet steel (same company). |
| 14 | 9,900 | 14,850 | 18,800 | Sheet iron ditto. |
| 7 | 11,200 | 16,400 | 19,900 | Sheet steel ditto. |
| 19 | 12,250 | 17,340 | 20,800 | Armature iron. |

favourably with the best wrought iron or cast steel tested. Although it has a lower saturation point than cast steel, unlike cast iron, it reaches that point in a finely-rounded curve, making it greatly superior to cast iron, and very well adapted to use in field frames and yokes where the density is usually low.

Some 40 samples of sheet iron and sheet steel were tested, and with widely varying results. In cases where a sufficient amount of one kind of metal was received, samples of it were treated in different ways, and then tested; in some cases, where only enough for one sample was furnished, this was tested as it came from the maker, then treated in a manner desired, and tested again. One mode of treatment was to place the metal in an open furnace for from 36 hours to 50 hours, no attempt being made to exclude the air

or to keep the iron at a constant temperature. In all cases but one this treatment produced to a greater or less degree, a diminution in the density for any given value of magnetising force. Other specimens were heated for an equivalent length of time in an air-tight compartment, not allowing the metal to come in contact with the combustible materials, and in all but one case the permeability was visibly increased. The best specimen tested was a sample of sheet steel which had been treated in this manner; it gave $B=14,100$ gausses at $H=10$, 18,200 gausses at $H=100$ and 22,100 gausses at $H=450$. The poorest piece was a sample of sheet iron in which $B=9,900$ at 10 gilberts, 14,850 at 100 and 18,800 at 450.

The variation of the quality of sheet metal proved to be no greater than was anticipated, but it is certainly beyond an allowable limit and shows the necessity of frequent tests to avoid the use of low grade iron. The curves on the best samples of each kind of material were run to a high value of H and are plotted separately to show the relative densities of the different forms of iron. The sheet steel gives the highest values throughout, and the cast steel curve crosses that of the wrought iron at $H$ = about 45.*

## CORRESPONDENCE.

### SUN SPOTS, MAGNETIC STORMS, COMETS' TAILS, ATMOSPHERIC ELECTRICITY, AND AURORÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting discussion of "Sun Spots, Magnetic Storms, Comets' Tails," &c., going on in your correspondence columns, by Prof. Rücker, Prof. Fitzgerald, and Dr. Lodge, brings to mind a talk given by me in January, 1894, before the Electrical Section of the Franklin Institute. The title was, "Thoughts on Cosmical Electricity." Concerning the electrification of the air, I quote:—

It is a legitimate thought, it appears to me, that the electrification may in large measure be due to influences outside of the earth itself. Let us assume a vast nebulous mass as having been the origin of the solar system by cooling and condensation according to the nebular theory, and if for any reason that nebulous mass have a small charge or be at a potential difference with respect to other gaseous masses in space, the diminution of surface during shrinkage would gradually increase the potential of the charge providing it could not escape through the surrounding ether. This charge would increase in potential until the finer particles on the outside of the mass were repelled outwards with a force equal to the centripetal tendency or gravity. A dispersion of such particles would ensue and result in a fall of potential. The dispersion and accumulation of charges would occur periodically while the hot mass of gas was shrinking, and the particles sent off would be condensed vapours, liquid or solid, forming a charged cosmic dust proceeding in a radial direction from the central mass, &c.

Again, concerning the improbability of direct induction between earth and sun:—

Now the distance between the sun and a planet such as the earth is so great that it is not probable that any considerable static inductional effect could exist between them even if they were at great differences of potential. On the other hand, electrified particles repelled periodically from the sun would reach the earth's atmosphere. It has been suggested that the coronal streamers seen during eclipses, particularly during the active or sun-spot period, may consist of electrified particles leaving the sun. If so their lack of visibility beyond a few diameters from the sun would not forbid the assumption being entertained as a rational one, that the streams may pass outward indefinitely until they encounter some obstacle like the earth. But auroral displays are frequent only when the solar activity is greatest, &c.

Further concerning auroras there appears:—

Can we not consider that, during an aurora, the earth is passing through a coronal stream and developing, as it were, a secondary aurora (corona?) either by directly encountering in space the electrified particles from the sun, or by induction from streams of such particles near the earth's course?

The probable influence of such streams on terrestrial magnetism was then mentioned, and a further brief statement in regard to the sun's action as a charged body followed, after which comes:—

During these actions the earth passes through or near to electrified streams, and an aurora, or earth corona, is developed.

After this are given considerations which go to show that auroral streams are frequently nearly radial to the earth, with observations of a magnificent aurora in April, 1883. With regard to the possible effects of the earth's magnetic field upon auroras it is said:—

Now, if a discharge is taking place under critical conditions in a high vacuum, the relation of its path and direction to a magnetic field in the vacuum may determine the continuance or cause a stoppage of the discharge, &c., or cause its deflection.

Brief reference is made in the Paper to the effect of the higher rays of the spectrum in causing electric discharges and the possible bearing of this fact on the case. As to comets' tails:—

Again, if the sun be a highly electrified body, may it not be possible that cometary masses may owe some of their illumination to redistribution of electricity as they approach towards or recede from the sun, or to encounter with electrified particles leaving the sun? Here, again, the radial direction of the comet's tail is suggestive.

This Paper, or talk, was given long before the electron theory was in existence. In my lecture on "Electricity at High Pressures," given before the New York Electrical Society, March 29, 1899, these views were further developed as follows:—

Auroral displays are shown to be probably dependent upon solar disturbances: an earthly coronal stream perhaps developing in response to some unusual coronal development on the sun or to some vast sun-spot disturbance. I am tempted to think that possibly the flame gases of the sun actually reach the upper atmosphere of the earth, and break down the insulation of the layers already under electric stress, or themselves bring electricity which disturbs the condition of our air. . . The earth may, in fact, be brushed by an invisible prolongation of a coronal streamer the effects of which acting like ionised gas, or flame gases, or gases through which an electric discharge has been passed, is to make the upper thin air conduct and relieve its accumulated electric stresses.

The possible like origin of comets' tails is again referred to. Some three years ago I suggested the possibility of invisible radiation, of the nature of cathode or Röntgen rays from the sun reaching the outer air, being prevented from reaching us by the absorptive power of the air, but I have not the reference at hand now.—Yours, &c., ELIHU THOMSON.

Lynn, Mass., Dec. 27.

### MAGNETIC OBSERVATIONS AND TRACTION DISTURBANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reading the discussions in regard to the tramcars putting an end to the magnetic observations at Greenwich, I have been expecting, from time to time, that the perfectly simple and obvious method of doing away with all interference due to electric railway currents which I am about to mention would be suggested. But no one seems to have done so, and I understand that there is really some danger that the invaluable records referred to will be necessarily discontinued, so I hasten to give the entirely simple and entirely sufficient remedy.

It is merely to use alternating current motors on the cars. This is the only practicable way. No system of earth returns, or compensating circuits, such as are used in some places in Germany, will do, for the reason that the direction of the earth currents changes with the variations in the conductivity of the ground, due to rain, damp weather (the effects are entirely different in these two cases, rain making the surface of the streets less conducting, dampness more conducting), &c. I have a considerable amount of data in regard to this, taken at my laboratory, but it is not necessary to go into details, and I would merely say that in dry weather the passage of a watering cart up the street has repeatedly changed the magnetic component appreciably.

But with alternating currents there will be no trouble. I understand that a very foolish regulation was passed some time ago, to the effect that alternating currents with earth returns should not be permitted. I say foolish because it was avowedly, if I remember, made in the interest of the telephone companies; but, as a matter of fact, one can always stop out alternating-current disturbances from a telephone with a proper condenser, but one can never stop out direct-current disturbances. This because the periodicity of an alternating current is definite, and we can make the admittance for that periodicity as low as we please, whilst the humming from a direct-current line depends upon the speed at which the motor is running and the number of commutator bars, and whilst the motor is accelerating, the periodicity of the disturbance passes

* [The authors, it will be observed, apply the name *gilbert* to the unit of magnetic field strength or magnetising force, and the name *gauss* to the unit of magnetic induction (per square centimetre).—ED. *E.*]

over a wide range of values, and so cannot be compensated. This I have repeatedly proved by experiment, and it is the reason why Messrs. Stanley and Kelly's method has not come into use —it only works when the periodicity does not vary much.

This regulation should be repealed at once, especially since, in any case, all telephone circuits should be metallic return, and it is easy, or at least not very difficult, to fix it so that there is no disturbance even without the use of condensers.

Supposing, however, that in your much too previously governed country this cannot be repealed within a reasonable time, then use single-phase motors of the condenser type designed by Mr. Steinmetz. These motors have the following advantages over direct-current motors (in common with, of course, all polyphase motors):—

1. Greater starting torque for a given percentage over full load current than direct current motors.
2. Greater efficiency at same percentage of full load.
3. No commutators to get out of order.
4. Much less liability of break down of insulation.
5. Make no magnetic disturbances which would affect observatory.
6. Any leakage effect on telephones can always be compensated by condensers, which is not possible with direct current motors.

There is, however, no reason why there should be any leakage if two trolleys are used. Two trolleys for direct-current lines have been used for many years in some of the large cities of the States with perfect success. The greater starting torque of polyphase motors over direct-current motors is a considerable advantage,* and hence they are rapidly coming into use on this side of the water for driving rolling mills, tube rolls, crane and elevator motors, &c. The reason they have not been used for street railways is because the street railway material is now standardised, and the slight gain in efficiency and up-keep which would ensue from the use of polyphase motors is not sufficient to warrant abandoning the millions of dollars of patterns, special jigs, &c., now in use. But for special cases, such as that of the Greenwich Observatory, there is no reason why single-phase two-trolley condensered or non-condensered motors should not be used.—Yours, &c.,

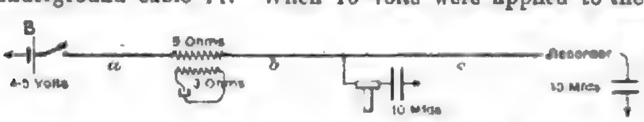
Rock Point, Md., Dec. 26. REGINALD A. FESSENDEN.

## A COMMON PHENOMENON IN CABLE WORK.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Acting on the suggestions contained in Mr. Barwell's extremely interesting article, published in your issue of Sept. 21, 1900 (Vol. XLV., p. 816), we have repeated some of his experiments, and have made a few others of which the following brief account may prove interesting.

Proceeding in the manner described by Mr. Barwell we could distinctly read signals in a telephone when sheathing wires were tapped together at a distance represented by a KR of 218—viz., artificial line 207, and nearly 2 knots of underground cable 11. When 15 volts were applied to the



sheathing of the same underground cable at its distant end we could read signals in the telephone when the KR was 18,000, the signals being still readable when all the sheathing wires but one of the underground cable were connected firmly through short thick copper wires to all the sheathing wires but one of a sea cable, the battery circuit being made and broken between the remaining two sheathing wires. The difference in potential of the two sheathings was not measured

In the following experiment the primary winding consisted of 90ft. of No. 24 cotton-covered copper wire wound round a solid iron bolt $4\frac{1}{2}$in. long, diameter [illegible]in., and the secondary winding of 270ft. of the same wire. A milammeter in the primary circuit indicated 660 milliamperes.

The KR of $a$ was 30,700, of $b$ 50,000, and of $c$ 136,400.

Large signals were obtained on the recorder from battery B of 4·5 volts, which might have been of much greater voltage and much nearer to the telephone without causing any sound in the same. The signals from the induction coil which were readable in the telephone were barely visible on the recorder.

I do not know whether quadruplex has ever been worked on this principle through submarine cables, though I am, of course, aware that for many years past telegraph instruments and telephones—the latter being used for speech—have been employed simultaneously on land lines. It is evident that ordinary telegraph instruments and telephones can be simultaneously worked telegraphically with perfect success, provided the KR of the telephone circuit is within the limit for Morse signals in the telephone, and provided, also, that the KR at each end of the telephone circuit is high enough to prevent any interference in the telephone instruments from induction coils and any sound in telephone from recorder battery.

I wish here to express my thanks to Mr. Barwell. It certainly never occurred to me that the telephone would indicate the existence of a splice at any considerable distance from the ship, though I have, of course, noticed the kicks during making of splice, also when men were walking on cable in tank, and when the sheathing of a taped cable came in direct contact with the iron cable drum, for instance. In picking up cable during heavy weather we once drew a splice at a distance of 0·215 knot of cable from the ship. For some time before the cable parted we observed very violent kicks on the Sullivan galvanometer, although the insulation was still perfect. Those kicks were puzzling then, but are now no longer so after reading Mr. Barwell's article.—Yours, &c.,

Peru, Dec. 2, 1900. HERBERT KINGSFORD.

# LEGAL INTELLIGENCE.

### Teague v Russell.

In the First Division of the Court of Session, Edinburgh, on Wednesday, this action was heard. The plaintiff, Mr. Francis Teague, burgh electrical engineer, Paisley, sued Dr. William Russell for £1,000 damages for slander. The defendant is a member of Paisley Town Council and one of the members of the Electric Lighting committee. Plaintiff alleged that at a meeting of the committee on Sept. 24, 1899, the defendant used language which represented that the pursuer was an agent for the sale of electric lamps, and obtained a royalty thereon, and that with a view to earning the royalty he refused to discharge his duty as a servant of the Town Council, and declined to furnish to an intending consumer an electric lighting installation unless the consumer agreed to purchase the lamps in which the pursuer was interested. The charge was denied by pursuer as a malicious invention. Defendant denied the slander and pleaded privilege. He averred that all that was said was uttered in the course of the business of the committee, and was entirely pertinent to the matter under consideration. He had no ill-will to the pursuer, nor had he any intention of slandering him. The jury, after 25 minutes' deliberation, returned a verdict for pursuer, and assessed damages at £100.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

London County Council require an electrical engineer to superintend, under the Council's chief engineer, the work of constructing or reconstructing for electric traction the Council's tramways, &c. Applications by Jan. 14.

The Council of the Borough of Reigate invites applications for the appointment of a resident electrical engineer, at a salary of £200 per annum. Applications have to be sent in to Mr. Clair J. Grece, town clerk, 136, Station-road, Redhill, Surrey, before noon of 17th inst.. An advertisement gives further particulars.

Glasgow Tramways Department require a first-class mechanical engineer to take charge of the steam plant and general oversight of the power station. An advertisement contains further particulars, and applications must be sent to the general manager (Mr. John Young), 88, Renfield-street, Glasgow, by 15th inst.

Manchester Electricity committee require an electrical engineer for their electricity undertaking. An advertisement contains further particulars. Applications (addressed to chairman) must be in by 19th inst.

* In making estimates for a large tube works some years ago, I found that the saving in cost of copper due to the smaller change in speed for given changes of torque was over $90,000, because the speed of tube rolls could only vary within certain limits and give good results.

Manchester Electricity committee also require a deputy electrical engineer. An advertisement contains further particulars, and applications (addressed to chairman) must be in by 19th inst.

Manchester Tramways committee require a chief engineer for the tramways department. Applications to chairman by Jan. 12.

West Ham Guardians require an expert to advise on the engineering work in connection with their new infirmary at Leytonstone. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. Fred. E. Hilleary), Union Workhouse Leytonstone, N.E., by 23rd inst.

Rotherham Corporation invite applications for the post of borough electrical engineer. Applications to town clerk by Jan. 14.

Burnley Corporation require a general manager for their tramways. Applications by Jan. 19.

The Governors of Sir John Cass's Technical Institute, Jewry-street, Aldgate, E.C., require a principal. Applications to clerk, 10A, Idol-lane, Eastcheap, E.C., by Jan. 26.

---

Mr. A. Doxey, hitherto chief electrician at the Sheffield electric lighting station, has been appointed chief assistant engineer and deputy manager to the Corporation electric supply department at a salary of £250 per annum.

Mr. A. P. Dryburgh has been appointed assistant engineer at the Great Grimsby electricity works. There were four candidates selected for interview by the Lighting committee—viz., Messrs. A. S. Channon (Barrow-in-Furness), A. P. Dryburgh (Doncaster), O. F. Francis (Bootle), and L. L. Foster (Newport, Mon.).

Mr. F. T. Hall, of Derby, has been appointed assistant engineer at the electricity works of the Hampstead (London) Borough Council.

Mr. John Wallis, of York, has been appointed mains foreman by the Bermondsey (London) Borough Council.

---

**A.S.E.**—The Amalgamated Society of Engineers has reached its 50th anniversary (Jan. 6, 1851). According to a statement of the secretary, at the date of the amalgamation in 1851 of a number of small engineering trades unions the membership was between 5,000 and 6,000, and now numbers 88,000.

**Abercarn.**—As a result of the conference between representatives of the Abercarn and Risca District Councils, it has been decided to obtain a report from an expert on the question of establishing joint electricity works.

**Ashton-under-Lyne.**—The new borough electrical engineer (Mr. N. Appelbee) commenced his duties on the 3rd inst. The chairman of the Electrical committee (Mr. Barlow) announced at a meeting of the Council, on Wednesday, that very shortly they would take into consideration the report of the consulting engineer (Mr. R. Hammond) on the position of the electricity works.

**Barrow-in-Furness.**—The lease of the existing steam tramways expires on Feb. 11, and it is improbable that it will be renewed as the lines have been condemned by the Board of Trade. The tramways were purchased some time ago by the British Electric Traction Co. for £22,000, who wished to substitute electricity for steam, but have been unable to come to terms with the Corporation.

**Batley.**—The Council have obtained sanction to a loan of £25,402 for the erection of electricity works, and tenders for generating plant are advertised on another page of this issue.

**Blackburn.**—The Electricity committee have decided to increase the salary of Mr. A. S. Giles, the electrical engineer and tramways manager, from £500 to £700, and to allow him £150 per annum for the next four years for the supervising of the Tramway extensions, estimated to cost about £200,000.

**Blackpool.** Mr. A. P. Trotter will hold an inquiry here on 21st inst. into the application of the Council to borrow £76,780 for electric tramways.

**Bognor.**—The question of erecting electricity works is engaging the attention of the District Council, who obtained a provisional order in 1899.

**Bradford.**—Hitherto the Electrical committee have been supplying current for traction at 1d. per unit. This has proved to be less than the actual cost, which, worked out on the basis of the capital expenditure, interest, sinking fund and establishment charges, is about 1½d. per unit. The Tramways committee have now undertaken to pay the cost price for power.

An inquiry will be held here on the 18th inst. into the application of the Corporation to borrow £140,000 for electric lighting extensions.

**Brighton.**—The Corporation have adopted a joint report of the tramways engineer (Mr. Holliday) and the resident electrical engineer (Mr. John Christie) as to the arrangements to be made for supplying electric current to the municipal electric tramways, and application is to be made for borrowing £13,200 for carrying out the proposals.

**Blaydon.**—At the meeting of the Council last week, a deputation from the Newcastle and District Electric Light Co. (Ltd.) attended to explain their proposals for giving a supply of electric current in this district. Mr. J. B. Simpson pointed out that the company would include the whole of the district in their scheme, and in regard to price would, in all probability, fix something like 5d. a unit for the first 200 hours, and about 3d. per unit for the next 200 hours, and 2d. for the remainder. Consideration of the matter was adjourned for a month.

**Burton-on-Trent.**—The Council have formally approved the omnibus bill promoted for the construction and working of new electric tramways, &c.

**Carnarvon.**—The Council has altered its mind with regard to the provisional order applied for by Mr. E. W. J. Peterson, and the application is now to be opposed.

**Cheltenham.**—The borough electrical engineer (Mr. Hamilton Kilgour) recently recommended the Council to incur additional expenditure of £14,511 on additional machinery for the electricity works in order to supply electric current to the Cheltenham and Cleeve light (electric) railway; £9,744 for additional arc lamps and street lighting; and £780 for main extensions for private lighting. This report and recommendations were endorsed by the Electric Lighting committee, which recommended the Council to apply for sanction to borrow £25,000 to carry out the extensions. On Monday the mayor (Ald. G. Norman), who is Chairman of the Electric Lighting committee, moved the adoption of the report, and this was agreed to. All arc lamps over 300 are to be charged for at £14 10s. each per annum.

**Chester.**—The result of the poll of the ratepayers has resulted in a decisive majority for the Council's tramways bill.

**Cleckheaton.**—The Council have decided to apply for a loan of £19,260 for erecting electricity supply and £5,740 for refuse destructor works. The consulting engineers are Messrs. Gibbings and Baker.

**Colwyn Bay.**—The Electricity committee have instructed Messrs. Lacey, Clirehugh and Sillar to prepare plans and specifications for the extension of the plant at the electricity works required to meet the increased demand for current.

**Customs Tariffs.**—Under the new Venezuelan customs tariff apparatus and machinery for lighting by electricity (and for their manufacture in the country) are admitted free of duty, as are also carbons for electric lighting and telegraphic machinery and apparatus, the latter with the previous permission of the Venezuelan Government.

**Dalkeith.**—The application of Messrs. Crompton & Co. for a provisional order has been approved by the Council.

**Darwen.**—Application has been made for sanction to borrow £13,000 for electric lighting extensions.

**Dublin.**—A special meeting of the Electric Lighting committee was held on Friday last in order to consider a joint report from the consulting engineer (Mr. Robert Hammond) and the borough surveyor (Mr. S. Harty) on the estimate for the erection of a power house at the Pigeon House Fort. Mr. Hammond suggested that certain items in his original plan should be deleted or altered so as to reduce the cost, and he recommended the omission of several provisional items which in the original estimate amounted to £5,000. The Lord Mayor moved that the firms who had already tendered be requested to fix the sums at which they would be prepared to take the contract on the basis of the alterations and omissions proposed by Mr. Hammond. It was pointed out that the original plans had already been submitted to the Local Government Board, and that on that account it would be necessary to acquaint that body with the omissions and changes proposed. The committee declined to take that course. Mr. Hammond was then asked if he could state approximately what the ommissons he had recommended would represent in cash, but he stated that the L. and N.W.R. Co. had (for the second time) lost his luggage on the way across, and that the memorandum containing the items was in the missing luggage. Roughly speaking, he thought the amount should now be about £27,000. The Lord Mayor's motion was adopted.

**Eccles.**—The Corporation have received sanction to a loan of £5,308 to meet excess expenditure on the electricity undertaking.

**Edinburgh.**—3,217 applications for electric current have been received, and 1,090 for motor connections, making a total of 4,307. The Electric Lighting committee recommend the appointment of a deputation to visit English towns in connection with the provision of condensing plant for the M'Donald-road station.

**Electric Supply "in Bulk."**—The Highways committee of the London County Council is approaching the metropolitan borough councils to ascertain their views on the subject of the insertion of a purchase clause in bills relating to the supply of electricity in bulk in London.

**Electrical Inkless Printing.**—Some time ago we joined with the leading printing trade journals in desiring additional information before accepting the roseate views of a few enthusiasts as to the immediate or even early success of the electrical inkless printing process. Some time has passed, and, as might reasonably be expected, certain progress has been made, but the commercial

success of the process has yet to be demonstrated, altogether apart from the question of economical working when the many technical difficulties have been cleared away. The issue of Barnett's *Printing Trades' Gazette* for Jan. 2 contains an interesting supplement alleged to have been produced by the process owned by the Electrical Inkless Printing Syndicate (Ltd.). In a leading article the editor fairly describes this supplement as a novel one, and declares that no special treatment has been adopted in making up the formes for the printing machine, and that the supplement has been put to press just as any ordinary printing work would be prepared, the only difference being that in place of the ink used in the ordinary course of printing, the medium for reproducing the face of the linotype metal bars has been a current of electricity passed through these bars. The success of the inkless process, it now appears, depends largely upon the skill of the paper maker, as the sheet has to be rendered "conductive" by the introduction of certain chemicals into the pulp from which the finished sheet is made. It would appear that it is in this connection that the past difficulties of the Electrical Inkless Printing Syndicate have chiefly arisen, but the syndicate is declared to have succeeded in bringing the manufacture of the reel of paper to such a stage as to render possible the publication of the present supplement. Notwithstanding this measure of success, it is announced that it may take months or even a year or two before the syndicate will be justified in placing the process at the disposal of printers, and this may involve the special equipment of paper mills by the syndicate. This latter statement justifies, we think, the scepticism with which the claims put forward by the exploiters of this process were received, and clearly proves how immature was the process to which, some time ago, the public were asked to subscribe considerable sums. The electrical as well as the printing trades are deeply interested in the success of the inkless printing process, and if it can be proved that machinery can be built more cheaply than the present "platens," "one-siders" and "perfectors" that the use of printing ink can be abolished, with all its troubles of irregularity of feed of the ink ducts, fluctuations in the consistency of the printing roller (caused by variations of temperature), set-off, filling up of the letters, to say nothing of the dirty nature of the present system; and that adequate supplies of the specially prepared paper in anything like the variety of the present supplies—then, and not till then, will the success of inkless printing effect the promised revolution, and bring fortune to those associated with the early working of the process. In the meantime the issue of the supplement above referred to (always assuming that it has actually been produced by the electrical inkless process) is a considerable step in advance.

It would appear from the following note which appeared in the same issue of the *Printing Trades' Gazette*, that the exploiters of the inkless printing patents are entering the field of finance by the aid of the discredited "puff preliminary," which has done so much in the past to wean the public from investing in industrial ventures. We are told that

"The £1 shares of the Electrical Inkless Printing Syndicate (Ltd.) have recently been dealt in at £2 per share. The perfect adaptation of the process to newspaper printing will send the syndicate shares booming at fabulous prices. They are now held in few hands."

There is an odour of the Pearson Fire Alarm about this, and investors should beware.

**Enfield (Middlesex).** On Monday a ratepayers' meeting discussed a resolution endorsing the action of the Enfield Council in joining with Tottenham, Edmonton, Southgate and Wood Green in promoting a bill for a joint electricity supply undertaking. This resolution was lost by 20 votes, and a poll was demanded.

**Epsom.**—The Electric lighting committee are to discuss with representatives of the County of Surrey Electrical Power Distribution Co. the question of the transfer of the Council's provisional order to the company.

**Felixstowe.**—The District Council have invited Sir William Preece to prepare a report on the electric lighting question at a fee of 50 guineas.

**Fulham.**—At the meeting of the Electric Lighting and Dust Destructor committee, last week, a report was presented by the consulting engineer (Mr. F. H. Medhurst) on the probable annual profits on the combined scheme. These were put by Mr. Medhurst at £2,785.

**Gas-Driven Electric Plant.**—The extensive works of Messrs. Geo. Richards & Co., machine tool makers, Broadheath, Manchester, have been changed over from steam to gas driving. A 320 H.P. Dowson gas generating plant has been put down by the Dowson Economic Gas Power Co., and has been found to work very satisfactorily. A 100 B.H.P. gas engine drives a Royce dynamo, from which power is transmitted by six electric motors to all parts of the machine-tool department. An 80 B.H.P. gas engine is used for driving electric motors for the pulley shop and a 42 B.H.P. engine for the power required for the erecting and testing shop. A 26 B.H.P. engine drives the motors for the machinery connected with the foundry. Steam is retained for driving the electric lighting plant for the entire works, in which about 800 lamps are used. The lighting and power switchboards have been constructed and erected by Cowans Limited, of Manchester. The alterations at the works have been carried out at a cost of about £4,000, and are estimated to save in working expenses £1,000 per annum. A 5-ton electric crane is on order for the foundry from Messrs. Berry, of Swinton.

**Glasgow.**—Last week a memorial plate was unveiled at the Pinkston electric power station to commemorate the erection of the works. This station is claimed to be the largest on this side of the Atlantic—240ft. long by 200ft. wide. The first sod was cut 16 months ago, and the chief part of the work has been carried out by the Corporation officials and employees. With regard to the tramways—which are to be supplied with current from the new station—there is a slight fear that these may not be completed in time for the exhibition largely owing to bad weather which has materially interfered with the conversion of the tramway system from horse lines to electric traction.

**Glasgow International Exhibition.**—The main buildings for this exhibition being now practically complete, the lighting arrangements are engaging chief attention. The contractors for the electric installation are Claud Hamilton (Ltd.) and Messrs. Lowdon Bros., and both firms are busy carrying out the work. The electricity department of the Corporation have agreed to supply a triple 15in. cable, about a quarter of a mile in length, for use in the grounds on condition that its laying down and removal is paid for by the exhibition authorities. The British Aluminium Co. offered on loan 10,000 yards of overhead wire for arc cabling, and the offer has been accepted. The central portion of the grounds will be lighted by incandescent gas.

**Great Yarmouth.**—The Town Council have received sanction to a loan of £27,000 for electric lighting extensions.

**Horsham.**—An inquiry was held here on Wednesday into the application of the Council to borrow £15,500 for electric lighting. Mr. Bartley Dennis, in support of the application, gave particulars of the population, rating value, &c., of the district, and technical particulars were supplied by the consulting engineer (Mr. W. C. C. Hawtayne). A petition against the loan was presented by ratepayers.

**Hull.**—Twelve additional 2,000 c.p. arc lamps are to be erected in George and Prospect-streets.

**Ilford.**—A number of applications have been received by the Council for the position of resident electrical engineer, and the following 11 were selected for interview by the Electric Lighting committee, but only 10 were interviewed. The following were the selected eleven:—Messrs. F. Bruton (Ashton-under-Lyne), G. G. Scurfield (Carlisle), W. F. Long (Manchester), G. H. Carter (St. Helens), W. M. H. Burland (Newcastle-on-Tyne), F. L. Todd (Wandsworth), F. C. Pay (Chiswick), H. F. Foster (Dover), N. Staniland (Canterbury), A. H. Shaw (Harrow) and A. J. C. Waterland (Ilford).

**Ilfracombe.**—The District Council have given up the proposal to establish electricity works, and the provisional order is to be transferred to a company.

**Irvine (N.B.).**—The Council will at its next meeting be invited to pass a resolution in favour of instructing Mr. W. A. Bryson to prepare a report on electric lighting.

**Jedburgh.**—By 12 votes to 3 the Council have consented to the application of Messrs. Crompton & Co. for a provisional electric lighting order.

**Kingston-on-Thames.**—An inquiry was held here on Tuesday into the application of the Corporation to borrow £17,808 for electric lighting extensions. The town clerk (Mr. H. Winser) appeared in support of the application, and stated that the loan was necessary owing to the rapidly increasing demand for current. At present there was an equivalent of 20,000 8 c.p. lamps connected, and the demand had doubled during the past three years.

The poll of the ratepayers on the Council's electric tramway scheme has resulted as follows:—For the bill 1,123, against 3,701, giving a majority against of 2,578.

**Lake District Electric Railway Scheme.**—With regard to a report that has been published locally that the British Electric Traction Co. have decided to abandon their Bowness-Windermere-Ambleside electric railway scheme, we have authority for stating that this is beyond the fact. The company made an application to the Light Railway Commissioners in May last, and a public inquiry was to have been held in October on the subject. In October, however, the company withdrew their application, and the matter therefore remains in abeyance. It is incorrect to state that the project has been abandoned.

**Leigh.**—A joint report by the town clerk, the borough surveyor and the electrical engineer upon the advisability of constructing tramways in the district was considered by the Council on Tuesday. The report recommended that statutory powers be obtained to construct tramways, and to request the South Lancashire Tramways Co. to withdraw from their bill the clauses relating to the tramways now proposed to be constructed and worked by the Corporation. The cost of laying and electrically equipping certain recommended routes

would be about £45,771, and the annual expenditure about £8,140, with receipts probably amounting to over £10,000 per annum. The Council resolved to delay the confirmation of the minutes for a fortnight in compliance with the desire of the South Lancashire company, who wish to submit suggestions.

**Leith.**—The application of the Edinburgh Street Tramways Co. for permission to adopt the overhead trolley system of traction on the Leith-walk tramway route is under consideration by a committee.

**Light Railways.**—The Loughborough and District Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by 31st inst.

Longton Town Council have raised objections to the application of the Potteries Electric Traction Co. for an order to construct additional light (electric) railways in the district.

**Liverpool.**—The Tramways committee have completed arrangements for opening the new electric tramway service on the outer circular route. A six minutes' service will be given. The Board of Trade inspection took place on Tuesday.

**London Chamber of Commerce (Electrical Section).**—A meeting of this section was held on Tuesday, under the presidency of Mr. Sydney Morse. The chairman recounted the matters which had occupied the attention of the section during his period of office, and referred particularly to the evidence which had been brought before the Royal Commission on Local Taxation with regard to the action of the rating authorities detrimental to large industrial undertakings. The section had urged that uniformity of rating throughout the country should be adopted by an independent valuation authority. The section had also been actively concerned in connection with the question of Municipal Trading. Mr. Morse concluded by moving that Mr. R. Percy Sellon be chosen chairman of the section for the ensuing session, and the proposal was adopted unanimously. It was decided to appoint a special sub-committee to report upon the action of the gas and water companies in endeavouring to upset the settlement of the joint Parliamentary Committee with regard to the question of earth returns as embodied in the clause inserted by the Board of Trade in a number of provisional orders.

**Manchester.**—The chairman of the Electricity committee (Dr. Bishop) on Wednesday submitted a recommendation to the City Council that application be made for sanction to borrow £500,000 for electricity supply to cover work extending over a considerable time. This sum did not include any of the expenditure which would be incurred by the erection of the Stuart-street station. It would cover, in accordance with the estimate of the electrical engineer, the balance of the three-phase mains required in the city. He had also made allowance for carrying those mains forward into the outlying districts the provisional orders of which the Corporation had agreed to take over, but he had not provided the three-phase mains in those outlying districts, nor the mains connecting those districts to the nearest sub-station. Mr. SUTTON asked whether in a short time the committee would come to the Council for another £500,000 for the erection of the Stuart-street station. Dr. BISHOP said that if they furnished electric supply they must have a station. The Council had already approved of the provision of telephonic communication included in the committee's project. The recommendation was then agreed to.

The City Council also resolved to give formal notice to the Manchester Carriage and Tramways Co. to sell to the Corporation so much of the company's tramways undertaking authorised by the Manchester Suburban Tramways Act (1879) as is within the city of Manchester.

**Marienbad-Königswart Electric Railway.**—A preliminary concession has been granted to the Helios Company for the construction of a light electric railway between Marienbad and Konigswart.

**Middlesbrough.**—Already the equivalent to 10,000 8 c.p. lights has been applied for, exclusive of Corporation buildings and street lighting. The Electric Lighting committee have decided to get out specifications for additional plant and for extensions of the mains.

**Newcastle-on-Tyne.**—The City Council on Wednesday approved the recommendation of the new Tramways committee to purchase about 130 arc lamps, &c., for lighting the tramway routes.

**Newcastle and District Association of Electrical Contractors.**—This association has been formed with offices at 36, Northumberland-street, Newcastle-on-Tyne. Mr. Robert Robson, 12, Lisle-street, Newcastle-on-Tyne, is secretary. The object of the association is to "effect a general improvement in electrical engineering in the Newcastle district."

**Nottingham.**—The first section of the Corporation electric tramways was opened on New Year's day, and up to Jan. 5 91,000 passengers had been carried, realising £176, compared with an average weekly earning of about £125 with horse traction.

**Oswestry.**—The Oswestry Electric Light and Power Co. have recently put down additional plant, doubling the capacity of their generating station.

**Plymouth.**—The Tramways committee recommend that electric tramways be constructed to the eastern boundary of the estate belonging to the Corporation at an estimated cost of £10,530. The annual charge for interest and sinking fund would be £536.

**Portsmouth.**—We refer briefly elsewhere in this issue to the result of the proceedings before the Portsmouth Town Council on Thursday last when a report from the Telephone sub-committee was discussed. Mr. A. R. Bennett was present at the meeting during the discussion of the report.

Mr. BREWIS asked whether the Council was committed to a system of municipal telephony.

The TOWN CLERK replied that on Sept. 11 the Council had instructed the Finance committee to apply to the Postmaster-General for a licence. This had been done, and the licence had been granted. Mr. Bennett was then consulted and terms agreed upon. In Mr. Bennett's report two schemes were presented for the Council's selection, and the Council adopted the smaller of the two and appointed Mr. Bennett as consulting engineer. They had advertised for tenders, had appointed canvassers, &c., and he regarded that as evidence that the Council had pledged itself to a system of telephonic communication.

Mr. DIDDMAN said the Telephone committee asked to be allowed to spend £26,000. The Finance committee had received 39 applications for the post of manager to the telephone department. This number had been reduced by Mr. Bennett to six, the committee had reduced the number to three, but the final appointment had not yet been made. Amongst the statements published by the opponents of the proposed municipal telephone scheme was that it was impossible to connect up subscribers at the capital outlay mentioned in Mr. Bennett's estimate. The committee, however, satisfied themselves that these figures were reliable, and felt justified in going on with the work on these lines. He quoted from various sources to prove the correctness of Mr. Bennett's figures. If the Corporation established an exchange he contended that they would get a better and cheaper service than they were getting from the National Company. He denied that Sir Wm. Preece was a great authority on telephones, or that he had any actual experience in their construction. He charged the National Company with giving preferential rates, which was unfair. In conclusion, he contended that the opposition to the project was not genuine, and moved the adoption of the committee's report, which recommended that £26,500 be borrowed for the establishment of a municipal telephone exchange in Portsmouth to provide for 1,200 lines at once, and to make provision for 600 immediate subscribers.

Mr. H. R. PINK (ex-Mayor) concurred in approving Mr. Bennett's figures, and urged that the municipalisation of the telephone was necessary. Those subscribers who had connection with the present company would doubtless have to subscribe to both systems unless some scheme was devised for providing connections between the municipal and the company's system.

Mr. CURTISS said he was opposed to the spending of this money. In his opinion the project was against the interests of the ratepayers. The Post Office rate for an unlimited telephone service was £7, 10s., and the Portsmouth Corporation proposed to supply it for £5. 17s. 6d., out of which they would pay the Post Office 10 per cent., leaving £5. 6s. If £7. 10s. was a fair price for the service and the Corporation would do it for £5. 6s., either the Post Office must make a very large profit or the Corporation must make a loss. The project before them provided for 600 subscribers, leaving them a profit of £105. If they only got 580 subscribers where would this profit be? He considered the Corporation had quite enough municipal undertakings in hand already. He therefore moved that no further action be taken in this matter until the ratepayers had had an opportunity of discussing the subject.

Dr. EMMOTT, who seconded, said they were asked to mortgage the rates to the extent of £14,400 to make a net profit of £105. In the list of salaries provided under the scheme they were to pay telephone inspectors less than dockyard labourers' wages, and it was a statement in the scheme that "the pay of operators need not at first average 10s. a week, as any number of respectable and intelligent girls could be had for 6s., or even less, to begin with." Mr. Bennett (in the speaker's view) had considerably under-estimated the expenses.

Mr. MURTOUGH urged that the telephone should be in every ratepayer's house, and be made as useful as the penny-in-the-slot gas supply.

Mr. DUMMER asked why the working man should not have the right to the telephone as much as any member of the Council? Why should not they, by means of a halfpenny-in-the-slot be able to send messages to the baker or butcher?

In reply to questions, Mr. A. R. BENNETT defended his figures and said the staff to be employed would be a similar set of officials to those engaged at Guernsey, where a 700-subscriber line was in operation.

A vote was then taken on Mr. Curtiss's amendment, and for this there voted 16; against, 23.

Mr. PALIN then moved that the subject be deferred for two months and in the interval a public meeting be held, and, if necessary, a poll be taken. Seventeen voted for this amendment and 18 against.

Mr. F. G. FOSTER moved that the matter be referred back for further consideration, and this was carried by 20 votes to 17.

The discussion lasted for three hours and a-half.

**Private Bill Legislation.**—A bill has been lodged for power to incorporate a company to construct and work about 8 miles of electric tramway in Scarborough. The capital will be £120,000, with power to borrow £40,000.

Petitions against the London County Council's tramways bill have been lodged by the Westminster and Hammersmith Borough Councils and Messrs. James Shoolbred & Co.

The London United Tramways Co.'s bill is being opposed by Kingston-on-Thames, Hammersmith, and Hampton municipal authorities.

The South-Western and Isle of Wight Junction Railway Co. have lodged a bill for power to construct an electric railway under the Solent and to give a complete land communication between the mainland and the Isle of Wight. The length of the proposed railway will be over 7½ miles, and will commence at Sway by a junction with the Lymington branch of the London and South-Western railway, and will terminate by a junction with the Freshwater, Yarmouth and Newport railway. The length of tunnel under the Solent will be about 2 miles 500 yds., and as the estimated expense of constructing the tunnel is exceptionally large, it is proposed to ask for power to charge in respect of the tunnel as for a distance of 12 miles. The line is intended to be worked by electricity, and, with the consent of the London and South-Western and the Freshwater, Yarmouth and Newport Railway Companies, the traffic from the proposed railway may continue to be worked by electric power over those systems into Brockenhurst station and into Freshwater and Newport stations. Running powers are also sought over the Isle of Wight Central railway and over the Newport, Godshill and St. Laurence railway. The capital is to be £600,000, with power to the London and South-Western Co. to subscribe one-half the capital, or undertake to construct the railway and raise the whole of the necessary capital, including £200,000 which may be borrowed. The promoters are the Earl of Egmont, Sir J. Blundell Maple, Bart., Mr. F. G. Aman, Mr. R. W. E. Middleton and Mr. R. C. Murray.

Leeds Chamber of Commerce have unanimously resolved to support the West Yorkshire Electric Power bill.

**Rating Appeal.**—Decision has been given by the Recorder of Canterbury in the appeal of the Electricity committee against the rating of the electricity works. The Recorder said that at the hearing the question was raised whether the electricity works premises were capable of separate assessment. With regard to the electric light works the receipts and expenditure to March 31, 1900, were given and relied upon by both parties for the purpose of ascertaining the proper amount which the works should be assessed at. The receipts after deducting working expenses were accepted by both parties at £2,041. He found the electricity works and dust destructor were capable of being distinct and separate occupations of value, and were properties capable of separate assessment. He found the lamp standards, with the exception of the perishable parts, were not to be considered tenant's capital. The respondents satisfied him that in placing the gross value at £1,050 they had not placed it too high, but they had failed to satisfy him that the deductions they had made were sufficient. He found the rateable value of the electricity works to be £370 and it must be reduced accordingly, but it had to be further reduced by deducting £27 for the mains in parishes outside the Canterbury Union, thus making the rateable value £343 for Canterbury parish. With regard to the dust destructor he found the gross value £180. With regard to the costs he saw no reason why they should not follow the ordinary course, and respondents being unsuccessful must pay the costs. The original assessment was £700 for the electricity works, not including mains, and £250 for the dust destructor.

**Redditch.**—In reply to criticism passed on the electricity undertaking of the Council at the meeting on Wednesday, the chairman of the Lighting committee (Mr. J. Warner) said he thought it unreasonable that the ratepayers should expect the scheme to pay at so early a stage of their career. He was quite satisfied that in a few years the scheme would pay. The Finance committee report a deficiency up to Dec. 31 of £973 on electric lighting account. Up to March 3 next the estimated deficiency is £1,776, the working expenses for the quarter being put at £500, and loan repayment £303. 4s. 9d. To meet the deficiency it is proposed to make a special rate of 1s., estimated to produce £1,750.

**Riga.**—It is stated that the chief telephone exchange in this town was set on fire and burnt down yesterday (Thursday) by the fusing of the wires. The damage is estimated at 300,000 roubles.

**St. Helens.**—The Board of Trade inspection of the electric tramway to Rainhill and Prescot took place on Tuesday.

**Scandinavia.**—Great progress is being made in electrical development in Scandinavia. Negotiations for providing telephonic communication between Sweden and Denmark are in progress, and also for a line between Copenhagen and Christiania, the rate being fixed at 1 kroner (1s. 1½d.) for three minutes' conversation. A telephone line is also being established between Sweden and Finland, the Russian Government reserving the right of breaking the connection at any moment.

The question of the introduction of electric traction is also being taken up, and, if decided upon, power will be derived from the waterfalls, which are easily available. In Gottenburg the municipality are extending the electric tramways and converting the horse lines to electric traction. The Stockholm Council is similarly engaged. At Sodermalm a private company has recently opened an overhead trolley line with satisfactory results.

The largest electric locomotive constructed in Sweden has just been delivered from the works of Messrs. Luth and Rosen, Stockholm, for goods traffic on a line in Norrbotten. The engine is a 4-axle bogie loco, driven by four motors totalling 70 H.P., and has a hauling capacity of 35 tons at a speed of 18 kilos. per hour. It is similar in appearance to the locos in use on the Central London Railway, and has a total weight of 10 tons. Electric current on the Norrbotten line is turbine-generated.

It is proposed to develop the electricity works at Stockholm, and for this purpose water power is to be derived from the Dal river, distant about 180 kilos. It is estimated that the falls will develop about 8,000 effective H.P. The cost of the works is estimated from 650,000kr. to 2,000,000kr. according to the voltage decided upon, which is to be between 20,000 and 40,000 volts. To meet the demand for current pending the completion of this scheme a steam-driven generating station for 5,000 H.P. is to be erected and equipped. The Stockholm Gas Co. are also erecting a steam-driven electricity generating station for lighting and industrial supply.

The manufacture of electric machinery in Sweden has hitherto been somewhat limited, most of the heavy machinery and general plant being imported. It is now proposed to establish a powerful joint-stock enterprise, to be called "The Magnet of Ludrika," where big works are in course of construction. The capital is 1,500,000kr., and the new venture will employ about 1,000 hands. The new works are to be in operation in the spring of 1901, and will ultimately be electrically driven; 1,500 H.P. will be required when the works are completed, and an adjacent waterfall is to be utilised.

**Sheffield.**—A town's meeting has approved the Corporation electric tramway bill.

**Stafford.**—Sanction to a loan of £10,000 for electric lighting extensions has been received by the Council.

**Sunderland.**—At the meeting of the Council on Wednesday, the chairman of the Tramways committee made a statement on the working of the electric tramways. One section had been in operation since August, and another (four miles in all) since the end of November. The receipts, which had been estimated at 10d., had proved to be 1s. 6d. per mile. Notwithstanding the loss on horse traction, owing to disturbance caused by altering the system, there was a net profit of over £3,000. The Corporation decided to spend £27,000 in extensions, making the total amount invested about a quarter of a million, which it is anticipated will produce a net profit of £10,000 per annum.

**Telephone Trunk Line Extension.**—Braintree (Essex) is now connected with the telephone trunk system of the country.

**Telephone Developments in Glasgow.**—The very latest development of telephonic enterprise in Glasgow is represented by the following announcement:—

THE NATIONAL TELEPHONE COMPANY (LTD.).

REVOLUTION IN TELEPHONE CHARGES.
An Exchange Telephone Connection can now be had for
TWOPENCE A DAY.
No Annual Rental.
THIS IS STARTLING, BUT TRUE.
The Company is enabled to offer these Rates by the introduction of a New System, which
THOUSANDS HAVE ADOPTED IN AMERICA.
Full particulars on application to
THE NATIONAL TELEPHONE COMPANY (LTD.), Royal Exchange, Glasgow.

**The Alleged Theft of Electric Current at Liverpool.**—At Liverpool police-court last week Edwin Isherwood, of Isherwood Bros., South John-street, was summoned under the Gasworks Act, 1847, as amended by the Electric Lighting Act, 1882, for abstracting electric current belonging to the Corporation of Liverpool. Particulars of this case were given in our issue of the 28th ult., and after hearing the evidence the bench dismissed the charge, the chairman stating that they unanimously considered the charge unproven.

**The Past Year's Work.**—Messrs. Drake and Gorham forward a lengthy list of important London and country house electrical installations which have been put down by the firm during 1900. In addition, large installations are being carried out for the Mazawattee Tea Co., the Calico Printers' Association, and at Aldershot camp. Mill lighting also forms a notable feature of the past year's work. The various specialities supplied by this firm have continued to meet with a large demand. These specialities include the "Nevile" patent automatic accumulator switch, spring contact switches, &c. The Jandus lamp maintains its position in the enclosed arc lamp industry. After several years of experiment the alternating lamp has now been introduced, and, in addition, special lamps have been brought out for use on tramway and high voltage circuits.

Messrs. GEIPEL and LANGE report a satisfactory increase of business during the past year. For the Geipel steam trap the hors concours distinction was obtained at Paris. Contracts have been carried out by the firm for a number of electric power installations,

chiefly on the three-phase system with Brown-Boveri plant, for which the agency for the South of England is held by Messrs. Geipel and Lange. The agencies added during the year include those for Ward-Leonard apparatus, the Vulcan Electricity Meter, the Centrator motor speed-reducing gear, and the Chapman voltage regulator.

**Tube Railways.**—At a meeting of the Vestry of St. Botolph, Bishopsgate (City of London), it was decided to provide a fund of £100 to be used "in protecting the interests of owners and occupiers in the parish" when the applications to Parliament by the Central London Railway Co., the City and North-Eastern Suburban Electric Railway Co., and the North-east London Electric Railway Co., for powers to construct four tube railways through the parish are heard.

**Valparaiso (Chili).**—Congress has voted a credit for obtaining expert advice on the introduction of electric traction into this city, and tenders are to be invited for the concession.

**Warwick.**—The application of the British Electric Traction Co. for a provisional order is not to be opposed, an arrangement having been made to establish the generating station in Warwick.

**Wednesbury.**—A special committee has been appointed to consider the question of erecting electricity works.

**Wigan.**—An inquiry was held here last week into the application of the Corporation to borrow £16,500 for electric light extensions. Technical details were supplied by the borough electrical and tramways engineer (Mr. H. Collings Bishop). It was stated that the loan was required to meet the demand for current in streets where mains had not already been laid. The Corporation have already borrowed £85,000 for electricity supply.

**Willesden.**—We learn that the poll of the ratepayers, taken yesterday (Thursday) has resulted in a majority against the Council's electric tramway proposals.

**York.**—The salary of the city electrical engineer (Mr. C. J. Midgley) has been increased from £200 to £300 per annum. The chairman of the Electric Lighting committee (Ald. Dodsworth) announced at a meeting of the Council this week that the actual result of the first nine months' working of the electricity undertaking was a profit of £142, and he thought that was a unique experience in municipal electrical enterprise.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Canterbury* Lighting committee invite tenders for boiler and engine-house plant, condensing apparatus and pipework, and extension of switchboard. An advertisement contains further particulars, and specification may be obtained by manufacturers at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after 9th inst. An advertisement contains further particulars, and tenders must be sent in to the town clerk (Mr. Henry Fielding), Town Hall, Canterbury, before 4 p.m. on 30th inst.

*Oldham* Corporation require tenders for two 600 I.H.P. engines and four 1,200 I.H.P. engines, each direct coupled to a continuous-current dynamo. Specifications may be obtained from Mr. A. Andrew, Gas and Water offices, Oldham, and can also be seen at (but not obtained from) the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, London, S.W. An advertisement gives further particulars, and tenders must be sent to Mr. Andrew by Jan. 29.

*Southport* Tramways committee require tenders for material for electric tramways, including poles, brackets, and scrolls, bases, trolley wire, trolley wire attachments, galvanised steel wire, and section boxes. Specifications and forms of tender may be obtained from the borough electrical engineer (Mr. Charles D. Taite), and tenders must be delivered at the offices of the town clerk, Town Hall, Southport, by 21st inst. An advertisement gives further particulars.

*Edinburgh* Corporation invite tenders (contract No. 12) for an engine and dynamo for the electricity station at McDonald-road. Some particulars are set out in an advertisement elsewhere. Specifications, &c., can be obtained from the resident electrical engineer, Dewar-place, Edinburgh, on and after 16th inst., and can be seen at, but not obtained from, the office of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, London, S.W. Tenders have to be sent in to Mr. Thomas Hunter, W.S., town clerk, City-chambers, Edinburgh, by Feb. 9.

*Great Yarmouth* Corporation invite tenders for two water-tube boilers and two 200kw. high-speed continuous-current steam dynamos for electric traction. Specifications, &c., can be obtained from Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W., or from Mr. J. W. M. Cockrill, M.I.C.E., borough surveyor, Town Hall, Great Yarmouth, and tenders have to be sent to the town clerk's office, Town Hall, not later than noon of Feb. 5. Some further particulars will be found in an advertisement.

*Brighton* County Borough Council invite tenders for the supply and erection, at the Corporation electricity works, North-road, Brighton, by 31st Aug., of tramway plant, including (1) three direct-coupled compound-wound steam dynamos (Willans engines), (2) tramway switchboard, (3) negative booster. Specifications, &c., can be obtained at the Town Hall, Brighton, and tenders must be sent in to Mr. F. J. Tillstone, town clerk, by 10 a.m. of 28th inst. An advertisement contains further particulars.

*Batley* Corporation invite tenders for three high-speed triple expansion steam dynamos, one balancer, and one motor generator. Specifications, &c., can be had at the London offices of the engineers to the Corporation (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and tenders must be sent to Mr. J. Hanson Craik, town clerk, Batley, Yorks., by Feb. 9. See advertisement for further particulars.

*Tynemouth* Corporation invite tenders for a 150kw. steam dynamo. Specifications, &c., can be obtained at the offices of the engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, London, on and after 12th inst. Tenders to Mr. Horatio A. Adamson, town clerk, Tynemouth, by 31st inst. An advertisement gives further particulars.

*Aberdeen* Electric Lighting committee require tenders for surface condensers, air and circulating pumps. An advertisement contains further particulars, and tenders (addressed to the city electrical engineer, Mr. J. Alex. Bell) must be delivered at the electricity works, Cotton-street, Aberdeen, by noon of Feb. 8.

*Launceston* (*Tasmania*) Corporation invite tenders for the supply of 500 electric meters. Specifications, &c., are obtainable of Mr. W. Corin, city electrical engineer, Launceston, or from Messrs. John Terry & Co., 7, Great Winchester-street, London, E.C. Tenders have to be sent direct to Mr. C. W. Rocher, town clerk, Town Hall, Launceston (or c/o Messrs. Terry & Co., as above), not later than 12 noon of April 8 next. Further particulars are given in an advertisement. (The post to Launceston occupies about six weeks.)

*London County Council* require tenders for forming the concrete foundations for, and erecting the bases of, the lamp standards for electric lighting of Victoria Embankment, and also for trenching work, &c. Tenders by 22nd inst.

*Sunderland* Corporation invite tenders for condensing plant and cooling tower, secondary battery, main switchboard, and travelling crane. Tenders (addressed Chairman of Lighting committee) to the town clerk by noon Feb. 1.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal Buildings, Lavender-hill, S.W., before noon Feb. 1.

*Sheffield* Tramways committee invite tenders for a slow-speed vertical engine for driving a 1,000kw. tramway generator. Tenders by Jan. 21.

*Ilford* District Council invite tenders for the electric lighting of the town hall and public offices. Tenders to chairman by 31st inst.

*Poplar* Borough Council require a 5-ton electric crane. Tenders to acting town clerk, 117, High-street, Poplar, E., by Jan. 16.

*Glasgow* Corporation require tenders for telephone apparatus in connection with their tramways. Tenders to town clerk by Jan. 18.

*Rotherham* Corporation invite tenders for electricity meters. Tenders by Jan. 19.

*Colne* Electrical committee require tenders for electrical plant and apparatus. Tenders by 19th inst.

*Leeds* Tramway committee require tenders for poles and bracket arms for carrying overhead electric wires. Tenders by Feb. 6.

The *Victorian* Government will receive tenders until noon of 29th inst. for the supply and delivery of 20 miles of underground telephone cable. The tenders have to be deposited at the General Post Office, Melbourne. The official notice of these tenders can be seen at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W.

*New South Wales* Government will receive tenders up to 2:15 p.m. of Feb. 22, for the supply of telegraph, telephone, and electric light material for the years 1901-2. Tender forms are to be seen at the offices of the Chief Electrician, General Post Office, George-st., Sydney, and samples at the Postal and Electric Telegraph Stores at the same address. The conditions of contract can be examined at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W. Tenders are to be sent to the Public Service Board, 42, Young-st., Sydney.

The *French* Telegraph Administration require tenders until 22nd inst. for 200 kilometres of submarine cable core, 60 tons of iron wire 5mm. diameter, 50 tons ditto 7mm. diameter, and 170 tons 8mm. diameter. Tenders to le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

## TENDERS RECEIVED AND ACCEPTED.

Shoreditch (London) Borough Council have accepted the tender of the Wallsend Slipway and Engineering Co. for the supply (under contract No. 26) of two engines, dynamos and condensing apparatus for £23,170. The engines are of the Wallsend Company's own make and the dynamos are Westinghouse machines.

Seventy-eight tenders from 28 firms were sent in, and the selected tender was one of four sent in by the Wallsend Company. The highest tender (£38,950) was sent in by Messers T. Metcalfe & Co. for their own type of engine and Schuckert dynamos. The lowest tender (£16,040) was received from Messrs. Siemens Bros. & Co. for engines by Carels Frères and the firm's own dynamos.

The firms tendering were as follows: J. Carmichael & Co., T. Metcalfe & Co. Ltd. (2), Ashton, Frost & Co. (3), Frank Suter & Co., Victor Coates & Co., Bever, Dorling & Co., Anchor Electric Co., Duncan Stewart & Co., Fullarton, Hodgart and Barclay, F. Nell (5), Clayton Engineering Co. (2), Bergtheil and Young (2), Bow, McLachlan & Co., Richardsons, Westgarth & Co., Mather and Platt (2), Cole, Marchent and Morley (4), Yates and Thom, British Westinghouse Co. (7), Electrical Co. (5), Electric Construction Co. (7), R. W. Blackwell & Co., Siemens Bros. & Co. (7), Crompton & Co. (3), S. Z. de Ferranti (Ltd.) (2), Brush Co. (4), Dick, Kerr & Co., and British Schuckert & Co. (7).

*Feed Pumps, Steam Pipes, Water Tank and Sundry Ironwork.*

| | | | |
|---|---|---|---|
| Aiton & Co. (*accepted*) ...... | £5.202[1] | Mechan & Sons .............. | 5 800[2] |
| ditto ...... | 5.084[2] | Clay, Henriques & Co. .... | 5.500[2] |
| Ashton, Frost & Co. ........ | 7.150 | Alley and Maclellan ......... | 5 355[1] |
| Babcock and Wilcox ......... | 6.865[1] | Crompton & Co... .......... | 5.165[2] |
| ditto ........ | 6.745[2] | Maxim Engineering Co. ..... | 4.970[1] |
| Railway & General Eng. Co. | 6.206[1] | ditto ..... | 4.896[2] |
| John Spencer (Ltd.) ........ | 5.860[1] | | |

[1] Weir's pump. [2] Hall pump.

Ayr Corporation have received the following tenders for electric tramway equipment:—

*Cables.*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Callender's Co. (*accepted*) | £5,158 | 13 | 0 | St. Helens Cable Co. | 5,138 | 0 | 11½ |
| | | | | B.I.W. Co. ...... | 4,941 | 13 | 3 |
| Siemens Bros. & Co... | 6,064 | 4 | 8 | R.W. Blackwell & Co. | 4,872 | 5 | 5 |
| W. T. Glover & Co.... | 5,444 | 12 | 1 | Western Electric Co. | 4,690 | 5 | 8 |
| W. T. Henley's Co..... | 5,301 | 15 | 3 | | | | |

*Overhead Work.*

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Lowdon Bros. (*accepted*) | £4,096 | 0 | 0 | R. W. Blackwell & Co. | 4,397 | 6 | 1 |
| B.I.W. Co. ............ | 4,051 | 3 | 10 | Macartney, McElroy & Co. ......... | 4,216 | 16 | 3 |

The following tenders have been received by the Bermondsey (London) Borough Council for 71 cast-iron arc lamp columns, arc and incandescent lamps, automatic switches and fittings.—

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Crompton & Co. (*accepted*) .......... | £2,595 | 0 | 0 | Haydn Harrison & Co. .................. | £3,292 | 0 | 0 |
| General Electric Co.. | 3,640 | 0 | 0 | Oliver & Co. ....... | 2,848 | 10 | 3 |
| Brockie-Pell Arc Lamp (Ltd.). ..... | 3,371 | 0 | 0 | Veritys (Limited) ... | 2,845 | 0 | 0 |
| | | | | Johnson and Phillips | 2,765 | 14 | 3 |

Leeds City Council last week confirmed the acceptance of the following tenders in connection with the extension of the mains and two-phase distribution in Holbeck and Hunslet:—

| | £ | s. | d. |
|---|---|---|---|
| British Insulated Wire Co. (mains) ......... ...... | £18,781 | 12 | 8 |
| Electric Con. Co. (14 60kw. transformers) .....each | 119 | 0 | 0 |
| Brush Co. (switch gear) ............................ | 467 | 2 | 0 |
| S. Z. de Ferranti, Ltd. (switch gear) .................. | 344 | 0 | 0 |

Reigate Corporation have received the following tenders for the supply of electricity meters:—

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Chamberlain & Hookham (*accepted*)............... | £223 | 17 | 6 | Electrical Co. ...... ...... | £234 | 0 | 0 |
| British Westinghouse Co. | 304 | 0 | 0 | Johnson and Phillips... | 273 | 3 | 0 |
| B.T.H. Co. ..... ........ | 301 | 7 | 0 | Geipel and Lange ..... | 234 | 0 | 3 |

Kendal Town Council at their meeting on Tuesday, accepted, subject to approval of the L. G. Board, the following tenders in connection with their electricity supply scheme:—

Contract No. 1 (station equipment), Johnson and Phillips.
Contract No. 2 (mains, meters, &c.), British Insulated Wire Co.

The Colchester Corporation have accepted the tender of Messrs. Davey, Paxman & Co. for the supply of a steam-engine at £796, and also for surface condensers, with air and circulating pumps, at £730. Messrs. Siemens Bros. & Co. are to supply a dynamo at £760.

Swansea Corporation have received 10 tenders for wiring the public library. The amounts varied from £2,106 to £650. 8s. Consideration of tenders has been deferred.

Cardiff Corporation have accepted the tender of Mr. D. W. Davies for the erection of an electric tramway depot, at £6,774.

Wakefield City Council have accepted the tender of Messrs. S. Z. de Ferranti for a 400kw. steam alternator at £3,830.

Brighton Corporation have placed an order with Messrs. Willans and Robinson for additional condensing plant at £900.

York Corporation have placed an order with Messrs. Crompton & Co. for additional machinery for the electricity works at £5,750.

Greenwich Guardians have accepted the tender of Messrs. Lea and Warren, for the electric lighting of the workhouse at £4,910.

## BUSINESS NOTICES.

An established firm of electrical engineers and suppliers to the trade desire to represent first class manufacturing houses as sole agents for the United Kingdom. See advertisement.

Messrs. J. Dale and T. J. Lloyd (trading as Dale and Lloyd), electricians, &c., 285, Icknield-street, Birmingham, have dissolved partnership. Debts by Mr. Lloyd.

Messrs. J. B. Robb, J. Topping and T. R. Topping (trading as J. B. Robb & Co.), electrical engineers, 31, King-street, Wigan, have dissolved partnership. Debts by Mr. T. R. Topping, who continues in his own name.

There is a change of name to announce in connection with the well-known Glasgow firm of James White. In future the style of the company will be Kelvin and James White (Ltd.).

Mr. L. Broekman, electrical and mechanical engineer and storage battery specialist, has removed from 34, Victoria-street to 12, Dartmouth-street, Queen Anne's gate, London, S.W.

Messrs. Congdon and Powell, switchboard base manufacturers, &c., have removed from 155, Buckingham Palace-road, to Bravington Works, Bravington-road, London, W.

## BANKRUPTCIES, LIQUIDATIONS, &c.

An application for the discharge in bankruptcy of Alec Gavan Inrig, electrical engineer (trading as the Globe Electrical Co.), 46, White Post-lane, London, E., will be heard on 24th inst. at Bankruptcy-buildings, Carey-street, London, W.C.

A receiving order has been made against A. Hudson, electrical commission agent, 67, Thurnscoe-road and 23, Piccadilly (lately trading at 5, Cheapside), Bradford, on his own petition. The first meeting of creditors will take place on 15th inst., and the public examination on 23rd inst, at Bradford.

Claims against G. T. Godfrey (trading as Godfrey Bros.) electrical engineer, &c., Boundaries-road, Balham, and 40, Trinity-road, Upper Tooting, London, S.W., must be in by 22nd inst. to Mr. P. Ravenscroft, Jewry House, Old Jewry, London, E.C.

Frederick Ludovic Lloyd Lindsay, electrical engineer, Bangor, recently attended for his public examination at Bangor Bankruptcy Court. Examination was closed.

Claims against the Automobile Association (Ltd.) must be sent by Feb. 7 to Mr. H. M. Gowar, 23, College-hill, London, E.C.

A meeting of G. R. Blot & Co. (Ltd.) will be held on Feb. 8 at 64, Cannon-street, London, E.C., to receive an account of the winding up.

---

**Sale by Auction.**—On another page Messrs. Wheatley Kirk, Price & Co. announce the sale by auction at an early date upon the works premises, Haunch of Venison Yard, Brook-street, London, W., of the contents of the works, including gas engines, dynamos, lathes, drilling and milling machines, &c. Catalogues are in course of preparation and will shortly be obtainable from the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

**For Sale.**—Nelson Corporation electricity department have for disposal a storage battery of E.P.S. central station K type cells. Particulars are given in an advertisement. Tenders have to be sent in to Mr. R. M. Prescott, town clerk, Town Hall, Nelson, by Jan. 23.

An advertisement gives particulars of an extensive engineering workshop in the London suburbs which is for sale with or without machinery.

**Competition.**—The Corporation of Conway are considering a scheme of electric lighting, and invite, in an advertisement elsewhere, electrical engineers to send in applications (with testimonials, and stating total fee required for making a report) to Mr. T. E. Parry, town clerk, Conway, North Wales, by 15th inst.

**Alteration of Pressure.**—An advertisement gives notice that application has been made to the Board of Trade for an alteration to Proviso No. B (6) of the Regulations made by the Board for insuring a proper and sufficient supply of energy. It is desired to substitute for the words "with the consent of the consumer" the following: "On such terms and conditions as may be agreed upon between the undertakers and the consumer, or, failing agreement, as may be settled by an arbitrator appointed by the Board of Trade." Objections must be lodged with the Board by Jan. 29.

**Westinghouse Plant.**—Engine-type alternators are described in circular No. 1,037 issued by the British Westinghouse Co. The make-up and full views of several of these machines are shown.

**B.T.H. Plant.**—Direct-connected traction and power generators is the subject of pamphlet No. 83 issued by the British Thomson-Houston Co. Several fine examples of these generators are illustrated, and a list of installations where this plant is installed is given, totalling over 90 machines, with an aggregate of 13,630kw. These machines are for continuous current. Direct-connected generators aggregating 17,540kw., for three-phase, are put down or in course of construction for Middlesbro', Glasgow, Dublin, and the London United Tramways, and the Central London Railway.

**Fire**.—The United Asbestos Co. (Ltd.), Dock House, Billiter-street, E.C., inform us in regard to the statement in Friday's papers that the company's works at Millwall had been damaged by fire, that the premises formed only a small branch of the company's manufacturing business. The chief part of the company's operations are carried on at the extensive works at Harefield, near London, and orders can therefore be executed with the usual promptitude.

**High-Resistance Wires**.—We recently referred to the price list and particulars of high-resistance materials issued by Messrs. W. N. Brunton & Son, of Musselburgh, N.B. A new list of these resistance materials is now issued, in which is described the specialities of the firm.

**Calendars, &c.**—Good wishes for a Merry Christmas and a Happy New Century reach us from the electrical engineers in Pretoria, and are heartily reciprocated.

A well made-up desk or hanging calendar reaches us from the Cape Asbestos Co., 8, Minories, London, E.C., and will be found of service.

A useful tear-off pad calendar has been forwarded by Messrs. Nalder Bros. and Thompson, of 36, Queen-street, Cheapside, London, E.C.

**Catalogues**.—A catalogue of new fittings is issued by the Sun Electrical Co.

The British Electric Works Co. have just issued to the trade the first 48 pages of their main catalogue. All the goods listed are made at the company's Birmingham works, the porcelain parts being made at the company's potteries at Hanley. On pages 39 to 46 the "Stellite" distribution system is described.

**Exports of Electrical Apparatus and Material**.—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 2 to Jan. 8, with the ports of destination:—

*Africa*—Cape Town, £844 (including £225 telegraph material); Chinde, £39; Durban, £824; East London, £533 (including £449 telegraph metal); Port Elizabeth, £27. *Argentina*—Buenos Ayres, £469 (including £80 telegraph material). *Australasia*—Lyttleton, £31; Sydney, £778; Wellington, £79. *Azores*—£4,970 (including £4,950 telegraph cable). *Brazil*—Rio Janeiro, £13. *Chili*—Boca, £319 (telegraph material). *Colombia*—Santos, £810 (including £320 telegraph material). *Denmark*—Copenhagen, £405 (telegraph wire). *France*—Calais, £30. *Germany*—Hamburg, £1,125 (including £1,100 telegraph material). *Gibraltar*—£13,669 (including £13,080 telegraph cable). *Holland*—Amsterdam, £55. *India*—Bombay, £925; Calcutta, £468. *Japan*—Moji, £160; Yokohama, £119. *North Atlantic*—£34,700 (telegraph cable). *Russia*—Kure, £1,514 (telegraph cable). *Spain*—Malaga, £120. *Straits Settlements*—Singapore, £40. *Sweden*—Gothenburg, £28 (telegraph wire). *Uruguay*—Monte Video, £150 (telegraph material). Total £63,250, against £8,905 in the corresponding week last year (Jan. 3 to Jan. 9).

**Imports of Electrical Goods into the United Kingdom**.—The value of the electrical goods and apparatus imported into this country during December was £147,205, against £149,537 in the preceding month. The total for the 12 months ended Dec. 31 was £1,265,965.

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

November 5, 1900.

19,782. D. Roberts. Derby. Improvements in metal or composition-sheathed insulated electricity conductors.

19,809. S. Hutchins and C. E. Fry. Altrincham. An improvement in or in connection with trolley arm standards for electric railways or tramways.

19,822. O. C. Summers. London. An improved conduit for electric cables and the like.

19,824. J. Berry. London. Improvements in and relating to printing by telegraphy.*

19,829. C. H. Jelks. London. An improvement in electrical locking apparatus for railway signals.

19,836. M. J. Buxbaum. London. Improvements relating to electric call apparatus.

19,847. O. L. Peard. London. Improvements in electric fuses.

19,852. W. Felsch. London. Improvements relating to electric lamps.

19,858. W. Sumner. Liverpool. Improvements in electrical switches.

November 6, 1900.

19,900. H. Specht. Manchester. Improvments in and connected with electric punka motors.*

19,902. F. E. Hammond. Glasgow. Improvements in joint boxes for distribution of electric current from concentric or other cables.

19,910. A. W. Hancock, J. Leighton, and R. Hacking. London. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like.

19,922. P. T. J. Estler and F. Kleinsteuber. London. Improvements in overhead electric fittings.

19,934. C. Wottequand. London. Improvements relating to the mounting of electric bells.*

19,945. W. P. Thompson. Improvements in incandescent electric lamp. (Alf. Sinding-Larsen, Norway.)*

19,948. J. P. Pehrson. London. Improvements in and relating to automatic switch systems for telephone lines. (Date applied for under Patents, &c., Act, 1883, sec. 103, April 10, 1900, being date of application in Sweden.)

19,951. G. E. Heyl-Dia. Liverpool. Improvements in or relating to dry-core cables and the like electric conductors.

November 7, 1900.

19,987. W. R. Sykes, A. H. Johnson and C. J. Cooke. Bickley. An improved electrical connection or bond for application to railway or tramway rails.

19,988. W. R. Sykes, A. H. Johnson and C. J. Cooke. Bickley. An improved insulating rail joint for railways or tramways which offers considerable resistance to currents of electricity.

19,909. A. J. C. Jackson. Greenisland. Telephone transmitter of the sounds of rifle fire, Maxim fire, pom-pom fire, and Long Tom fire, with the noise of its shell in progress and its ultimate bursting.

20,016. H. Oppenheimer. London. Improvements in and connected with switches of keys in electric lampholders. (Actiengesellschaft Mix and Genest, Germany.)

20,049. J. M. Richardson and H. Ramsbottom. London. Improvements in the manufacture of elements or plates for electrical storage batteries.

November 8, 1900.

20,091. H. Christian. Bradford. Improvements in clutches for transmitting power.

20,110. H. G. Thomas. London. A safety swinging arm for carrying overhead electric wires.

20,112. J. R. Quaix. London. Induction electric telephony and telegraphy.

20,135. E. H. Tyler and A. G. Hansard. London. Improvements in the control of electrically propelled vehicles or trains.

20,139. J. P. Pehrson and G. A. Betulander. London. Improvements in automatic telephone switches. (Date applied for under Patents, &c., Act, 1883, sec. 103, April 12 1900, being date of application in Sweden.)

20,146. F. Oppender and L. Roder. London. A sound strengthening appliance for telephone stations.

November 9, 1900.

20,152. J. Ridley and G. Gibson. Birkenhead. Improvements in or relating to magneto electric and other ignition devices.

20,177. E. Batault. London. Commutator or collector for electrical purposes.

20,179. E. R. Smith, J. J. Rathbone, and C. B. King, jun. London. Improved construction of electric arc lamp.

20,186. C. D. Abel. London. An improvement in air brakes controlled electrically and by air pressure. (Siemens and Halske Aktien Gesellschaft, Germany.)*

20,197. M. Lachman. London. Improvements in the construction of metal troughs for laying electric mains.

20,200. J. H. Noble and A. Merry. Liverpool. Improvements in or relating to electrolytic cells.

20,201. G. E. Heyl-Dia. Liverpool. Improvements in or connected with apparatus for covering electric conductors with insulation.

20,214. T. Bergmann. London. Electric lighting cane.*

November 10, 1900.

20,231. R. F. Hall. Birmingham. Improvements in electrical connections.

20,255. W. G. Stones. Manchester. A new or improved fitting or accessory for electric ceiling roses and the like.

20,256. A. J. Boult. London. Improvements in or relating to swinging brackets for electric lights and the like. (K. M. Seifert & Co., Germany.)

20,264. C. D. Burney. London. Improvements in connections for electric mains.

20,277. O. Imray. London. Improved means for supporting the osmium filaments of electric incandescent lamps. (The Oesterreichische Gasglühlicht-und Electricitats Gesellschaft Germany.)

20,285. E. Fletcher. Birmingham. Improvements in chains for suspending electroliers, electric lamps, and the like.

November 12, 1900.

20,357. J. McHardy. London. An improved self-contained portable electric lamp.

20,362. C. Howard. London. Improvements in renewing the filaments for electric incandescent lamps.*

20,383. B. G. Lamme. London. Improvements relating to alternating-current induction motors. (Date applied for under Patents, &c., Act 1883, sec. 103, April 14, 1900, being date of application in United States.)

20,384. B. G. Lamme. London. Improvements relating to systems of electrical distribution. (Date applied for under Patents, &c., Act 1883, sec. 103, April 14, 1900, being date of application in United States.)

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

10,273. HADDAN (Garton Daniels Co.). Controller regulators for electric motors.
10,312. WILSON. Wireless telegraphy.
10,312A. WILSON. Electric wireless signalling. (Date claimed under Patents Rule 19, June 5, 1900.)
10,751. WILLATT. Electrical generators and electrical motors.
12,139. COLLIS and KELLY. Backing-up machine for mechanically backing up electros and half tone work either for books, periodicals, or trade work.
12,249. LAKE (Langville). Thermo-electric cells.
12,950. GARSTI and POMPILI. Apparatus for the electrolysis of water.
13,048. ELLIOTT and ESKHOLME. Means for controlling the speed of electro motors.
13,415. Y LÓPEZ. Manufacture of electric insulators.
14,525. JOHNSON (Riker Motor Vehicle Co.). Electric controller brushes.
14,582. CHAVARRIA-CONTARDO. Electric furnaces.
15,710. LAKE (Bowker). Electric storage batteries.
16,050. BRITISH THOMSON-HOUSTON CO. (LTD.) (Rice). Controlling high-potential electric circuits.
16,129. BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz.) Dynamo-electric machines.
16,130. BRITISH THOMSON-HOUSTON CO. (LTD.) (Hewlett and Emmett.) High potential electric switches.
16,147. RYAN. Electrically propelled motor road vehicles.
16,483. FULD. Portable electric batteries.
17,549. JERRARD. Electrically operating signal bells and apparatus for that purpose.

## COMPANIES' MEETINGS AND REPORTS.

### Perth Electric Tramways (Ltd.).

The second ordinary general meeting of this company was held on Wednesday at the offices, 3, Laurence Pountney-hill, Cannon-street, London, E.C., Mr. EDWARD HEASMAN (chairman of the company) presiding.

The SECRETARY (Mr. E. R. Tasman) having read the notice convening the meeting,

The CHAIRMAN said: Before moving the resolution for the adoption of the report and accounts, which I assume you will take as read, it will, I think, be well to make a few remarks upon the company's position, although it is so very fully dealt with in the report that there is little left for me to say. It will, I am sure, be satisfactory for you to know that the works of construction and equipment have been very substantially carried out, the material used being of the best description and much beyond what was required by the Government under the concession. Our object, however, in thus substantially building and equiping the tramways will be perfectly obvious, as, although it entails an additional outlay of capital at the outset, the economies in the future under the head of maintenance and renewals will more than compensate for this In an undertaking such as this it is imperative that the very greatest care and supervision be made in selecting the various materials and seeing that the construction of the works is substantially carried out. As an instance, take the item of permanent way, which represents a large proportion of our outlay. This does not always receive the attention it deserves, but, fortunately, those who have been sponsors for this company realised from the commencement the importance of obtaining everything of the very best manufacture, and no expense whatever has been spared in the constructional work. You will see by the report that the construction was commenced in the early part of 1899, and we have now a track of about 10½ miles in full running order. I think you will agree with me that the returns shown in the revenue account are very gratifying considering all the circumstances under which they were obtained. The working expenses, as you know are disproportionately high on the first sections of a tramway like this, and, therefore, as further sections are opened the ratio of working expenses correspondingly decreases. Therefore, I think to have earned any profit at all upon the working of the first sections with which our accounts deal is a very satisfactory feature, and, indeed, we should not have been disheartened if no profit had been earned at all during that time. During November the gross receipts amounted to £2,412. 10s. which is at the rate of nearly £29,000 per annum; and the working expenses for that month were about 48½ per cent. In December, however, the gross receipts amounted to £3,410, which is at the rate of nearly £41,000 per annum the working expenses being about 51½ per cent. This result is exceedingly gratifying seeing that it is obtained with only about one half the total mileage which we are authorised to construct. It will, I think, be interesting for you to know that the gross traffic receipts for the week ended Friday, 4th inst., were £975, and for the previous week £888. The average gross receipts for the four weeks ending Jan. 4 were nearly £825 per week, or at the rate of nearly £43,000 per year, and from such a result it is quite evident that our returns are progressive and are steadily increasing as the use and convenience of the tramways are becoming more recognised. We are expecting to have another section of about 2½ miles opened some time this month, which will run in a north-westerly direction towards the suburb of Leederville, and it is anticipated that very good returns will be received from that source, so that during the current year with about 13 miles of track working we have reasonable grounds for anticipating that our profits will be at the rate of not less than £20,000 per year. Our managing director has always said that with this next route open our takings will amount to not less than £1,000 per week. He has not been over the mark hitherto, and probably, therefore, he is not too high in this instance. In that event our profits would be about £25,000 per annum; but we shall very soon have this route open, so it is not worth while forecasting. You will see that our annual fixed charges in respect of interest on the debenture stock amounts to £7,500. The profits, therefore, which we anticipate, and which I think we can confidently expect to realise upon the 13 miles of track, which will be running some time this month, will be nearly three times as much as is required to pay our debenture interest. Out of the surplus profits we shall be able to form a substantial reserve fund for the redemption of the debentures and also for other purposes of the company, which in the ordinary course of prudence it is necessary to provide. It will thus be seen that the preference shareholders may reasonably expect to receive within a short time a distribution on account of the accumulated profit, and at a later stage the ordinary shareholders will naturally participate in the dividends.

The cost of building the remaining routes included in the concession will be comparatively small, as it must be borne in mind that the heavy expenditure which has been incurred in connection with the erection of the power-house plant and machinery gives practically all that is necessary for running the whole system of tramways. It will, however, be necessary to add another power generating engine when the further sections are opened beyond the 13 miles I have already referred to, and you will see in the report that steps have already been taken for installing this. With this exception, the work to be done to complete the system will consist only of the construction and equipment of the track, and the erection of the overhead work. It will no doubt be necessary to provide further rolling stock; in fact, we have recently received a telegram from Mr. Somerset to the effect that the traffics are already more than the 20 cars which are now in use can deal with. Fortunately, we have six more cars ready to ship, but when the next section is opened it is perfectly evident that still more cars will be required. From the report you will have noticed that the company is seeking to obtain the right to supply electric light to the city of Perth, and we are told by Mr. Rogers, our managing director, that there is every hope of our securing this. It is perfectly clear that with the excellent plant and machinery which we already have for the purpose of the tramways, we can very successfully compete with any other corporation which may be desirous of supplying electric light to the city; and whilst it will be a benefit to the people of Perth, both as regards convenience and economy, the acquisition of this concession will, at the same time, be a very valuable asset of the company, from which an increased net revenue should be gained, more than justifying the capital outlay which would be necessary for carrying out the works in connection therewith.

I would like to express, on behalf of the board, our appreciation of the services of our managing director, Mr. E. E. Rogers, in Western Australia. You will readily understand how many difficulties Mr. Rogers has had to overcome in connection with the different negotiations which were necessary in the first stages, and throughout the subsequent stages in which he had to deal with the authorities in Western Australia, but his unfailing tact and energy have been successful in overcoming all the troubles with which he has had to contend. We also wish to record our appreciation of the services of the manager and engineer, Mr. H. J. Somerset, and we consider that in securing the services of this gentleman, after the most careful investigation of many applications, we obtained for the company a very competent man, and one in whom we have the greatest confidence. Certainly our good opinion of Mr. Somerset has been borne out by the result of the work he is doing, and we are perfectly satisfied that the tramways will prosper under his management; and, further than this, if we are successful in obtaining the right to supply electric light to the city of Perth, Mr. Somerset's experience is such that his services will be invaluable in this direction, because in his former capacity as manager of the Winnipeg Electric Street Railway Co. he had the supervision of the electric lighting plant of that city, which further supplied power for stationary motors, all of which were under his guidance. I would like to read an extract from a telegram just received. It states this: "Newcastle-street begins running Jan. 30; general prospects are most encouraging." I now move—

"*That the report of the directors and the statement of the accounts to June 30, 1900, now submitted to this meeting, be and the same are hereby adopted.*"

Mr. OLIVER WETHERED seconded the resolution, and said, I do not propose to mention more than material facts, but as the only director who has had the advantage of seeing the tramways within a recent period—some six months ago—I should like to testify from my personal observations as to the excellence of the work done in Perth—that is, from the engineering point of view—the excellence of the plant, and also regarding the excellent work done for us by Mr. Rogers and Mr. Somerset. Unintentionally, I think, our chairman omitted to mention the name of one gentleman to whom much credit is due—I mean Mr. Childs who laid the track, for, in my opinion, no tramway line has ever been laid in a more efficient way than that which has been laid for us by Mr. Childs. I think the chairman will bear me out that some recognition is due to Mr. Childs. With the two gentlemen named, Mr. Rogers and Mr. Somerset, we should get good results: but I admit I am astonished with the wonderful results we have already got in working with the nominal service of only 20 cars. We have another six going out, and it will not be long before we add to our stock. Taking all these facts into consideration—a thorough good system, a well laid track, and a thoroughly good staff and an appreciative public, as evidenced by the splendid traffics we get, I have no hesitation in confirming the views of the chairman that the preference shareholders will soon get a dividend, and that at no distant date, and that the ordinary shareholders will not have to wait very long before they also receive a dividend. We have present with us to day Mr. Alfred Morgan, a gentleman who is closely identified with many successes in Australia. He has been kind enough to come here

to-day, and probably the meeting would be glad to hear his opinion with regard to our system.

Mr. ALFRED E. MORGAN (M.P. for Coolgardie): Mr. Chairman, as a member of the West Australian Parliament, as a resident of Western Australia, and of Perth in particular, and as one who is largely connected with mining interests in that great colony, I have much pleasure in making a few remarks to-day in reference to the Perth tramways. I had the opportunity of witnessing the construction of this tramway from the time of its commencement up to its completion at the end of Hay-street West, and as an engineer by profession, I am very glad to bear my testimony to the fact that it is the finest bit of work of the kind I have ever seen. The whole of the road-bed of the tramway was constructed upon the best possible lines. The whole of the excavations made were fillled in with the highest quality of concrete, and I was informed by Mr Childs, the engineer in charge of the work—and who, I am glad to say, well deserves the enconium passed upon him to-day—the whole of the system was laid down with rails weighing 92lb. to the yard. I saw the whole of this work carried through. Each day, as a matter of fact, I witnessed the carrying out of the operations, and there is no question that this tramway is built upon the best possible lines; in fact, I think it would be quite impossible, from an engineering point of view, to lay it down better. I regret to say I am not a shareholder in this undertaking, and I say so sorrowfully, for I think it would be better to be a shareholder in this undertaking than to be a member of the West Australian legislature. Certainly there will be more profit attached to it; but speaking now as a public man, as a resident of Perth, and as one who takes a great interest in the development of the resources of the great Colony of West Australia, I may say this tramway has given to the public of Perth and the public of Western Australia generally, the greatest satisfaction. There is no doubt that it has filled a long-felt want in Perth. Perth is a beautiful city; it is built upon the banks of the Swan river. It has every convenience necessary for the development of life, and also it is a favourite spot in Western Australia as a residence. One great want there was the question of transit and communication, and there is no doubt that this tramway has filled up the great need. The public have appreciated the tramway, and I think when I tell you, as a public man, that I have not heard one single complaint against the construction or the working of the line, that that speaks volumes for the enterprise. In a democratic country such as Australia is it is rather difficult to satisfy the public. I have had considerable experience in such matters, and this is one of the things that has struck me very forcibly in connection with this undertaking, that not a single complaint has been made; indeed, the only references I have heard made regarding it are in its praise. With regard to its utility, I have no doubt at all that the enterprise will be a financial success and a great success. It cannot be otherwise, seeing it is serving a very important district such as the capital of West Australia. It really is carrying out what was desired there—some kind of communication with the suburbs of Perth. It will be gratifying to you all to know that as soon as the construction of your tramway from the power station to the end of Hay-street West was completed the value of the property along the route increased immensely in value. I can assure you of this from my own personal knowledge, as I am a holder myself of some of the property on the line of route. I may safely tell you that the value of property has increased far more than the total capital of the tramway itself. Seeing this, and looking at the fact that you have had such splendid traffic returns up to the present time, I think there cannot be any doubt that you have a magnificent enterprise—one that will be profitable to you as well as advantageous to the inhabitants of the great city of Perth. I have had very great pleasure in coming here to-day, and hearing your very favourable report. I can only say that in my own mind I have not the slightest doubt that the receipts you are anticipating will be more than fulfilled, and that you will find that so soon as the line from Newcastle-street is completed, and especially when the line is extended to Leederville, that then the traffic over the line will be so great that it will be necessary for you to increase the number of your cars and also the power of your plant station. This is the first instance of the establishment or inauguration of electric tramways in Western Australia, but now there is an effort to be made in Kalgoorlie for the establishment of a similar system there. Although the public in Western Australia has not been accustomed to tramway traction, they have taken to it very kindly indeed, and looking at the fact that for five or six months in the year the weather in Perth is very warm and dusty, I can assure you the advantages offered by the tramways will be fully taken advantage of. At Kalgoorlie, from the concentration of population in that centre, the tramways must prove a great success. The opportunities you have before you are great, and I am perfectly satisfied that you could not have found a better field for your enterprise—your practical enterprise—than in the colony of Western Australia, and in these great and populous centres of Perth and Kalgoorlie.

The CHAIRMAN thanked Mr. Morgan for attending the meeting and confirming all the information that the board had received from the other side.

The resolution was then put and agreed to.

A SHAREHOLDER moved that a sum of £500 be voted to Mr. Rogers, the managing director in Australia, as a mark of their gratification for his successful management of the company's business during the first two years of construction, and that the sum of £250 be voted to Mr. Somerset, the engineer, as a mark of gratification for his successful operation of the power plant and construction work during the time he had held the appointment of engineer.

This, after some discussion, was unanimously agreed to.

The CHAIRMAN moved and Mr. R. C. OGILVIE seconded the re-election of Mr. Oliver Wethered as a director, which was approved.

The auditors, Messrs. Monkhouse, Stoneham & Co., were re-appointed and the proceedings terminated with a vote of thanks to the chairman.

## Metropolitan District Railway Co.

An extraordinary meeting of this company was held on Monday to sanction the raising of additional capital to provide for the electric working of the company's system. Mr. J. S. FORBES (chairman of the company) presided.

The SECRETARY (Mr. William Jones) read the notice convening the meeting.

The CHAIRMAN said: We are met to ask you to sanction our doing what Parliament has already authorised us to do, subject to that sanction. The position of the District line has become desperate from causes over which neither we nor you have control. Something must be done. Will you, or will you not, take measures which, according to ordinary human prescience, are calculated to pull you out of a great dilemma? Our dangers and difficulties have all arisen from two causes not foreseen at the time of the formation of the District Company. The omnibus competition for a number of years has aggregated into an enormous loss to us in the way of traffic, and we have had a taste of another cause—the Central London Railway—whose effects are visible immediately in the abstraction of traffic which used our line and that of the Metropolitan Railway Co. How, for want of a better means of communication, are we to make an effort to retrieve the position? because if the advantages of electrical traction are so great as they are said to be—and no doubt are—nobody has a greater interest than ourselves in applying that remedy. By the adoption of electrical working we shall have no vitiated atmosphere, have plenty of room to move, and we can dispense with deep descents into the earth and systems of lifts and so forth, because we are on the surface. What we want is to apply electricity so that we may utilise our line, near the surface as it is, at a very small expense. We are told this can be done, and we ought to do it, and that is the object of this meeting—to give us the means of doing it. What was speculative two or three years ago is now proved to demonstration—that our railway can be "electrified" or adapted to electric traction, and that this can be done at moderate cost and in a very short time. Are we to do it? That will depend upon your vote to-day. We shall have to decide whether we shall carry out the extensive works ourselves or put it up to lump-sum contract with responsible people. We do not profess to be skilled in this matter ourselves. It is a novel departure, and, providing the speculator or contractor gets no undue advantage, the latter seems the only possible and proper course. I will propose a resolution that you accord your assent to the general idea, trusting us, if you think fit, to carry it out to the best of our ability. We have, in conjunction with the Metropolitan Railway Co., received tenders from the greatest electrical firms, not only in this country but elsewhere, and we are advised by Sir William Preece on the electrical branch, and by Sir John Wolfe Barry in other matters, to adapt electricity to this particular line, and your directors are themselves pretty well satisfied that this thing can be done, and will be done promptly and effectually, if you will vote the money. You will remember that we have already obtained a bill from Parliament in which certain powers are secured affecting capital—another method, in fact, of dealing with this question of ways and means if our appeal to the shareholders should fail, as in our present condition we cannot afford to rely upon only one chance. Remember, there is a public duty thrown upon the company; it is not merely a matter confined to the immediate necessity of any particular class of shareholders. If we do not convert our railway to electric traction we must go on depreciating, and there will be no answer that I can find against other railways being promoted parallel with our own, with the express object of denuding it of the traffic which it now possesses. The issue is too great for small considerations. This is one of those occasions when people who have got to bear the onus of initiating these measures must appeal to the confidence of the shareholders, without which, of course, they are helpless; and I make that appeal to you on behalf of the board and for myself on this occasion. I now move: (1) "That under the powers of the Metropolitan District Act, 1897, and the Metropolitan District Railway Act, 1900, there be created and issued £500,000 ordinary stock of the company, and that the directors are authorised to issue such stock. (2) That this meeting sanctions the exercise by the company of their borrowing powers to the extent of £166,000 authorised by the Metropolitan District Railway Act, 1897, and the Metropolitan District Railway Act, 1900, by the creation and issue of debenture stock with a fixed and perpetual preferential interest at such rate not exceeding 5 per cent. per annum as the directors may determine, payable half-yearly."

Mr. S. C. NOBLE asked if the resolutions were agreed to it was the intention to proceed with the clauses in the company's act by which they sought to confiscate the rights of the existing holders of perpetual preference stock by a reduction of from 5 per cent. to 3½ per cent.

The CHAIRMAN replied that if the shareholders sanctioned the resolutions, they believed they would be armed with sufficient funds to enable them to apply electric traction to their railway as it existed. Therefore the alternative methods would not be required. But if they could not raise the money in the manner proposed they would have to go to the shareholders for a more stringent power—raising money, in fact, over the heads, more or less, of the preference holders. Their property could not be saved without more money, and unless the shareholders found the money, or enabled the directors to find it, they would be worse off than they were now. As to the finding of the money, it would be possible to enter into a contract with some of the great electrical construction and manufacturing companies, who might, in virtue of this £500,000 of ordinary and £166,000 debentures, enter into a lump-sum contract to execute all the work necessary. They had in hand a number of tenders from firms of high standing, and with great capital behind them, all anxious to get hold of this job. The electrical industry is in limited hands. It is somewhat complicated, but it is possible to enter into a contract with some of those companies.

Mr. RAWLINGS inquired if there was an American syndicate in connection with the word "combination."

The CHAIRMAN said there were some American people—the Westinghouse Company, for instance, but they were only one out of a great many. The Board had tenders from all sorts of places—some from Austria, some from Germany, and some from firms in this country. The work would have to be done by a combination in the sense of going to some of those people in the manner he had described.

Mr. WALFORD asserted that if the line was not electrified he believed that in a couple of years they would be in the hands of a receiver.

Mr. ROBERTSON said they must have more capital, and the sensible and straightforward thing to do was to at once set about getting that capital. They must save their line, and it was only by that meeting giving the directors the power they now sought that they could save the line. If they travelled by the Central London Railway they found the difference in locomotion, comfort, light, and everything else, and that meant, other things being equal, that travellers would go by the Central London rather than by the District. With a better system of locomotion, carriages, and lighting there was a good future for the District, but without it they must fail.

The resolutions were then carried unanimously, and the proceedings terminated.

## London Electric Omnibus Co. (Ltd.)

An adjourned meeting of this company was held on Monday. Lieut. Col. T. T. TURNBULL presided, and said that, when he accepted a seat on the board, and became managing director, the funds of the company were nearly exhausted, and many complicated questions had to be dealt with. These points had been cleared up now. The principal subject which had recently occupied the attention of the board was that of finding an omnibus which could be run, not as an experiment, but on commercial lines. They believed that a suitable vehicle could now be obtained at a moderate cost, and had, therefore, sent out a circular to the shareholders advocating a scheme of reconstruction with a view to providing the necessary additional funds. The circular had been received by the shareholders with favour, as only two replies were unfavourable. The idea was to register a new company with a capital of £100,000.

Mr. HAWKINS thought before the old company was liquidated, more particulars should be given of the new class of omnibus proposed to be acquired.

The CHAIRMAN said the omnibus they proposed to adopt would seat 14 passengers, and would, it was believed, earn satisfactory profits.

Mr. HAWKINS said originally the shareholders were promised as much with regard to the company's then omnibuses and these had proved a failure. He wished to know the name of the company running the new type of omnibuses, and asked if an example of the vehicle could be seen in England.

The CHAIRMAN replied that one could be seen in this country, but he did not think it prudent to mention in public the name of the company now running them. He added that none of the new omnibuses would be purchased until they had undergone a practical trial of 30 consecutive days' running. In any case, unless the shareholders gave a decided opinion in favour of reconstruction, and supported the scheme in a practical shape, there would remain only one course open, and that was to wind-up the company.

A motion for reconstruction, proposed by Mr. ARNOLD, and seconded by Mr. C. SPAGNOLETTI was eventually carried.

**BRUSH ELECTRICAL ENGINEERING CO. (LTD.).**—Notice is given of an extraordinary general meeting of this company at Winchester House, London, E.C., on Monday, Jan. 14, at noon, to consider and adopt an agreement with the British Electric Traction Co., Ltd. The terms of the proposed agreement are appended to the notice. The notice continues: "The British Electric Traction Co. is a large buyer of electric generating plant, cars, &c., and is anxious to associate itself with a manufacturing Company capable of meeting its requirements in this direction. These requirements are of a class which the works of the Brush Company are well adapted to supply. With the object of obtaining an interest in the Brush Company, the B.E.T. Co. offers to issue fully paid ordinary shares, ranking for dividend as from April 1, 1900, to shareholders in the Brush Company, in exchange for fully paid ordinary shares of the Brush Company ranking for dividend as from Jan. 1, 1900, in the proportion of one £10 ordinary share of the B.E.T. Co. for 7½ £2 ordinary shares of the Brush Company, all transfer fees, &c., being borne by the B.E.T. Co. When an exchange involves fractions of a share of the B.E.T. Co., scrip will be issued for such fractions, and scrip for fractions amounting to a whole share will, within a limited time, be exchangeable for a certificate for a whole share. . . . The market value of the existing £10 ordinary shares of the B.E.T. Co. is about £13. 5s., and of the £2 ordinary shares of the Brush Company about £1. 15s. . . . To facilitate the carrying out of this arrangement four directors of the Brush Company (Messrs. A. Ayres, A. H. Sanderson, Col. F. G. Steuart, and E. Woods) have tendered their resignations conditionally on the adoption of the agreement, the B.E.T. Co. undertaking to pay them £2,250 as compensation for loss of office subject to the Brush shareholders approval. Three of these vacancies are proposed to be filled by the appointment of Lord Vaux of Harrowden, and Mr. C. S. B. Hilton nominated by the B.E.T. Co., and Mr. R. Percy Sellon, general manager of the Brush Company. Mr. Slater Lewis has been elected by the board to fill the vacancy caused by the death of Mr. B. H. Van Tromp. In the event of the agreement being approved a further agreement set out in the notice is to be entered into, providing for the supply of plant by the Brush Company to the B.E.T. Co. and its associated companies at fair current prices less a special commission of 5 per cent."

**ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.).**—The first annual general meeting of this company was held on Monday, Mr. J. B. Braithwaite, jun., presiding. The chairman said the transfer of the two properties at Melbourne had not yet been completed, but the delay had resulted in the companies having obtained powers under a new Act of Parliament for the supply of electricity to the important suburbs of Melbourne for 25 years. At Geelong the Order in Council, in the name of the company, extended for a period of 30 years. The generating station at that town was completed, and the plant had been sent out. At Port Adelaide the company had taken over a small generating station, which had been run at a loss, but the revenue from which would no doubt be increased when current could be supplied from the central station in Adelaide itself. The accounts were rather meagre, as the profits from the Melbourne stations could not be included, owing to the delay in the transfer of the properties. The only items on the credit side of the profit and loss account were the premium received on the 20,000 preference shares issued, amounting to £10,000, and interest on deposits, £531. Against that the loss incurred in working the Adelaide undertaking amounted to £2,087 and expenses to £2,432, leaving a profit of £6,013. Out of this it was proposed to pay a dividend on the preference shares at the rate of 6 per cent. per annum. Further capital would shortly have to be raised for the purchase of additional plant, mains, &c., and the matter was engaging the attention of the board. The report and accounts were adopted and the preference dividend declared.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**AMERICAN ROLLER BEARING CO. (LTD.).**—This company was registered on Dec. 22, with a capital of £15,000 in £1 shares (5,000 preference), to acquire from the American Roller-Bearing Co. and Mr. L. W. Holmes a licence to deal with certain patents, and to carry on the business of iron-founders, engineers, &c. The first directors are L. W. Holmes and M. F. Hill (both permanent), and three to be appointed by the subscribers.

**W. A. S. BENSON & CO. (LTD.).**—This company was registered on Dec. 22, with a capital of £55,000 in £10 shares, to acquire the business of art metal workers and manufacturers of electric light fittings, &c., under the style of W. A. Benson & Co. The subscribers are: *W. A. S. Benson, *H. C. Marillier, *J. Lovegrove, *E. Hinton, G. R. Benson, Mrs. V. M. Benson, and Mrs. K. P. Marillier. (* First directors.)

**BOARDMAN ELECTRICAL PATENTS CO. (LTD.).**—Registered Dec. 24, with a capital of £2,000 in £1 shares, to carry on the business of manufacturing electrical engineers, electricians, manufacturers of and dealers in electrical appliances, &c. The subscribers are W. C. Edwards, T. J. Edwards, J. H. Coulson, G. Cross, W. H. Harvey, W. H. C. Boardman, and F. R. Boardman (electrical engineer).

**COLEY ELECTRIC WORKS (LTD.).**—Registered on Dec. 22, with a capital of £2,000 in £1 shares, to carry on the business of electricians, mechanical and electrical engineers, &c.

**EWART & SON (LTD.).**—Registered Dec. 22, with a capital of £36,000 in £1 shares, to carry on the business of metal workers, sanitary and electrical engineers, &c. Mr. G. Ewart is the first sole director.

**HIRE PURCHASE ELECTRIC WIRING CO. (LTD.).**—Registered Dec. 22, with a capital of £10,000 in £1 shares, to supply apparatus for and connected with the transmission, distribution and use of electric current for light and power. The subscribers are D. A. Clarke, H. T. Rutter (consulting engineer), J. J. A. Feak, F. V. P. Rutter, O. Cloudesley, A. E. Black, and F. W. Black. The first directors are E. Mann, F. Inman, and H. T. Rutter.

**PARK BROS. (LTD.).**—Registered Dec. 22, with a capital of £1,000 in £1 shares, to carry on the business of electricians, electrical and general

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900–1 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Dec. 29 | 666 | + 34 | 30 | 21,168 | + 3,076 |
| *Birmingham Tramways. | Jan. 5 | 4,077 | + 148 | 26 | 117,442 | + 4,942 |
| Blackpool Corporation... | " 3 | 221 | + 80 | 40 | 28,418 | + 7,584 |
| Blackpool and Fleetwood | " 5 | 193 | + 52 | 1 | 193 | + 52 |
| Bolton Corporation ...... | " 6 | 1,800 | ... | 40 | 54,640 | ... |
| Bradford Corporation... | " 6 | 842 | + 504 | 40 | 23,377 | + 7,788 |
| Brisbane Trams ........ | Nov. 21 | 1,871 | + 309 | 20 | 37,562 | + 7,149 |
| *Bristol Trams & Carriage | Jan. 4 | 3,685 | + 918 | 1 | 3,685 | + 918 |
| *Buenos Ayres & Belgrano | Dec. 9 | 3,080 | + 606 | 23 | 57,776 | + 5,729 |
| Central London Railway | Jan. 5 | 5,847 | ... | 25 | 122,326 | ... |
| City & South London Ry. | " 6 | 2,018 | + 874 | 1 | 2,018 | + 874 |
| Cork Elec. Trams ........ | ... | ... | ... | ... | ... | ... |
| Dover Corporation ...... | " 5 | 180 | + 21 | 40 | 8,930 | + 572 |
| Dublin & Lucan Rly. | " 5 | 70 | + 14 | 1 | 70 | + 14 |
| Dublin United ............ | " 4 | 3,461 | + 448 | 1 | 3,461 | + 578 |
| Dublin Southern Dist.... | " 4 | 736 | + 130 | 1 | 736 | |
| *Dundee Corporation ... | " 2 | 660 | + 156 | ... | ... | ... |
| *Glasgow Corporation ... | " 5 | 11,535 | + 1,715 | 1 | 11,535 | + 1,715 |
| Hull Corporation ......... | " 5 | 1,621 | + 939 | 27 | 38,433 | + 20,722 |
| *Liverpool Corporation... | Dec. 29 | 9,154 | – 2,314 | 52 | 415,378 | + 57,403 |
| Liverpool Overhead Rly. | Jan. 6 | 1,543 | + 88 | 1 | 1,543 | + 88 |
| *Sheffield Tramways ...... | " 5 | 2,878 | + 1,060 | 1 | 2,878 | + 1,060 |

* Partly electrical.

engineers, &c. Amongst the subscribers are F. W. V., J. M., E. G., and T. Park (electrical engineers), who are the first directors.

**RIKER MOTOR VEHICLE CO. (LTD.)**—Registered Dec. 22, with a capital of £1,000 in £1 shares, to manufacture, sell, let on hire, and deal in electric motors, cycles, velocipedes, vehicles, launches, flying machines, &c.

**STANDARD ELECTRIC CO. (LTD.)**—Registered Dec. 22, with a capital of £10,000, in £1 shares, to take over the business of the Standard Electric Co., and to carry on business as art metal workers, electrical and general engineers, electricians, manufacturers of electrical, scientific and other apparatus, &c. The subscribers are R. J. Green (electrical engineer), C. P. Gunn (electrical engineer), M. Maclean (electrical engineer), E. J. Baker, W. Taylor, Miss A. B. Macrone, and Miss M. F. Coombs. The first directors are R. J. Green, C. P. Gunn, and M. Maclean.

## CITY NOTES.

**MEMORANDA.**—Bank rate 5 per cent. (since Jan. 3, 1901). Price of silver 29⅜d. per oz. (Jan. 10). Consols (2¾ per cent.) 97$\frac{7}{16}$—95$\frac{9}{16}$ for money, 97$\frac{7}{16}$—97$\frac{9}{16}$ for account; 2½ per cent. 97—97½ (Jan. 10). Stocks and Shares Continuation Days, Jan. 14 and 29; Ticket Days, Jan. 15 and 30; Pay Days, Jan. 16 and 31; Mining Share Carry-over Days, Jan. 11 and 28.

**CROMPTON & CO. (LTD.)**—An interim dividend at the rate of 6 per cent. per annum for the half-year to Sept. 30 (payable 28th inst.) has been declared.

**ELECTRIC CONSTRUCTION CO. (LTD.)**—In order to provide capital for further extensions this company are offering for subscription to the existing shareholders 12,500 £2 7 per cent. preference shares at £2. 15s. per share.

**MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)**—At an extraordinary meeting, held on Wednesday, the resolution passed on the 18th ult. altering the articles of association was confirmed.

**NERNST ELECTRIC LIGHT (LTD.)**—The adjourned ordinary general meeting will be held at Westminster Palace Hotel, S.W., on Friday, Jan. 18, at 2:30 p.m., and will be followed by an extraordinary meeting to approve a resolution for certain alterations in the articles of association.

**NEW ZEALAND ELECTRICAL SYNDICATE (LTD.)**—A drawing of £1,500 first mortgage debentures of this syndicate will take place on 18th inst.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has been asked to allow the further issue of £177,951 sterling 4 per cent. 500 year debenture stock of the *Commercial Cable Co.* to be quoted in the official list. The committee has also ordered the £250,000 4½ per cent. first debenture stock of the *Calcutta Tramways Co. (Ltd.)*, to be quoted in the list.

## ELECTRICAL COMPANIES' SHARE LIST.

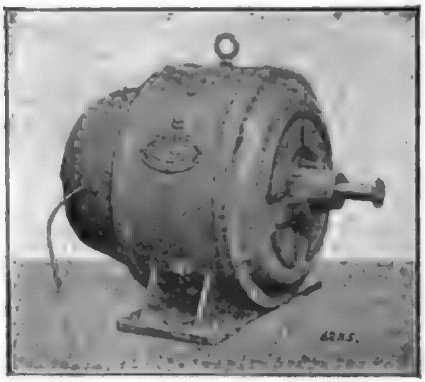
| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Jan. 2. | Price Wednesday, Jan. 9. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Jan. 9. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch Dist'ct Elec. Lt. Ord. (fully pd.) | ⅝ ⅞ | ⅝ ⅞ | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12¾ 13¾ | 12¾ 13¾ | 3 16 1 | ... | ... | ... |
| 6,000 | 10 | 4/8 | Do. 4⅔ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½ | Do. 4½ per Cent. Debenture Stock (red.) | 100 103 | 100 103 | 4 7 5 | ... | ... | ... |
| 19,561 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 8 | 7 8 | 3 16 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ 9¼ | 8¾ 9¼ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ 6¾ | 6¼ 6¾ | ... | ... | ... | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9¾ 10¼ | 9¾ 10¼ | 4 8 1 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ 5¾ | 5¼ 5¾ | 3 18 3 | " " | 5⅞ | ... |
| 31,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ 7 | 6½ 7 | 4 5 9 | March | 6¾ | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| $1,000,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 31 years Gold Bonds (red.) | 109 110 | 109 110 | 4 10 11 | April and October | ... | ... |
| 70,570 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 10 | 9 10 | 6 0 0 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 14 | 13 14 | 4 5 9 | January and July | 13$\frac{1}{16}$ | 13$\frac{3}{16}$ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 122 127 | 3 18 9 | June and December | 125 | ... |
| [illegible] | Stock | | Do. 4½ 2nd Deb. Stock [illegible] (red.) | ... | 61 63 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8¾ 9¼ | 8¾ 9¼ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ 12½ | 11½ 12½ | 4 16 0 | March and September | 12¼ | ... |
| £100,000 | Stock | 4½% | Do. 4½ Deb. Stock [illegible] (red.) | 105 109 | 105 109 | 4 2 7 | ... | 107½ | ... |
| 10,000 | 5 | ... | Folkestone Electric Supply Co. Ordinary | 5½ 6 | 5½ 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | House-to-House Electric Lighting Ordinary | 7¾ 8¼ | 7¾ 8¼ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11½ 12½ | 12 13 | 4 0 9 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6¾ 7 | 6¾ 7 | 4 3 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ 2 | 1½ 2 | ... | ... | ... | ... |
| 40,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 99 101 | 99 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 13 | 12 13 | 4 4 7 | April and October | 12¾ | 11¾ |
| £130,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 118 | 110 118 | 3 19 5 | June and December | ... | ... |
| £450,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 95 99 | 95 99 | 3 10 8 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ 15½ | 14½ 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ 6½ | 5½ 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅞ 1⅛ | ⅞ 1⅛ | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb. | 75 85 | 75 85 | 5 18 0 | January and July | 75 | ... |
| 15,000 | $100 | $3 | Royal Electric Company of Montreal Shares | 170 181 | 170 180 | 4 8 11 | April and October | ... | ... |
| £115,600 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 104 | 102 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric, Ordinary | 15 16 | 15 16 | 4 10 8 | February and August | 15½ | ... |
| 30,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ 9¼ | 8¾ 9¼ | 3 13 8 | " " | ... | ... |
| [illegible] | Stock | 3½% | Do. 3½ per Cent. Debenture Stock (red.) | 98 101 | 98 101 | 3 9 4 | ... | 100½ | 99½ |
| 14,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | 2 | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 85 95 | 85 95 | 4 4 2 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12½ 13½ | 12 13 | 5 0 0 | March and September | [illegible] | ... |
| 29,015 | 5 | ... | Do. Do. | 12 13 | 11½ 12½ | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | |
| 16,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 3 15 0 | ... | [illegible] | 14½ |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 101 105 | 101 105 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 25 | 24 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ 11½ | 10½ 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 120 | 116 118 | 3 6 1 | February and August | ... | ... |
| 11,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9¾ 10¼ | 9¾ 10¼ | 4 17 6 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 13 14 | 12½ 13½ | 6 5 11 | ... | 11¾ | 13 |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 13 14 | 12 13 | 4 5 9 | February and August | 12¾ | 13 |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 123 | 120 123 | 4 1 4 | ... | 120½ | 120½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4¾ 5¼ | 4¾ 5¼ | 5 16 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4¼ 4¾ | 4¼ 4¾ | ... | ... | 4⅞ | ... |
| £120,000 | Stock | 5% | Do. 5 per Cent. Debentures | 102 105 | 103 106 | 4 14 2 | ... | 105 | ... |
| £150,000 | Stock | 5 | Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) | 91 97 | 91 97 | 5 3 1 | ... | ... | ... |
| 285,297 | 10 | 3/0 | Central London Ordinary | 9½ 9¾ | 9¼ 9¾ | 3 4 10 | June and December | 9½ | 9 |
| £555,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 61 66 | 63 66 | 2 0 7 | February and August | ... | ... |
| 17,500 | 10 | 1/3 | Do. Ordinary (Nos. 33,501 to 60,000) | 4½ 5½ | 4½ 5½ | 2 13 9 | " " | ... | ... |
| £130,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 143 | 134 143 | 3 9 11 | " " | ... | ... |
| £211,000 | Stock | 5% | Do. (1898) | 130 135 | 130 135 | 3 14 1 | ... | ... | ... |
| £211,355 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 115 120 | 115 120 | 3 18 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896) Ltd., Ordinary | 17 18 | 17 18 | ... | ... | ... | ... |
| 31,237 | 10 | ... | Do. 6 per Cent. Preference | 13½ 14½ | 13½ 14½ | ... | ... | ... | ... |
| [illegible] | 100 | ... | Do. 4½ per Cent. Mort. Debs. (red.) | 102 105 | 102 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 22½ 23½ | 22½ 23½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ 15 | 14½ 15 | 3 19 8 | " " | ... | ... |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. Debentures | 113 114 | 113 115 | 3 17 11 | January and July | ... | ... |
| 80,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | 9½ | 9¼ 10½ | 4 15 3 | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 6¾ 6¾ | 6¾ 6¾ | 4 9 6 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13½ 13¾ | 13½ 13¾ | 3 14 1 | " " | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 14 10 | January and July | ... | ... |
| $[illegible] | $1,000 | 5% | London United Tramways [illegible] | [illegible] 104 | 102 104 | 4 17 7 | ... | ... | ... |
| $[illegible] | 100 | 5 | Montreal Street Railway [illegible] Mort. Debs. (1908) | 104 105 | 104 105 | 4 16 0 | ... | ... | ... |
| [illegible] | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 105 | 103 105 | 4 0 9 | ... | ... | ... |
| [illegible] | 5 | ... | New General Traction Ordinary | 3½ 4 | 3½ 4 | ... | ... | ... | ... |
| [illegible] | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4¾ 5¼ | 4¾ 5¼ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | | 16 17 | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | ... | 10½ 11½ | 4 13 0 | " " | ... | ... |
| 13,554 | 10 | ... | Potteries Electric Traction Ordinary | 10½ 11½ | 10½ 11½ | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 37/0 | Do. 4½ per Cent. Debenture Stock | 102 105 | 102 105 | 4 5 8 | ... | ... | ... |
| 640,000 | Stock | 3% | Waterloo and City Ordinary | 94 97 | 94 97 | 3 2 3 | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Jan. 2. | | Price Wednesday, Jan. 9. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Jan. 9. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) ...x d | 99 | 102 | 99 | 102 | 3 18 5 | January and July | ... | ... |
| 35,000 | 10 | ... | Amazon Telegraph | — | | — | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 85 | 90 | 5 11 1 | ... | — | — |
| £439,720 | Stock | 15/0 | Anglo-American | 53 | 55 | 53 | 55 | 5 11 10 | Feb., May, Aug., Nov. | ... | ... |
| £1,089,640 | Stock | 30/0 | Do. Preferred | 87 | 89 | 87 | 89 | 6 2 5 | " " | 88½ | 87½ |
| £3,065,610 | Stock | 27/0 | Do. Deferred | 10 | 10½ | 10 | 10½ | 12 17 2 | " " | 10⅝ | 10 |
| 13,333,300 | $100 | 8¼ | Commercial Cable Capital Stock ...x d | 170 | 180 | 170 | 180 | 4 8 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,563,073 | Stock | 4% | * Do. 4 per Cent. Debenture Stock ...x d | 101 | 103 | 101 | 103 | 3 17 8 | " " | 103¼ | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 6½ | 7½ | 6½ | 7½ | 7 6 8 | February and August | 6⁷⁄₁₆ | 6¼ |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15 | 16 | 15 | 16 | 6 5 0 | " " | — | ... |
| 12,073 | 5 | 3/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | — | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures ...x d | 103% | 104% | 103% | 104% | 4 6 7 | January and July | ... | — |
| 60,710 | 10 | 3/0 | Direct United States Cable ...(1 to 1,200) (red.) x d | 10 | 10½ | 10 | 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10¼ | ... |
| £109,300 | 100 | 4½% | Direct West India Cable 4½% Reg. Do. (within Nos. 1 | 98 | 101 | 99 | 102 | 4 8 2 | June and December | ... | ... |
| £3,002,000 | Stock | 25/0 | Eastern Ordinary | 139 | 141 | 139 | 141 | 4 19 3 | Jan., Apr., July, Oct. | 139 | 138½ |
| £1,636,490 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 95 | 93 | 95 | 3 13 0 | " " | 94½ | 93 |
| £1,412,369 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 111 | 110 | 112 | 3 11 5 | May and November | 111½ | ... |
| 250,000 | 10 | 3/0 | Eastern Extension | 14 | 14½ | 14 | 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14¼ | 14⁷⁄₁₆ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £4 pd, is'd at 60pm, all pd | 11½ | 11¾ | 11½ | 12 | ... | ... | 11¾ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 | 115 | 113 | 117 | 3 8 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 100 | 103 | 3 17 9 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 101% | 99% | 101% | 3 19 5 | May and November | ... | ... |
| 180,227 | 10 | 1/3 | Globe Telegraph and Trust | 10¼ | 10¾ | 10¼ | 10¾ | 4 17 8 | Jan., Apr., July, Oct. | 10½ | 10⁵⁄₁₆ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | " " | 15⁷⁄₁₆ | 15¼ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 32 | 31 | 33 | 3 11 9 | January and July | — | ... |
| £81,300 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos. | 99 | 101 | 99 | 101 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European ...(1 to 1,200) (red.) at ... 55 | 48 | 52 | 47 | 51 | 4 14 0 | May and November | 49¾ | ... |
| £103,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1898 | 104 | 107 | 104 | 107 | 5 12 1 | March and September | ... | ... |
| £163,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) ...x d | 99 | 102 | 101 | 104 | 3 16 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | 7¾ | ... |
| 2,361 | £100 Cert. | 6% | Submarine Cables Trust | 123 | 128 | 126 | 130 | 4 11 0 | " " | — | ... |
| 16,630 | 10 | ... | West African Telegraph | 3½ | 3¾ | 3½ | 3¾ | 4 9 3 | December and July | — | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) ...x d | 99 | 102 | 99 | 102 | 4 10 6 | March and September | ... | ... |
| 30,028 | 2½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures ...x d | 99 | 102 | 99 | 102 | 3 14 5 | January and July | 100 | 99¼ |
| 63,311 | 10 | 6d. | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | ... | ... |
| 34,542 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | 6¾ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures ...x d | 103 | 106 | 103 | 106 | 4 11 4 | January and July | ... | ... |
| 207,960 | 10 | 3/3 | Western Telegraph (late Brazilian Submarine) ...x d | 13½ | 14½ | 13½ | 14¼ | 4 14 3 | Mar., June, Oct., Dec. | — | — |
| £475,000 | 100 | 4% | * Do. 4 per Cent. Debs. (2nd Series, 1906) ...x d | 101 | 103 | 101 | 104 | 4 15 2 | June and December | ... | ... |
| £641,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) ...x d | 103 | 105 | 103 | 105 | 3 16 3 | ... | 103¾ | 103¼ |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | 3¼ | ... |
| 241,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 3/6 | 4/3 | 3/6 | 4/3 | ... | April and October | ... | ... |
| 72,080 | 1 | 3½% | Monte Video Telephone Ordinary | ¾ | 1 | ¾ | 1 | 5 0 0 | November | ... | ... |
| 83,492 | 1 | 1/0 | Do. 6 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | " | ... | ... |
| 630,000 | 5 | 3/0 | National | 4¼ | 4½ | 4¼ | 4½ | 6 8 11 | February and August | 4⅝ | 4¼ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 14 | 13 | 14 | 4 5 9 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4 | 5½ | 4¾ | 5½ | 4 15 3 | " " | ... | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) ...x d | 94 | 97 | 94 | 97 | 3 12 3 | June and December | 95½ | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) ...x d | 99 | 101 | 99 | 101 | 3 19 5 | ... | 101 | 99½ |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | ... | ... |
| 56,000 | 5 | 2/6 | United River Plate ...x d | 4½ | 5 | 4½ | 5 | 7 3 0 | July | ... | ... |
| 16,539 | 5 | 2/6 | Do. 5% Cumulative Pref. (Nos. 1 to 16,610) x d | 5 | 5½ | 4¾ | 5½ | 4 15 3 | June and December | ... | ... |
| 23,361 | 5 | 1/3½ | Do. do. (Nos. 16,610 to 40,000) ...x d | 3½ | 3¾ | 4¼ | 5¼ | ... | ... | ... | ... |
| £174,917 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) ...x d | 104 | 107 | 103 | 105 | 4 15 8 | June and December | 104 | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 9d. | Alliance Electrical Co. 6% Cum. Pref. | ¾ | 1¼ | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 125,000 | 1 | †1¼d. | Aron Electricity Meter 6% Cum. Pref. ...x d & bonus | [illegible] | [illegible] | [illegible] | [illegible] | 7 5 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| 53,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| £52,000 | 100 | 4½% | Do. First Mortgage Debentures ...x d | 97 | 99 | 95 | 97 | 4 7 8 | ... | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ | 11½ | 10½ | 11½ | 8 13 11 | July and February | 11½ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference ...x d | 6¼ | 6¾ | 6¼ | 6¾ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | 4¾ | ... |
| 90,000 | 2 | 1/2½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 6 8 4 | September | 1¾ | 1½ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 3 | " | 2¼ | 2 |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 109 | 111 | 109 | 111 | 4 0 11 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock ...x d | 101 | 103 | 101 | 103 | 4 7 5 | January and July | 103¼ | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 12½ | 13½ | 13 | 14 | 5 7 3 | " " | 13¼ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference ...x d | 5½ | 6¼ | 5½ | 6¼ | 4 6 11 | " " | 5¾ | 5⁷⁄₁₆ |
| £200,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) ...x d | 109 | 113 | 109 | 111 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9¾ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 0 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 19 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 19 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 64,000 | 5 | 2/6 | Crompton and Co. (Nos. 1 to 24,000) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | 3¾ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) x d | 98 | 101 | 99 | 102 | 4 15 0 | " " | 102 | 100½ |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 93,251 | 5 | 1/0½ | Edison and Swan United ("A" Shares) (£3 paid) | 1¾ | 2¼ | 1¾ | 2¼ | 5 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,029 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) x d | 89 | 93 | 88 | 90 | 4 8 11 | June and December | ... | ... |
| £100,000 | Stock | 37/11½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 99 | 100 | 99 | 101 | ... | ... | ... | ... |
| 35,500 | 5 | 6/0 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 6 0 0 | Half-yearly | ... | ... |
| £275,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 104 | 101 | 106 | 4 6 8 | ... | ... | ... |
| 112,103 | 2 | 1/2½ | Electric Construction Co. (Limited) | 2 | 2½ | 1¾ | 2¼ | 5 13 2 | January and July | 2⁵⁄₁₆ | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2¾ | 3 | 2¾ | 3 | 4 12 4 | July | ... | ... |
| £132,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 106 | 101 | 106 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | ... | Gillfre Electro Chemical and Power Co. Ord | ½ | 1 | ½ | | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13 | 14 | 13½ | 14½ | 5 8 5 | February and August | 14¾ | 13½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5½ | 5¾ | 3 19 3 | " " | 5¾ | ... |
| £250,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works ...x d | 20½ | 21½ | 20½ | 21½ | 4 13 0 | " " | 21⁷⁄₁₆ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 8 | March and September | ... | ... |
| 37,350 | 12 | 11/0 | Telegraph Construction and Maintenance | 38 | 43 | 38 | 43 | 4 5 9 | March and July | 43½ | 39½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 ...x d | 103 | 105 | 103 | 105 | 3 17 5 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 6 15 2 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 5¾ | 5½ | 5¾ | 4 6 11 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10¼ | 11½ | 10¼ | 11½ | 6 1 9 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6¾ | 7¾ | 6¾ | 7¾ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures x d | 103 | 105 | 103 | 105 | 4 0 11 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote them.



# GREENWOOD & BATLEY, Ltd.,

## LEEDS,

*ELECTRICAL ENGINEERS.*

**Four-Pole Motor List, No. 274 E,**

**NOW READY.**

***ALL SIZES IN PROGRESS FOR EARLY DELIVERY.***

**GREENWOOD & BATLEY, LTD., LEEDS.**

# IMPORTANT NOTICE.

**"THE ELECTRICIAN"**

# Electrical Trades' Directory & Handbook

ESTABLISHED IN THE YEAR 1882.

NEW NAMES AND ADDRESSES,
CORRECTIONS TO EXISTING ENTRIES,
SUBSCRIPTION ORDERS,
ADVERTISEMENT ORDERS, AND
MISCELLANEOUS INSERTIONS, FOR

**The NEW (1901) EDITION of the BIG BLUE BOOK**

(THE YEAR-BOOK OF THE GREAT ELECTRICAL ENGINEERING PROFESSION AND INDUSTRY)

Must be sent in

## AT ONCE

(latest date about January 21st). The book (with the vast number of new names and addresses and corrections to last year's entries which occur during January) will be published as usual about the end of January (corrected to January 31st) and will form the most complete and reliable work of the kind ever published. About 1,700 closely but clearly printed pages. Much additional matter relating to

ELECTRIC LIGHT & POWER. | ELECTRIC TRACTION.
ELECTRIC "BULK" SCHEMES. | MUNICIPAL TELEPHONY.

**Subscription Price, 6/6 post free (U.K.); British Colonies, 7/6; abroad, 8/- (United States, 9/-). Latest date for Subscriptions (payable in advance), January 21st, 1901. Price after that date 12/6, postage extra:—U.K., 9d.; Colonies, 1/6; abroad, 2/- (United States, 3/-).**

OFFICES: 1, 2 AND 3, SALISBURY COURT, FLEET STREET, LONDON, ENGLAND,
AND ALL LEADING BOOKSELLERS.

Digitized by Google

**SPECIALITIES.**

**WIRES** and **CABLES** up to one square inch section of copper insulated with Vulcanised Indiarubber.

**HIGH INSULATION VULCANISED INDIARUBBER.**

**LOW INSULATION VULCANISED INDIARUBBER** combined with great Mechanical Strength, Durability, and suitable for Highest Working Pressures. The most Economical and Reliable Cable for Central Station Work.

Tele. No. 2861.

## CONNOLLY BROTHERS, Ld.,

*Insulated Wire and Cable Makers,*

**Blackley, MANCHESTER**

Telegrams: CONNOLLYS BLACKLEY.

**LEAD COVERED CABLES.**

**CONCENTRIC CABLES of all Descriptions.**

**BOARD OF TRADE CABLES.**

*AGENCIES and STOCKS in LONDON, BIRMINGHAM, and GLASGOW.*

***SOLE MANUFACTURERS of "BLACKLEY" TAPE.***

THE BEST TAPE FOR OUTSIDE COVERING IN THE MARKET

---

# THAMES

**DYNAMOS**
**MOTORS**
**ELEC. DRILLS**

**The THAMES IRONWORKS, SHIPBUILDING & ENGINEERING CO., Ltd.,**

THAMES ELECTRICAL ENGINEERING WORKS,

**BLACKWALL, LONDON.**

---

# SPECIAL NOTICE

"The Electrician"
**ELECTRICAL TRADES DIRECTORY**
**AND HANDBOOK FOR**
**1901**

Will be Published as usual about **The END of JANUARY** And will contain all the ADDITIONS and CORRECTIONS to NAMES and ADDRESSES which are made in the important months of **DECEMBER** and **JANUARY**.

**50** of the changes in Names and Addresses for Directory purposes are effected in December and January—especially in January

New Names and Addresses, changes in existing Entries, Subscription and Advertisement Orders, &c., must be sent in **AT ONCE**. Full particulars, in English, French or German, free by post.

**Offices: 1, 2 & 3, Salisbury Court, Fleet Street, London, England.**

---

# DAVEY, PAXMAN & CO., L^D. COLCHESTER,

**Engineers and Boilermakers.**

**Speciality: STEADY RUNNING ENGINES FOR ELECTRIC LIGHT INSTALLATIONS.**

**MAKERS OF**

- Portable and Semi-Portable Engines
- Semi-Fixed Engines and Boilers.
- Horizontal Engines.
- Vertical Engines and Boilers.
- Tandem Engines, Simple and Compound.
- Triple-Expansion Engines.
- Corliss and Trip Gear Engines.
- Horizontal Winding Engines.
- Air Compressors.
- Compound Portable & Semi-Portable Engines
- Vertical Hoisting Engines and Boilers.
- Compound Semi-Fixed Engines and Boilers
- Compound Horizontal Fixed Engines.

**Engines of all Sizes up to 1,500 h.p.**

Paxman's Patent "Economic" Steam Boiler.

**The "ECONOMIC" Boiler is one of the best steam generators before the public not only for efficiency, but for Economy and Durability. This Boiler contains particularly good features and high qualities, and is BEING ADOPTED VERY LARGELY FOR CENTRAL ELECTRIC LIGHTING STATIONS, MILLS, and FACTORIES, &c., WITH GREAT SUCCESS**

**Cornish, Lancashire, "Essex," Vertical, Locomotive, "Economic," Safety, Water-Tube, Marine, and other Boilers.**

**D. P. & CO. ARE MAKERS OF HIGH-CLASS STEAM BOILERS OF EVERY DESCRIPTION.**

***ALL RIVET HOLES DRILLED.***

**Telegraph Address: "*PAXMAN, COLCHESTER.*"**

**BOILERS MADE UP TO 200lb WORKING PRESSURE.**

Catalogue and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ld., Engineers, COLCHESTER.**

London Office: 78, QUEEN VICTORIA STREET E.C.

// THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,183. [No. 13. Vol. XLVI.] FRIDAY, JANUARY 18, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Prof. Slaby, by his recent lecture, reprinted in abstract in our columns to-day, has shown that the application of scientific reasoning to the problems even of air-wire space telegraphy may lead to inventions elegant and valuable. Hitherto the development of this particular kind of wireless telegraphy has been left in the hands of experimenters who have seemed to the looker-on to have worked on blindly, though pluckily, apparently unguided by science and indifferent to its advancement. Prof. Slaby, though starting late, has more than overtaken his plodding predecessors, and has enriched science by his lucid exposition of the principles governing the action of the air-wire. He has merely substituted thought for drudgery. His application of the simple principles set forth in his lecture to his beautiful invention of the extension-wire, has, besides, removed the difficulties attending those atmospheric discharges frequent in summer and disastrous to the efficiency and continuity of wireless telegraphic communication in thundery weather. We heartily congratulate Prof. Slaby upon the scientific and practical success to which his researches have attained, as well as upon the Imperial recognition which they have brought to him.

The pleading of the London electric supply undertakers for an alteration in Rule B6 of the Board of Trade Regulations, and whose hardships we have had occasion to allude to more than once in our columns, is taking effect. The regulation, it will be remembered, refers to changes of declared pressure, and lays down that no change shall be made in the pressure supplied to any consumer at the date the regulations were originally sent to the "undertakers" by the Board of Trade, except with his consent. A few cantankerous consumers did withhold their consent in the case of some companies desiring to change over from 100 volts to 200 volts, and the undertakings referred to combined to make a representation to the Board of Trade on the subject. An advertisement was published in our last issue announcing that application had been made to the Board of Trade to alter the regulation to read as follows :—

**Declared Pressure at Consumers' Terminals.**—Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not at any time be altered or departed from, except in consequence of any authorised alteration of the corresponding standard pressure. In the case of a transformation of energy on the consumers' premises the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in each case the pressure so chosen shall be the declared constant pressure. Provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations are supplied with energy by the undertakers *except on such terms and conditions as may be agreed upon between the undertakers and the consumer, or failing agreement, as may be settled by an arbitrator appointed by the Board of Trade.*

The words we have italicised are new, and it is proposed that they shall replace the words "except with the consent of the consumers," which are the objectionable ones in the present regulation. As a consumer will find it difficult to put forward a valid reason to object to the above change, it may be predicted that the amended regulation will soon become law.

The short Paper and discussion on aluminium at the Institution of Electrical Engineers last week afforded a good example of the difference between theory and practice—between engineering on paper and the engineering of actual experience. Mr. Kershaw read a most interesting Paper to prove that aluminium wire was already cheaper than copper wire if conductance were taken as a basis of comparison, and that, except for its liability to corrosion in certain bad atmospheres it might economically displace the latter metal for overhead conductors. In his figures, however, Mr. Kershaw had apparently forgotten that windage should be an important element in the calculation, and had made no

allowance for a greater number of poles per mile required by his aluminium lines. The fallacy of this was obvious when Mr. Gavey got up and related how he had erected some miles —not merely 2ft. lengths—of aluminium line, with the result that it had been blown down by the first severe gale. Nor does it appear that the difficulty of jointing has yet been solved. Experiment is needed before it can be definitely determined to what extent aluminium can replace copper for electrical purposes. To a large extent this must be of a practical nature, such as in the list of instances cited by Mr. Kershaw in his Paper and in the trials which the Post Office is making; but there remains much to be done in the laboratory. A series of determinations is required of the relative conductivity and tensile strength of aluminium of various degrees of purity, and similar tests of the most promising aluminium alloys. We had hoped that the result of some such investigations would have been brought forward in connection with Mr. Kershaw's Paper.

Newspaper science is usually of the broadest kind of humour, but for an exceptional example of the truly subtle kind commend us to the *Daily Mail's* version of these Post Office experiments. As a good start our daily contemporary sagely substitutes "*platinum*" for "aluminium," and then, under the mirth-provoking title, "Copper *v.* Platinum," it proceeds as follows:—

A series of experiments are being carried on by the Post Office telegraph officials with the object of discovering whether platinum forms a good substitute for copper in telegraph and telephone wires. Platinum costs £130 per ton, and copper may be obtained at from £80 to £90 per ton, and its greater lightness renders it cheaper to use, and its conductivity is nearly as good as that of the more expensive metal. The tests have established the fact that the life of a platinum wire is shorter than that of a copper wire, as it is more susceptible to atmospheric action. The tests were carried out by setting up a 5-mile length of platinum wire near Hanley, a neighbourhood in which the atmosphere is heavily charged with sulphurous vapours. It has been practically decided not to use platinum wire unless some means can be found to toughen it.

This spread of smatterings of scientific knowledge among the general public, however, is frequently not merely humorous, but is also responsible for a number of ideas that are mischievous. Sometimes reports of deleterious effects of electric currents are endowed with a sufficient amount of verisimilitude to enable them to be accepted by the lay press, or to be passed from mouth to mouth as new scientific facts. One of the latest scares of this nature is the statement that passengers travelling by electric tramways or railways are liable to have their watches spoilt by magnetisation. It is well known to electrical engineers that watches, unless specially constructed with non-magnetic parts, are permanently affected by being brought once into proximity to a dynamo with powerful field magnets or a strong stray field. But traction motors, of course, are quite prevented by their iron cases from making their presence felt in such a manner. Notwithstanding this fact, it has been necessary for a large electric traction undertaking working in a town in the North of England to issue a statement that there was no ground for the belief that the watches of their passengers had been damaged by magnetisation.

Some curious things were said by well-known scientists at the recent conference of science teachers at Chelsea. Prof. H. E. Armstrong, who is nothing if not original, wanted to abolish the word "science," at all events from elementary teaching, and to have "nous" or "knowingness" used in its place. Girls, he said, ought to be trained "in domestic knowingness"—whatever that may mean; and he thought the essence of their domestic education ought to be to learn "how to weigh things." Prof. Lloyd Morgan, of Bristol, inclined to the view that a science teacher ignorant of psychology is "something of a quack." It surely augurs ill for the future of elementary science teaching when so much attention is paid to fads, and when faddists are in high places.

**Election of Vice-President of the Académie des Sciences.**—At the meeting on Monday, the 7th inst., a vice-president for the present year was elected by ballot. The vice-president was to be chosen from one of the mathematical science sections. The number of voters was 56, from whom M. Bouquet de la Grye obtained 54 votes and M. Mascart one vote.

**The Royal Society.**—The following were among the Papers down for reading at the meeting of the Royal Society yesterday: J. Evershed, on "Wave-length Determinations and General Results obtained from a Detailed Examination of Spectra photographed at the Solar Eclipse of January 22, 1898," and T. J. Baker, on "The Thermo-Chemistry of the Alloys of Copper and Zinc."

| Cable Interruptions. | Date of Interruption |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiro | Nov. 26, 1900 |
| Pernambuco—Ceara | Nov. 29, 1900 |
| Falmouth—Bilbao | Dec. 28, 1900 |
| Marseilles—Barcelona | Jan. 7, 1901 |
| Shanghai—Foochow | Jan. 16, 1901 |
| Shanghai—Amoy | Jan. 17, 1901 |

**The Boiler Explosion at the Crystal Palace District Electric Supply Co.'s Works.**—The Board of Works has issued its report on the enquiry it made into the disastrous boiler explosion which occurred at the Crystal Palace District Electric Supply Co.'s works last July. In our issue of September 7, 1900 (Vol. XLV., p. 749), we gave a full account of the enquiry and the decision of the Court. The report just issued is practically a repetition of what was published then, so there is no necessity to re-open the subject now.

**Wireless Telegraphy in the French Navy.**—The Paris correspondent of the *Morning Post* stated, last week, that the French Mediterranean squadron had received orders to engage in a decisive series of wireless telegraphy experiments. All the vessels composing the fleet would, he said, be fitted with wireless telegraphic apparatus, and it was believed that, after these experiments, all ships in the French Navy would be similarly equipped. He added that the Mediterranean squadron was also to experiment with an improved system of electric light signals.

**Submarine Telephony.**—Telegraphic despatches from New York announce that Dr. Pupin's invention of a system of submarine telephony has been sold to the American Telephone and Telegraph Co. for $200,000 and $7,500 a year during the life of his patents. It will be remembered that Dr. Pupin has been experimenting on an artificial cable in which he introduced distributed artificial inductance as indicated by Oliver Heaviside in his writings. In August last we described and commented on Dr. Pupin's experiments and gave extracts from the patents which are presumably the ones in question (see *The Electrician*, Vol. XLV., pp. 587 and 598.) Possibly we shall have further particulars by mail in the course of a few days.

**Wireless Telephony.**—It will be remembered that Mr. Gavey recently described some experiments in which he had

succeeded in telephoning—whether by conduction or electromagnetic induction—between two stations 8 miles apart, by means of two parallel wires 750 yards long terminating in earth-plates and not connected together. The *Figaro* and the Paris correspondents of the English daily newspapers are, however, very enthusiastic about some similar experiments on a much smaller scale, made by M. Maiche and sensationally announced by M. Gauthier. In this case the distance overcome was about 1,000 yards, and the distance between the earth-plates of each station 25 yards or 30 yards. A special transmitter was employed and an ordinary receiver.

**Australian Cable Rates.**—The Eastern Extension, Australasia and China Telegraph Company notifies that the Government of New South Wales has now accepted the agreement entered into last year by the Governments of South Australia, Western Australia and Tasmania with the Eastern Companies for establishing an alternative cable to Australia via South Africa. Consequently, the reduced rates recently announced (*The Electrician*, Dec. 21, p. 302) for telegrams exchanged with South Australia, Western Australia and Tasmania (3s. 6d. per word for Ordinary messages, 2s. 6d. for Government messages, and 1s. 4d. for Press messages) will be applicable to telegrams exchanged with New South Wales on and after February 1st. Telegrams for Victoria, Queensland and New Zealand will continue to be charged at the old rates.

**Obituary.**—It is with deep regret that we announce the death of Mr. C. E. Grove on Friday last, from an attack of typhoid fever. Mr. Grove had many personal friends in the electrical profession by whom his loss will be keenly felt, and the industry has moreover been deprived of an able and energetic worker. As chief electrical engineer at the Thames Ironworks, Mr. Grove has been responsible for many important contracts, and he will also be remembered for his energetic championship of the three-wire system during the discussion on Mr. A. K. Baylor's Paper on "Some Recent Developments in Electric Traction Appliances" at the Institution of Electrical Engineers in April, 1897, and his own important Paper "The Electrical Equipment of Ships of War," read before the Institution in April last. Mr. Grove, who was in his 38th year, was a Member of the Institution of Electrical Engineers, and an Associate-Member of the Institution of Civil Engineers. He also acted during the last few months as honorary secretary of the Electro-Harmonic Society.

**The Proposed American Pacific Cable.**—Our contemporary, *The Electrical World* of New York, remarks that it is alleged that in the interests of the American Steel and Wire Co., the Amalgamated Copper Co., and the Western Union Telegraph Co., agitation to secure the adoption of the Philippine cable bill is in progress at Washington. The cable is to extend from the Pacific Coast to the Philippines, touching at Hawaii and Guam. The bill, as now drawn, provides that the cable shall be owned and operated by an American company, that it shall be manufactured in the United States, and that it shall be laid by vessels flying the American flag. The only opposition which has thus far appeared to the bill has come from the Democrats who have advocated the ownership of the cable and its operation by the Government. Should it be decided that the Government should lay the cable, it is not at all likely that a change would be made of the clause which provides that the cable shall be of American manufacture. The first cable is approximately estimated to cost about \$11,000,000, the second cable the same figure, and other connections costing about \$600,000 additional. At the present time the only concern in the United States, it is asserted, that could turn out the entire cable within the stipulated time of five years, allowing a year at least for laying and making necessary connections, is the American Steel and Wire Co. Some of the other well-known cable manufacturers are understood to stand ready to do the work.

**The Telephone Muddle.**—An indignant frequenter of Fleet-street directs our attention to a passage in the life of Sir Charles Bright, wherein it is related how he performed the remarkable feat of laying the underground wires of Manchester in a single night. "It was essential," so the account reads, "that the traffic of so busy a city should be interrupted as little as possible. In one night [between 10 p.m. and 8 a.m.] he had the streets up, laid the wires, and had laid the pavements down again before the inhabitants were out of their beds in the morning. He was then but 19, and received great credit in the public journals, notably in *The Times*, which made this piece of work the subject of a leading article." Our correspondent continues: "This was in 1851. Manchester is a busy city, but London is busier; and this is 1901. In a letter to his sweetheart Bright, telling her all about it, says: 'I was pleased at the speed which I had calculated before on doing it in. The plan was a new one of my own.' He might well be proud of it, for at that time he had no examples to go upon, as we in these days have in abundance. Yet after 50 years' experience the scandalous condition of one of the main thoroughfares of this metropolis for weeks and even months past testify only too plainly that either we have learnt nothing or we are wanting the man." Our correspondent concludes by pronouncing the whole work, like the scheme which it is intended to carry out, a piece of magnificent blundering. Although we cannot agree with our correspondent that the two cases are parallel, we publish his remarks as an example of the present state of public opinion on the matter.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), January 18th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Annual General Meeting at Storey's Gate, when the adjourned discussion on Mr. H. A. Humphreys' Paper on "Power Gas and Large Gas Engines for Central Stations" will take place.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. Dewar, F.R.S., on "Gases at the Beginning and End of the Century."

**TUESDAY, January 22nd.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture II.: "On Practical Mechanics: First Principles and Modern Illustrations," by Prof. J. A. Ewing, F.R.S.

**WEDNESDAY, January 23rd.**

INSTITUTION OF ELECTRICAL ENGINEERS.—STUDENTS' SECTION.

*7.30 p.m.* Meeting at 28, Victoria-street, S.W. Papers to be read: (1) "Electro-Chemical Exhibits at the Paris Exhibition," by Maurice Solomon. (2) "Accumulators at the Paris Exhibition," by J. H. West.

INSTITUTION OF ELECTRICAL ENGINEERS.—BIRMINGHAM LOCAL SECTION.

*8 p.m.* Inaugural Meeting at the Birmingham University. Dr. O. J. Lodge, F.R.S., in the chair, will deliver his inaugural address.

SOCIETY OF ARTS.

*8 p.m.* Ordinary Meeting. Paper to be read: "The Proposed High Speed Electrical 'Monorail' between Liverpool and Manchester," by F. B. Behr.

**THURSDAY, January 24th.**

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.—DUBLIN SECTION.

*7.30 p.m.* Ordinary Meeting at the Royal Dublin Society.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Adjourned discussion on Mr. Mordey's Paper on "Capacity in Alternate-Current Working."

**FRIDAY, January 25th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Rooms of the Chemical Society, Burlington House. Agenda: (1) "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rucker. (2) "Note on an Absolute Method for Determining the Hygrometric State of the Atmosphere," by E. H. B. Wade. (3) Exhibition of an Experiment on the Migration of the Ions, by S. W. J. Smith.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at Westminster Palace Hotel. Paper to be read: "Railway Construction," by A. Ross.

**SATURDAY, January 26th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

Visit to the works of the India Rubber, Gutta Percha and Telegraph Works Co. (Ltd.), Silvertown.

INSTITUTION OF JUNIOR ENGINEERS.

*7 p.m.* Anniversary Dinner at the Westminster Palace Hotel.

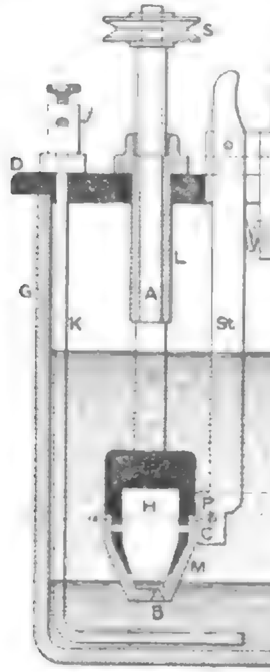
## CONTEMPORARY ELECTRICAL SCIENCE.

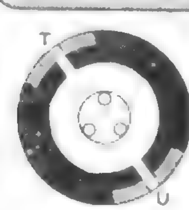
[Compiled by E. E. Fournier D'Albe.]

*Coherers.*—Röntgen rays often exert an apparent influence upon the resistance of coherers. Thus C. Jensen mentions that when he introduced a Röntgen tube into the secondary circuit of an induction coil a Kohl detector for wireless telegraphy showed an immediate response. The response occurred even after taking all kinds of precautions against stray sparks, but it was entirely obviated by enclosing the Röntgen ray tube in a box with an aluminium window, through which X-rays could freely penetrate. It is therefore clear that X-rays alone do not produce the effect described. The real cause of the effect upon the coherer was, after much investigation, found to lie in the appearance of "gliding sparks" inside the Röntgen tubes themselves. These gliding sparks play about the metallic conductors within the tubes, and appear to glide to and fro along them. That these sparks are the true cause of the phenomenon is made probable by the fact that the appearance or non-appearance of the response depends upon the position of the point at which the sparks appear with respect to the coherer. Preliminary experiments with Becquerel rays show that they have no influence upon coherers.

[C. Jensen, *Phys. Zeitschr.*, January 5, 1901.]

*New Interrupter.*—W. A. Hirschmann has put upon the market a new interrupter which involves the use of mercury,

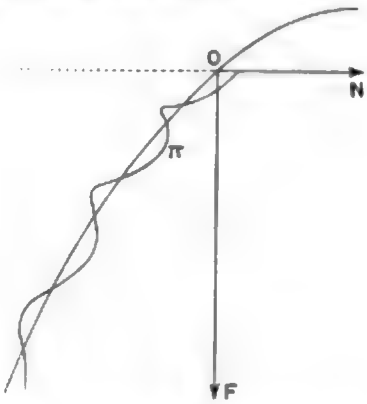




but not as a conductor, as its function is that of amalgamating the two copper surfaces forming the contacts. In the diagram (Fig. 1) H represents a hollow piece of ebonite revolving on the shaft A, and provided with two copper contacts M, provided with inlets into the interior of the ebonite as shown at T and U (Fig. 2). The other contact C is pressed against the former by a spring F. B is an opening in the ebonite block which is below the level of the mercury. It is so arranged that it scoops up the mercury into the interior of the block, and presses it out through the apertures at T and U. The contact P then spreads the issuing mercury over the contacts M, thus keeping them in good condition. The apparatus works noiselessly and well in an accumulator circuit or a 110 or 220-volt supply circuit.

[W. A. Hirschmann, *Phys. Zeitschr.*, January 5, 1901.]

*Motion of an Electrified Particle.*—E. Riecke has investigated the case where an electrified particle or ion moves in a magnetic field upon which an electric field is superimposed, both fields being uniform. The result of analysis shows that the particle moves along a cycloidal curve. In the diagram, OF is the direction of the electric force, and ON is normal to OF and to the magnetic force. The projection of the path of the particle upon the plane FON is the curve $\pi$. The axis of the cycloid is a parabola, the generating curve is no circle but an ellipse, and the arcs of the cycloid expand during the motion.



These results have an important bearing upon the phenomena in the vicinity of the cathode, the changes in luminous layers under magnetic influence, and the theory of the aurora.

[E. Riecke, *Phys. Zeitschr.*, January 5, 1901.]

*Sparking Distance between Plates.*—The researches conducted by R. F. Earhart on this subject are not correctly described by their title, since it was found practically impossible to employ true surface plates for the simple reason that the pressure required to press out the last traces of air between the plates causes strains in them which mar their flatness. The author, therefore, had recourse to an approximation by substituting for one of the flat surfaces that of a steel bicycle ball, heavily nickel plated and 2½mm. in diameter. The ball was fixed in one position, and a flat metallic surface was moved close up to it, the displacement being measured by an interferometer mirror attached to the flat surface. The results are curious and interesting. The "static" discharge potential increases very slowly from contact to about 0·2 micron, the curve being a straight line. After that distance a sharp bend occurs in the curve, which becomes another straight line at a considerable angle to the first portion, and indicates much higher discharge potentials. That happens in air at pressures of from 1 to 8 atmospheres, the discharge potentials being less at the higher pressures. With a pressure of 15 atmospheres the break occurs at about 0·5 micron. In $CO_2$ the phenomena are substantially the same.

[R. F. Earhart, *Phil. Mag.*, January, 1901.]

## ELECTROMAGNETIC THEORY.—CXXI.*

BY OLIVER HEAVISIDE.

(*Continued from page 206.*)

§ 482. When electrification moves along a straight line, the magnetic force generated is in circles centred upon that line, in planes perpendicular to it. One datum, the intensity of magnetic force at distance $r$ from the axis and distance $z$ along it is sufficient to specify H. The characteristic $v^2\nabla^2\mathbf{E} = p^2\mathbf{E}$ also suffers a reduction in the number of variables by the symmetry, $\mathbf{E}$ being representable by an axial component and a radial component. Say z is along the axis, x and y trans-

verse; then $r=(x^2+y^2)^{\frac{1}{2}}$, and the characteristic of the $z$ component is

$$\frac{1}{r}\frac{d}{dr}r\frac{dE}{dr}+\frac{d^2E}{dz^2}=\frac{p^2}{v^2}E. \tag{1}$$

This allows the immediate use of Bessel functions. Let

$$q^2=\frac{p^2}{v^2}-\frac{d^2}{dz^2} \tag{2}$$

then the characteristic is

$$\frac{1}{r}\frac{d}{dr}r\frac{dE}{dr}=q^2E, \tag{3}$$

of which the solution is

$$E=I_0(qr)A+K_0(qr)B, \tag{4}$$

where A and B are any functions of $t$ and $z$.

It being supposed here that E means the axial component of **E**, let F be the transverse component; then the second circuital law is fully given by

$$\frac{dF}{dz}-\frac{dE}{dr}=-\mu pH, \tag{5}$$

if H is the intensity of **H**. But the first circuital law has two representatives, namely

$$\frac{1}{r}\frac{d}{dr}rH=cpE, \qquad -\frac{dH}{dz}=cpF. \tag{6}$$

These equations (5), (6) are best obtained by immediate application of the circuital principles to elementary circuits. It follows that

$$H=\frac{cp}{q^2}\frac{dE}{dr}, \qquad F=-\frac{1}{cp}\frac{dH}{dz}. \tag{7}$$

The second of these is an obvious consequence of the second of (6). The first one is proved by inserting E according to (4), and then using (3).

These general equations (4) and (7) apply to other problems besides the present one, to straight round wires and tubes for example. (El. Pa., Vol. II., p. 175). But we do not require such complication as is then involved. Let there be no external interferences or boundaries or changes of medium. Then we have only one set of solutions, and we do not want the $I_0$ function in (4), but only the $K_0$. Or, if there was first an external boundary, its removal to an infinite distance would cause reflections to disappear and the $I_0$ function to drop out. That is, all we want now is given by

$$E=K_0(qr)A, \qquad F=-\frac{1}{cp}\frac{dH}{dz}, \tag{8}$$

$$H=\frac{cp}{q^2}\frac{d}{dr}K_0(qr)A, \tag{9}$$

with one function A, which must be found to suit given conditions at the axis.

Now the motion of a point-charge or electron along the axis obviously comes under this theory. Also, I have previously shown how to algebrise the special forms assumed in this case, without direct reference to a point-charge, however. (El. Pa., Vol. II., p. 456; E. M. T., Vol. II., p. 466). So, by now pointing out how to construct the operational solution, and previously how to algebrise it, I might consider the matter essentially completed, and leave the working out of details to my readers. Perhaps, however, they will be more satisfied if I continue to elaborate the subject. Besides, there are various other matters to be noticed in connection. So I continue.

To find A. If C is the electric current impressed at the axis, the circuitation of H must be C when $r$ is reduced to 0. That is,

$$2\pi r\frac{cp}{q^2}\frac{d}{dr}K_0(qr)A=C, \quad \text{when} \quad r=0. \tag{10}$$

$$\text{Or,} \quad 2\pi r\frac{cp}{q^2}\left(-\frac{2}{\pi r}\right)A=C, \quad \text{therefore } A=-\tfrac{1}{4}\frac{q^2}{cp}C. \tag{11}$$

Using this in (8), (9), we get

$$E=-\tfrac{1}{4}\frac{q^2}{cp}K_0(qr)C, \qquad F=-\frac{1}{cp}\frac{dH}{dz}, \qquad H=-\tfrac{1}{4}\frac{d}{dr}K_0(qr)C, \tag{12}$$

giving E, F, and H in terms of C, which may be any function of $z$ and $t$. What we have to find is $K_0(qr)C$. The algebrisation may be effected in a good many cases, immediately in simply periodic cases, but more difficultly in more interesting cases. If C is a convection current, and it is written $=\sigma u$, then $\sigma$ may mean the linear density of electrification moving along the line at speed $u$. But there may be two convection currents. In any case, it is the second of equations (8) that finds the linear density of electrification, which is $2\pi rcF$.

Regarding the use of the $K_0(qr)$ operator alone, a caution is needed which is of some significance. $I_0(qr)$ is finite at the axis, infinite at $\infty$, when $qr$ is numerical; whereas $K_0(qr)$ is infinite at the axis, and vanishes at infinity. This seems a sufficient reason for excluding $I_0$ when the source of disturbance is at the axis, and there is no external interference. For do not the waves expand, and so decrease in intensity as they go out to infinity? Certainly they do, but that is not the real reason for using $K_0$. The true reason is because $K_0(qr)$ is the operator appropriate to an outward going wave. The disturbance need not always vanish at infinity. There may be a wave front of infinite intensity, and which remains always of infinite intensity. (See Vol. II., pp. 240, 257, for the parts played by $H_0$ and $K_0$ in inward and outward waves.) There is a similar property in plane waves, when there is no attenuation at all. Thus, $\epsilon^{-qx}f(t)=f(t-x/v)$; so $\epsilon^{-qx}$ is the operator for a positive wave, $q$ meaning $p/v$. Now $\epsilon^{-qx}$ vanishes at infinity, but the disturbance does not, if it can be imagined ever to get there, which is a separate question.

The $K_0(qr)$ operator is the cylindrical analogue of $\epsilon^{-qx}$ for the plane. The analogue of $\epsilon^{qx}$ for a negative plane wave is $H_0(qr)$. This is appropriate when a wave travels towards the axis from an external source.

Nevertheless, the $I_0(qr)$ function can be properly used instead of $K_0(qr)$ to obtain a wave coming from a source at the axis, provided we know what the disturbance there is. This is not the same thing as the strength of source. The $I_0$ function is compounded of both $H_0$ and $K_0$. The disturbance at the axis is due to inward and outward waves. Knowing it, then $I_0(qr)E_0=E_r$ finds $E_r$ from $E_0$. In the purely mathematical aspect, these relations of $H_0$ and $K_0$ to $I_0$ are rather obscure, but the wave theory throws light upon them, and makes the two divergent functions useful working agents.

§483. Returning to equations (12), there are two differentiators in the operator $q$. But in the important case of steady motion, there is an effective reduction to one differentiator, which makes the algebrisation quite easy for an electron. Thus, let $C=\epsilon^{-ut\Delta}C_0$, and $C_0$ be a function of $z$ only. Then C is the same as $C_0$ in shape, but travels at speed $u$ along the $z$-axis, making $C=f(z-ut)$. In another form, we may say $C=\epsilon^{-pz/u}F(t)=F(t-z/u)$. This way is sometimes more convenient. $F(t)$ is the value of C at the fixed origin $z=0$, and may be the given datum. In either case, if $d/dz=\Delta$, $d/dt=p$, we have

$$u\Delta=-p, \qquad q^2=\lambda^2\Delta^2=\lambda^2\frac{p^2}{u^2}, \tag{13}$$

$$\text{if} \qquad \lambda^2=\frac{u^2}{v^2}-1, \tag{14}$$

and both $\Delta$ and $q$ are expressed in terms of $p$. Equations (12) become

$$E=\tfrac{1}{4}\epsilon^{-pz/u}\frac{\lambda^2\Delta}{cu}K_0\left(\frac{\lambda pr}{u}\right)C_0, \tag{15}$$

$$H=-\tfrac{1}{4}\epsilon^{-pz/u}\frac{d}{dr}K_0\left(\frac{\lambda pr}{u}\right)C_0, \tag{16}$$

$$F=H/cu, \tag{17}$$

where $C_0$ is the value of C at $z=0$, a function of the time.

Now let

$$U=\frac{1}{4cu}K_0\left(\frac{\lambda pr}{u}\right)C_0. \tag{18}$$

then the preceding equations assert that

$$E=\epsilon^{-pz/u}\lambda^2\frac{dU}{dz}, \qquad F=-\epsilon^{-pz/u}\frac{dU}{dr}, \qquad H=ucF. \tag{19}$$

These equations may be compared with § 463. They show that U is the travelling potential, and that the electric force is derived from it in the eolotropic manner there described, and that $H = VuD$. The operator $\epsilon^{-pz/u}$ merely does the translation.

We have therefore to determine U according to (18). First of all, for a travelling electron—a charge Q moving at speed $u$. Suppose that it passes the origin at the moment $t=0$, then $C_0 = Qp1$ operationally expressed. This makes

$$U = \frac{Q}{4\pi u} K_0(qr)p1. \tag{20}$$

which has been already algebrised. But as it is shortly done, it may be here repeated, for completeness.

Let $q$ be any differentiator, say with respect to the variable $l$, then

$$K_0(qr)q1 = \epsilon^{-qr}\left(\frac{2}{\pi qr}\right)^{\frac{1}{2}}\left(1 - \frac{1^2}{8qr} + \frac{1^2 3^2}{2(8qr)^2} - \dots\right)q1$$

$$= \epsilon^{-qr}\left(\frac{2}{\pi r}\right)^{\frac{1}{2}}\left(\frac{l^{-\frac{1}{2}}}{\lfloor -\frac{1}{2}} - \frac{1^2 l^{\frac{1}{2}}}{8r \lfloor \frac{1}{2}} + \frac{1^2 3^2 l^{\frac{3}{2}}}{2(8r)^2 \lfloor \frac{3}{2}} - \dots\right)$$

$$= \epsilon^{-qr}\left(\frac{2}{rl}\right)^{\frac{1}{2}}\frac{1}{\pi}\left\{1 - \frac{1}{2}\left(\frac{l}{2r}\right) + \frac{1.3}{2.4}\left(\frac{l}{2r}\right)^2 - \dots\right\}$$

$$= \epsilon^{-qr}\frac{1}{\pi}\left(\frac{2}{rl}\right)^{\frac{1}{2}}\left(1 + \frac{l}{2r}\right)^{-\frac{1}{2}} = \frac{1}{\pi}\left(\frac{2}{r(l-r)}\right)^{\frac{1}{2}}\left(1 + \frac{l-r}{2r}\right)^{-\frac{1}{2}}.$$

That is, finally,

$$K_0(qr)q1 = \frac{2}{\pi}\frac{1}{(l^2 - r^2)^{\frac{1}{2}}}. \tag{21}$$

Applying this to (20), we have $q = \lambda p/u$, so $l = ut/\lambda$. This makes

$$U = \frac{Q}{2\pi c}\frac{1}{(u^2t^2 - \lambda^2 r^2)^{\frac{1}{2}}}. \tag{22}$$

This is the potential at the plane of the origin. It is zero before the moment $t=0$, and later is given by (22), but only provided $ut$ is not less than $\lambda r$. We assume $u$ to be positive; then the operand 1 in (20) begins at the moment $t=0$; and then again the operator $\epsilon^{-qr}$ turns $ut$ to $ut - \lambda r$, so that $ut - \lambda r$ begins with the value zero.

Finally, if V is the potential at the point $z$, $r$, we have

$$V = \epsilon^{-pz/u}U = \frac{Q}{2\pi c}\frac{1}{\{(ut-z)^2 - \lambda^2 r^2\}^{\frac{1}{2}}}, \tag{23}$$

provided $(ut - z)$ is not less than $\lambda r$. This confines us to the cone behind the travelling electron, outside which we have $V = 0$.

The above argument appears to be perfectly distinct in all respects. But it is necessary to carefully note the underlying assumption, and its consequence. Thus, at the beginning, the assumption $C = F(t - z/u)$ implies that the electron has been in motion for an infinitely long time before it reached the origin. That is why we obtain a travelling steady state of **E** and **H**. No information is given as to how it was arrived at a long time previously. To show that, a different operand for C is required, showing how the electron passes from rest to the state of uniform motion.

Closely connected with this problem is that of a moving infinitely long line of electrification. Let $\sigma$ be the linear density and $u$ the speed (positive), and let its free end reach the origin at the moment $t=0$. Then $C_0$ jumps from 0 to the value $\sigma u$ at the moment $t=0$, and remains at that value for ever after. Therefore

$$U = \frac{\sigma}{4c}K_0\left(\frac{\lambda rp}{u}\right)1, \tag{24}$$

is the potential at the plane of the origin. It only differs from (20) in the absence of $p/u$. We have, instead of (21),

$$K_0(qr)1 = \frac{2}{\pi}\log\left\{\frac{l}{r} + \sqrt{\frac{l^2}{r^2} - 1}\right\}. \tag{25}$$

This may be proved in the same way as (21) was proved. But it is unnecessary to go through the work, because having the operand 1, now instead of $p1$, only requires us to integrate the former U solution from 0 to $t$. So

$$U = \frac{\sigma}{2\pi c}\log\left\{\frac{ut}{\lambda r} + \sqrt{\left(\frac{ut}{\lambda r}\right)^2 - 1}\right\}, \tag{26}$$

and then V is got by changing $ut$ to $ut - z$, as before.

Now for a change. Apply harmonic analysis to the operational solution (20), and see what we come to, and whether the definite integrals are recognisable. We have

$$p1 = \frac{1}{\pi}\int_0^\infty \cos nt\, dn. \tag{27}$$

Use this operand in (20), and work by differentations. Assume that $p = ni$ is true in the $K_0$ function, making

$$U = \frac{Q}{4\pi cu}\int_0^\infty K_0\left(\frac{\lambda nir}{u}\right)\cos nt\, dn, \tag{28}$$

where $i$ is the differentiator $p/n$ really, but has to be worked according to $i^2 = -1$. Now we at once note that if $\lambda^2$ is negative, that is, $u < v$, the argument of the $K_0$ function becomes real. Say $\kappa = \lambda i$, and $\kappa = (1 - u^2/v^2)^{\frac{1}{2}}$, then

$$U = \frac{Q}{4\pi cu}\int_0^\infty K_0\left(\frac{\kappa nr}{u}\right)\cos nt\, dn, \tag{29}$$

which is a real integral without further change.

Now we know, § 463, that the solution is

$$U = \frac{Q}{4\pi c}\frac{1}{(u^2t^2 + \kappa^2 r^2)^{\frac{1}{2}}}, \tag{30}$$

because changing $ut$ to $ut - z$ produces the proper ellipsoidal solution about which there is no difficulty. We conclude that

$$\int_0^\infty K_0\left(\frac{\kappa nr}{u}\right)\cos nt\, dn = \frac{u}{(u^2t^2 + \kappa^2 r^2)^{\frac{1}{2}}}. \tag{31}$$

On consulting Gray and Mathews' "Bessel Functions," p. 227, I find this integral given, ascribed to Basset. So far good. Then how does the doubling of the formula take place when $u > v$? The $4\pi$ in (30) has then to become $2\pi$.

Go back to (28) with $\lambda$ real. We have

$$K_0(xi) = G_0(x) - iJ_0(x), \tag{32}$$

when $x$ is real. (Vol. II., p. 253.) So (28) is

$$U = \frac{Q}{4\pi cu}\int_0^\infty \left\{G_0\left(\frac{\lambda nr}{u}\right)\cos nt + J_0\left(\frac{\lambda nr}{u}\right)\sin nt\right\}dn, \tag{33}$$

which is a real integral, $\lambda$ being real. Now our U in this case is zero when $t$ is negative, and since the second part changes sign, whilst the first does not, when $t$ is made positive it follows that

$$\int_0^\infty J_0\left(\frac{\lambda nr}{u}\right)\sin nt\, dn = \frac{u}{(u^2t^2 - \lambda^2 r^2)^{\frac{1}{2}}}, \tag{34}$$

$$\int_0^\infty G_0\left(\frac{\lambda nr}{u}\right)\cos nt\, dn = \frac{u}{(u^2t^2 - \lambda^2 r^2)^{\frac{1}{2}}}. \tag{35}$$

The first of these (34) I find in Gray and Mathew ascribed to Weber. The second (35) I fail to find, so for the present I will ascribe it to myself.

Thus, as $u$ passes from less than $v$ to greater than $v$, the value of the integral doubles itself. This would not perhaps be a correct way of putting it if the integral were purely algebraical, for we must consider that the integral concerned is really (28), in which $ni$ stands for $d/dt$. Strictly it takes two forms, one of which gives double the result of the other.

Observe, too, that the symbol $i$ has had two distinct meanings. In (32) it is algebraical. In (28) it is a differentiator. Both follow $i^2 = -1$. Although they have not come into conflict, it may very easily happen that such will happen in investigations of this class, involving definite integrals and harmonic analysis; and to avoid error, it is desirable to be guided by the conditions of the physical problem concerned. That will strengthen the weakness and ambiguity of the purely mathematical machinery.

If we employ the other method referred to above, making $C = f(z - ut) = \epsilon^{-ut\Delta}C_0$ where $C_0$ is a function of $z$ at the initial moment, and C what it becmes at time $t$ later, we eliminate $p$ and use $\Delta$ instead. The reasoning all through is quite similar to the above, and the results are the same. But this way of working I did not find so easy to follow in the particular problem of a moving electron on account of purely technical difficulties of the kind just mentioned, and the fact that the solution admits of a double interpretation. The conical wave may be either expanding or contracting, although only the expanding wave can be imagined to arise naturally.

*(To be continued.)*

# THE PARIS EXHIBITION.—XIV.*

(BY OUR SPECIAL CORRESPONDENT.)

During the last few years there has been an enormous spread in the practice of electric driving in workshops, and it was therefore to be expected that a large number of electrically-driven machine tools of various classes would be shown at the Paris Exhibition. In the early days, dynamos were driven by belts or ropes from any mill engine, in many cases off countershafting, and the maker of the engine knew nothing of the purpose for which it would be employed, while it was considered immaterial by the dynamo maker how his machine was driven so long as its armature made the requisite number of revolutions in a minute. Now, however, the engine is designed to drive the dynamo directly, and the dynamo is designed to be driven directly by the engine. Machine tools appear to be going through the same phase, but at a slower rate. Direct driving is a course not always feasible in their case, but we have a right to expect that their makers will soon realise the fact that, at all events in the case of tools for heavy work, the motor and the tool should be combined in one machine, and not be considered as two independent items to be connected by the user in whatever manner may occur to him. Several fine specimens of American machine tools were exhibited at Paris, but I believe that not one had an electric motor fixed on its bedplate. On making inquiries from some of the exhibitors, I was informed superciliously that they were not makers of electric motors, and that their machines would do equally good work, however driven. German firms also exhibited machine tools, but in their case also no special provision was made as a rule for electric driving. Some neat applications of electric motors for this and similar purposes were shown, however, by the Société Gramme. Fig. 90 is an electrically driven slotting machine, and Fig. 91 a blacksmith's forge in which the fan is driven by an electric motor. The small set shown in Fig. 92 is another interesting exhibit shown by this firm. It is a neat and compact 3 H.P. dynamo driven by a petroleum motor and intended for temporary purposes. The set is extremely small and very light.

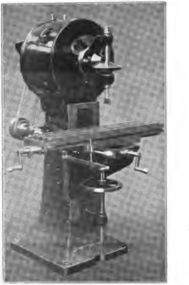


FIG. 90.—ELECTRICALLY-DRIVEN SLOTTING MACHINE MADE BY THE SOCIÉTÉ GRAMME.

FIG. 91.—BLACKSMITH'S FORGE FITTED WITH ELECTRICALLY-DRIVEN FAN MADE BY THE SOCIÉTÉ GRAMME.

Fig. 93 illustrates a machine for stamping the slots in armature core discs, exhibited by Messrs. Ganz & Co. There are two motions, the alternating movement of the stamp, which is actuated by an eccentric rod, and the rotation of the core itself, which is advanced and stopped in correspondence with notches in an intermittent

FIG. 92.—GRAMME THREE HORSE-POWER DYNAMO DRIVEN BY PETROLEUM ENGINE.

---

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24 and 31; September 14 and 28; October 5, 12, and 26; and November 2, 16 and 30, 1900.

**feed-motion wheel. A new machine for the same purpose but in which the discs were fed to the stamp automatically by means of vacuum suction washers, was exhibited by Messrs. Siemens and Halske, and attracted considerable attention from the engineering visitors to the exhibition.**

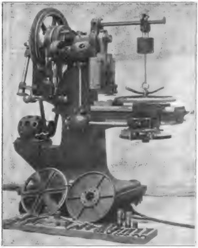


Fig. 93.—Ganz & Co.'s Core Slot Stamping Machine.

Two electrically-driven pumps shown are worthy of special mention. One was a high-pressure centrifugal pump (Fig 94), made by Messrs. Sulzer Bros. It is designed for a speed of 900 revs. per min., being directly driven by an electric motor, and to lift 1,540 gallons per minute to a height of 218ft. The pump was destined for pumping water for drinking purposes at Goldstein, Frankfort-on-Main, and the firm undertakes to manufacture similar pumps with a **lift up to 500ft., and claims an efficiency of 75 per cent. in its pumps of this type. Concentric with the vane wheel, a system of passages is built within the pump chamber in which a part of the velocity of outward flow from the vane wheel is employed to produce pressure. In order to keep down the number of revolutions as much as possible for a given power, there are several vane wheels with their surrounding system of passages, and these are all on the same** shaft and within one chamber. The water flows **out from** the first set of passages to the second vane wheel, **and so** on, each wheel increasing the pressure.

Fig. 94.—Sulzer High Pressure Centrifugal Pump.

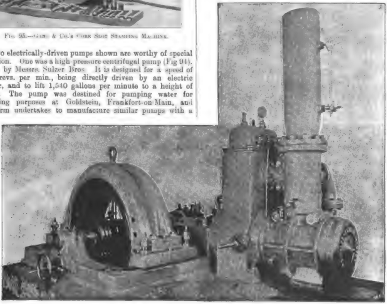


Fig. 95.—General View of "Riedler Express Pump."

**The other pump was a reciprocating one, but was nevertheless designed for high speed, being coupled directly to an electric motor, without intermediate gearing. It was exhibited by the Allgemeine Elektricitats Gesellschaft, having been constructed according to the patents of Profs. Riedler**

and Stumpf. A general view of the "Riedler Express Pump" is given in Fig. 95, and a section in Fig. 96. The plunger *p*, when moving in the opposite direction to the arrowhead in Fig. 96 causes the water to flow out of the suction chamber *e*,

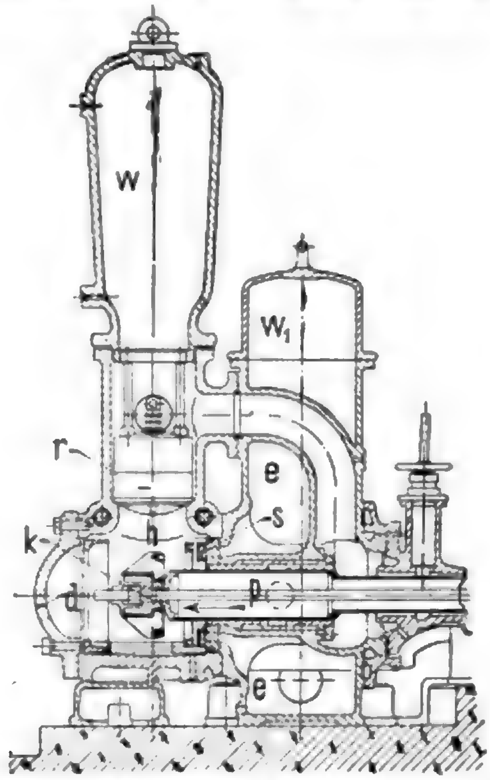


FIG. 96.—SECTION OF RIEDLER PUMP.

through the suction valve *s*, and into the actual pump chamber *h*. As the plunger moves in the direction of the arrowhead, the water flows through the pressure valve *r* into the

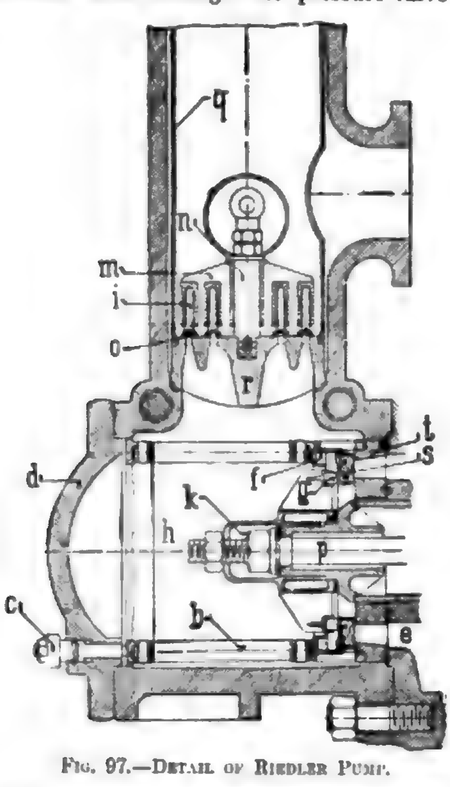


FIG. 97.—DETAIL OF RIEDLER PUMP.

pressure chamber (which is provided with an air-vessel *w*), and thence directly to the main. A second air-vessel, $w_1$, for the suction chamber contributes largely to the result of rendering possible the high speed employed.

The pressure-valve *s* (Fig. 97) is situated around the plunger *p*, and consists of a simple metal or metal-mounted wooden ring. The valve seating *t*, which is held in position by a casting stiffened with pillars *b*, serves as a guide for the valve and supports its small weight. This guide is, in its turn, held in place by screws *c* passing through the cover *d*. It also serves to limit the stroke on opening the valve, and for this reason is fitted with a rubber buffer ring *f*. As the valve is not loaded with any spring, and, as already mentioned, its weight is supported, it offers almost no resistance to the incoming water. It remains open until the end of the stroke and is then closed by the head *k* of the plunger itself exactly at the dead centre of the crank. The plunger head is provided with a rubber ring *g*. Fig. 97 represents the position of the plunger and valve at the moment of closing, and Fig. 96, on the other hand, shows the relative positions during the pressure period.

The pressure valve consists of rings *o* resting on the seating *r*. They are loaded by rubber springs *i*, kept in place by the casting *m* and the bolt *n*. On tightening the screws of the air vessel *w* (Fig. 96) the valve seating *r* is held in position with the assistance of the liner *q* (Fig. 7).

The addition of a suction air vessel, $w_1$ (Fig. 96), has been already alluded to. The level of the water in this is always maintained above the suction valve, so that there is always a certain quantity of water in the neighbourhood of the latter, and even when the pump is working at its fastest speed the column of water sucked in is not broken, since the water is always following on from the suction air vessel with a certain pressure.

The electrically-driven Riedler pump exhibited at the exhibition was, I was informed, one of several built since the beginning of 1899. It was directly coupled to a three-phase motor making 290 revs. per min., and was designed to lift 240 gallons per min. to a height of 850ft.

## THE CASE FOR ELECTRIC POWER DISTRIBUTION.*

BY W. B. ESSON, M.I.C.E., M.I.E.E.

In opening the case for the electrical distribution of power, let me clearly indicate the scope of my remarks. First I distinguish between electrical *distribution* of power and electrical *transmission*, and observe that I do not intend to say much of the latter. It is admitted, that for transmitting power the electrical method has no rival when the points, between which the transmission takes place, are beyond quite a moderate distance. For short distances, the telodynamic system of transmission, by means of wire ropes, is a rival worthy of consideration, but on the European continent where this method has been developed to the fullest extent I am not aware that the total distance has ever exceeded three-quarters of a mile. Possibly from this up to a mile or so there is a debatable land which is liable to be turned over to electrical transmission or telodynamic transmission as circumstances may direct, but beyond this electricity holds the field, and if it will not pay to transmit the power electrically it will not pay to transmit it at all. For *transmitting* power then, there is no question as to the superiority of electricity, though in many cases the advantages attendant on its use for *distributing* power are not so clear.

For the working of tramways and light railways the all-round advantage possessed by electricity over other agencies as a means of traction has been proved. There are also good reasons for believing that there is an important future for the transmission of electricity from large generating stations situated advantageously with regard to fuel to places scattered over a considerable area less favourably situated, and the electric power bills, the granting of which by Parliament constituted the electrical feature of last year, will enable us to see shortly whether our hopes with respect to these schemes are well founded. But with none of these things am I to occupy your attention. I am simply to discuss the *pros* and *cons* of electric power distribution in factories and workshops, and to see where an unbiassed consideration of this subject will lead us. This is merely a problem in mechanical engineering, and mechanical engineers as a class generally bear in mind that their business is to secure best results at least expense.

Whether power distribution can best be carried out electrically by continuous currents or by alternating currents of two or three phases is another question I am not dealing with now—that's the sort of thing we read Papers about at the Institution of Electrical Engineers

* Paper read before the Civil and Mechanical Engineers' Society.

over the way; its discussion here, however, would take us beyond the range of general principles and would require a greater amount of time than we have at our disposal. Our business to-night will be to consider the circumstances upon which must depend the decision as to whether electricity can, with advantage, displace the older methods of power distribution.

To begin, then, the older forms of power distribution we think about displacing may be generally summarised under two headings: First, cases in which the power is supplied by a number of engines driving individual machines or departments of the works, and, secondly, cases in which one engine furnishes the whole power, which is distributed to the various machine by shafting and belts or ropes.

Considering the first group a large number of tests have been made to determine the steam consumption of small engines with the result that these have been proved to be terribly wasteful. They consume in steam anything from 50lb. to 250lb. per I.H.P. per hour, and upon the tests made upon 100 engines taken at random Mr. Bryan Donkin found that the average consumption was no less than 150lb. These engines, though presumably not very carefully looked after, are not treated with exceptional neglect and may be considered as representative of the ordinary performance of the auxiliary engine usually seen in paper mills, bleach works, foundries, and the like. Seeing that first-class engines of moderate size, running at full load, consume only 20lb. of steam per I.H.P. non-condensing or 17lb. condensing, you will see that there is here a considerable margin of loss for possible reduction by a more economical system of distributing the power.

But if the results are so poor with auxiliary engines running indoors, what shall be said of the clattering, noisy, dripping abomination running in the open with its loose joints, its escaping steam and streaming glands familiar to everyone who has been through a ship-building or bridge-building yard. What such an engine costs in steam it is difficult to say, and when the additional loss due to condensation in the distributing steam pipes is taken into account, it will be realised that there are here enormous fuel losses to be diminished by the introduction of more economical methods.

It must not be supposed that I am purposely selecting bad examples in order to make out a strong case for electrical distribution. I am merely taking things as you and I know them to exist, and considering the conditions under which these isolated engines of which I am speaking have to run, you will see that much better could not very well be expected from them. Travelling in Yorkshire the other day, I observed in the collieries and ironworks I passed long ranges of steam-pipes, from which the non-conducting composition once covering them had long since fallen off, leaving them entirely unprotected from the weather, while in scarcely a single instance was the covering intact and in good order. The same is to be found in any old-fashioned shipyard or bridge works, and it must be allowed that to keep steam-pipes in good condition in the open requires a considerable amount of pains to be taken. Again, to keep those badly-used engines as they ought to be kept would require a great deal of attention. This attention they do not get, and uneconomical, even when cared for, they get worse and worse with time. It is different, of course, with auxiliary engines on board ship. These are of high-class workmanship, generally of the compound type, and having the advantage of exhausting into the condenser when the main engines are running, besides being, comparatively speaking, all close together, they give very good results. It may be said that in the mining districts coal is so cheap that it scarcely matters what the engines consume. Well, that is a point to be considered later; at the moment I am merely pointing out that the fuel consumption is extravagant beyond all reason, and please remember that one of the principal sources of loss—the condensation in the pipes—goes on whether the engines are running or not.

The second method of power distribution I have referred to is by shafting and belting, and a large number of experiments has been made from time to time to determine what fraction of the I.H.P. of the engine is actually returned as useful power to drive the various tools and machines in our workshops and factories. It is unlikely that any of these particular determinations would exactly fit the circumstances of a new case to which we might wish to apply it, nevertheless the results are of great value as indicating what we might expect in works of a like kind. The figures are got by first indicating the engine with all the machines or tools at work and then indicating it with these thrown off. The latter indication gives the I.H.P. lost in engine friction and in shaft and belt friction throughout the works, and the ratio of the difference between these two indications to the higher of the two gives the fraction of the I.H.P. utilised to drive the machines. For engineering shops in which heavy machine work is being done, the power utilised to work the tools is found, from several tests, to give an average of 45 per cent. of the I.H.P. For shops in which light machine work is carried on, such as the making of sewing machines, bicycles, small tools, &c., the useful return of I.H.P. available for driving the machinery is again found on the average to be 45 per cent. From the results obtained by making tests in eight factories in America engaged in the engineering trades, we learn that the power utilised to drive the machine tools averaged 56 per cent. of the I.H.P., while in one extreme case, that of the Baldwin Locomotive Works, the return was only 20 per cent. From tests made in over 300 factories and workshops in France we get an average return of less than 60 per cent., while returning home again, in the three principal shops of the Gloucester Waggon Co. the return was found to be 60·25 per cent., 44·9 per cent. and 38·3 per cent. respectively.

In these tests it is assumed that the ratio of the difference in the I.H.P. loaded and unloaded, to the I.H.P. running loaded, expresses the power utilised, and this carries with it the further assumption that the friction losses are constant and independent of the work being done. This is found to be practically the case. Once upon a time it was thought that the friction of an engine increased largely with the load, but this is not so. In many instances there is no appreciable increase at all, and in any case the addition is quite small. The same holds good for shafting and belting. Practically there is no increase of friction with the load, and any slight difference would only make the results worse than appears from the test, for in that case, obviously we have not, at full load, debited the transmission with the full friction loss.

The figures show great variation among the results, but that is only what we might expect. There is no fixed or even approximate relation between the I.H.P. and the length of shafting, number of pulleys, or number of belts. Every factory is laid out on different lines—some may be on one floor, some occupy several floors and so on. Again, even if care is taken to arrange the shafting in a scientific manner—a condition seldom fulfilled, let me say—it is unlikely that it will remain long in first class order. It is not easy to maintain shafts in

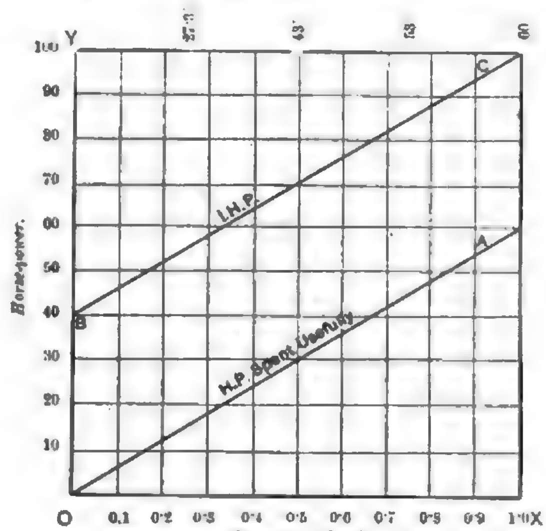


Fig. 1.

perfect alignment. The bearings are seldom very carefully attended to as regards lubrication, and in adjusting the cap bolts a careless labourer may very easily increase the friction of a journal by 100 per cent. But when all care is taken it is unlikely that we could with any degree of certainty count upon a greater return than 60 per cent. of the I.H.P. as an average. In some cases, of course, it would be more, in some cases less, but in fixing on the above figure as a basis for comparison I think I am, if anything, giving shafting and belting the advantage.

Taking 60 per cent. then as the useful return, this means that 40 per cent. is absorbed in friction. The engine accounts for 10 per cent. of the I.H.P., an amount, which cannot very well be reduced, and of the 90 per cent. which is given to the crankshaft, two-thirds reaches the machines as useful work, one-third being wasted in heating bearings, bending straps and wearing things out generally. It is this last item, representing 30 per cent. of the whole I.H.P., that we want to have a cut at.

We have seen that the friction of the shafting and belting remains constant, and from the nature of things the shafting and belting must keep on running whatever the number of machines at work. There is no way, when we stop a machine, of reducing the loss in transmission by the proportion which might be *pro rata* allocated to that particular machine, consequently, though the machines at work in the shop may only be a fraction of the whole all the shafting must run for them. The effect of this on the useful return is very well shown by the diagram Fig. 1. Here distances measured along OX as abscissæ represent fractions of the load and ordinates the H.P. The line OA represents the useful work done, and the line BC the I.H.P. of the engine, distances between these two lines

measured on the ordinates representing the waste. At full load we have a useful return of 60 per cent. of the I.H.P., at three-quarters of full load 53 per cent., at half load 43 per cent., and at quarter load 27·3 per cent. This then is the average result we may expect to obtain with power distribution by shafts and belts. The percentage of useful return always decreases rapidly as the machines are thrown out of work or as the load on them is diminished.

So much for the data at our disposal regarding the older methods of transmitting power. We will now see what can be done by electricity. Beyond emphasising the previously-expressed law of friction we need not at the present stage trouble ourselves about the engine, as whether it drives shafting or an electric generator it may be assumed to be of the same class and to behave in a similar manner under steam. We shall still take the friction of the engine to be constant for all loads, and assume that it absorbs 10 per cent. of the full load I.H.P.

To begin, then, with the generator. This may be directly coupled to the crank-shaft of the engine, and we may assume that when fully loaded it gives at its terminals a useful return in H.P. of 90 per cent. of the power given to the shaft. With large generators a somewhat larger return is frequently obtained, but 90 per cent. is a good, all-round figure. We may as well be on the safe side, and it does not do to be too sanguine. On the other hand, it is unlikely that a generator would be installed of such small size that the return would not reach 90 per cent. According to this the useful electrical return at the generator terminals is 81 per cent. of the I.H.P. of the engine.

Now for the law of the generator. The internal losses in the machine itself are partly independent of and partly dependent on the electrical power it is giving out. They consist of the energy expended in forcing the current through the copper windings of the fixed and rotating parts, and of the energy expended in the iron parts which are subject to the continuous reversal of their magnetism while the machine is working. For the sake of analogy we may very

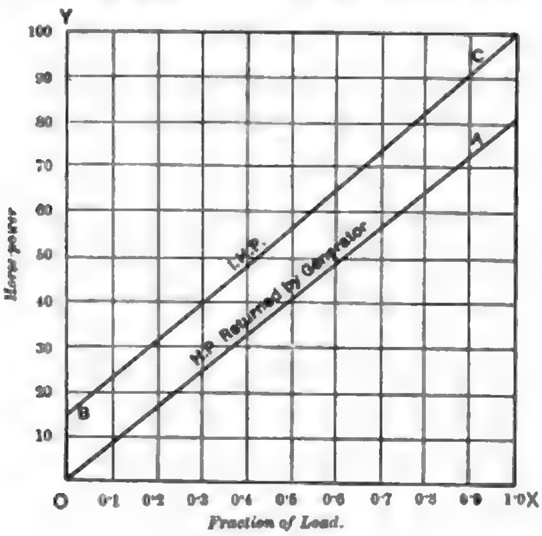


Fig. 2.

well call the former electrical friction and the latter magnetic friction. The magnetic friction is practically constant for all loads; the electrical friction is in part constant and in part variable. The variable part increases as the square of the load, so all the losses may be expressed in the form $=a+bC^2$ where $a$ and $b$ are coefficients depending on the construction of the machine, and C the current, which, for a machine giving uniform electric pressure, is of course proportional to the output. For the generator giving, as we have assumed, a useful return of 90 per cent., the coefficient $a$ will have a value of, say, 6 per cent. of the power put into the shaft of the machine at full load, while the value of $bC^2$ at full load would be about 4 per cent. Fig. 2 shows the useful return obtained from the generator at various loads computed on this basis. Abscissæ measured along OX represent fractions of the output, and ordinates represent the H.P. Heights measured to the line OA give the useful return, and measured to the line BC give the I.H.P. Distances measured vertically between OA and BC give that part of the H.P. wasted in engine friction and in the magnetic and electrical friction I have alluded to. You will see that the waste rises in a curve, owing to part of the loss increasing as the square. There results a useful return at the terminals of the machine of 81 per cent. at full load, 77·7 per cent. at three-quarter load, 71·3 per cent. at half load, and 56·4 per cent. at quarter load.

The electric power has to be distributed and converted where required into mechanical power through the agency of a system of electrical conductors and the electric motors. In the former the loss due to electrical friction is proportional to the square of the current, and it is very usual to fix the section of copper so that the power wasted in the conductors at full load shall be about $2\frac{1}{2}$ per cent.—that is to say, the pressure at the motor end of the conductor shall be $2\frac{1}{2}$ per cent. less than the pressure at the generator end. In terms of the full load I.H.P. of the engine this would mean that the loss is about 2 per cent, and, diminishing as the square, at half load it would be one-quarter of this, and so on.

We have now to consider the motors, and the law which governs the losses in these is just the same as that which governs the loss in the generators—that is to say, there is a certain loss which is constant and independent of the work the motor is doing, and a certain loss which is proportional to the square of the load. The useful return obtained from individual motors varies with their size, this reaching 90 per cent. of the electrical H.P. put into them

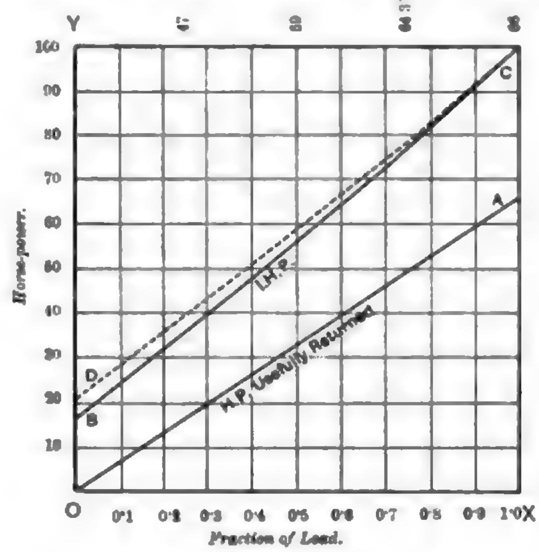


Fig. 3.

in motors of 50 H.P., and falling to 75 per cent. or so in motors of 1 H.P. If we assume that the motors installed are mixed large and small, and that the return is an all-round 85 per cent. at full load, we shall, I think, get pretty close to the conditions of practice, and on this basis, then, let us see what net return we get from the whole distributing system.

Before calling your attention to any further diagrams, however, let me point out one respect in which electrical power distribution differs radically from distribution by shafting and belts. It has already been pointed out that with the latter distribution the loss remains the same whether many or few machines are at work,

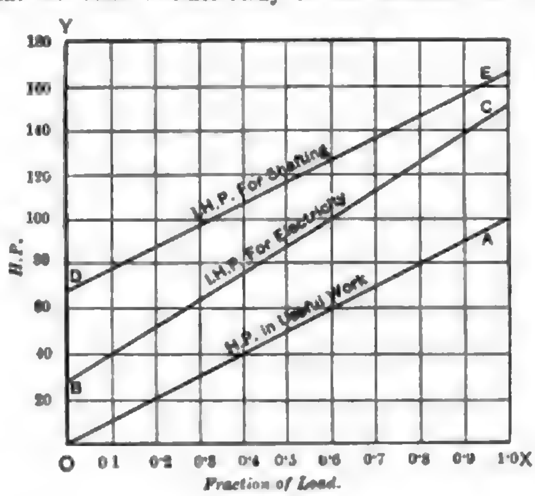


Fig. 4.

accordingly the percentage of power lost in distribution, referred to the work expended usefully, increases enormously with very light loads. With electric distribution, however, this is not the case, as the motors are stopped running when their power is not required. Accordingly for the time being and until the motor is started again the proportion of distribution loss which, in respect of one important factor, may be allocated to the machine or group of machines which the motors drive absolutely ceases.

The useful return obtained from a system of power distribution by electricity is shown in Fig. 3. As before, abscissæ represent

fractions of the load and ordinates H.P. The line OA shows the H.P. usefully returned, and the line BC the I H.P. As will be seen, at full load we get from the motors 66 per cent. of the I.H.P., at three-quarter load 64·3 per cent., at half load 59 per cent., and at quarter load 47 per cent. This is under the best conditions, the motors being stopped as the machines they drive are thrown out of action. If the motors were allowed to run—that is, if the plant were run under the worst conditions, the I.H P. would be as shown by the dotted line DC, in which case the return would be at full load 66 per cent. as before, at three-quarter, half, and quarter loads, 62 per cent. 57 per cent. and 41 per cent. respectively. We shall assume for the purposes of this argument that the real return will lie between the two. Note, however, that at full load we get 66 per cent. for electricity as against 60 per cent. for shafting, and at quarter load about 44 per cent. as against 27 per cent.

By superposing diagrams, Figs. 1 and 3, and reducing the useful return to a common basis for both we get Fig. 4, which shows the I H.P. required for electrical and mechanical distribution respectively, the line BC representing the former and the line DE the latter. Distances between BC and DE measured on the ordinates show the difference in the I.H P. required by the two systems. Observe that at full load we save about 10 per cent. in the I.H.P. by electrically distributing the power, and at three-quarter, half, and quarter load 16 per cent., 24 per cent., and 38 per cent. respectively.

*(To be concluded.)*

## THE USE OF ALUMINIUM AS AN ELECTRICAL CONDUCTOR, WITH NEW OBSERVATIONS UPON THE DURABILITY OF ALUMINIUM AND OTHER METALS UNDER ATMOSPHERIC EXPOSURE.*

BY JOHN B. C. KERSHAW, F.I.C.

*Introduction.*—The following table shows that the price of aluminium has fallen and the quality has improved with increasing output each year since 1890, when the present electro-metallurgical process of manufacture was first adopted in this country :—

**Table I.**—*World Production and Average Price of Aluminium each year for the period* 1890-1900.

| Year. | Production in metric tons of 2,204 lbs.† | Price in pence per lb. in U.S.A. | Quality.‡ |
|---|---|---|---|
| 1890 | 165 | ... | ... |
| 1891 | 233 | 75 | ... |
| 1892 | 487 | 49 | ... |
| 1893 | 715 | 37 | 0·93 to 1·64% silicon, 0·32 to 1·66% iron. |
| 1894 | 1,240 | 30 | ... |
| 1895 | 1,418 | 27½ | ... |
| 1896 | 1.789 | 20 | ... |
| 1897 | 3,394 | 17¼ | ... |
| 1898 | 4,033 | 16½ | 0·02 to 13% silicon, 0·12 to 0·32% iron. |
| 1899 | 5,000 (Estimated) | 16½ | ... |

*Relative Costs of Copper and Aluminium.*—Taking the most reliable values for the physical constants of the two metals, and the most recent market prices, namely—

| *Copper.* | | *Aluminium.* | |
|---|---|---|---|
| Specific gravity... | 8·93 | Specific gravity... | 2·68 |
| Conductivity...... | 100 | Conductivity...... | 59 |
| Price .............. | £91 per ton. | Price ............... | £224 per ton. |

we obtain the following price ratio :—

$$\frac{8\cdot93 \times 91 \times 59}{2\cdot68 \times 224 \times 100} = \frac{798}{1,000} = \frac{\text{Cu}}{\text{Al}}.$$

Expressing this ratio in another manner £798 expended upon copper will equal £1,000 expended upon aluminium for the same length of wire of equal carrying capacity; and aluminium is, therefore, much the dearer metal of the two.

Special rates are, however, offered where large qauntities of aluminium are taken in rod or wire form for electrical purposes, and in the United States large quantities of the new metal have been sold at 29 cents per lb. = £135 per ton.§ Using this figure the cost ratio for conductors of equal length and equal carrying capacity becomes—

$$\frac{8\cdot93 \times 91 \times 59}{2\cdot68 \times 135 \times 100} = \frac{1,325}{1,000} = \frac{\text{Cu}}{\text{Al}},$$

and copper is seen to be the more costly material.

* Abstract of a Paper read before the Institution of Electrical Engineers, Jan. 10.

† From *The Mineral Industry*, Vol. VIII., 1900.

‡ Moissan's tests, *Comptes Rendus*, 1898.

§ Messrs. T. Bolton and Sons inform the writer that in this country £170 per ton is quoted for large orders of the wire.

*Installations of Aluminium in the United States and in the United Kingdom.*—The low price at which aluminium is being sold for conducting purposes in America therefore explains the readiness of electrical engineers in that country to adopt the new metal. It may be explained here that at present there is no talk of using aluminium for insulated conductors; the greater sectional area of the metal for equal carrying capacity (1·68 : 1·00) rendering it impossible to use it for such covered conductors until it has fallen to a much lower price relative to copper.

Bare aluminium transmission lines have already been completed at Niagara Falls, and by the Hartford Electric Light and Power Co., the Snoqualmie Falls Power Co., the Blue Lakes Power Co., and the Telluride Power Company.* Other power companies in America, in connection with which aluminium is used, or is about to be used, in place of copper, are the following :—

1. North Yuba Power Co., supplying 1,000 H.P. to Sacramento from a generating station 63 miles distant.
2. The Municipal Supply Co., supplying 2,000 H.P. to Orillia, Ontario, from a generating station at Ragged Rapids, 18 miles distant.
3. The Big Cotton-Wood Power Co., supplying Utah with 500 H.P.
4. The Standard Electric Co. The company has been floated to develop a scheme for supplying San Francisco from a generating station in the Sierra Nevada Mountains, 150 miles distant. The success of this project depends upon the possibility of using and maintaining the proposed pressure of 60,000 volts. It has been decided to use aluminium cables for the scheme; and estimates have been prepared.

In addition to the power-transmission lines named above, aluminium is being used in place of copper for conducting purposes by the Waxahachie Electric Light Co., of Texas; by the North-Western Elevated Railroad Co., of Chicago; by the Kansas City and Leavenworth Electric Railroad Co.; and by the Manhattan Elevated Railroad Co., of New York. For telephonic and similar purposes it is in use by the Pennsylvania Railroad Co., by the Pacific States Telegraph and Telephone Co., and by the New York Telephone Exchange. In this country the Northallerton Electric Lighting Co. have 4 miles, and the British Aluminium Co., at their Foyers Works, have several miles of aluminium in use for various purposes; and the Post Office authorities are making experimental trials of the metal for long-distance telephonic communication.

The difficulty of soldering aluminium has been surmounted in most of these schemes by using mechanical joints, the MacIntyre sleeve-joint being that usually adopted. In one or two cases, as at Niagara and at Northallerton, soldered joints have been made, but the writer doubts whether these will prove as satisfactory.

*Durability of Aluminium and other Metals under Atmospheric Exposure.*—The old idea that aluminium was absolutely proof against attack by all agents excepting alkalies and hydrochloric acid is now known to be incorrect; and Ditte in communications made to the Academie des Sciences† has shown that aluminium is easily attacked and corroded by air and water under certain conditions. It is therefore of considerable importance to inquire whether these conditions are present when aluminium is used as a bare conductor for overhead lines, and is exposed to all the varieties of weather that we

**Table II.**—*Results of Exposure Tests of Aluminium and other Wires.*

| Composition and form of sample. | Waterloo set; 10 months. | | St. Helens set; 10 months. | |
|---|---|---|---|---|
| | + = gain − = loss in weight | Remarks. | + = gain − = loss in weight | Remarks. |
| | Per cent. | | Per cent. | |
| Aluminium rod No. 1...... | nil. | These 5 samples were all pitted, especially on the under sides, where water drops had coll'cted and dried. | +0·27 | These 5 samples were very badly pitted. Dirt had settled in their corrosions and could not be removed by scrubbing. |
| Ditto No. 2 ..... | +0·13 | | +0·51 | |
| Aluminium wire No. 1 ... | +0·41 | | −0·83 | |
| Ditto No. 2 .. | nil. | | −0·83 | |
| Ditto No. 3 ... | +0·55 | | −0·54 | |
| Galvanised iron wire No. 1 | −0·15 | No change in appearance to the eye. | −1·44 | Badly corroded. Zinc partly eaten away. |
| Ditto No. 2 | −0·16 | | −2·13 | |
| Copper wire No. 1 ........ | nil. | Oxidised on surface, but not pitted or corroded. | −1·65 | These wires were perfectly black, and could not be distinguished. |
| Tinned copper wire No. 1 | nil. | | −1·31 | |

* [Particulars of these and other lines have been published from time to time in *The Electrician*. A summary of them will be found in an article by Mr. Kershaw, published in our columns in August and September last —Vol. XLV., pp. 669 and 743.—ED. *E.*]

† *Comptes Rendus*, March-April, 1899.

experience in the course of the four seasons of the year. In America, electrical engineers are conducting this inquiry in the usual American fashion; and their installations of aluminium for transmission lines in California and other places, are in reality large scale experiments which, if unsuccessful, will cause heavy losses to fall upon those who have been financing these undertakings.

In order to obtain independent and reliable figures concerning the effects of exposure upon aluminium, the writer, since October, 1899, has been carrying out two series of observations in the North of England. The samples of aluminium used are in rod and wire form, and were kindly placed in the writer's hands by Messrs. T. Bolton & Sons, of Oakamore Wire Works, and by the British Aluminium Co. In order to make the investigation more complete, the inquiry was extended to all metals and alloys used for electrical conductors, and samples of copper, tinned copper, and of galvanised iron wire were also sent to the writer by Messrs. T. Bolton & Sons. It is a curious fact that there would appear to have been no previous scientific observations upon the durability of these metals or alloys under atmospheric exposure; and the choice of the metal or alloy for overhead wires in any particular district has apparently been settled by custom rather than by scientific knowledge. The methods of observation adopted by the writer in his experiments were as follows:—

The rods and wire were cut into 2ft. lengths, and were mounted upon glass insulators in two frames, so that their position was parallel one to the other, and horizontal with regard to the ground. Fig. 1 is a reproduction of a photograph of one of these frames containing the sample wires. The frames carrying the wires were so placed that the drops of water collecting upon the wires in wet weather could not by any chance pass from one wire to another, and thus bring electrolytic action into play. Each length of wire was carefully marked and weighed before commencing the exposure, and the weights recorded. The one frame with its nine insulated sample wires was exposed upon the roof of a building in St. Helens, Lancashire, from October 11, 1899, to August 23, 1900; and the second frame was similarly exposed at Waterloo, Lancashire, for the same period of 10 months.

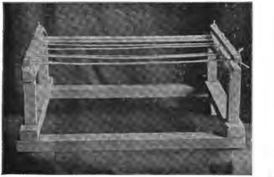


FIG. 1.—FRAME USED FOR WIRE EXPOSURE TESTS.

FIG. 2.—CORROSIONS ON SURFACE OF ALUMINIUM WIRE, MAGNIFIED 4 TIMES.

The climate of St. Helens is probably too well known to need description; but it has improved considerably in recent years, owing to the closing of several chemical works. The place in which the wires were exposed is now singularly free from chlorine and hydrochloric acid gases. Waterloo is on the Mersey, 6 miles north of Liverpool, and its atmosphere is that of an ordinary west-country seaside town, plus much sand. During the exposure period of 10 months the frames were not touched or moved. At the end of this period the wires were removed from the frames, cleaned from the soot and dirt of all kinds which had accumulated upon them, and after thoroughly air-drying, were re-weighed. The results are set forth in Table II.

The above figures show that the aluminium wires and rods had nearly all gained in weight during the 10 months' exposure, the gain varying from nil up to 0·83 per cent. on the weight of the original wire. This gain must be attributed to the corrosion of the rods and wires, and to the settling of soot and dirt in the crevices. No amount of scrubbing would remove this dirt. The weights of these aluminium rods and wires were, therefore, of very little use in determining how far they had suffered by the exposure, and the two samples of aluminium wire marked No. 1 in Table II. were submitted to conductivity and tensile strength tests.[*] The results are given in Table III.

**Table III.**—*Tests of Aluminium Wire for Conductivity and Tensile Strength.*

| — | Conductivity; copper 100. | Tensile strength; tons per square inch. |
|---|---|---|
| Original wire .................. | 51·3 | 13-16[†] |
| Waterloo sample ............ | 51·4 | 12·06 |
| St. Helens sample ............ | 46·6 | 11·15 |

It has been customary to assume that the aluminium wire supplied for electrical purposes had a conductivity of from 57-63 per cent. that of copper, taking equal sectional areas of the two metals. The following figures were, in fact, sent to the writer with the samples of aluminium wire used in some of these experiments.

| Sample Wire | Composition. | Conductivity; copper 100. | Tensile strength; tons per sq. in. |
|---|---|---|---|
| 1. Rod ......... | 98·99½ per cent. Al ............... | 60-62 | 16-18 tons |
| 2. Wire ...... | 99 per cent. Al .................. | 65 | 13-16 tons |
| 3. Wire ...... | 99 per cent. Al, 1 per cent. Fe | 62 | 16-18 tons |

Samples 2 and 3 were, however, submitted to independent tests for conductivity, before exposing, and it was found that in place of conductivities of 65 per cent. and 62 per cent., they only possessed conductivities of 51 per cent. and 54 per cent. respectively. It is, of course, known that pure aluminium has a conductivity 63 per cent. that of copper; and the low conductivity of these samples can only be explained by the presence of iron, or other metals, introduced to increase their strength. The conductivity tests supplied by the firm in question were evidently based on surmise, not on actual results.

The tests given in Table III. show that although the St. Helens wire had gained in weight, yet considerable loss in conductivity and tensile strength had resulted from the exposure and consequent pittings. The Waterloo samples, although pitted to a less extent, had not lost in conductivity; and the tensile strength had probably not suffered, although in the absence of a special test of the original wire it is impossible to be quite certain on this point. The remains of these two sample wires are here on the table for examination by those interested in the subject, and photographs of the more badly corroded wire are also exhibited.

Examining Table II. again, in order to study the results obtained with the remaining wires, we see that both in Waterloo and in St. Helens the galvanised iron wires had lost in weight; the losses in the latter case being serious and amounting to 1·44 per cent. and 2·13 per cent. of the original weight of the wires. In this case almost the whole of the zinc had been dissolved away by the action of the acid gases, and the exposed iron was badly oxidised. The two Waterloo samples were, on the other hand, bright and clean, and to the eye did not appear to have suffered.

---

[*] NOTE.—These tests were made by the Faraday House Testing Institution.

[†] This test was supplied by the firm from whom the wire was obtained, and it is therefore not strictly comparable with the others.

The copper and tinned copper wires exposed at Waterloo were oxidised on the surface; but no pitting had occurred, and there was neither loss nor gain in weight. The two samples of similar wire exposed at St. Helens had both lost in weight (1·65 and 1·31 per cent. respectively) and as the whole of the tin had been dissolved off the tinned copper wire, it was impossible to distinguish one from the other.

*Conclusions.*—It is perhaps unwise to found any general conclusions upon the results of these observations, since they refer to two districts only. The British Isles can afford a very wide and ample selection in the way of climates. It would, of course, be interesting to have similar series of observations established in London, and in one or more of our large cities with a manufacturing population—say Manchester, Glasgow, or Sheffield; but at the moment the writer is unable to establish these. The investigation, however, proves that the aluminium wires at present sold for conducting purposes in this country are not perfectly resistent to atmospheric corrosion, and that in the atmosphere of a town where sulphurous acid gas exists as an impurity in the air the metal is very badly attacked.

Though St. Helens is certainly an exceptional town, it is probable that in any large town burning a large amount of coal, either for domestic or for manufacturing purposes, the atmospheric conditions will approach those obtaining there, and that the various metals will be attacked to a somewhat similar degree. Under such conditions all metals used for overhead conductors are subject to attack, and aluminium is unsuitable for use, owing to the pitting which occurs. In such towns it is advisable to use copper for all overhead wires, and the proposal to use aluminium, *especially for overhead trolley lines*, must be condemned.

FIG. 3.—CORROSIONS ON SURFACE OF ALUMINIUM WIRE. MAGNIFIED 20 TIMES.

In country districts or in small towns, where the impurities present in the air are reduced to a minimum, all metals experimented with seem to be fairly durable, but the slight pitting of aluminium which occurs, even in such an atmosphere, may prove serious; for by allowing the lodgment of small particles of foreign matter it may in time lead to the disintegration of the whole mass of metal. Upon this point the researches of Ditte, already alluded to, are of importance. The observations are being continued at the two localities named, and on a future occasion the author hopes he may have the pleasure of presenting further figures on this subject for your consideration.

The following is an abstract of the discussion that took place in connection with the above Paper:—

The PRESIDENT read the following communication which he had received from the Director of the National Physical Observatory (Dr. R. T. GLAZEBROOK): "I had hoped to be present at the Institution to-morrow night, but I fear I shall be unable to come. It occurred to me on reading Mr. Kershaw's Paper that it might be thought desirable to repeat and extend his very interesting observations on the relative reliability of aluminium and other metals for certain electrical purposes. If this is the case, I should be glad to endeavour to arrange to have such experiments carried out at the National Physical Laboratory, and shall welcome advice and assistance from any members of the Institution interested in the matter." I believe, said Prof. Perry, that Lord Kelvin is making very large experiments in this direction, and that he has stretched wires somewhere in Scotland. (Mr. SWINBURNE: "At Foyers.") If these experiments had been nearer London it would have been better. They would have been near some sulphury town.

Mr. J. GAVEY mentioned that the Post Office, for something like 12 months, had under consideration the desirability of carrying out certain experiments with aluminium wires, and the reason they were deferred for such a long time was the difficulty in obtaining a suitable soldered joint. Old telegraph engineers whose memory carried them back to the period before the invention of the "Britannia" joint, had a very holy horror of unsoldered joints, and the Post Office had deferred their trials until something satisfactory could be obtained. The question of soldering seemed to have been solved so far as the mere soldering was concerned, but unfortunately the heat necessary in the process annealed the wire and reduced its strength by exactly 50 per cent. Ultimately, in order to defer the experiments no longer, he had arranged to run out the wires to the full length of the coils, and to terminate each coil of wire on an insulator, and to solder the joint in a little loop so that the annealing of the wire had no injurious effect upon the strength of the portion suspended. The Post Office had obtained something like 18 miles or 20 miles of wire, and about 15 miles had been erected in the Potteries near Hanley, which was thought to be a suitable place to expose it to a very crucial trial. This was done in December, but although the wire handled well, their first experience—he did not want to make too much of it—was not very promising. Within a fortnight of the erection of these wires a heavy gale of wind blew across the country and caused something like eight or 10 breaks in the spans erected. The wire employed weighed 78lb. to the mile. Its approximate diameter was 124 mils, its breaking strain 340lb., which being reduced to tons per square inch came out at 12·568 tons. It had stood 10 twists in 3in., its maximum resistance was approximately 6·158 ohms, and its specific resistance came out at 2·974 ohms. He did not want to make too much of this experience, and it was, perhaps, a little bit early to come to any conclusion on the matter. It was quite possible that either in the billets or in the rolling or drawing of the wires there were places which were either over-crystallised or which differed in character from the remainder of the wire. When hard-drawn copper wire was first used for telegraph and telephone circuits he remembered how considerable was the difficulty in obtaining exactly the quality of wire asked for. In the first place it was very difficult to meet the rather stringent specification of the Post Office, but English manufacturers had come to the front, and after considerable expenditure had succeeded in meeting the necessary requirements. No doubt in the manufacture of aluminium wire, when a little more experience had been obtained, a similar success would crown the efforts of manufacturers. With regard to the reference to California, he had had the pleasure of a conversation with the president of the Pacific Telegraph and Telephone Co. about six months ago, who had erected a considerable length of aluminium wire for telephonic purposes, but these lines had been subjected to breaks similar to those experienced in the Potteries, and which could not be accounted for exactly.

Mr. J. SWINBURNE thought the question of the purity of the aluminium had not been sufficiently dealt with in the Paper. A very small proportion of any foreign metal in alumunium would probably alter the conductivity, and, therefore, throw the price-ratio wrong—*i.e.*, a little further purification of the aluminium would probably make its current-carrying capacity greater so that the price comparison was altered. A very little purification would also probably prevent corrosion. The three chief impurities in aluminium were sodium (which was about the worst thing they could have), iron (which did dot matter much), and silicon (which probably also gave rise to corrosion). The aluminium people were continually improving the metal, and there was considerable hope in that direction, but the next difficulty, which Mr. Gavey mentioned, was that sufficient attention was not given to the question of soldering. Aluminium alloys were usually unstable unless they had either a very large or very small proportion of aluminium. Alloys with about equal proportions of one metal and aluminium were very curious. They were nearly always unstable and tumbled to powder if they were touched. It was quite easy to solder aluminium, but the joint did not last two or three months, and the reason was probably—although he had been told he was wrong—that, owing to the solder used not being all aluminium, that part of the surface of the wire which was in the unstable condition gave way. He did not altogether agree with Mr. Kershaw that aluminium was hopeless for insulated conductors, and for this reason. With a pressure of, say 30,000 volts, the waste of power in ordinary copper leads became very serious, and therefore aluminium was better than copper unless the copper was made into a tube, and it was even probable that it would be cheaper to use a conductor of aluminium wire than a copper wire.

Mr. J. B. C. KERSHAW stated that he would send in what reply he had to make to the secretary.

**Electricity on the Siberian Railway.**—It is stated that the trains on the Moscow to Irkutsk section of the Trans-Siberian Railway are heated and lighted by electricity. A boiler, steam turbine, and a dynamo of 5 H.P. in the baggage car supply the current. Accumulators capable of supplying current for four hours are installed in case the generator breaks down. There are electric cigar-lighters in each compartment, and the water and milk in the dining car are kept from freezing by electric heaters. Portable lamps hung from brackets can be placed on the tables. The lamps are 5 c.p. to 16 c.p., and the whole amount to 1,000 c.p.

## CAPACITY IN ALTERNATE-CURRENT WORKING.*

BY W. M. MORDEY.

This is an attempt to consider some of the effects of electrostatic capacity in insulated cables for alternate-current working, especially as regards the power and plant. Distinctions formerly drawn between "current electricity" and "static electricity" have left impressions on our minds by no means helpful now. When we come to deal with electrostatic capacity in engineering applications with rapidly alternating currents, we find that so far from being "static" the conditions and effects are those of current or flow, and may most usefully be studied as such.

Electrostatic capacity in cables in some respects is an advantage, but on the whole it is a serious drawback in alternate-current work, mainly because it is directly and indirectly a cause of waste of power. Now that many applications of extra high tension alternate-current distribution are being promoted, it may be useful to carefully examine what is involved in this property as regards the power and plant required. In attempting to do this I may be allowed to begin at the beginning, as I think this may be useful to many engineers who have not hitherto considered the subject in its relation to economy of working.

The capacity of a cable is measured usually by comparing it with that of a standard condenser, using a low pressure and observing the throw of a ballistic galvanometer. The unit of capacity is the farad, but as it is too large for practical purposes the practical unit adopted is the microfarad or $\frac{1}{1,000,000}$ of a farad. Electric supply cables have a capacity varying from about one-fifth of a microfarad to about 1 microfarad per mile, according to the size, the form, and the kind of insulating material used. If two cables are connected to the terminals of an alternator a current to charge the cables will flow into them as the pressure rises in each half period, and back again as the pressure falls. As this occurs usually from 100 to 200 times a second it is, of course, just as "continuous" as any other alternating current. The amount of this charging current is easily found if we know the capacity of the cable. Perhaps I may be allowed to give a practical idea of what a microfarad is, in terms of volts and amperes and periods.

The capacity current in amperes

$$= \frac{\text{volts} \times \text{periods per second} \times \text{microfarads} \times 2\pi}{1,000,000}$$

Take an illustration from ordinary familiar working conditions in order to fix in the mind a quantitative idea of this:—

*One microfarad takes 0·6283 amperes at 2,000 volts 50 ∿.*

The above expression assumes that the capacity is independent of the pressure. In order to satisfy myself on this point I was able, by the kindness of Mr. Gray and the Silvertown Company, to make some tests on some rubber cable in the tanks at the Silvertown Works. The alternator ran at 90 ∿, and the pressure was varied from 2,000 to 5,000 volts. The following readings were obtained:—

| Volts. | Amperes. | Volts. | Amperes. |
|---|---|---|---|
| 2,000 | 0·62 | 4,000 | 1·29 |
| 2,500 | 0·75 | 4,500 | 1·45 |
| 3,000 | 0·97 | 5,000 | 1·65 |
| 3,500 | 1·11 | | |

These results, which are plotted in Fig. 1, show that the current is simply proportional to the pressure, and therefore that the capacity is not affected by the pressure.

I may here draw attention to the ease with which capacity measurements of systems of mains may be taken. It is a measurement that is, I think, never taken by station engineers. Knowing the E.M.F. and the periodicity, it is only necessary to take the current. Then

$$\text{the capacity} = \frac{\text{amperes} \times 1,000,000}{\text{volts} \times \sim \times 2\pi} = \text{microfarads.}$$

If the tests are always taken at one E.M.F. and periodicity, the scale of the ammeter may be marked to read directly in microfarads. This method is of course merely according to the "Ohm's law" of the subject, but it does not appear among those given in standard works on the subject. As it can be applied wherever an alternator is available, it should be useful to station engineers and others, especially for taking the capacity after the mains have been laid. The test can be made at the full working pressure, and variations of capacity with age may be easily observed.

In order to show what the capacity current may amount to in practice, I have worked out the following table for a length of cable having a capacity of 1 microfarad. The capacity current is directly proportional to the pressure and to the periodicity. The "apparent watts," or the amperes multiplied by the volts, are proportional to the square of the pressure for any given periodicity. The table gives the current taken at various pressures by a cable of 1 microfarad at 50 ∿, also the apparent watts taken and the apparent H.P. Another column, to be referred to later, gives the true watts.

**Table I.**—*Capacity Losses in Cables.*

Capacity current, apparent energy, and actual energy required by a cable of 1 microfarad at various E.M.F.s, 50 ∿.

| Volts. | Amperes. | Apparent watts. V × A. | Apparent H.P. | True watts. V × A × 0·124. |
|---|---|---|---|---|
| 1,000 | 0·314 | 314 | 0·42 | 39 |
| 2,000 | 0·628 | 1,256 | 1·69 | 156 |
| 3,000 | 0·942 | 2,826 | 3·8 | 350 |
| 4,000 | 1·256 | 5,024 | 6·7 | 623 |
| 5,000 | 1·57 | 7,850 | 10·5 | 973 |
| 6,000 | 1·88 | 11,300 | 15 | 1,400 |
| 7,000 | 2·2 | 15,400 | 20 | 1,910 |
| [illegible] | 2·5 | 20,100 | 27 | 2,490 |
| 9,000 | 2·83 | 25,430 | 34 | 3,150 |
| 10,000 | 3·14 | 31,400 | 42 | 3,890 |
| 15,000 | 4·62 | 69,300 | 93 | [illegible] |
| [illegible] | 6·28 | 125,600 | 166 | 15,570 |
| 25,000 | 7·85 | 196,000 | 263 | 24,300 |
| 30,000 | 9·42 | 282,600 | 380 | 35,040 |
| 35,000 | 11·0 | 385,000 | 516 | 47,730 |
| 40,000 | 12·56 | 502,400 | 672 | 62,300 |

Fig. 2 is plotted from this table, the upper curve giving the apparent power, and the lower curve the true power. Fig. 3 is the lower part of Fig. 2 drawn to a larger scale.

At 100 ∿ the current and watts would be double, and at 25 ∿ they would be one-half of the values given in the table.

When it is remembered that large distribution systems working at 10,000 to 20,000 volts, may, and probably often will, have cables the capacity of which may be scores of microfarads, it will be realised that the magnitude of the capacity effect is considerable. Even at low and moderate pressures it is by no means negligible.

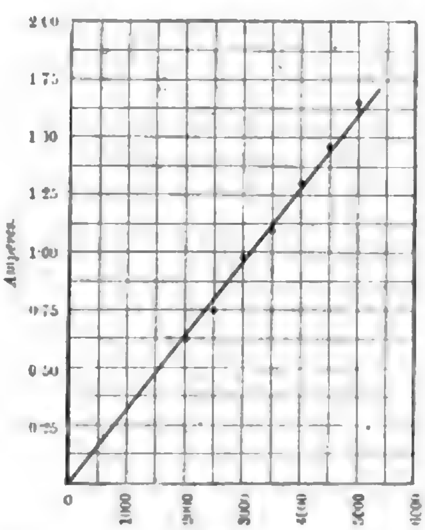


FIG. 1.—Capacity Current taken by Cable at various E.M.F.s, 90 ∿.

The term "apparent watts" is rather unsatisfactory. It is generally used to indicate that the whole of some volt-ampere quantity is not true watts, but it is sometimes applied to volt-amperes that are not watts at all. For instance, people will say, "So many true watts and so many apparent watts." Sir William Preece has suggested to me the term "phantom energy" for the false watts. The safest plan seems to be to use the term "apparent watts" as including both true and false watts, adding the power-factor, when known, to show how many of the apparent watts are true and how many are false.

The next question to consider is, What is the power factor of the cables? This is very important, for whatever we may be able to accomplish in neutralising or compensating the charging current, so far as I know we can do nothing to reduce the true watts absorbed by the dielectric of any given cable at any given pressure and periodicity. These true watts are made up of ordinary copper loss or $C^2R$ due to any charging current flowing in the conductor, to leakage, and to dielectric hysteresis.

The $C^2R$ loss due to the passage of the capacity current is usually unimportant, at least in large cables. It is easily calculated. The leakage is also usually unimportant. Thus, if a 2,000-volt cable has an insulation resistance of, say, 1,000 megohms per mile, the

* Paper read before the Institution of Electrical Engineers, January 10.

leakage will only be $\frac{3}{1000000}$ of an ampere and $\frac{1}{500}$ of a watt der mile.

Then there is the loss from dielectric hysteresis—that is, the loss of energy due to the insulating material being subjected to rapidly-repeated and violent electric strains. Whether this effect is simply due to mechanical friction caused by rapidly-repeated attractions and repulsions between the particles of the insulating material, and between that material and the metal within it and outside of it; or whether it is due to some more obscure molecular or polarisation effect I do not know. A simple explanation is to be preferred if a satisfactory one can be got. From what we can observe of actual mechanical vibration it seems possible that the first-mentioned cause is sufficient to account for the loss. But how much is this loss? By the kindness of Mr. Sparks and the County Company I have been enabled to make some tests on this and other points.

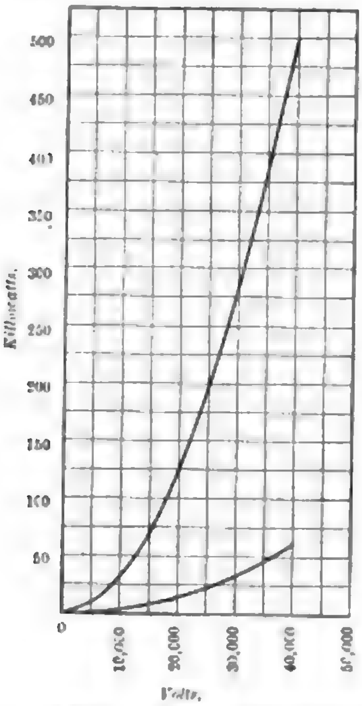


FIG. 2.—Apparent and Real kw. taken by Cable of 1 mf. at various E.M.F.s 50 ∿.
Upper Curve = Apparent kw. Lower Curve = Real kw.

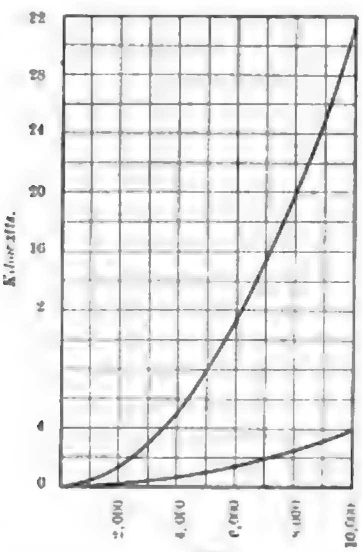


FIG. 3.—This is the lower part of Fig. 2 drawn to a larger scale.
Upper Curve = Apparent kw. Lower Curve = Real kw.

The cable placed at my disposal was 5½ miles of 37/15 concentric rubber covered. It was steel sheathed, drawn into 2in. cast-iron pipe—the outer conductor was earthed, and the steel sheathing also earthed every 220 yards by stranded copper cables bolted to the iron pipe. This cable was intended to be used at 6,000 volts 50 ∿, but my test was made at 2,050 volts 100 ∿. The makers' test gave the capacity as follows:—

0·86 microfarad between inner and outer, and
1·06 " " outer and earth.

As the outer was earthed, I need only consider the inner. The capacity current should be

$$\frac{2{,}050 \times 100 \times 0{\cdot}86 \times 5{\cdot}5 \times 2\pi}{1{,}000{,}000} = 6{\cdot}092 \text{ amperes.}$$

I found the actual current was 6 amperes—practically confirming the makers' test. It was interesting to find a measurement made at a high E.M.F. and high periodicity gave the same result as a ballistic galvanometer test with a low E.M.F. The cable was run for several hours with a Thomson recording wattmeter in circuit, this instrument having been specially tested by the County Company at low power factors. The pressure was nearly steady at an average of 2,040 volts, the current being 6 amperes. The apparent watts were, therefore, $6 \times 2{,}040 = 12{,}240$. The true watts, by the wattmeter, were, 1,515, or 275 watts per mile. The power factor $= 1{,}515/12{,}240 = 0{\cdot}124$; that is to say, the true watts were 12·4 per cent., or about one-eighth of the apparent watts.

The $C^2R$* and the leakage were both negligible, so the whole of this loss was due to dielectric hysteresis. It cannot be said that 2,226 apparent watts and 275 true watts per mile are negligible quantities. This is at 2,000 volts, 100 ∿. When the cable is worked as intended at 6,000 volts 50 ∿ the losses per mile will be—

$0{\cdot}86 \times 0{\cdot}6283 \times 3 = 1{\cdot}621$ amperes.

The apparent watts per mile $1{\cdot}621 \times 6{,}000 = 9{,}726$; and the true watts $9{,}726 \times 0{\cdot}124 = 1{,}206$ per mile.

This, of course, is on the assumption that the power-factor is the same at high pressures as at low (as seems probable), and that the loss in this instance was accurately determined.

The dielectric loss is not preventible. It may be lessened by increasing the thickness of the dielectric—that is, by reducing the strain—or by using a dielectric of low specific capacity, and by working at a low periodicity; but for any given case it must be accepted as one of the conditions of working. In some respects it is like the hysteresis loss accompanying the magnetising and demagnetising of iron. But dielectric hysteresis seems to differ from magnetic hysteresis in showing no saturation effect. Possibly at very high pressures the curve may begin to bend down, but I should expect the insulation to break down earlier than the proportional law.

I have already said that the actual loss in the dielectric, whatever its amount, is going on always when the mains are energised—whether any power is being transmitted or not. In the case just examined of the 6,000-volt 50 ∿ transmission it amounts to about 0·23 watt per foot of cable. So far as it is a cause of waste of power this may be, and often is, a much more important loss than the ordinary $C^2R$ copper loss. This will be seen from the following comparison:—The 37/15 cable (0·154 sq. in.) has a resistance of 0·271 ohm per mile, or 0·542 per mile for the two conductors. The constant dielectric loss of 1,206 watts per mile is therefore equivalent to a copper loss due to the constant passage through both conductors of 47·2 amperes, or at the current density of 326 amperes per square inch (or, in the single conductor, 67 amperes = 460 amperes per square inch); or a current that would give a drop of 25·6 volts per mile, or 0·46 per cent. per mile on a 6,000-volt circuit. If the cable is in continuous use its dielectric uses up 10,564 B.T. units per mile per annum.

To further illustrate this loss I have worked out tables for 2,000 volts and 7,500 volts, taking five commercial sizes of concentric cables and giving the dielectric losses and the copper losses that would be equivalent to those dielectric losses. I have taken the dielectric power factor as 0·124, as before. This factor may, of course, vary with different cables.

One rather unfortunate property of cables is shown by these tables. I refer to the fact that as different sizes of cables, made systematically to be suitable for safely working at any given pressure, have capacities which do not lessen very much with decrease of size, the dielectric loss of small cables is, therefore, disproportionately large. For example, in the five sizes given the section increases in the ratio 1 to 17, but the capacity only as 1 to 2·28.

The carrying power of a cable is limited in most cases by drop of volts rather than by heating or loss of power, otherwise this dielectric loss would very much restrict the load that could be put on cables. Nevertheless, this loss seriously affects the question of raising the pressure for long distances or large powers, at least where underground or covered conductors have to be used. As the copper loss is inversely in the square of the current, the temptation is to increase the pressure and reduce the current. But the dielectric

* The $C^2R$ in this case = 13·4 watts.

**Table II.**—*Cables working at 2,000 volts, 50 ∼.*

Losses in Dielectric per mile.

| | | | | | | |
|---|---|---|---|---|---|---|
| Size of cable | | 17/20 | 19/20 | 19/16 | 19/14 | 37/16 |
| Copper section : sq. in. | | 0·007 | 0·019 | [illegible] | 0·094 | 0·118 |
| Resistance | | 6 | 2·213 | 0·7 | 0·45 | 0·36 |
| Capacity, mfd. | | 0·33 | 0·5 | 0·6 | 0·7 | 0·75 |
| Apparent watts | | 419 | 628 | 754 | 880 | [illegible] |
| True watts | | 52 | 78 | 93 | [illegible] | 117 |
| Current (and current density) in conductor that would give loss equivalent to that in dielectric | Amp. | 2·95 | 5·96 | 11·55 | 15·6 | 18 |
| | Amp. per sq. in. | 420 | 312 | 192 | 165 | 153 |
| B.T. units per mile per year | | 455 | 683 | 815 | 955 | 1,025 |

**Table III.**—*Cables working at 7,500 volts, 50 ∼.*

Losses in Dielectric per mile.

| | | | | | | |
|---|---|---|---|---|---|---|
| Size of cable | | 17/20 | 19/20 | 19/16 | 19/14 | 37/16 |
| Mfd. per mile | | 0·2 | 0·33 | 0·364 | 0·425 | 0·454 |
| Apparent watts | | 3,300 | 5,450 | 6,000 | 7,000 | 7,500 |
| True watts | | 410 | 670 | 744 | 870 | 930 |
| Current (and current density) in conductor that would give loss equivalent to that in dielectric | Amp. | 8·3 | 17·4 | 32·6 | 44 | 50·7 |
| | Amp. per sq. in. | 1,180 | [illegible] | 540 | 467 | 430 |
| B.T. units per mile per year | | 3,590 | 5,870 | 6,520 | 7,630 | 8,147 |

NOTE.—In these two tables the equivalent copper loss is taken as that in a single coductor—not in a "lead and return"—for the reason that the dielectric loss is the same (for the same capacity) whether the main is a single one or double. Take a higher pressure illustration. Imagine a system of 40 miles of cables working at 20,000 volts, 50 ∼, the capacity being 0·5 microfarad per mile. With no load and no apparatus connected to the mains, the generator would have to provide a charging current of 125·6 amperes at 20,000 volts = 2,512,000 apparent watts. If the power factor is 0·124, then the actual energy absorbed by the mains will be 311,488 watts, and the number of B.T. units consumed per year will be 2,728,633, or an annual output that is exceeded by only a very few electric supply stations in this country. The loss works out at 1·5 watts per foot of the cable.

loss being proportionate to the square of the pressure, and being moreover a constant or all-day loss, whereas the copper loss is only fully felt at times of full load limits to increase of pressure are imposed which may be reached sooner than has been supposed. This opens a field for very careful consideration—and balancing of advantages—of high and low (or lower) pressure. I do not attempt to make any comparisons now. Every case must be examined on its merits and due weight given to load-factor, drop, value of power plant capacity, and so on.

I believe the general opinion has been that the production of capacity current involved practically no expenditure of energy; that it was in reality a wattless current, and that the only waste—a sufficiently considerable one—was in running the alternator under light load. I think nothing contrary to this opinion was put forward before the recent parliamentary committees on power bills. Those committees were assured, for instance, that so far as power was concerned, the losses with underground cables were the same as with aerial lines. I fear this is by no means the case. I do not wish to adopt an alarmist tone on this subject, but I think it will be admitted that if the tests referred to above are even only approximately correct, the subject deserves the very serious consideration of electrical engineers. It is probable that those who have had to do with extra high-tension mains, or even with long or extensive mains working at moderate high pressures, will have noticed, as I have, that when switching such mains on, the engine has been checked much more than would be consistent with the production of merely wattless current.

We may now pass from the question of the power-factor and the true power, to the wattless part of our "apparent watts." This we see is about 87·6 per cent. or seven-eighths of the total. It is very desirable we should do anything we can to lessen the production of "wattless current" by the alternator, as the amperes are real even if the watts are not. In producing "wattless current" at full pressure the alternator is taking a good deal of power, and is working very wastefully as to steam consumption. It takes practically as much plant to produce the current as if the energy were real. In fact it might easily happen from the known wastefulness of engines working at light load and from other causes that the true energy would cost less to produce it than the false or wattless energy. For example, to charge 20 miles of the 6,000-volt cable referred to above (and assuming that no means are used to counteract the capacity) the alternator would have to be run at 6,000 volts sending out 1·621 × 20 = 32·4 amperes = 194,500 apparent watts or 260 apparent E.H.P. This would require a 200kw. alternator fully loaded so far as current is concerned, although the true energy would only be 194·5 × 0·124 = 24kw. As there are objections to running a large alternator by a small engine, a large combined plant is often run on a low power-factor circuit.

Fortunately the difficulty can be avoided very simply by the application of known principles. To some extent this is done now, but I think it is done accidentally or unconsciously, or at least without system. In explaining how the wattless current may be reduced and the power factor raised to unity or nearly so, I hope those who prefer the mathematical treatment of such questions will not be impatient at my attempts to express my meaning in the vulgar tongue.

In a conductor or circuit having capacity, the charging current has a positive phase displacement of 90deg. from the E.M.F., while the current in an inductive circuit has a negative phase displacement of 90deg. from the E.M.F. Thus there is a difference of phase of 180deg. between these two currents. This is well known. Its systematic application affords a solution of the problem we are now considering.

Imagine an alternator supplying a circuit having capacity. Then if an inductance or choking coil is put in parallel with the capacity, and if it is so designed and adjusted that it takes a wattless self-induction current equal in amount to the wattless capacity current of the mains, the two will balance one another, and the generator will not have to produce any wattless current for either the capacity or the self-induction. Each will take its full current, which will pass to and fro between the capacity and the choking coil, being alternately a capacity or charging current with a positive phase displacement, and a self-induction current with a negative phase displacement. The generator will only have to keep up the E.M.F. and to produce the energy component of the current for the cable and the energy component of the current for magnetising the choking coil, and for leakage and resistances losses. As these energy currents are in phase with the E.M.F., the alternator will act as if working on a circuit having neither capacity nor self-induction—that is, a circuit having a power factor of unity. This will at least be the case if the balance is perfect.

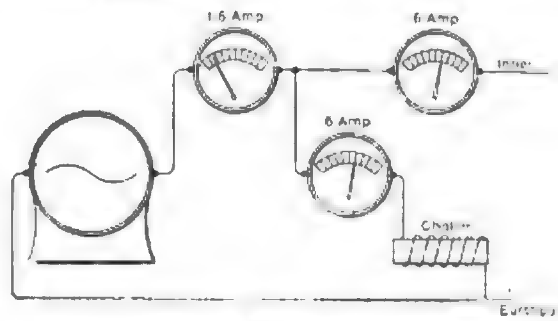


FIG. 4.

By the kindness of Mr. Sparks and the County Company, I have been able to try some experiments on the 5½ miles of mains already alluded to. The arrangement is shown in Fig. 4. I made a choking coil to take 6 amperes at 2,000 volts 100 ∼. Particulars of this coil are given later on. When working at 2,000 volts 100 ∼, the alternator gave 6 amperes when connected to the cable alone. The current was also 6 amperes when the alternator was working on the inductance coil alone. When the cable and the coil were put in parallel, with ammeters in circuit as shown, the alternator produced 1·625 amperes only, although there was still a current of 6 amperes in the cable and 6 amperes in the choking coil.

There was not a perfect balance. The true watts taken by the cable and the choker were about 2,000, therefore the alternator current should have been only about 1 ampere, but I was not able to get a closer adjustment. I must have had very nearly the best balance obtainable, as any adjustment of the choking coil, either in the direction of increasing or of decreasing its current, caused an increase in the alternator current. Possibly the slightly imperfect balance was due to a difference of effect of a sine curve alternator on the choker and on the capacity.* The actual practical result however, was quite satisfactory, as the choking coil effected a saving on the system of about 9,000 apparent watts, the energy absorbed by it being about 500 true watts. I need not say that the saving under these circumstances is not only "apparent."

It is not easy to say what would be a fair estimate of the cost of producing "wattless energy." I venture to think it is not much less than one-fourth of the cost of true energy. Whatever figure is taken the desirability of economising in such matters will be realised when I point out that at one penny per electrical horse-power-hour 1 watt for one year costs one shilling,† or say £1 capital.

*(To be concluded.)*

* See Paper in *Journal* XXIX., p. 154, Jan., 1900, by Alexander Russell, according to whom a sine curve wave gives a smaller condenser current and a larger magnetising current than any of the other wave shapes considered in his Paper.

† Or, more precisely 11·74 pence.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## ELECTRIC POWER DISTRIBUTION IN WORKSHOPS.

Electrical engineers and mechanical engineers have long been agreed that in the majority of engineering shops and shipbuilding yards the electrical method is the most economical one for conveying power to the various pieces of machinery utilised on the works. If any doubt remains on the subject, a perusal of the Paper by Mr. ESSON, which we commence in this issue, should be convincing. Mr. ESSON looks on the matter from an exceedingly broad point of view, and in his anxiety to discuss it with absolute impartiality, gives if anything, too many points to the other side, although the title of the Paper "The Case of Electric Power Distribution" might convey the idea of partizanship. Nevertheless, his clear discussion of all sides of the question leaves the superiority of electrical power-distribution indisputable except in special instances, such as cotton mills, where a large group of machines closely packed together are working practically continuously at a fairly constant load. Even when economy of fuel is no object, electrical methods of power distribution in workshops have much in their favour. By a coincidence, our special correspondent's serial article on the Paris Exhibition, which we resume this week after an interval necessitated by the various statistical and retrospective articles published at this season of the year, also touches on electrically-driven machine tools. Our correspondent deplores that the electrical engineer and the machine-tool maker do not work more hand-in-hand. In a large number of cases where the size and distribution of machine tools render practicable the employment of motors for each individual one of these, the original design of the machine for belt-drive has been left unmodified, so that the motor has often to occupy an unfavourable position. In spite of the possibility of varying the speed quickly and economically by means of double-wound motors and series-parallel controllers or other electrical methods, belts on cone pulleys are frequently seen in conjunction with individual motor drive, and are probably much more common practice. Nevertheless, no works manager would deny that

the time spent in changing the belts on the pulleys and the repair of the broken joints following on this operation mount up to a considerable value in wages during the year. Another direction in which the tool maker and works manager afford the electrical engineer less assistance than they should is in computing the H.P. required. Only recently we heard of a pattern shop for which a 25 H.P. or 30 H.P. motor was demanded, and in which subsequently a 10 H.P. motor was found to be amply sufficient. Tables have been published from time to time giving rough—usually very rough—figures for the power required by various machine tools, but there still appears to be considerable haziness about the matter. Of course the values depend almost entirely on the depth of the cut and the sharpness of the actual tool, but a fair maximum ought not to be too difficult to arrive at.

Mr. Essox called attention, as many have done before him, to the small engines scattered about shipbuilding yards and ironworks. His description of the "clattering, noisy, dripping abomination . . . with its loose joints, its escaping steam and streaming glands" was graphical and not at all overstated. Where such engines are employed there can be no doubt whatever as to the wastefulness of the present methods, and the economy which would follow the adoption of electric motors. But, taking the case of an ordinary workshop with an arrangement of countershafting corresponding to average practice, Mr. Essox actually shows a saving in power of 10 per cent. of the I.H.P. at full load, 16 per cent. at three-quarter load, 24 per cent. at half-load, and 38 per cent. at quarter load, by the employment of electric motors. Add to this the saving in time and in attendance, the possibility of obtaining better lighting, and the enormous gain in being able to place the machines in the best position for the work they have to do irrespective of the position of already existing lines of countershafting, and the case for electric driving is fully made out. When, besides, we take into account the extra convenience and economy in the electric working of cranes and hoists, the enormous gain in labour by using portable electrically-driven tools, and the further economy in electric lighting by combining the lighting and power plant, it is difficult to see how a works manager could contemplate any other system of power distribution in erecting new works. The re-equipment of existing works on these modern lines must also take place at a greater rate than hitherto, and it behoves the electric motor manufacturer and machine-tool maker to work in unison with a view to perfecting combined plant ready to meet a demand that has already tarried too long. A considerable number of electrically-driven works already exists both in this country and abroad, and they have proved uniformly successful; it should not be long before electric power transmission in workshops is the rule rather than the exception.

## UNIVERSITIES AND POST-GRADUATE STUDY.

[COMMUNICATED.]

At the present time we have become accustomed to hear attacks made upon our Universities as being hopelessly behind the times and utterly inadequate to equip our young men for successful competition with those of foreign countries. The teaching of science is especially singled out for attack, because it is recognised that our industries are in many cases now highly scientific, and require highly-trained men to carry them on. It cannot be denied that there is a very considerable amount of truth in these criticisms, however distasteful they may be to our national pride; but critics are too prone to see only the evil and close their eyes to the good, and thus, when they come to propose a remedy, they ask us to copy Continental or American universities before ever trying to find if there is not in our own country anywhere some college or univerity which might more advantageously be copied. If we planted to-morrow in this country a university conducted entirely on the lines of an American or German university it does not follow that it would be a success, for the conditions are different; but there is hope for the general success of any scheme which is found to produce excellent results in some parts of the British Isles.

At the present moment there is in England a school of science which has not received the attention it deserves, a school which more than any other in the country meets with present-day requirements. Probably it may surprise some to learn that this is to be found in Cambridge University. It is not, however, to the ordinary course for the mathematical or natural science tripos that we wish to refer, but to the special regulations providing a post-graduate course for advanced students or research students. These regulations are comparatively new, having only come into force in 1895, but already they have made their mark on the University, and have raised one department especially—that of experimental physics—to be probably the most prominent school of that subject in Europe and America. What then are these regulations? Briefly, they are as follows: Any man who has taken a degree in any university and wishes to pursue further his studies on some one subject out of those on which he was examined for that degree may apply to Cambridge University to be admitted as an advanced student, or as a research student if he proposes to engage in laboratory work. In that application he has to state what his course of study for his degree has been, so that the authorities may satisfy themselves that the applicant is able to profit by the advanced course. When he is admitted —and this is the important provision which encourages men to apply—he is eligible for the Cambridge B.A. degree at the end of two years, and, if he be a research student, the degree is awarded not as the result of an examination, but on the report made by referees on his original research during that time. A research student, therefore, working in one of the scientific laboratories, has this great inducement ever before him, that if he does good work for two years he may submit it as a dissertation and receive the B.A. degree as his reward. Of course, when once he has received the B.A., he may proceed in the ordinary way to the M.A. and higher degrees.

Such is the theory of these new regulations; how have they worked in practice? It would be somewhat difficult to deal with every branch of study (for there are advanced students in literature, history, divinity, and so on), but as it is with science we are especially concerned, we may confine our attention to that branch. Take then, for example, the Cavendish Laboratory of Physics, with Prof. J. J. Thomson at its head. So long as this was only used by men who had been undergraduates at Cambridge, the number of men engaged in original research was very small; but as soon as these regulations came into force the number began to increase rapidly, and now there are almost 20 men, coming from England, the colonies, America, and the Continent, each of them carrying out some original investigation. These men, on leaving Cambridge, usually apply for teaching posts in universities and technical schools, so that Cambridge is now supplying a continuous stream of highly-trained physicists to assist in the teaching of that subject throughout the country.

The success of the scheme may be illustrated by reference to the number of appointments now held by men from the Cavendish Laboratory. There have been three professorships of physics vacant within the last six months—namely, those of University College, Liverpool (formerly held by Principal Oliver Lodge), of University College, Dublin (formerly held by the late Prof. Preston), and the new Wykenham chair of physics in Oxford—and all have been supplied from the Cavendish Laboratory. Another student there has recently been appointed Principal of the Hartley College, Southampton. The chair of physics in the McGill University, Montreal, was also filled two years ago from this same quarter. With the exception of the

new professor at Liverpool, who received his whole training in Cambridge, these professors are all men who came to Cambridge for post-graduate study under the new regulations, and took the research degree. The others who have graduated and have entered the teaching profession have all received appointments in various colleges and schools throughout the country. The academic success which has attended the students of the Cavendish Laboratory is no less remarkable. Of those who received their undergraduate training also in Cambridge, two have been made Fellows of their respective colleges, and one of these two has been elected a Fellow of the Royal Society; while of the new research students, one has been made a Fellow of his college (Trinity), one has since leaving Cambridge been made, and one was while at Cambridge, a Fellow of the Royal University of Ireland, three have held or are holding Cambridge scholarships, and four at least have received the D.Sc. of London University. (It may be mentioned also that a research student in the anatomical laboratories, who came from Australia, was elected a Fellow of his college, and has recently been appointed to a professorship of anatomy in Cairo.)

If we seek the reasons for the success of this school of physics, the primary reason lies, of course, in the reputation of its distinguished head, Prof. J. J. Thomson. It is a remarkable tribute to his genius that so many Americans and students from the Continent come to his laboratory to engage in research work. No doubt many more would go there from our home and colonial universities but for the fact that the expense of living at Cambridge University is great. No student who is without private means can hope to go there unless he receives a scholarship from his own university or from some other source. There are, however, very few scholarships or fellowships of the value of £150 per annum (which is about the minimum required by a Cambridge research student) to be found at our universities; and where these are found the university authorities unfortunately usually require the recipients to remain with them and assist in the teaching work of their particular department. Under these circumstances the assistance given by the research scholarships, granted by the Royal Commission for the 1851 Exhibition, has proved invaluable, and most of the British and colonial students who have entered Cambridge University under the new regulations of 1895 have done so as being the privileged holders of these scholarships. As is well known, the Royal Commission allows most of our English and Irish university colleges and our Scottish and colonial universities to nominate each year some student considered worthy of receiving an "1851 Exhibition" scholarship. It is a condition of tenure of such a scholarship that the nominee shall carry on his studies at some university other than that by which he is nominated, and a large number of the students of physical science have naturally chosen to go to Cambridge. Thus Cambridge is receiving year by year a good percentage of the picked men from all the British and colonial universities, and this has no doubt helped considerably to secure the great success to which reference has been made. The new professors of Montreal, Dublin, and Southampton all formerly held "1851 Exhibition" scholarships; and it is of interest to note, as an instance of the Imperial Federation which is now in the air, that the new Professor of Physics in the McGill University came to Cambridge from the University of New Zealand, and thus we have a New Zealander receiving the finishing touches to his education in the mother country and then being sent on to become a teacher in the great colony of Canada.

Judged therefore either by theory or by practical results, the initiation of this advanced post-graduate school of research in Cambridge has proved most valuable and most successful. The granting of the degree as a reward for valuable original investigation instead of as the result of an examination is an innovation which will surely meet with the approbation of all who are interested in science and in education, and is a striking refutation of the charge that Cambridge is far behind the times and still bound fast in the bonds of her Conservative traditions. We have dealt above only with the particular case of the Cavendish Laboratory, because there we find the most striking growth; but progress is being made in other departments as well. In the engineering laboratory of Prof. Ewing, for example, research students are to be found too; and the number will probably increase from year to year.

Would it not be possible to develop our universities and colleges by seeking to introduce schemes to provide for post-graduate instruction somewhat on the lines of the Cambridge scheme? Surely there can be no doubt as to the answer. If we are to cope properly with modern demands, we *must* provide more than we do for post-graduate study, as it is only by such study that the really valuable training can be acquired; for so long as a student has to devote his attention to preparation for examinations (and especially if they be competitive), he is practically compelled to cram himself with all sorts of ill-assorted information and is unable to pursue a calm and reflective search after knowledge. The problem therefore is: How can students be encouraged and induced to remain at the university after they have taken their degrees? There will always, of course, be a certain number of men who are of themselves anxious to do so; but at our universities there is a large number of able men who cannot afford to do so unless they are pecuniarily assisted from some quarter or other. This assistance must be given to them. We have seen what a powerful factor the "1851 Exhibition" scholarships have proved in the success of the Cambridge scheme. These scholarships of course are limited in number, but some effort should be made to get more scholarships of this nature. They need not all be of the annual value of £150, because living in most provincial towns, and even in London, is cheaper than in Cambridge for anyone who is a member of the university. Many of the provincial laboratories are quite as well equipped as is the Cavendish Laboratory, and reasons of expense would probably cause many to go there rather than to Cambridge if something like the same inducements were offered.

It seems right to say here one word with special reference to some of the Scottish universities. They have recently been roused to the knowledge that they are behind the times, and in at least two of the universities a serious effort is being made to remedy this state of affairs, and to procure especially scientific laboratories in accordance with modern acquirements. In the December number of the *Fortnightly Review*, Dr. Wallace has written a most interesting and instructive article on the present condition of these universities, and in that article he makes reference to the cry which is often raised in Scotland, Why can our Scottish universities not train their own Professors? The answer of course is pretty evident when we examine their present condition; but there is another serious charge which can be brought against them. They have in many instances deliberately prevented their best men, who had distinguished themselves in their undergraduate course in some branch of study, from proceeding further with their studies in that branch. This perhaps requires explanation. There are in the Scottish universities several very valuable scholarships which can only be held by men who have taken their degree, and which are practically confined to men who have taken honours degrees. These then fall as prizes to the most distinguished men in each department of study and form the coping-stone to their academic career. Now, as money prizes, these are very valuable, reaching in some cases almost to £200 a year, and therefore they would serve admirably to keep the holders at some place where they could pursue further their studies in the subject for which they have shown an aptitude. But this is rendered impossible by the conditions of tenure attached to most of these scholarships by the university authorities. In most cases it is insisted as a first essential that the holder shall remain at that university and assist in the teaching work of the department in which he has gained the scholarship. He is therefore kept tied down to his university, he has to hold tutorial classes for perhaps two or three hours a week—classes which are seldom largely attended and never of real importance—and the rest of his time he may spend as he pleases; but the university will render him no assistance should he desire to spend that time on prosecuting his studies further on his own subject, for no provision is made for study beyond the course required for the honours degree.

If the Scottish universities had as many lecturers on advanced branches of each subject as, for example, we find at Cambridge, or if their scientific laboratories were thoroughly equipped and organised in accordance with present-day needs, then no one would find fault with them for keeping their scholars at home; but to do so when there is no possibility of these men prosecuting their special studies further there unless by private industry is quite inexcusable. The consequence of this system is that very promising men, who with proper encouragement might possibly come to the front in some particular subject, are encouraged to believe that they have learned everything when in fact their knowledge is just beginning, and if they grow tired of vegetating, they turn their attention to some quite new subject, in which they may entirely fail to gain distinction; whereas if they were allowed to go elsewhere, for at least a portion of the period of their tenure of the scholarships, they would not only greatly increase their knowledge of their special subject, but would on their return be in a position to render much more valuable service to their first university as members of the teaching staff. The present policy therefore seems a short-sighted one.

This question, then, of the proper conditions to be attached to scholarships in each university will have to be considered, as well as the question of the provision of more scholarships than exist at present, when a serious effort is made to provide post-graduate courses of instruction throughout the country. The Continental and American system appears to consist largely in having a multiplicity of professors and lecturers, without regard to how many or how few students attend their lectures; but there is room for argument whether the money required for all this staff would not be more profitably expended in encouraging more of the abler men to pursue to a more advanced stage their special studies, and thus increase the number of highly-trained men sent out by our universities. We have made special reference to a physical laboratory, but, of course, in the scheme for the future, technical laboratories will be of great importance.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.

"Fortschritte der Elektrotechnik." Edited by Dr. Karl Strecker. 1900. No. 1. (Berlin: Julius Springer.)

Lockwood's Builders' and Contractors' Price Book for 1901. Edited by F. T. W. Miller. (London: Crosby Lockwood & Co.). 4s.

## ELECTRICITY WORKS ACCOUNTS.

### Tunbridge Wells Municipal Electric Supply Works.

Although the accounts of this undertaking for the year to March 31st last show that a considerable falling off in the net financial result took place, yet a close study of our table will disclose the fact that essentially the year's working was most satisfactory.

Owing to alterations in the tariff the revenue naturally declined, and instead of a total return (from all sources) of 5·29d. per unit sold the total revenue was barely 3·96d. per unit—at this value being slightly below the average.

The total costs remained practically constant at 2·5d. per unit. Situated as is Tunbridge Wells the fuel charge must always be a serious load on the undertaking, but during the year we are considering not only had increased prices for coal to be met, but also an increased consumption owing to the engines being run non-condensing. We learn that for a portion of the period coal was paid for at the rate of over 33s. per ton. The high fuel item of 1·18d. per unit is thus explained and a different complexion assumed by the aggregate generating works and total costs. In fact, these totals present values practically coincident with the average values at municipal stations of similar output and load factor in the same year. This is, of course, saying a great deal in view of the handicapping conditions of working already referred to. We must, however, note that the collective management and property charges, at 0·71d. per unit were still at rather too high a value to be allowed to rest; they would certainly be more consistent with the works costs were they nearer, say, 0·55d. per unit.

During the year the lamp connections were advanced by about 19 per cent, the output was 48 per cent. above that of the preceding year, and the load factor 13·4 per cent. as compared with 12 per cent.

From the engineer's report we gather that of the total number of units sold to private consumers 125,007 units, or more than 40 per cent., were sold at 8d. and 207,266 at 6d. per unit, while the relative prices obtained from various classes of consumer were as follows:—

| | | |
|---|---|---|
| Public houses and hotels | (average price paid) ... | 3·9d. |
| Shops | ditto ... | 4·8d. |
| Private houses | ditto ... | 4·89d. |
| Offices (early closing) and churches | ditto ... | 6·00d. |

### Leyton Municipal Electric Supply Works.

The Leyton accounts, summarised in our second table, indicate that while very gratifying advances were made in the extent of business done and acquired, the working results were decidedly less satisfactory. An unfortunate general increase is noticeable in the costs, and, excepting the fuel item and the collective management and property charges, they are all rather too high considering the nature of the load.

It will be noticed that the net outcome of the year's operations was a deficit of £1,465 after paying capital charges representing 4·9 per cent. on the mean capital expended. In relation with this it has to be remembered that the average total revenue at 3·44d. per unit is unusually low.

During the year the lamp connections increased by no less than 52 per cent., while the output was higher than that of the preceding year by 70 per cent. Leyton has the advantage of a load factor above the average, and we are glad to note that it is increasing. Its mean value in the period we are considering was 12·8 per cent.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Jan. 19, 1900 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Sept. 8, 1899 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | June 22, 1900 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 23, 1900 | Notting Hill (Company) | Mar. 16, 1900 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Dec. 1, 1899 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 13, 1900 |
| Cambridge (Company) | April 13, 1900 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 9, 1900 | Preston (Company) | Dec. 14 1900 |
| Chelsea (London) (Co.) | Mar. 23, 1900 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Dec. 8, 1899 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Feb. 16, 1900 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Dec. 29, 1899 |
| Dewsbury (Municipal) | Nov. 24, 1899 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Southampton (Municipal) | Nov. 10, 1899 |
| Dundee (Municipal) | Nov. 2, 1900 | Southport (Municipal) | July 7, 1899 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Stafford (Municipal) | Aug. 17, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Sunderland (Municipal) | Nov. 9, 1900 |
| Folkestone (Company) | April 27, 1900 | Taunton (Municipal) | June 16, 1899 |
| Glasgow (Municipal) | Sept. 14, 1900 | Tunbridge Wells (Mun.) | Sept. 1, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Wandsworth (Company) | May 18, 1900 |
| Hampstead (Vestry) | Oct. 19, 1900 | Westminster (Company) | Mar. 9, 1900 |
| Hanley (Municipal) | July 27, 1900 | Whitehaven (Municipal) | July 28, 1899 |
| Harrogate (Municipal) | Oct. 20, 1899 | Winchester (Company) | Oct. 26, 1900 |
| Harrow (Company) | Dec. 21, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Woking (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woolwich (Company) | Jan. 13, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kens'gton & Knightsbr' (Co.) | Mar. 16, 1900 | Great Yarmouth (Mun.) | Dec. 24, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | | |

| | TUNBRIDGE WELLS. | LEYTON. |
|---|---|---|
| *Undertaking Worked by* | Tunbridge Wells Corporation. | Leyton Urban District Council. |
| *Date of Commencement of Supply* | 1895. | September, 1896. |
| *System of Supply* | Alt. curr. transformer sub-stations and house [transformers. | 3 wire continuous current with batteries.[a] |
| *Chief Engineer* | H. L. P. Boot. | F. Harman Lewis. |

| YEAR ENDED | MAR. 31, **1899.** | MAR. 31, **1900.** | MAR. 31, **1899.** | MAR. 31, **1900.** |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 466,901 | 620,558 | 336,0[illegible] | 634,157 |
| „ **SOLD (TOTAL)** | 334,709 | 496,297 | 248,905 | 423,476 |
| „ sold to consumers | 249,627 | 332,275 | 144,312 | 272,281 |
| „ sold for public lighting, &c. | 85,082 | 164,024 | 104,593 | 151,195 |
| „ used on works | 7 565 | 9,173 | 25 000 | 35,000 |
| **UNITS SOLD PER 8 C.P. LAMP CAPACITY** | 16·0 | 13·6 | 30·0 | 23·3 |
| Maximum supply demanded | 319 kilowatts | 423 kilowatts | 2[illegible]5 kilowatts | 378 kilowatts |
| Number of public lamps | [illegible] of 1,313 [illegible] c.p. | 66 arc, 256 16 c.p. glow | 12 arc, 260 glow | 24 arc, 265 glow |
| Number of consumers | 419 | 530 | 265 | 404 |
| Connections to mains in 8 c.p. lamps | 24,000 | 28,502 | 13,644 | 20,741 |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 20,900 | 36,600 | 8,285 | 18 120 |
| **CAPACITY OF PLANT IN KILOWATTS** | 670 | 1,170 | 265 | 580 |

| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| **AUTHORISED (TOTAL)** | £40,000 | £59·7 | £64,682 | £55·3 | £47,860 | £181 | £83,353 | £144 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 40,000 | 59·7 | 64,682 | 55·3 | 47,860 | 181 | 83,353 | 144 |
| **RECEIVED (TOTAL)** | 40,000 | 59·7 | 40,000 | 34·2 | 47,860 | 181 | 65,181 | 112 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 40,000 | 59·7 | 40,000 | 34·2 | 47,860 | 181 | 65,181 | 112 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | nil | — | 24,682 | 21·1 | nil | — | 18,172 | 31·3 |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | nil | — | 24,682 | 21·1 | nil | — | 18,172 | 31·3 |
| **REPAID (TOTAL)** | — | — | — | — | 1,847 | 6·97 | 3,354 | 5·78 |
| **RESERVE OR SINKING FUND** | 2,264 | 3·38 | 3,473 | 2·97 | — | — | — | — |
| **DEPRECIATION FUND** | — | — | — | — | — | — | — | — |
| **EXPENDED (TOTAL)** | 37,818 | 56·4 | 42,843 | 36·6 | 47,047 | 178 | 71,528 | 123 |
| Lands and buildings | 6,629 | 9·89 | 6,755 | 5·78 | 7,977 | 30·1 | 16,441 | 28·4 |
| Plant | 18,275[a] | 27·3 | 21,392[c] | 18·3 | 17,551[b] | 66·2 | 25,816[h] | 44·5 |
| Mains | 11,713 | 17·5 | 13,582 | 11·6 | 19,978 | 75·4 | 25,346 | 43·7 |
| Miscellaneous | 1,141 | 1·70 | 1,114 | 0·95 | 1,541 | 5·82 | 3,924 | 6·77 |
| **BALANCE OF CAPITAL ACCOUNT** | +2,182 | +3·26 | −2,843[f] | 2·43 | 813 | 3·07 | −6,347[i] | 10·9 |

| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
|---|---|---|---|---|---|---|---|---|
| **TOTAL** | £7,381 | 5·290d. | £8,180 | 3·955d. | £3,417 | 3·295d. | £6,072 | 3·440d. |
| Revenue from supply | 5,907 | 4·235d. | 6,455 | 3·120d. | 2,415 | 2·326d. | 4,474 | 2·536d. |
| „ meters, &c. | 209 | 0·150d. | 265 | 0·129d. | 7 | 0·007d. | 117 | 0·066d. |
| „ public lighting | 1,232 | 0·884d. | 1,363 | 0·662d. | 962 | 0·928d. | 1,448 | 0·821d. |
| „ sale of lamps, &c. | 8 | 0·006d. | 22 | 0·011d. | — | — | 10 | 0·006d. |
| „ miscellaneous sources | 25 | 0·018d. | 63 | 0·030d. | 35[e] | 0·034d. | 23 | 0·013d. |

| **EXPENDITURE OUT OF REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
|---|---|---|---|---|---|---|---|---|
| **TOTAL COSTS** | £3,484 | 2·498d. | £5,170 | 2·500d. | £2,491 | 2·402d. | £4,634 | 2·626d. |
| **WORKS COSTS** | 2,283 | 1·636d. | 3,707 | 1·792d. | 1,919 | 1·850d. | 3,590 | [illegible] |
| *Generation of electricity* | [illegible] | 1·393d. | [illegible] | [illegible] | [illegible] | [illegible] | 3,135 | 1·777d. |
| Fuel (including cartage, &c.) | 1,351 | 0·969d. | 2,446[g] | 1·185d. | 703 | 0·678d. | 1,244 | 0·705d. |
| Oil, waste, water, stores | 109 | 0·078d. | 171 | 0·083d. | 119 | 0·115d. | 326 | 0·184d. |
| Wages at station | 501 | 0·359d. | 567 | 0·274d. | 715 | 0·690d. | 984 | 0·558d. |
| Repairs and maintenance at station | 122 | 0·087d. | 196 | 0·095d. | 151 | 0·146d. | 583 | 0·330d. |
| *Distribution of electricity* | 10 | 0·007d. | [illegible] | [illegible] | 10 | [illegible] | 52 | 0·029d. |
| Wages, &c. | — | — | 23 | 0·011d. | 10 | 0·010d. | 52 | 0·029d. |
| Repairs, renewals of mains, &c. | 10 | 0·007d. | 26 | 0·013d. | | | | |
| *Public lighting* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0·228d. |
| Attendance | 131 | 0·094d. | 1[illegible]2 | 0·096d. | 196 | 0·189d. | 344 | 0·195d. |
| Renewals | 60 | 0·043d. | 81[k] | 0·039d. | 31 | 0·030d. | 59 | 0·033d. |
| **MANAGEMENT AND PROPERTY CHARGES** | 1,201 | 0·861d. | 1,463 | 0·708d. | 572 | 0·552d. | 1,044 | 0·592d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | 0·1[illegible]d. | [illegible] | 0·1[illegible]5d. | 1 | [illegible] | 1 | 0·001d. |
| *Management* | [illegible] | 0·[illegible]8d. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0·591d. |
| Salaries | 813 | 0·583d. | 757 | 0·366d. | 351 | 0·339d. | 674 | 0·382d. |
| Stationery, &c. | 45 | 0·032d. | 44 | 0·021d. | 97 | 0·094d. | 111 | 0·063d. |
| Establishment charges | 39 | 0·028d. | 224 | 0·108d. | 56 | 0·054d. | 120 | 0·068d. |
| Law charges, &c. | 91[b] | 0·065d. | 138[l] | 0·067d. | 67[f] | 0·065d. | 138[d] | 0·078d. |

| **FINANCIAL RESULTS—** | Total. | % to mean cap. expended. | Total. | % to mean cap. expended. | Total. | % to mean cap. expended. | Total. | % to mean cap. expended. |
|---|---|---|---|---|---|---|---|---|
| **WORKING PROFIT FOR YEAR** | £3,895 | 11·3% | £3,010 | 7·47% | £926 | 2·46% | £1,438 | 2·43% |
| Sum carried to Depreciation Fund | — | — | 53[i] | — | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 835 | 2·41% | 1,143 | 2·81% | 991 | 2·64% | 1,506 | 2·54% |
| Net interest on loans (incl. Debenture charges) | 890 | 2·58 | 1,214 | 3·01 | 861 | 2·29% | 1,397 | 2·36% |
| **BALANCE FROM LAST ACCOUNT** | 2,258 | 6·54% | 2,469 | 6·12% | — | — | −2,285 | −3·82% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 4,430 | 12·8% | 2,988[l] | 7·41% | — | — | — | — |
| *Deficit* | — | — | — | — | [illegible] | [illegible] | [illegible] | 6·49% |
| **ORDINARY DIVIDEND PAID** | — | — | — | — | — | — | — | — |

| | | | | |
|---|---|---|---|---|
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 47·2% | 63·2% | 72·9% | 76·3% |
| Expenditure per kilowatt capacity | £[illegible] 4s. 0d. | £4 [illegible] | £9 [illegible] | £7. 19s. 10d. |
| **REVENUE PER KILOWATT CAPACITY** | £11. 0s. 2d. | £6 19s. 10d. | £12. 18s. 0d. | £10. 9s. 2d. |
| Expenditure per 8 c.p. lamp capacity | 3s. 4d. | 2s. 10d. | 6s. [illegible] | 5s. 1½d. |
| **REVENUE PER 8 C.P. LAMP CAPACITY** | 7s. 0½d. | 4s. 5½d. | 8s. 3d. | 6s. 8½d. |
| **REVENUE PER 8 C.P. LAMP CONNECTED** | 6s. 1½d. | 5s. 8½d. | 5s. 0d. | 5s. 10½d. |
| Price charged for lighting, per unit | [illegible] to 3d.[i] | 6d. to 3d.[i] | [illegible] | 5d. to 2d.[e] |
| Price charged for power, per unit | — | 3d. | 5d. [illegible] 1d.[f] | 5d. to 1d.[f] |
| Price charged for public lighting | — | [illegible] per unit | £18 per arc per ann.[g] | £1[illegible] per arc per ann.[g] |

TUNBRIDGE WELLS. [illegible] £795 to new lamps on alteration of pressure [illegible] expended. g Includes £2,0[illegible] on coal and [illegible]

LEYTON. REMARKS. [illegible] battery; 300 kw. hours' capacity. [illegible] public lamps and [illegible] f On maximum demand [illegible] of 16 c.p. glow lamps £4 per annum [illegible] Includes £2,1[illegible] on public lamps and [illegible] Over-expended.

## PROF. SLABY'S TUNED AND MULTIPLE SPARK-TELEGRAPHY.*

Prof. A. Slaby, on beginning his lecture, explained that he entered upon his researches in "spark-telegraphy" with the idea of devising a system to replace that of Marconi; the prohibitive prices charged by the Marconi Company rendering their system impossible of wide adoption by any but the English navy. Prompted, then, by a desire to assist the employment of spark-telegraphy in the German navy, the author, assisted by Count Arco, commenced a series of experiments which they little guessed would lead them to something better than the mere similarity to Marconi's performance which they aimed at. And last summer he hit upon their present method of exact tuning, Count Arco being mainly responsible for the working out of the practical details.

Prof. Slaby then entered at length into the elementary theory of the electric oscillations on an air-wire, and showed that a potential node exists at the earthed end, and at the free upper end a potential loop, and hence that the wave-length of the oscillations is four times the length of the air-wire. Hitherto the practice has been to lead the insulated air-wire to one terminal of the coherer whose other terminal was earthed. The large capacity of the coherer, however, makes its

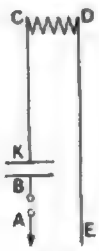


FIG. 1.

air-wire end a potential node, and thus but poor results were obtained. The fact that signals were obtained with this arrangement is accounted for by the existence of other frequencies among the incident waves. But pursue instead the following plan: Lead the air-wire directly to earth, so as to produce a true node of potential, and connect there another wire of length equal to the air wire, and with a free end. At the free end of this extension is produced a potential loop similar to that at the free upper end of the air wire. This extension need not be stretched away in a horizontal line; it may be wound on a reel. It is found to increase greatly the accuracy of signalling, and is, in fact, the kernel of the Slaby invention. In the lecture demonstration the extension wire of calculated length was lead directly from the lightning conductor to the receiving apparatus in the room.

Till some such method as the above was found, tuned telegraphy was impossible. According to Prof. Fleming, Marconi has found such a method, but he keeps his solution of the problem secret. In practice the Slaby-Arco solution consists in two corresponding

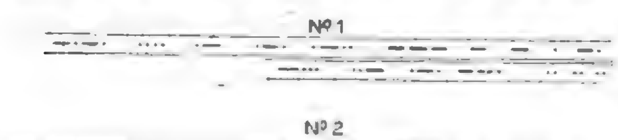


FIG. 2.

stations working with consistent wave-lengths, whose diversity is controllable within wide limits. The manner in which a certain wave-length only is detected is set out above; the method of producing a definite wave-length follows. The apparatus is a modification of that which was first described more than a year ago, and has since been in use in the German navy. It is designed to produce as much oscillatory energy as possible. Instead of the single insulated wire an earthed loop of wire is used (Fig. 1), to which is attached one plate of a condenser of Leyden jar form. In the charging of the system the whole loop, closed through the earth, as shown, is used; in the discharging the part KC only is employed. The discharge commences when the spark begins, and is powerfully oscillatory. The coil of wire CD prevents the passage of the oscillations to earth by DE. This apparatus produces waves of a definite length calculable from the known capacity of the condenser and the known length of the wires.

Messages were then received simultaneously from a station at Schonweide, 8 miles distant, and from the lecturer's laboratory at Charlottenburg Technical College about 2½ miles distant. The rate of transmission was about 72 letters per minute. Fig. 2 is a reproduction of two simultaneously received messages.

The author, since the delivery of his lecture, in replying to questions concerning the path by which he was led to his discovery, states that he was guided solely by purely theoretical considerations. The theory of the air-wire leads to the differential equation

$$R_1 \frac{di}{dt} + L_1 \frac{d^2 i}{dt^2} = \frac{1}{C_1} \cdot \frac{d^2 i}{dx^2}$$

where $i$ is the current at any time $t$ at the place $x$ on the air wire, and $R_1$, $L_1$ and $C_1$ are the resistance, self-induction and capacity per unit length of the wire. A solution is

$$i = Ae^{-\frac{R}{2L}t} \cos \frac{2\pi}{T}t \cdot \sin \frac{\pi}{2l}x,$$

where $T = 4\sqrt{LC}$, $l$ is the length of the wire, A is a constant, and R, L and C relate to the whole length of wire. The frequency is $\frac{1}{T}$, and the wave-length is equal to $4l$. The potential fall per unit length of wire is

$$\frac{dv}{dx} = Be^{-\frac{R}{2L}t} \cos \frac{2\pi}{T}t \cdot \cos \frac{\pi}{2l}x.$$

These formulæ show that the oscillations follow the simple harmonic law, and that the free end of the wire is a potential loop and

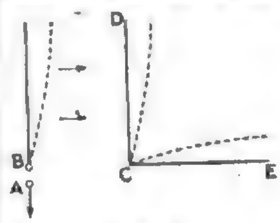


FIG. 3.

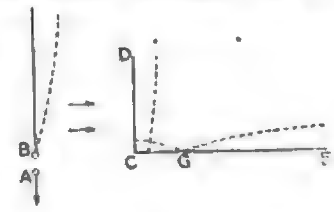


FIG. 4.

the lower end a potential node. The simple relation between wave-length and wire-length is considerably affected, however, by the proximity of the earth, and an increase in the slope of the wire makes a great alteration in its capacity and hence in the wave-length. These alterations can be followed only by experiment, but both Prof. Slaby and Count Arco have shown that the above simple relation may, roughly, be adhered to.

Consider, then, a straight vertical wire, B, acting upon a distant vertical wire, CD, as represented diagrammatically in Fig. 3. During an oscillation nodes occur on both wires at the earthed parts A and C respectively. Suppose, now, a second wire, CE, beyond the inductive action of B, attached at C. At E, then, is produced a potential loop of strength equal to that at D. The earth connection at C has no effect in this case. If the receiver wire be shorter than the inducing quarter wave-length (Fig. 4), then at D and E loops are again formed as before, but an earth connection at C greatly weakens these. An

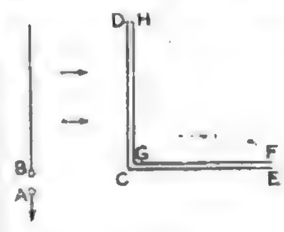


FIG. 5.

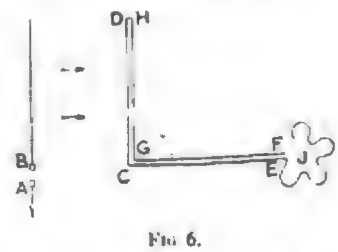


FIG. 6.

earth connection at G, however, has no effect. If the air-wire is loop, as shown in Fig. 5, D and H being connected, then at D, H, E and F equal potential loops occur, and at C and G nodes. But if to E a length of wire J be attached (Fig. 5), and if this wire EJ be a half wave-length, then a phase difference of 180deg. is established between F and J, and, as experiment confirms, the potential difference between E and J is double that between F and earth. Moreover, the whole receiving apparatus may now be earth-free—a great advantage; and the effects due to atmospheric electricity are completely eliminated. By a happy inspiration Count Arco abolished one of the two wires in the last-described apparatus and thus this is reduced to a single wire DCE and J, the coherer being applied between J and E.

The theory of the intensifier described above is not quite simple. In the author's opinion, its action depends on a shifting of phase in the windings of the coil, with an inversion in direction of the mutual induction in some of them.

In concluding, Prof. Slaby mentions that the Secretary of State for the German navy has consented to a number of experiments being made on warships in order that the maximum distance attainable by this means of signalling might be determined.

* Lecture delivered before the German Emperor, at Berlin, December 22. A brief summary of this lecture appeared on p. 343 of our issue of December 28.

## PRACTICAL NOTES ON WATER POWER FOR ELECTRICAL PURPOSES.

**The following is an abstract of the discussion on Mr. R. F. Yorke's Paper on this subject, read on the 9th inst., before the Glasgow section of this Institution of Electrical Engineers. The Paper was reprinted in our issue of the 11th inst., p. 436.**

Mr. WILLIAM McWHIRTER, in opening the discussion, said that he was afraid there was very little to discuss. It was natural for any one who had the *Proceedings* of the Institution at hand, to turn back for a few years, and doing this he had been led to read a Paper on turbines in the volume of the *Proceedings* for 1896. In this Paper every aspect of the very important question was entered into.

Mr. RITCHIE, on the invitation of the chairman, said he had listened with pleasure to Mr. Yorke's Paper, and, as a manufacturer of turbines, was naturally interested in the development of water power. Mr. Yorke had spoken on the subject very generally, and he would have liked him to have given a little more detail in connection with the running of water power machinery. Mr. Yorke, in referring to suction pipes for turbines, stated that a pipe laid on a slope was a failure in maintaining a good vacuum, and this he had proved, and Mr. Yorke's theory of the air bubbles was the correct and generally accepted one. At the same time sloping suction pipes are used in America, but perhaps the turbines to which they are fitted work mostly at full load with the pipes running full, when there is less tendency to destroy the vacuum. Every turbine ought to be fitted with a governor. A storage battery may, in many cases, be a necessity, and where storage batteries are used it is generally considered that a governor is not necessary, but as everyone knows batteries have their weaknesses, and where the water supply is such that the turbine can be run continuously a governor is to be preferred. Mr. Yorke has said there are no large transmission plants in this country, and when compared with those on the Continent and elsewhere this is true. The largest he knew of was in Ireland, where at Milford, on the river Barrow, there are two 50 H.P. and one 80 H.P. turbines at work generating alternating current at 2,500 volts, which is sent into the town of Carlow, 5½ miles distant, where it is used for lighting and also for motors in several small industries. A contract has just been made for nearly 2,000 H.P. in the North of Ireland, and several thousand H.P. is being negotiated in the North-west of Ireland, and people are now waking up to the fact that even in this country there is some prospect of useful work being got on a large scale from water power. Perhaps it is not generally known that some very high falls are already used for power. On the Ochils, near Stirling, there is a Girard turbine working under a head of 860ft., and at Brora, in Sutherlandshire, there is a Pelton wheel working under 950ft. head, and these are only samples of what might be done all over the North and West of Scotland.

Mr. G. T. BLACKWOOD MURRAY said his father and he had a fairly wide experience in designing and putting down water-power electric generating plant, and had met with some of the difficulties with suction pipes which Mr. Yorke mentions in his Paper. For long suction pipes the plan suggested by Mr. Yorke, namely, of taking them out horizontally and then vertically downwards, would not always be found satisfactory. Although the air given out by the water due to the reduction of pressure below atmosphere would be carried along the level portion, it would almost certainly lodge just where the bend-down occurred, as the speed on the air bells upwards in the vertical portion would be greater than the down velocity of the water, unless this latter were made fairly high by reducing the section of the vertical pipes. From experiments he found that for every size and slope of pipe there is a certain speed at which bells of air travel along the pipe. It is evident, of course, that unless the speed of the water in the pipe be greater than this speed, the air will not be carried forward and discharge, but will lodge or travel back. He quoted as an instance a small turbine, which was put down in 1887. This was worked with 10ft. of head and a suction tail race of 180 yards long of 6in. cast-iron pipe, having a gross fall of 19ft. Of this 3ft. was lost by friction; the pipe was carried out nearly horizontal from the turbine, having, in fact, in the 180 yards barely 3ft. of a fall, and then had a vertical drop of rather over 13ft. When started up, the suction gradually rose to about 9ft., but remained there, whereas 16ft. of suction ought to have been got. The velocity of the water in the pipes was 3ft. per second. To remedy matters he put on a butterfly type of foot valve at the outlet and a self-acting air valve at the turbine. The suction pipe was then filled up before starting by turning on a small quantity of water and allowing the air to escape. The turbine was started by opening the foot valve and turning on full water. The full suction of 16ft. was then got, but after about 8 hours' run, this fell to about 14ft., showing clearly that air was gradually gathering.

Mr. W. A. CHAMEN asked if Mr. Yorke would be good enough to explain in his reply whether the turbines at Chevres maintained their load even with so large a variation in the head as 50 per cent. Mr. Yorke had stated that they maintained the speed, but he presumed that they could not maintain the same load. He also asked why, if the air bubbles destroyed the vacuum with an inclined suction pipe, they did not act in the same way with a vertical suction pipe. With regard particularly to the question of governing, as applied to turbines, used for private house installations, he described the turbine and dynamo plant, put down at Braemore, Rosshire, for the late Sir John Fowler. The head of water available was about 200ft., being obtained from a reservoir away up the side of the mountain above the house. The turbines were fixed in part of the kitchen premises of the house itself. They were of Messrs. Gilkes' make, and of the vortex type, three in number, each being of 12 H.P., and running at a speed of 1,200 revs. per min., and each being coupled direct to a Crompton dynamo. The governing was managed by a Willans electric governor, consisting of a shunt solenoid, working a water relay which controlled the supply to a powerful hydraulic ram, and arranged so as to open and close the guide blades of the turbine, an operation requiring a considerable amount of power. No accumulators were used, and the governing proved extremely successful, the only trouble being that at first the delicate water relay valve got choked by some of the peaty matter from the water. This was remedied by inserting a fine filter, which, however, itself became choked after a few days' run, and required frequent changing of the filter papers. There being no accumulators, a novel device in the shape of an alarm clock, arranged to open the connection to a hydraulic cylinder working a sluice valve, was fitted so that everyone, including the attendant, could retire to bed leaving the plant running. When the desired time arrived the clock turned on the water to the cylinder, which, however, was only allowed to pass very slowly through a small bore cock and pipe so as to ensure a very gradual shutting down of the plant, giving notice by the dimming of the light to any persons, who might not be already in bed, that the supply would absolutely cease within about a quarter of an hour.

After some remarks by Mr. Munro and Mr. Clarke,

Mr. YORKE, in reply, said he only proposed briefly to touch on some of the points raised, as in a general way the various speakers had answered each other. Mr. McWhirter was inclined to doubt that it was possible to run an electric light installation working under the continuous system described in the Paper, but such a system is and has been in use for a great number of years without any of the troubles anticipated by him having arisen. It must be pointed out, however, that when a charging current is spread over 24 hours instead of the ordinary six or eight hours the charging current is, of course, reduced by one-third or one-fourth, and it is found that when charging continuously at this low rate the variation in pressure is only slight. On the other hand, as pointed out in the Paper, the lifetime of the accumulator is greatly prolonged. Many of the speakers referred to the question of suction pipes alluded to in the Paper. Mr. Chamen asked as to the reason of air troubles arising with a suction pipe laid on the slope, when no air troubles appear when the pipes are laid vertically. His explanation was that when the pipes are laid vertically the velocity of the downward current of water is greater than the upward velocity of air bubbles, and therefore it is impossible for air to accumulate at the top of the suction pipe. The result to be deduced from this theory is fully confirmed by the fact that suction pipes of too large a diameter do not answer, and recently a case was reported where suction pipes too large in diameter had had to be taken up and replaced by those of smaller diameter. Mr. Murray was under the impression that under Mr. Yorke's system of laying the suction pipes horizontally and then vertically there will be a tendency for the air to collect at the bend, but in practice such an effect does not occur, and the same vacuum is obtained as if the pipes were fixed vertically. Mr. Chamen asks whether, while maintaining the speed of such turbines as those in use at Chevres, the full power also is maintained, but he understands that such was not the case. With a full fall of 30ft. 1,200 H.P. is obtained, and 800 H.P. with a reduced fall of 15ft., the speed of 80 revs. being maintained.

## CORRESPONDENCE.

### CAPACITY IN ALTERNATE-CURRENT WORKING AND DIELECTRIC HYSTERESIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: At the close of the meeting of the Institution on Thursday the 10th inst., it occurred to me that an excellent method for ascertaining the *outside limiting* value of the dielectric hysteresis in a cable was the following, since it was entirely free from the possible chance of serious error which might arise from employing a wattmeter, or an integrating wattmeter (energy meter), with a circuit possessing an extremely low power factor: *First*, calculate $h$, the self-induction that the inductive shunt to the cable should have so that the alternator-current may be a minimum. This, as I stated, is given by the formula—

$$h = \frac{1 + \sqrt{1 + 4F^2p^2\omega^2}}{2Fp^2} \text{ henry},$$

where F is the capacity of the cable in farads, $p$ is $2\pi$ times the frequency of the alternator, and $\omega$ is the resistance in ohms of the inductive shunt. And this best value of $h$ in Mr. Mordey's case, as I also stated, comes out to be 0·58 henry.

*Next*, calculate what will be the alternator-current with such an inductive shunt, when using his "*sine curve alternator*," if there be no dielectric hysteresis. This current, $A_1$ ampere, is given by $VF\omega/h$, and, as I mentioned, is 0·075 ampere in Mr. Mordey's case.

*Thirdly*, make the experiment with the cable shunted with an inductive shunt *made without iron* to have this best value

of the self-induction, viz., 0·53 henry in the case in question. Observe the alternate current; let it be $A_2$ ampere.

Then an outside limit of the current due to dielectric hysteresis is obviously $A_2 - A_1$ ampere, and an outside limit of the power spent in dielectric hysteresis is $V (A_2 - A_1)$ watts.

Two other points have also been noticed since the meeting on Thursday. One, that Mr. Mordey must have forgotten that he was present at the reading of the Paper in question, on March 6, 1891, at the Physical Society since, on p. 572 of *The Electrician* for March 13, 1891 (Vol. XXVI.), his contribution to the discussion on that occasion is given; secondly, that between the date of that meeting and the subsequent one at which Major Cardew described his own experiments on this method of measuring the capacity of a condenser with alternating currents (p. 448, Vol. XX., *Journal* of the Institution of Electrical Engineers, May 21, 1891). Dr. Fleming described the same method and the results obtained (pp. 395 and 396, Vol. XX., *Journal* of the Institution of Electrical Engineers, May 7, 1891). This method for measuring the capacity of a condenser may, therefore, be found in essentially standard works on electrical engineering.—Yours, &c.,

London, Jan. 15. W. E. Ayrton.

## THE "MUSICAL" ARC.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: My attention has been called to a Paper on "Rapid Variations in the Current through the Direct-Current Arc," by Mr. W. Duddell, read before the Institution of Electrical Engineers, and published in your issue of December 21, 1900. Under the heading "Musical Arc," Mr. Duddell describes certain phenomena as if they were entirely new. I take pleasure in enclosing copy of a paper in the form of a patent specification, filed July 18, 1892, and issued July 4, 1893, which, it will be seen, contains substantially the same arrangement as that used by Mr. Duddell. This method for producing high periodicity alternating currents should be better known.—Yours, &c.,

Lynn, Mass., Jan. 2. Elihu Thomson.

[Prof. Thomson's patent specification (American Patent No. 500,630, dated July 4, 1893) is entitled "Method of and Means for producing Alternating Currents," and describes the arrangement of an induction coil and condenser connected in series and shunted to the terminals of an arc or spark-gap. Alternating currents of high frequency are produced in the induction coil, and it is proposed that the latter should be the primary of a step-up transformer the secondary of which could be connected to "lighting appliances adapted to the use of high frequency discharges." A "powerful" magnet is shown opposite the spark-gap in the drawings accompanying the specification, "the purpose of which is to break any arc between the balls." The specification adds that this magnet is not always necessary, and that it may sometimes be replaced by an air jet.—Ed. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have received the enclosed letter from Prof. Elihu Thomson; as he says he is sending you a copy of the specification, and presumably a similar letter, I take the opportunity to say that I was quite unaware of the work Prof. Thomson had done on this subject, or I should certainly have given him the credit for it in my Paper.

I do not remember having seen a description of Prof. Thomson's experiments in the current literature of the arc, but judging from his patent specification, I do not think he realised the necessary condition—viz., that $\frac{\delta V}{\delta A}$ be negative, which the arc, or other conductors which may be substituted for it, must fulfil in order that the current through the arc may oscillate and a musical note be given out without the use of the blowing magnet illustrated in all his patent drawings. He evidently, however, contemplated omitting the magnet, for he says: "At M is represented a powerful magnet which is not always, however, necessary, but the purpose of which is to break any arc between the balls at G. It may sometimes be replaced by an air jet," and in claim 9 he says: "Said spark-gap being adjusted and arranged so as to respond to the desired frequency," though he gives no instructions as to what are the necessary conditions that it may respond.

As to the use of the ordinary *carbon* arc in place of his spark-gap, he makes no mention of it in the specification—in fact, he says in the body of the specification, "At G is a discharger consisting of two balls or terminals of brass or other such metal, the distance between which can be adjusted," and in the claims he uses the expressions, "rupturing said circuit at a spark-gap" or at "suitable terminals."

I gather from his letter, though he does not say so in so many words, that he tried the *carbon arc.* I should greatly welcome either a reference to where a full description of his experiments may be found, or failing that, if he can find time, a description of them now, as I feel certain that any addition to the available facts which he supplies will materially help those of us who are endeavouring to understand the physics of the electric arc.—Yours, &c.,

London, Jan. 15. W. Duddell.

[We do not reprint Prof. Thomson's letter to Mr. Duddell, as its subject-matter is similar to that from Prof. Thomson to ourselves, printed above.—Ed. *E.*]

## MR. CAMPBELL'S PHASE-TURNING DEVICE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of January 4 you print Mr. A. Campbell's valuable Paper before the Physical Society "On a Phase-turning Apparatus for Use with Electrostatic Voltmeters." In connection with this I should like to point out some limitations to the methods therein proposed. The main practical applications of his "phase-turning" apparatus depend on being able to obtain by its aid an auxiliary potential difference V (R.M.S. value) which can be either in "power phase" or in "power quadrature" (I am using Mr. Campbell's own terms) with the unknown potential difference X (R.M.S. value).

Consider first the case of obtaining V and X in "power phase." If I have correctly understood Mr. Campbell's Paper, he maintains that he can obtain with his "phase-turning" apparatus an auxiliary potential difference V which shall be in "power phase" with X *irrespective of the wave form of* X, the only condition being that V and X have the same frequency. This seems to me to be impossible unless some method (not described in the Paper) is provided to vary the wave form of V. For if V and X are to be in "power phase" the power factor of V with X (I use the expression power factor in the extended sense to denote the value of

$$\frac{\int_t^{t+T} vx\,dt}{\left[\int_t^{t+T} v^2dt \int_t^{t+T} x^2dt\right]^{\frac{1}{2}}},$$

where $x$ and $v$ are the corresponding instantaneous values of the ordinates of any two periodic curves at the time $t$, and T is their common periodic time) must be unity, and, therefore, *the wave forms of V and X must be similar curves* and cut the zero line at the same time (for proof see Alexander Russell, *The Electrician*, Vol. XLIV., p. 49). The wave form of V produced by Mr. Campbell's "phase-turning" apparatus will depend mainly on the wave form of the source of supply, and, to a certain extent on the position of his contacts, and therefore can *not* be similar to all of the many unknown wave forms which X may have, so that it is impossible by the aid of Mr. Campbell's "phase-turning" device to obtain a potential difference V in "power phase" with the unknown potential difference X irrespective of the wave form of the latter. It is thus evident that whatever the phase that the apparatus really indicates may be, it is certainly *not* the "*power* phase."

In order to give some idea of the errors that may be introduced by determining X from the equation, the R.M.S. value of the resultant $= P = V + X$, after first having adjusted the phase until P is a maximum, as in experiment I. of the Paper, I assume that the "phase-turning" apparatus gives V a sine wave-form 100 volts R.M.S. value, and that it is required to find the value of X, which has a rectangular wave-form and also 100 volts R.M.S. value. Using the data given by

Mr. Russell, I calculate that the measured R.M.S. value of P should be 194·9 volts, $\therefore X = 94{\cdot}9$ volts by Mr. Campbell's method, or is 5·1 per cent. too small. Similarly, if V is the peaked wave ($f$) of Mr. Russell's Paper, and X is the rectangle as before, the R.M.S. values being the same, the error works out to 17·7 per cent. in measuring X with the "phase-turning" apparatus.

Taking next the "power quadrature," there seems no physical impossibility in obtaining V in "power quadrature" with X irrespective of wave form, but the method proposed in the Paper for the "Measurement of Power Lag" will not in general give an angle whose cosine is the power factor. I illustrate this by an example: Suppose the "phase-turning" apparatus gives a sine wave, and it is required to find the power factor between two voltages, $X_1$ having a rectangular wave form and $X_2$ having a peaked wave form, both cutting the zero line at the same time I take the two curves ($a$) and ($f$) of Mr. Russell's Paper (*The Electrician*, Vol. XLIV., p. 72). Owing to the symmetrical shape of the wave forms of $X_1$ and $X_2$, V will be in "power quadrature" with $X_1$—*i.e.*, power factor is zero when V has its maximum value at the same time that $X_1$ cuts the zero line, and similarly for $X_2$, so that the "power phase difference" between $X_1$ and $X_2$ as measured by Mr. Campbell's method will be zero, as the two curves are assumed to cut the zero line at the same time, whereas the true value of the "power phase difference" given by Mr. Russell is 48·6deg., and the true power factor 0·6613.

I hope that what I have said above will not be taken as in any way minimising the value of the most ingenious and useful piece of apparatus which Mr. Campbell has devised and which will, when the wave forms are approximately similar, give satisfactory results as his experiments show; my object is solely to point out what seem to me to be theoretical limitations to the method, as it is only by knowing them that satisfactory results can be depended upon.—Yours, &c.,

Jan. 10. W. Duddell.

## MAGNETIC OBSERVATORIES AND TRACTION DISTURBANCE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 4th inst. Dr. Glazebrook contributes some notes of theoretical interest in connection with the above. I venture to raise a few points which seem to give a different aspect to the question. But first, to refer to a personal matter, I believe Prof. Rücker is aware that the theorem attributed to him by Dr. Glazebrook was proved by me independently some time before he arrived at it. As, however, my Paper did not appear in any of the scientific journals Dr. Glazebrook would not be cognisant of this.

Some of your readers may perhaps have examined Dr. Glazebrook's explanation of the freedom from disturbance of the Kew instruments in conjunction with a map. His argument surely loses some weight when one finds that "the limited portion of the earth at some distance from the observatory" measures some 7 miles in extent, whereas the "distant observatory" is not a mile from the line.

One may well doubt whether it would be possible to "modify within very considerable limits the path of the stream line between A and B without affecting the magnetic force at the distant observatory" when the said distant observatory lies almost between the points A and B A few experiments to determine the curve of potential along the line would materially aid in arriving at the true facts of the case. One must remember, too, that the whole of Dr. Glazebrook's contention is based on the aforementioned theory assuming a homogeneous earth, while there is strong reason to believe that the earth is not homogeneous, and perhaps a careful examination of the Kew records with this idea in view would throw some light on this point.

Last April an abstract appeared in your paper of an article by Dr. Edler, in which he brought forward strong evidence that a layer of the earth of comparatively small depth conveys practically the whole body of current. While there were several points in that Paper not quite satisfactorily cleared up, the general agreement between the measured results and the results calculated was very close, and, in addition, although this point was not alluded to in the Paper, the observed directions of the magnetic force at different points were just such as would be expected on theoretical grounds. Before Dr. Edler's Paper appeared, I had an opportunity of comparing the results observed at Middlesbrough with results calculated on the assumption of a homogeneous earth and the agreement was satisfactroy. Figures based on Dr. Edler's formulæ, however, agree equally well, while my formulæ (based on a homogeneous earth) would not fit Dr. Edler's figures, which were obtained over a larger area and at points several times more distant from the line than those at Middlesbrough.

Now the above has a considerable bearing on the point at issue. The stray currents observed are evidently due to some traction system or systems, while all such systems are at a considerable distance from Kew. According to Dr. Edler's formulæ, there should already be a considerable vertical disturbance at Kew, and this should be augmented by the presence of the bonded rail in the immediate neighbourhood. I should like to ask Dr. Glazebrook whether Kew records do not show signs of this disturbance. From my own experience with an instrument similar to that erected at Kew, I should be inclined to expect that say 100 amperes in the line at Chiswick would not produce so large a disturbance at Kew as would be produced by existing conditions.—Yours, &c.,

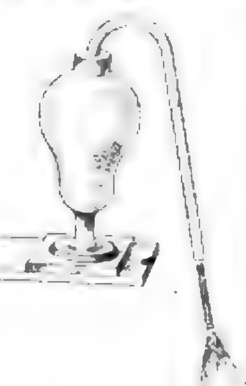
London, Jan. 11. E. Basil Wedmore.

## THE EFFECT OF AN ELECTRICAL CHARGE ON A LIQUID.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The action of an electrical charge on a liquid is familiar to most readers of electrical science. We know the beautiful arrangement by which, in the syphon recorder, a jet of ink is electrically shot against a moving band of paper. As, perhaps, the antiquity of this phenomenon may not be generally known, I venture to send you the following quotation from the writings of the famous L'Abbé Nollet (A. D. 1745—*Acad. des Sciences de France*):—

Cette loi [Nollet is speaking about the behaviour of electrified particles of matter] est si constante que si le corps solide électrisé est un vaisseau plein de liqueur qui s'écoule, l'origine de cet écoulement étant alors comme une prolongation de l'endroit par où il se fait.



L'électricité s'y montre de deux manières très remarquables; premièrement elle rend la liqueur lumineuse, fût ce même de l'eau commune; secondement elle presse la sortie, de manière qu'un écoulement qui ne se seroit que goutte à goutte, devint continu et se divise en plusieurs petits jets qui divergent entre eux comme les rayons des aigrettes lumineuses.

The little picture is a nearly exact copy of the figure which accompanies the paragraph. Since reading the passage I have tried the first effect on rather a large scale; the luminous shower is exceedingly beautiful. When making the experiment the electrical machine should be placed at a considerable distance from the jet (4m.), otherwise the machine soon gets damp.—Yours, &c., F. J. Jervis Smith.

Oxford, Jan. 12.

## POLYPHASE TRACTION PLANT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of 28th ult., in an account of the Albany and Hudson electric railway, there appears a statement to the effect that the polyphase current employed for

working the railway—presumably the rotary converters—has a frequency as high as 60 ~ per sec. As far as I know, this is a considerable increase over what has been done where rotary converters are employed. I should be glad to know whether there is any mistake and whether your readers know of any other case where such a periodicity is employed. It seems to supply a want long felt—viz., that of capacity to perform both lighting and traction from the same station without having to employ two sets of generators that are not interchangeable.—Yours, &c ,

Birmingham., Jan. 8. "IGNORAMUS."

## LEGAL INTELLIGENCE.

### Wolverhampton Corporation v. British Electric Traction Co. (Ltd.).

In the Chancery Division, before Mr. Justice Farwell, Mr. Warmington, Q.C., moved for an order to enforce the judgment given in favour of the plaintiffs in this action at the trial by Mr. Justice Joyce last sittings. Mr. Warmington said the action was brought for specific performance of a contract contained in an Act of Parliament by which the defendants were to sell the whole of their undertaking to the plaintiffs. Notwithstanding this statutory contract plaintiffs were obliged to sue, and judgment was pronounced in their favour on November 29, the purchase price being fixed at £4,259. Plaintiffs, requiring possession, tendered this sum to defendants' solicitors, who, however, declined to receive it. The money had been tendered a second time.

Mr. THOMPSON, for defendants, said he had no objection to the order asked for if it were necessary, and upon payment of the purchase-money plaintiffs could have possession notwithstanding that the conveyance had not been executed.

His LORDSHIP inquired if there was an order for possession in Mr. Justice Joyce's judgment.

Mr. THOMPSON said there was an order for payment of the purchase-money with interest, and defendants were to execute a proper assignment of the property comprised in the contract.

His LORDSHIP failed to understand why defendants had not given up possession, but after Mr. Thompson's expression of willingness to do so now on payment of the purchase-money this was all that was asked for, and only the costs of the motion remained to be dealt with. Those he ordered defendants to pay.

### Motor Carriage Law.

At the City of London Summons Court on Friday, Mr. Walter Charles Bersey, was summoned for causing a light locomotive to be used without a competent person in charge. The summons was taken out under article 2, sec. 8, of the Locomotives on Highways Act, 1896, ordering that a light locomotive should be in charge "when used on any highway of a person competent to control its use and movement." The car was not moved while defendant was absent. Other articles in the act deal with obstruction, for which defendant was not summoned. The constable who took out the summons said he considered the car was in use on the highway, although defendant had left it so that it could not be moved.

Mr. Alderman F. GREEN said the constable might have wanted it moved.

Mr. FIRTH, for defendant, said the Prince of Wales and others were motorists and took a groom or footman not a skilled engineer with them. As to the car being moved the constable could have called upon the defendant to move it, and that would have come under the head of obstruction, for which defendant was not summoned.

Mr. BERSEY said he took away the plug which connected the battery with the motor, and it could not have been moved in his absence. He believed the meaning of the act was that the driver should be competent. As an expert he would say the car was not in use.

Mr. FIRTH contended that Mr. Bersey's was the correct view. An inanimate thing could not be controlled, and here the actuating force was dormant.

The ALDERMAN, however, decided that the car was in use, and fined defendant 20s. and costs, but said he would be glad to state a case.

Mr. FIRTH said he should apply for a case and take the question to the High Court.

### British Thomson-Houston Co. (Ltd.) v. Bristol Tramways Co.

Mr. Eldon Bankes on Friday last applied *ex parte* on behalf of the defendants for leave to appeal from a decision of Mr. Justice Day affirming the decision of the Master appointing a barrister as the umpire in an arbitration which had arisen between the parties. The parties had entered into a contract to provide electric tramways at Bristol. In the contract there was a provision to appoint an engineer who was to certify from time to time the amounts to be paid to the contractors, and there was an arbitration clause to govern any dispute between the parties as to whether the engineer had certified sufficient. The engineer had certified what he thought was the fair value of the goods supplied by the British Thomson-Houston Co., who, not being satisfied, demanded arbitration. The Bristol Tramways Co. were prepared to go to arbitration, but said it was a matter which ought to be referred to an engineer as umpire. The other side wanted a barrister appointed, and the Master said that a barrister should be appointed, and Mr. Justice Day upheld his decision. The amount involved was a large one, and there were also technical questions involved. The contract provided that disputes should be referred to two arbitrators or their umpire, and each party had appointed a very eminent engineer.

The MASTER OF THE ROLLS: And they want an engineer to keep them right?

Their lordships decided it was not a matter in which the Court could interfere, and dismissed the application with costs.

### Lane v. Elliott Bros.

This case came before Mr. Justice Ridley on Friday last on an interpleader issue. The plaintiff, Mr. Reuben Lane, a chartered accountant, of Birmingham, sued as receiver of the New Fowler-Lancaster (Ltd.) to recover £267 due from the Corporation of Brighton for certain electrical work done under contract. The defendants carried out the work for the Birmingham Company, and had obtained from Mr. Justice Buckley a garnishee order for the balance of an account due from the Brighton Corporation. The issue sent to the Court for trial was whether the plaintiff as receiver for the debenture holders of New Fowler-Lancaster (Ltd.) was entitled to the money, or whether the defendant firm which carried out the work had a prior claim.

Mr. TURNER, for plaintiff, said the original company was incorporated in Birmingham in 1894 as the Fowler-Lancaster Co. (Ltd.), and was reconstructed in 1897 as the New Fowler Lancaster (Ltd.), and in August, 1897, debentures for £12,000 were issued. In January, 1898, the name of the company was further altered by dropping out the word "New." Although the alteration in name was duly registered at Somerset House the secretary omitted to apply for the sanction of the Board of Trade, and that being necessary under the Companies Acts, the new name was not a legal name. However, the company contrived to carry on its business under the amended title, and among other contracts entered into that with the Brighton Corporation, which was dated Aug. 17, 1899. Counsel argued on these facts that, there being no such company as Fowler-Lancaster (Ltd.), the contract was really entered into with the New Fowler Lancaster (Ltd.), which was the only company legally in existence at the time. In that case the debenture holders of the company had a prior claim to the property of the company, and plaintiff, as receiver on their behalf, was entitled to judgment.

Mr. LOEHNIS, for defendants, characterised the whole proceedings on the part of the Fowler-Lancaster Company as a juggle. Defendants had carried out this work for a body of persons calling themselves Fowler-Lancaster (Ltd.), which had no debentures, and now it was sought under some convenient family hocus-pocus to deprive his clients of payment for the work done, under the pretence that the company was all the time the New Fowler-Lancaster (Ltd.), whose debentures were held by the Fowlers and Lancasters and their bank. He contended that his clients were entitled to judgment, the name under which the company entered into the contract being misleading.

His lordship reserved judgment.

### Electricity Supply Co. for Spain (Ltd.).

The petition of this company for power to alter its capital was before Mr. Justice Wright on Wednesday.

Mr. KIRBY, for the application, said the capital was £100,000 in £5 shares, of which 100 shares were vendors' shares, which were really deferred shares. The company had issued debentures for about £250,000, and the capital had been expended mainly in the erection of electrical plant in Madrid. The company was formed 11 years ago, and found the greater part of its plant was now superseded and of little value, and the company was obliged to obtain further capital and renew their plant almost entirely.

His LORDSHIP: I cannot deal with that matter until I see the report of the engineer. There is an item of £23,351, which is said to represent an asset. What asset does it represent?

Mr. KIRBY said the item consisted of the expenses of issuing debentures.

His LORDSHIP said the articles gave power to reduce capital, but not to increase it. There must be further evidence as to preference shares, &c., and the matter must stand over for a week.

### Re River Plate Electric Light and Traction Co. (Ltd.).

In the Companies' Winding-up Court on Wednesday, Mr. Justice Wright made an order that the petition of Messrs. Glyn, Mills, Currie, & Co. for the compulsory winding up of this company should stand over until the first petition day of next sittings. It was explained by counsel that the company required a considerable sum of money, and the directors were considering whether they would find it and so put the company out of its present difficulties.

### Legal Fixtures.

The following cases with an electrical interest have been entered for trial during the Hilary Sittings at the Royal Courts of Justice:—

SUPREME COURT OF JUDICATURE.—COURT OF APPEAL.

(CHANCERY DIVISION.)

*General Appeals.*

City of London Electric Lighting Co. *v.* Corporation of London. (Appeal of defendants from order of Mr. Justice Farwell, dated May 3, 1900.)

Cuba Submarine Telegraph Co. (Ltd.) *v.* The West Indian and Panama Telegraph Co. (Ltd.) (Appeal of defendants from order of Mr. Justice Farwell, dated May 29, 1900.)

Chamberlain and Hookham (Ltd.) v. Corporation of Bradford. (Appeal of plaintiffs from order of Mr. Justice Farwell, dated May 25, 1900.)

Isle of Thanet Electric Tramway and Lighting Co. (Ltd.) v. Abbot. Appeal of plaintiffs from order of Mr. Justice Byrne, dated June 21, 1900.

QUEEN'S BENCH.

*Final Appeal.*

National Telephone Co. (Ltd.) v. Corporation of Huddersfield. (Appeal of plaintiffs from judgment of Justices Grantham and Channell, dated June 20, 1900.)

National Telephone Co. (Ltd.) v. the Corporation of Tunbridge Wells. (Appeal of plaintiffs from judgment of Justices Grantham and Channell, dated June 18, 1900.)

*Crown Paper.*

National Telephone Co. v. Gulliver & Co. (Appeal by defendants from Judge Lumley Smith, Westminster County Court, for judgment or new trial.)

CHANCERY DIVISION.

(*Before Mr. Justice Kekewich.*)

British Motor Traction Co. (Ltd.) v. Vaughan-Sherrin. (Action with witnesses.)

*Before Mr. Justice Cozens Hardy.*—(Causes for trial with witnesses.)

Evered v. Electrical Undertakings Ltd. Barham v. Evered—Action. To come on together.

QUEEN'S BENCH.

*Common Jury.*

Columbus Co. (Ltd.) v. Adams-Randall Telephone Patents, Ltd. (Work.)

*Non-Juries.*

Veritys Limited v. Johnson & Co. (Ltd.) and another. (Goods sold.)

National Telephone Co. (Ltd.) v. Exchange Telegraph Co. (Ltd.). (Injunction.)

Corporation of Middlesbrough v. Imperial Tramways Co. (Injunction.)

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Keighley Corporation require a chief assistant engineer, an office clerk, and an engine-driver for their electricity department. Further particulars are set out in an advertisement, and applications must be sent in to the borough electrical engineer (Mr. J. M. Smyth), Bridge-street, Keighley, by 10 a.m., 26th inst.

An electrical engineer is required as clerk to the works to supervise the installation of the electric light at the Lancashire County Asylum, Winwick, Newton-le-Willows. Applications to Medical Superintendent. See advertisement.

Ayr Corporation invite applications for the position of manager of tramways. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. A. G. Young), Council Chambers, Ayr, by Feb. 2.

Devonport Corporation require a chief assistant engineer to the borough electrical engineer. An advertisement gives further particulars, and applications must be sent to the town clerk (Mr. A. B. Pilling), Municipal Offices, Ker-street, Devonport, by Feb. 17.

The Metropolitan Borough of Fulham (London) require an assistant engineer to take charge of a shift at their electricity works. An advertisement contains further particulars, and applications must be sent to the acting town clerk (Mr. J. H. Denselow) by noon on Jan. 24.

Paisley Corporation require an engineer to take charge of the working and management of their electricity works. An advertisement contains further particulars, and applications must be lodged with the town clerk, Municipal Buildings, Paisley, by 31st. inst.

A draughtsman, with a good training in a mechanical engineering works, is required for the Bradford Electricity Department. Applications to city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. See advertisement.

Charge electricians and switchboard attendants are required for extra high-tension power station and sub-stations operating electric tramways. See advertisement.

A junior mathematical master, with a knowledge of physics, is required for the Merchant Venturers' Technical College, Bristol. See advertisement.

Engineers, with sound experience in electrical and general engineering, are required. Applications to Messrs. Dick, Kerr & Co. (Ltd.), 110, Cannon-street, London, E.C. See advertisement.

West Ham Guardians require an expert to advise on the engineering work in connection with their new infirmary at Leytonstone. Applications to clerk (Mr. Fred. E. Hilleary), Union Workhouse, Leytonstone, N.E., by 23rd inst.

The Governors of Sir John Cass's Technical Institute, Jewry-street, Aldgate, E.C., require a principal. Applications to clerk, 10A, Idol-lane, Eastcheap, E.C., by Jan. 26.

Jandus Electric Co. (Ltd.), Hartham works, Hartham-road, Holloway, N., require an assistant tester. See advertisement.

Mr. Charles D. Taite, borough electrical engineer at Southport, has been appointed to a similar position at Salford at a salary of £700 per annum. Mr. Taite has been electrical engineer at Southport for about 5 years.

Mr. C. T. Yerkes has appointed Mr. J. B. Chapman, of the Union Traction Co., of Chicago, Ill., to superintend the construction of the Charing Cross, Euston and Hampstead underground electric railway.

Mr. A. H. Shaw, of Harrow, has been appointed resident electrical engineer by the Ilford District Council.

**Abercarn.**—The Joint Electric Lighting committee of the Abercarn and Risca District Councils have engaged Messrs. Medhurst and Lloyd to prepare a report on electric lighting at a fee of 40 guineas.

**Baker-street and Waterloo Railway.**—The *Daily Mail* announces that the purchaser of this undertaking from the London and Globe Finance Corporation is Mr. Thomas L. Johnson, of Cleveland, Ohio.

**Bangor (Ireland).**—The North Down Tramway Co. have protested against the proposal of the Town Council to expend £4,000 in extending the plant at the gas works, and intimate that they are prepared to undertake the electric lighting of Bangor, Groomsport and Donaghadee. The matter is to be considered in committee.

**Bath.**—The Corporation have applied for a loan of £4,000 for purchasing property adjoining the electricity works for extensions.

**Birkenhead.**—The revised scale of charges for electricity came into operation on 31st. ult., and is as follows:—During the winter quarters: For the first hour and a-half of maximum demand, 6d. per unit; second hour, 3d.; after, 1½d. Summer quarters: For the first half-hour of maximum damand, 6d. per unit; second, 3d.; after 1½d. For power and heating for the first hour and a-half during winter quarters, 4d. per unit; second, 3d.; after, 1½d. During summer quarters: For the first half-hour, 4d.; second, 3d.; after, 1½d.

**Bolton.**—The chairman of the Technical Instruction Committee (Mr. Walter M. Musgrave) has resigned his seat on the Council. Mr. Musgrave is the head of the firm of Messrs. Musgrave & Sons (Ltd.) whose dealings with the Corporation were referred to in the recent report of the special committee on the contracts question.

**Bradford Technical College.**—In the second annual report of the Bradford Technical and Instruction committee, it is stated that the teaching of electrical engineering, which had not previously been satisfactory, has now been placed on a sound basis. A well equipped laboratory has been provided, and a highly competent lecturer appointed.

**Cheadle.**—Circulars have been sent out by the Council in orde to ascertain the support likely to be accorded to their proposed electric lighting scheme.

**Cork.**—At the quarterly meeting of the County Council last week the Irish Electric Railway Co. (Ltd.) asked the Council to sanction the construction of an electric tramway from Kenmare and Castletownbere to Bantry, at a cost of between £600,000 and £700,000. It is expected that the line will greatly develop the tourist traffic on the southern route to Killarney. The General Electric Co. (Ireland) (Ltd.) also applied for approval of a scheme to construct an electric tramway between Middleton, Cloyne and Ballycotton, at a cost of £60,000. Both schemes were referred to committee, the Council being favourable to the projects.

**Court of Common Council (City of London).**—At yesterday's (Thursday's) meeting of the Court of Common Council, on the report of the Remembrancer, the following bills were referred to the various committees within the scope of whose reference the matters dealt with came: City and North East Suburban Electric Railway, Central London Railway, Piccadilly and City Railway, City and Brixton Railway (Extension of Time), Metropolitan and District Railway, and the British Westinghouse Electric and Manufacturing Co. (Ltd.)

The REMEMBRANCER stated that he was informed by the agents that the Victoria, City, and Southern Electric Railway Bill would not be proceeded with.

Mr. PRIDMORE then asked whether, in view of the interests likely to be affected by the proposed tube railways, it would not be advisable that the City should be represented at any inquiry held by the committee appointed by the Board of Trade into the complaints of damage caused by vibration on the line of route of the the Central London Railway.

The REMEMBRANCER thought it would be advisable. He did not, however, see how the committee were going to obtain the information they desired.

It was afterwards agreed that the Streets committee should have power to confer with the Board of Trade, or be represented at any inquiry on the subject.

Numerous complaints of the inconvenience caused by and protesting against the continual breaking up of the streets by the Postmaster-General and urging continuous working day and night were presented from various wardmotes and bodies of electors, and were referred to the Street committee.

Mr. MORTEN complained that the Court's instructions with reference to continuous working were not being carried out by the Post Office, and, moreover, that the works were closed practically the whole of Christmas week. The Court, he urged, had plenty of power to compel the Postmaster General to do that which was right and reasonable, as they could refuse permission for him to open the streets. How long was this state of things to exist? He hoped the officers of the Court would do their duty and see that the orders of the Court were carried out.

Mr. WILLIAMSON asked the engineer whether any protest had been lodged at the office of the Postmaster-General?

The ENGINEER (Mr. D. R. Ross) replied that very strong protests had been made by his department to both the Post Office authorities and to the Charing Cross and Strand Co. He had issued 500 letters, and received an equal number of replies with regard to complaints as to the cause of this inconvenience. The works of the Charing Cross and Strand Co. were being carried on continuously, as were those of the Post Office to some extent.

Mr. Deputy MALTHOUSE remarked that in his view the workmen were simply idling their time away; no work was done.

Mr. MORTEN moved, in connection with the complaints of the roadway being used for storage purposes, that in all cases where, despite the orders of the Court, such stores were not, after request, removed, they should be carted to the City greenyard.

The TOWN CLERK suggested that it should be referred to the Streets committee to consider the advisability of such a course being adopted.

Mr. MORTEN agreed, if the committee were empowered to act at once if they deemed it desirable.

The motion, amended accordingly, was agreed to.

A letter from the London County Council, enclosing copies of resolutions passed at the conference on June 14, 1898, between representatives of the London County Council and the London local authorities with reference to certain proposals then before Parliament for the establishment of undertakings for the supply of electricity in bulk to local authorities or companies which might require it, and asking whether the Corporation agreed to the principle laid down in these resolutions, or whether it considered it desirable, having regard to the changes in the government of London since the Conference was held that another conference should take place. Letter was referred to the Streets committee.

**Dock Lighting.**—The Admiralty have decided to introduce electric lighting in the Portsmouth Dockyard.

**Dublin.**—A circular has been issued by the town clerk (Mr. Henry Campbell) to electric lighting consumers stating that on and after 1st inst. the charge for electric current will be at a uniform rate of 6d. per unit.

**Edinburgh.**—Sanction of a further loan of £76,000 for electricity extensions has been obtained by the Council. The Electric Lighting committee presented a report on Tuesday recommending the appointment of a deputation of seven members to visit English towns in connection with the proposed provision of condensing plant at M'Donald-road power station. The matter was ultimately referred back to committee.

**Electrical Equipment of Machine Works.**—The well-known Bedford works of Messrs. J. and F. Howard, agricultural machinery and implement makers, are to be remodelled, and a complete system of electric driving is to be installed, the whole of the present system being taken out or converted. The contract for the equipment has been placed with Messrs. W. H. Allen, Son & Co., of the Queen's Engineering Works, Bedford.

**Electrical Theatrical Effects.**—We are informed that the Drury Lane pantomime and the ball room scene at the Hippodrome were among the first orders executed by the company recently started to put the work of Electric Lighting Boards (Ltd.) on a commercial basis. Large quantities of the company's patent strip are used both in the great palace of glass scene at Drury Lane and at the Hippodrome. At the latter house the British Electric and Telephone Co. applied the new strips, and at Drury Lane Messrs. Salviati and Jesurum did the installation work, in both cases in consultation with Mr. Julian Halford, the company's manager, and inventor of several of the accessories used in connection with the system.

**Exhibitions.**—An exhibition, entitled the New Century Engineering and General Trades Exhibition, will be held at Bingley Hall, Birmingham, from March 25 to June 1. Particulars from the manager (Mr. Geo. Stanley), 6, Holborn-chambers, Broad-street, Birmingham.

A meeting was held at Wolverhampton, on Wednesday, in support of a proposal to hold an art and industrial exhibition in the town in the early part of 1902. A guarantee fund of £25,000 is required.

The Prince of Wales has promised to open the Glasgow International Exhibition on Tuesday, May 7.

The Automobile Club of Great Britain and Ireland will hold their third exhibition of motor cars, &c., at the Agricultural Hall, Islington, London, from May 4 to 11 inclusive.

**Fulham (London).**—The electricity works are rapidly approaching completion, and current will shortly be available. Already applications for the equivalent of over 10,000 8 c.p. lamps for private lighting have been received.

**Hampton Wick.**—The Council have sanctioned the application of the Richmond (Surrey) Electric Light and Power Co. for a provisional order. The charge for current to private consumers is to be 7d. per unit, or 8d. for the first 1½ hours and 2d. after. Should the company supply Teddington or Hampton the first charges are to be reduced to 6d. and 7d., and in any case the charges are to be reduced to 6½d. and 7½d. on the company paying a dividend of 7 per cent., and to 6d. and 7d. on a dividend of 10 per cent. being paid. Current for motors and power purposes is to be 4d. per unit, and for public lighting for a minimum period of 7 years 3d. per unit, or for not less than 100 lamps £3 per annum for each 16 c.p. lamp. The Council have the option of purchase on giving six months' notice, and paying "about £140 for every £100" of capital expended by the company. Supply is to be available within a year from the passing of the order.

**Harrogate.**—An inquiry was held here on Wednesday, into the application of the Corporation to borrow £10,000 for electric lighting. The loan was required principally for additional generating plant. The present station has a capacity equal to about 26,000 8 c.p. lamps, but there are 30,400 connected, and applications are being continually received. Financial details were supplied by the town clerk (Mr. J. T. Taylor), and technical particulars by the borough electrical engineer (Mr. G. Wilkinson.) £70,000 has already been spent on electricity supply, and it is stated that a further £30,000 will shortly be required for extensions. The supply commenced at Harrogate in 1897, and the undertaking is a very successful one.

**Indian Telegraphs.**—The report of the Indian Telegraphs Department for the year 1899-1900 states that the number of paid telegrams was 6,237,300, an increase of nearly 14½ per cent., while the revenue increased by 17·6 per cent. During the year over 10,000 miles of wire were added and 253 new offices opened. In 1899-1900 the number of private inland telegrams was four times as great as in 1882-83. An extraordinary growth of 53½ per cent. in number and 51½ per cent. in value, due to the South African war, has to be chronicled under foreign press messages. The net receipts of the department (including State messages) amounted to over 35 lakhs of rupees, or 5·19 per cent. on capital. Excessive traffic was responsible for a decline in the speed of transmission on all the routes, but efforts are being made to remedy this defect by adding new wires, by enlarging the signalling staff, and by introducing the Wheatstone automatic system between the busiest centres.

**Islington (London).**—The Electric Lighting committee will in future be known as the Lighting committee, and will have control of gas as well as electric lighting.

**Johnstone (N.B.).**—The Council have entered opposition against the Clyde Vale and Caledonian electric power schemes.

**Keighley.**—The undertaking of the Keighley Tramways Co. has been acquired by the Corporation at £8,900.

**Leeds.**—An official statement has been made by the tramway authorities on the subject of the magnetisation of passengers' watches by the tramway currents. It is stated that during the whole four years the electric cars have been running not a single letter of complaint has been received by the authorities.

**Leith.**—The Council have intimated to the Edinburgh Street Tramways Co. that they are prepared to extend the company's lease in order that the tramways of Leith might be worked electrically, provided the company could arrange to carry the electric tramways to Princes-street either by Leith-street or Picardy-place and St. Andrew square or both. It was also agreed that current be supplied by the Corporation at 1½d. per unit.

**Libau (Russia).**—On Oct. 1, 1900, the Société Continentale de Traction et d'Elairage pour l'Electricité, of Paris, commenced the supply of continuous current in this city. At Dec. 31 there was an equivalent of 11,800 8 c.p. lamps connected and 152 consumers. The generating plant, which is of Schuckert make, is assisted by a battery of Tudor accumulators.

In the same city the Libauer Strassenbahn und Elektrizitätswerk supply current to the tramways owned by the Société Continentale. These lines, which commenced working in September, 1899, are 11,500km. in length to 1m. gauge. The contractors for the electrical equipment of the line were the Schuckert Co., of Nurnberg. There are 27 cars running—18 motor cars and nine trailers.

**Light Railways.**—An inquiry was held at Dublin on Tuesday into the application to construct the Dublin, Scalf and Enniskerry Light (Electric) Railway and the Bray Light Railway. The Dublin Corporation opposed in order to secure clauses to protect their water mains. The Dublin, Wicklow and Wexford Railway and the Bray Electric Tramway Companies also opposed.

**Liverpool.**—The Electrical Power and Lighting committee have decided to apply for sanction to borrow £300,000 for extending and developing their undertaking.

**Maceio.**—The Empreza Luz Electrica Alagoas, established in Maceio, has a concession for supplying current for all lighting and industrial purposes for 50 years. At present current for lighting is supplied from sundown and the public lighting is also contracted for on the same basis.

The Companhia Telephonica is the owner of the telephone system of the city, which is in a flourishing condition.

**Merthyr.**—The Merthyr Electric Lighting and Traction Co., which is erecting electricity works for supplying current for lighting and also for operating the light (electric) railways between Merthyr and Dowlais and Merthyr and Cefn (at present under construction), has announced that it is now in a position to make connections. The equipment of the tramlines is practically complete. The machinery for the power station has not been delivered, but a portion is expected to be delivered in a few days. It is anticipated that the undertaking will be completed by March.

**Municipal Telephony.**—The Hartlepool Corporation on Tuesday decided to invite the co-operation of West Hartlepool in applying for a licence to establish a local municipal telephone exchange.

**Musselburgh.**—An application to the Board of Trade for an extension of time to comply with the provisions of the provisional order which was obtained in 1899 has been referred to the Law committee.

**Nuneaton.**—A further outlay of £2,500 on electric lighting extensions has been approved.

**Paisley.**—Mr. Francis Teague has resigned his position as burgh electrical engineer. The resignation will take effect on the 28th prox., and an advertisement elsewhere invites applications for his successor.

**Perth.**—Of the applicants for the position of borough electrical engineer, the following leet of 12 have been selected :—Messrs. J. Lambert (Dundee), G. H. Carter (St. Helens), E. W. Rees (Liverpool), E. Cross (Aberdeen), C. A. L. Prussman (Doncaster), R. Paterson (Edinburgh), A. Hunter (Glasgow), J. Wilson (Glasgow), J. O. Whittaker (Chiswick), H. Hastings (Sidcup), A. H. Clark (Preston) and J. I. Robertson (Dumfries).

**Perth (Western Australia).**—Some time ago the Legislative Council threw out the bill promoted by the Perth Electric Tramways (Ltd.) for the erection of electricity works, and recently the ratepayers were invited to express their views upon the question of a municipal scheme, with the result that there was a large majority against the Corporation undertaking the work. It is now thought that the Council will grant the concession to the company without waiting for parliamentary sanction.

**Postal Telegraph Clerks' Grievances.**—A crowded meeting of postal telegraph clerks was held on Saturday at Manchester "to protest against inadequate pay and other causes of dissatisfaction in the postal telegraph service." An attempt was made for a minimum annual salary of £72. 16s. after five years' service, an addition of £6 10s. per annum for the next five years, and an increase of £8 per annum up to a maximum of £200 a year in large offices and £150 a year in small offices. A resolution was carried protesting against the inadequacy of pay and the stagnation of promotion in the telegraph service of the Post Office, and urging the appointment of another Select Committee of the House of Commons to enquire into this and other causes of discontent in the department.

**Private Bill Legislation.**—Notice of opposition has been given to the following electric railway and tramway bills: Brompton and Piccadilly Circus Railway (extensions); Charing Cross, Hammersmith and District Electric Railway; Metropolitan District Railway; Scarborough Electric Tramways; Harrogate Corporation and South Yorkshire Electric Power bills.

The Cleveland and Durham County Electric Power Co. have deposited a bill to enable them to generate and supply electricity "in bulk" to authorised distributors for lighting and to private persons for power only. The area comprises the whole or portions of the unions of Easington, Sedgefield, Hartlepool, Stockton, Darlington, Teesdale, Auckland, Weardale, Lanchester, Durham and Middlesbrough, Guisborough and Stokesley in the North Riding of Yorkshire. The generating stations are to be erected in Witton-le-Wear, Lanchester, Consett, Hutton Henry, Woodham, Brotton and Billingham. The capital of the company is £1,000,000, in £10 shares, with the right to divide them into preferred and deferred half-shares. Borrowing powers are sought to the extent of £333,000 by the issue of debenture stock. The promoters are Sir T. Wrightson, M.P., and Messrs. G. Ainsworth, H. Bell, A. J. Dorman, H. W. Hollis, W. H. Hopkins, A. Leith, A. F. Pease, H. P. Pease, M.P., E. L. Pease, W. R. Stobart, J. Forbeck, J. Walton, and R. E. Whitwell.

The Richmond Gas Co. have lodged a bill for, *inter alia*, powers to enable the company, "if they think fit to acquire powers to supply electrical energy for public and private purposes."

**Provisional Order Amendment.**—Hindley District Council give notice of intention to apply to the Board of Trade to amend the draft of the Hindley Electric Lighting Order by omitting the streets in which the Council would have to lay mains within two years from date of order.

**Pudsey (Yorks.).**—A sub-committee of the Council has been formed to confer with two of the electricity supply companies in Yorkshire as to the supply of electric current for Pudsey.

**Rhodesia.**—The Bonsor Gold Mining Co., at Seluke, possess an alternating three-phase belt-driven electric light and power plant of 100kw. capacity, with an equivalent connection of 400 8 c.p. lamps distributed by overhead bare copper mains. A G.E. 100kw. generator is installed. In the same district the Globe and Phœnix Gold Mining Co. inaugurated in August, 1900, a continuous current supply to connections equal to 400 8 c.p. lamps through bare copper overhead mains. The plant consists of one G.E. 30kw. generator, and supplies current for lighting the mining buildings and to one 15 H.P. motor which drives the cyanide works machinery.

The telephone department of the Rhodesian Postal Telegraphs established at Salisbury has four exchanges with 256 subscribers. The exchanges are situated at Bulawayo, Salisbury, Umtali, and Seluke. The subscription for private subscribers is £15. 15s. per annum within a radius of 1 mile of the exchange, and £3. 3s. per annum for each additional quarter mile.

There are 3,780 miles of aerial telegraph lines erected in Rhodesia belonging to the State, and 105 miles belonging to the African Trans-Continental Co. (between Umtali and the Portuguese border). The charge for inland telegrams is 2d. per word, with a minimum charge of 2s.

Water power throughout Rhodesia is described by an esteemed correspondent as incalculable.

**St. Albans.**—The Council recently received three offers for the transfer of their provisional order from (1) the Electrical Power Distribution Co., which offered to erect and equip the necessary works paying the Corporation the cost incurred in obtaining the order and giving them the right of purchase at the end of 14 years at a valuation as a going concern, the offer also detailing the prices to be charged for current for public and private lighting; (2) the British Schuckert Electric Co. would undertake to construct the necessary works, the Corporation paying for same, and the company undertaking to lease them for seven years at a rental equal to 6 per cent. on the amount of the loans outstanding for the cost of the works, this offer also containing details as to prices to be charged for public and private lighting; (3) the St. Albans Gas Co. offered to pay £100 for the order, and to construct the works, and after retaining 5 per cent. on the capital, apply surplus profits as to one moiety to the Corporation and as to the other moiety by way of dividend to their shareholders. The Electric Light committee thought that they should have the benefit of expert advice as to these offers and as to the desirability of the Council constructing and working the undertaking themselves, and recommended that Mr. Robert Hammond be retained at a fee not exceeding fifty guineas and travelling expenses. The Council adopted this proposal.

**St. Pancras (London).**—The Borough Council have decided to convene a conference of municipal owners of electricity works to discuss the question of promoting legislation for conferring powers to supply motors, fittings, and other electrical apparatus on consumers' premises on the hire-purchase system. Some years ago Mr. Fletcher Moulton, Q.C., advised the late Vestry that they had no power to supply motors on the hire-purchase or any other system. Bearing in mind the recent surcharge of £2,000 at Dublin, the Council naturally desire to move slowly.

The Electricity committee are making inquiries as to a site for a new generating station to meet increasing demands in the northern part of the borough.

**Shoreditch (London).**—The Finance committee have submitted a statement showing the capital expenditure on the refuse destructor from March 26, 1896, to Sept. 29, 1900, £23,808, receipts £22,561. The statement has been referred to the Lighting committee.

**Trans-Pacific Cable.**—At a meeting of the New York Chamber of Commerce, on Jan. 3, Mr. G. H. Schwab, speaking for the Committee on Foreign Commerce and Revenue Laws, submitted a report strongly favouring a trans-Pacific cable to be laid and operated by a private corporation rather than by the Government of the United States, on the grounds that the first cost of a Government cable would be excessive, and the annual upkeep greater than if conducted by a private undertaking. It is pointed out in the report that to be commercially profitable and useful the trans-Pacific cable should touch Japan and China, and that, while landing permission might be granted to a private undertaking, it was doubtful if the United States Government would obtain such permission, as the governments concerned would reserve the right to control every new cable landed on their shores. Finally, it is urged that the laying, maintaining, and operating of ocean cables requires a large amount of expert knowledge, and, in the opinion of the committee, no department of the United States can supply these essential requisites. It was finally resolved that the general principles of the bill introduced into the House of Representatives by Mr. Sherman, entitled "A Bill to Provide for Telegraphic Communication between the United States of America, the Hawaiian Islands, Guam,

the Philippine Islands, Japan, and China, and to Promote Commerce," should receive the support of the New York Chamber of Commerce.

**Underground Telegraph Wires.**—The Glasgow Chamber of Commerce have adopted a resolution to invite the co-operation of other Chambers of Commerce and the various Stockx Echanges in petit ioning the postal telegraph authorities to establish a complete system of underground telegraph wires.

**Walsall.**—The Finance committee have authorised the raising of a sum not exceeding £20,048 on mortgage for the electricity undertaking. Application has also been made for sanction to borrow £3,000 further for extensions.

**Water Power in Scandinavia.**—For the purpose of inquiring into the horse-power available from the water-courses of Sweden the Crown has appointed a Waterfall Commission, and this commission has visited the principal rivers of Norseland where new lines of railway are required but which it would be impossible to work remuneratively by steam. The commission has recently appointed two experts to calculate the power obtainable from the various falls, and has recommended the passing of a law providing that the State shall acquire the waterfalls wherever possible in order that they may be controlled nationally. It is proposed that the State shall lease these falls for the generation of electricity for industrial purposes.

A second proposal emanates from Dr. G. de Laval, the well-known inventor and hydraulic engineer, who has formulated a scheme for the constitution of a huge waterfall "Trust" for the whole of Sweden. He proposes that all the private owners of these falls shall join the "Trust," which would be worked for the mutual benefit of the owners. As a counter-blast to this proposal the Swedish Crown lays claim to all falls where no specific inclusion has been made in riparian sale contracts. Amongst the falls included in this edict is the famous Trollhätte waterfalls near Gothenburg, the most important in Sweden, where Dr. de Laval, the owner of the riparian rights, sold his supposed property to a syndicate, who propose to supply Gothenburg with electricity for all purposes. The Crown has refused to ratify the sale, claiming for itself the waterfall rights. The matter is to be settled in the Swedish courts.

One of the chief questions before the Waterfall Commission above referred to is to report upon the falls most suitable for the working of railways, and the many important experiments which have been made on the Continent in attempting to solve the problem of utilisation of water power for transmission for long distances for railway work are to be carefully studied. Last autumn the commission appointed experts to study and report upon these various experiments on the spot. The Swedish State Railway Administration also appointed experts for the same purpose. In the meantime many Swedish engineers, including the General Swedish Electrical Co., are making experiments and preparing plans for the working of railways by electricity, and it is suggested that the first line of the kind to be so worked shall be the Gillivare-Ofoten railway, as through the route of this line water power from numerous falls can be obtained. The main drawback at the present moment to the realisation of this project is that during the winter period the falls are frozen. An attempt is being made to overcome this difficulty by the erection of a large storage battery plant.

A company, represented by Dr. de Laval, is endeavouring to secure the right to exploit the Hedensfors falls on the Lule river for industrial purposes, and Herr Emile Hager is endeavouring to secure similar rights for the Lilla Edett waterfall near Gothenburg, a preliminary estimate being that 7,000 H.P. would be available and could be profitably worked. Herr E. Reuterwall is also seeking a concession for a similar undertaking for the supply of electric current to Sundsvall, power equal to 1,600 H.P. being obtained from a neighbouring fall. The total cost of this scheme is put at 438,000kr., and it would work at an estimated profit of 80,000kr. per annum.

In Norway water-power schemes are under consideration, the chief being one for the supply to Christiania of electric current, generated by the falls of the river Glommen. This scheme is now in progress and is expected to be in working order next year, although the technical difficulties are admittedly great.

**Wellingborough.**—The Council have sanctioned the transfer of the provisional electric lighting order from the Electrical Power Distribution Co. to the County of Northampton Electrical Power Distribution Co.

**West Hartlepool.**—Electric current was supplied for the first time on Tuesday evening for public lighting.

**Whitehaven.**—References to the cause of the recent interruptions of supply of electric current were made at the Council meeting on Thursday last. It was stated that a sample of the lead-covered cable which had given out had been sent to the makers, Messrs. Siemens Bros. & Co., who replied that in their opinion the defects were due to moisture percolating through the joints of the brick conduits in which the cables were laid, and the destruction of the insulation by some chemical compound contained in the soil. Messrs. Hopkinsons and Talbot had also written with regard to the breakdown of the armatures, stating that they were of opinion that this had occurred owing to the age and construction of the machines.

**"Willing's Press Guide."**—This compact and complete list of newspapers and periodicals has, in its 28th annual issue (1901), improved upon past issues from the fact that a bolder type has been used for the names of publications. No alteration has been made in the arrangement, which is as perfect as it can very well be made. The information given includes the classification of the journals into trades and professions, the addresses of colonial and foreign newspapers, the names of those Continental papers which are printed in English, and a mass of other particulars which those who have occasion to use a guide of this character will find of service. "Willing's Press Guide" is published by James Willing, jun. (Ltd.), 125, Strand, W.C., and 162, Piccadilly, W., London, price 1s.

**Workhouse Lighting.**—The Brighton Guardians have asked Mr. G. R. Peers to report on the electric lighting of the workhouse premises.

**Yeadon.**—At a meeting of the Council on Wednesday, replies were received from the councils in the Wharfedale Union intimating their intention to attend a joint meeting of authorities to discuss the proposals of the Yorkshire Electric Power Syndicate. The conference is to be held at Guiseley at an early date. One of the engineers to the syndicate will be invited to attend and explain the scheme.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"SUBMARINE CABLE-LAYING AND REPAIRING."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists, and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Great Yarmouth* Corporation invite tenders for two water-tube boilers and two 200kw. high-speed continuous-current steam dynamos for electric traction. Specifications, &c., can be obtained from Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W., or from Mr. J. W. M. Cockrill, M.I.C.E., borough surveyor, Town Hall, Great Yarmouth, and tenders have to be sent to the town clerk's office, Town Hall, not later than noon of Feb. 5. Some further particulars will be found in an advertisement.

*Oldham* Corporation require tenders for two 600 I.H.P. engines and four 1,200 I.H.P. engines, each direct coupled to a continuous-current dynamo. Specifications may be obtained from Mr. A. Andrew, Gas and Water offices, Oldham, and can also be seen at (but not obtained from) the offices of the consulting engineer (Dr. Alex. B. W. Kennedy), 17, Victoria-street, London, S.W. An advertisement gives further particulars, and tenders must be sent to Mr. Andrew by Jan. 29.

*Brighton* Corporation require tenders for the supply, delivery, drawing-in and jointing complete of feeder, distributing, test and telephone cables. Further information is given in an advertisement. Specifications, &c., can be obtained at the offices of the tramways engineer (Mr. Thomas B. Holliday), Town Hall, and tenders must be sent to the town clerk (Mr. Francis J. Tillstone), Town Hall, Brighton, by 4 p.m., Feb. 14.

*Brighton* Corporation also invite tenders for the supply and erection of the overhead trolley construction and equipment of the tramway routes. Specifications may be obtained from the tramways engineer (Mr. Thos. B. Holliday), Town Hall, and tenders must reach the office of the town clerk (Mr. Francis J. Tillstone), Town Hall, Brighton, by 4 p.m. of Feb. 14. See advertisement.

*Brighton* County Borough Council invite tenders for the supply and erection, by 31st Aug., of tramway plant, including (1) three direct-coupled compound-wound steam dynamos (Willans engines), (2) tramway switchboard, (3) negative booster. Tenders to town clerk by 10 a.m. 28th inst.

*Wigan* Electric Lighting and Tramways committee invite tenders for two 210kw. steam dynamos, two Korting condensers and cast-iron piping, lap-welded flange steam piping, switchboards, feeder boosters and battery milker. Specifications from the borough electrical engineer (Mr. H. Collings Bishop), and further particulars are set out in an advertisement. Tenders must reach Mr. Bishop by Feb. 2.

*Aberdeen* Tramways committee require tenders for the electrical equipment for their Bathing Station tramway route, comprising the supply and erection of all overhead material (poles being provided by the Corporation), and the supply and laying of lead-covered, paper or fibre insulated cables. An advertisement gives further particulars, and tenders addressed to the city electrical engineer (Mr. J. Alex. Bell), must be delivered at the electricity works, Cotton-street, Aberdeen, before noon Feb. 13.

The Corporation of the royal burgh of *Kirkcaldy* require tenders for dry-back marine boilers, with mountings, &c., but alternative tenders for water-tube boilers will be considered. Specifications can be seen (but not obtained) at the offices of consulting engineers (Messrs. Kennedy and Jenkin) 17, Victoria-street, Westminster, S.W., and tenders must be sent to the town clerk (Mr. Wm. L. Macindoe), Council Offices, Kirkcaldy, by 10 a.m. of Feb. 15. An advertisement contains further particulars.

The Guardians of the *Poplar* (London) Union invite tenders for the provision and construction of the necessary brickwork, flues and settings, &c., for two Lancashire boilers and an economiser. An advertisement gives further particulars, and drawings may be inspected after 23rd inst., at the offices of the consulting engineer (Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E.), 34, Victoria-street, Westminster. Tenders must be sent in to the clerk (Mr. G. H. Lough), 45, Upper North-street, Poplar, London, E., by 6 p.m., Feb. 6.

*Wimbledon* Urban District Council invite tenders for steam and exhaust pipes, &c., and moving two boilers, feed-pumps, feedwater heater and storage tank; independent surface condensing plant; and the supply and erection of two water-tube boilers. Specifications may be obtained from the electrical engineer (Mr. F. Barnes Spencer, Durnsford-road, Wimbledon), and tenders (addressed Chairman of Electric Lighting Committee, Broadway, Wimbledon) must be delivered to the clerk (Mr. R. H. S. Butterworth), Council Offices, Wimbledon, by noon on Feb. 18. Further particulars are given in an advertisement.

*Luton* Town Council require tenders for wiring the council chamber, town hall, free library, corn exchange and baths. An advertisement gives further particulars, and tenders must be sent in to the town clerk (Mr. Geo. Sell) by 4 p.m. on March 4.

*Launceston* (*Tasmania*) Corporation invite tenders for the supply of 500 electric meters. Specifications, &c., of Mr. W. Corin, city electrical engineer, Launceston, or from Messrs. John Terry & Co., 7, Great Winchester-street, London, E.C. Tenders direct to Mr. C. W. Rocher, town clerk, Town Hall, Launceston (or c/o Messrs. Terry & Co., as above), by 12 noon of April 8 next. (The post to Launceston occupies about six weeks.)

*Southport* Tramways committee require tenders for material for electric tramways, including poles, brackets, and scrolls, bases, trolley wire, trolley wire attachments, galvanised steel wire, and section boxes. Tenders to town clerk, Town Hall, Southport, by 21st inst.

*Canterbury* Lighting committee invite tenders for boiler and engine-house plant, condensing apparatus and pipework, and extension of switchboard. Tenders to town clerk, Town Hall, Canterbury, before 4 p.m. of 30th inst.

*Sunderland* Corporation invite tenders for condensing plant and cooling tower, secondary battery, main switchboard, and travelling crane. Tenders (addressed chairman of Lighting committee) to the town clerk by noon Feb. 1.

*Aberdeen* Electric Lighting committee require tenders for surface condensers, air and circulating pumps. Tenders to city electrical engineer (Mr. J. Alex. Bell) Cotton-street, Aberdeen, by noon of Feb. 8.

*Edinburgh* Corporation invite tenders for an engine and dynamo for the electricity station at McDonald-road. Tenders to town clerk, City-chambers, Edinburgh, by Feb. 9.

*Batley* Corporation invite tenders for three high-speed triple expansion steam dynamos, one balancer, and one motor generator. Tenders to town clerk by Feb. 9.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal Buildings, Lavender-hill, S.W., before noon Feb. 1.

*Wigan* Corporation require tenders for the supply of general stores, including electrical accessories, carbons, &c., for their electric lighting and tramway department. Tenders by Feb. 2.

*Bournemouth* Corporation require tenders for 42 electric cars. Tenders by March 2.

*Eastbourne* Electric Light committee require tenders for the erection of electricity station buildings. Tenders by Feb. 4.

*Burnley* Corporation require tenders for a traction switchboard. Tenders by Feb. 7.

*Southend* Corporation require tenders for four electric motor cars. Tenders by Feb. 6.

*Great Yarmouth* Corporation also require tenders for about 800 tons of steel girder tramway rails. Tenders by Feb. 6.

*Croydon* Corporation require an overhead travelling crane for their electricity works. Tenders by 21st inst.

*Tynemouth* Corporation invite tenders for a 450kw. steam dynamo. Tenders to town clerk by 31st inst.

*Ilford* District Council invite tenders for the electric lighting of the town hall and public offices. Tenders to chairman by 31st inst.

*Leeds* Tramway committee require tenders for poles and bracket arms for carrying overhead electric wires. Tenders by Feb. 6.

*Plymouth* Council require tenders for the extension to the electricity works at Prince Rock. Tenders to borough engineer by 24th inst.

*New South Wales* Government will receive tenders up to 2:15 p.m. of Feb. 22, for telegraph, telephone, and electric light material for the years 1901-2. The conditions of contract can be examined at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W. Tenders are to be sent to the Public Service Board, 42, Young-st., Sydney.

*New South Wales* Government invite tenders for the supply, delivery, and laying of about 29 miles of 6,000-volt, three-core, lead-sheathed cable, together with the necessary troughing, filling-in compound, &c. Specifications, &c., can be obtained at the electrical engineer's office, Phillip-street, Sydney, and tenders, addressed to the Railway Commissioners' Office, Bridge-street, Sydney, have to be delivered by 12 noon on March 4.

*New South Wales* Government also invite tenders for the supply, erection, and maintenance of two storage batteries of 280 cells of 1,300 amperes maximum output each. Tenders, addressed to the Railway Commissioners' Office, Bridge-street, Sydney, have to be in by Feb. 25. Specifications of the electrical engineer, 51, Phillip-street, Sydney.

*Amsterdam* Municipal Council require tenders until March 25 for the equipment of electricity supply works.

Tenders will shortly be invited for a telephone system in *Huelva* Spain. Conditions are published in *Madrid Gazette* of 12th inst.

### TENDERS RECEIVED AND ACCEPTED.

Middleton Corporation have accepted the tender of Messrs. W. H. Haigh & Co. (Ltd.) for the supply of superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and acces-

sories. Tenders were also sent in by W. H. Bailey & Co., Middleton Engineering Works, Goodbrand & Co., Jno. Spencer (Ltd.), Maxim Electrical Engineering Export Co., Edwin Danks & Co., Alley and McLellan, C. Whittaker & Co., Crompton & Co., Jno. Fowler & Co., and J. P. Hall & Co.

St. Pancras (London) Borough Council have received estimates for Conradty carbons for the ensuing year as under :—

| | | | |
|---|---|---|---|
| Sloan Elec. Co. (*accepted*) | £742 10 0 | Crompton & Co. ......... | £778 6 8 |
| General Elec. Co. ......... | 833 15 0 | De Grelle, Houdret & Co. (other make) ...... | 698 15 0 |
| Ditto (other make) | 760 12 6 | | |

Reigate Town Council have accepted the tender of Messrs. Chamberlain and Hookham for electricity meters, for £223. 17s. 6d.

Glossop Town Council have accepted the tender of Messrs. Drake and Gorham for the electric lighting of the new technical school at £603. 10s. The tender of the same firm has been accepted for the supply of electric motors at £50. 10s.

Wolverhampton Town Council have accepted the tender of Mr. H. Gough, for the erection of a tramcar depot at £7,598, and that of the Rex Foundry Co. for iron and steel work required for the depot at £1,979. 2s. 5d.

Blackpool Corporation have accepted the tender of Messrs. Crompton & Co. for carbons for their electricity department for one year, and that of the Kingfisher Co. for oils.

Cheltenham Corporation has placed an order for a second 500kw. turbo-alternator with Messrs. C. A. Parsons & Co.

Bristol Electrical committee have accepted the tender of Messrs. Doulton & Co. for water softeners ; that of G. and J. Weir for feed pumps ; and that of Babcock and Wilcox for boilers for the Avonbank electricity station.

Halifax Corporation has accepted the tender of Messrs. Witting Bros., Ltd., for the supply of three-core high tension cable.

Newcastle-on-Tyne Corporation has accepted tenders for telephone and pilot wires from Callender's Co. at £2,037, and for arc lamps from the Brockie-Pell Co. at £4,095.

## BUSINESS NOTICES.

In reference to the note appearing in our issue of Jan. 11, page 450, we are asked to state that there will be no alteration either in the management or in the general business of Messrs. W. A. S. Benson & Co., whose business has just been converted into a private limited company.

Mr. Morton Beales, who has for some time past been associated with Messrs. S. Z. De Ferranti (Ltd.), has resigned his position with that company and has joined the staff of Messrs. J. G. White & Co. (Ltd.), College-hill, Cannon-street, London, E.C.

The partnership hitherto existing between J. E. Spagnoletti and Joseph Crookes (trading as J. E. Spagnoletti and Crookes, Goldhawk Works, Goldhawk-road, W.), has been dissolved by mutual consent. Mr. Spagnoletti will continue the business at the same address, in conjunction with Mr. H. M. Bayly (who for many years has acted as manager) as J. E. Spagnoletti & Co.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. G. Dundas Price (G. Dundas Price & Co., 82, Bishopsgate-street Within, London, E.C.) has been appointed receiver for the debenture holders of the whole of the property in Headland's Patent Electric Storage Battery Co., Ltd. Mr. Price writes :—"Consequently, there is nothing at present out of which to pay the unsecured creditors. I am endeavouring to sell the patents, in which event there will be sufficient to pay the whole of the creditors in full."

A meeting was held at Bradford on Tuesday of the creditors of Arthur Hudson, electrical agent, &c., 23, Piccadilly, Bradford. The statement of accounts showed a deficiency of £102. The Official Receiver, Mr. J. A. Binns, acts.

The Queen's Dock Electric Works (Ltd.), 75, Hitchen-street, Liverpool, is to be wound up voluntarily. Mr. S. B. Simmons, 26, North John-street, Liverpool, has been appointed liquidator.

---

**Sale by Auction.**—Our advertisement columns contain details of the sale by public auction by Messrs. Wheatley Kirk, Price & Co. at an early date upon the works premises, Haunch of Venison Yard, Brook-street, London, W., of the entire contents, including gas engine, dynamo, lathes, drilling, screwing and milling machines, vices, shafting, belting, &c., and a large stock of electrical plant and apparatus, which is being disposed of by instructions from Messrs. Laing, Wharton and Cunnington. Catalogues are in preparation, and may be obtained shortly of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

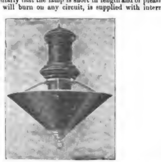
**Plant for Sale.**—The Gas and Electric committee of Belfast Corporation have for disposal a quantity of plant, including gas engines, dynamos, &c., particulars of which are set out on another page.

Belfast Gas and Electric committee invite offers for four 120 I.H.P. (Dick, Kerr) double-acting tandem gas engines, four 57·6kw. (Siemens) continuous-current dynamos, two 60 I.H.P. (Dick, Kerr) double acting gas engines, two 26·5kw. (Siemens) continuous current dynamos and compressed air starting apparatus. An advertisement gives some additional information, and full particulars can be obtained from the city electrical engineer (Mr. Victor A. H. M'Cowen), East Bridge-street, Belfast.

**Works for Sale.**—An advertisement gives particulars of an extensive engineering workshop in the London suburbs which is for sale with or without machinery.

"**Hart**" **Accumulators.**—A well got-up catalogue and price list of "Hart" accumulators is just published, in which particulars of the various types of these cells are set out. Instructions for erecting and working, and a sketch plan of the general arrangement of the battery-room, is included, and the catalogue is altogether an attractive and useful publication.

**Inverted "Ark" Lamps.**—Messrs. Johnson and Phillips have just issued a circular describing an inverted enclosed long-burning "Ark" lamp, recently introduced, for which several advantages are claimed, particularly that the lamp is short in length and of pleasing design, that it will burn on any circuit, is supplied with internal resistance or choking coil, and that its method of construction enables an ordinary arc lamp to be altered to the inverted type by removing the outer globe and inserting the inverted reflector. The makers state that this is the first inverted lamp made on the "enclosed" principle. Our illustration shows the lamp with inverted reflector.



"**Mackey**" **Incandescent Lamps.**—An illustrated price list of incandescent lamps (high and low voltage) manufactured by Mackey's Electric Lamp Co. is now ready. The list is well got up and a good variety of lamps is shown.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 9 to Jan. 15, with the ports of destination :—

*Africa*—Beira, £213 ; Cape Town, £299 ; Durban, £508 (including £127 telegraph material) ; East London, £19. *Australasia*—Adelaide, £218 ; Brisbane, £30 ; Melbourne, £475 (telegraph wire) ; Perth, £58 ; Sydney, £4,553 (including £70 telegraph material) ; Wellington, £433. *Ceylon*—Colombo, £73. *China*—Shanghai, £155 (including £100 old telegraph wire). *Denmark*—Copenhagen, £187. *Germany*—Hamburg, £400 (telegraph material). *Gibraltar*, £14. *Holland*—Amsterdam, £100. *India*—Bombay, £53 ; Calcutta, £959. *Madeira*, £490,305 (telegraph material). *Portugal*—Lisbon, £9,720 (telegraph cable). *Russia*—St. Petersburg, £57. *St. Vincent*, £2,603 (telegraph material). *Siam*—Bangkok, £225. Total £511,567, against £14,032 in the corresponding week last year (Jan. 10 to Jan. 16).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

November 13, 1900.

20,439. O. FREYMANN. London. Improvements in electric fire-alarms.
20,466. EVERSHED AND VIGNOLES (LTD.) and S. EVERSHED. London. Improved electric apparatus for exploding mines.
20,471. J. R. JONES. London. Improvements in or relating to connectors for electric wires and the like.*

November 14, 1900.

20,493. A. M. Taylor and R. Steel. Glasgow. Improvements in and appertaining to distributing boards for electrical circuits.

20,507. R. F. Hall. Birmingham. Improvements in sparking plugs for electrically-fired internal combustion engines.*

20,510. A. E. Dean. London. An improved vacuum tube for X-ray production.

20,522. British Thomson-Houston Co. (Ltd.). London. Improvements in high-potential line switches for electric currents. (E. M. Hewlett, United States.)*

20,544. E. Gates. London. A method of and apparatus for the separation of paramagnetic and diamagnetic materials.*

20,558. The Berliner Telephone Manufacturing Co. London. Improvements in and relating to combined telephone and electric bell circuits. (J. Berliner, Germany.)*

20,573. W. H. Hatfield. London. Improvements in electric controllers.

20,576. J. A. Fleming and Marconi's Wireless Telegraph Co. (Ltd.). London. Improvements in apparatus for signalling by wireless telegraphy.

November 15, 1900.

20,579. W. H. R. Kelley. London. An improvement in the means of shaving the cylinder or obliterating the record or engraved matter from the cylinders used with phonographs.

20,590. R. Smith. Birkenhead. Certain improvements in carriers for portable electric cables in combination with holders for lamps.

20,631. H. Dubs and L. Laffitte. London. Improvements in automatic electric carriages and appliances for the transport of light goods or traffic.

November 16, 1900.

20,707. M. B. Ryan. Cologne. Electric exercising machine.

20,710. W. P. Thompson. Liverpool. Improvements in or in connection with phonographs or other like sound-reproducingi nstruments. (F. Myers and H. Smythe, United States.)*

November 17, 1900.

20,757. E. van Haanen. Manchester. Improvements in apparatus for generating pulsative constant electric currents.

20,758. E. van Haanen. Manchester. Improvements in machines for generating constant electric currents.

20,761. D. F. B. Coles. Burton-on-Trent. A new method of constructing electrical cells of the Leclanché type.

20,764. A. A. Guest. Birmingham. Improvements in shade fittings for incandescent electric lamps.

20,765. C. W. Kemp. Birmingham. Improvements in or relating to electric lamp holders.

20,778. J. A. Heany. London. Improvements in electric arc lamps.*

20,779. J. A. Heany. London. Improvements in electric arc lamps.*

20,797. O. Reuker. London. Improvements relating to sound magnifying appliances for telephones, phonographs, and the like.

20,800. R. Kandler. London. Manufacture of a primer for producing ignition by electricity.

20,808. J. H. Pennington and V. Yates. London. Improvements in or connected with electrical burglar alarms.*

November 19, 1900.

20,858. C. V. Drysdale. New Barnet. Improvements in and relating to arc lamps for projection purposes.

20,868. J. Schmidt. London. Improvements in electric lamps for use in photography.

20,870. H. H. Lake. London. Improvements in electrical signalling for railways. (L. Olper, Italy.)

20,873. H. R. Gregory. London. Improvements in the manufacture of carbons for electrical and other purposes.

20,878. A. Muirhead. London. Improvements in telegraphic receiving and transmitting arrangements.

November 20, 1900.

20,926. Crompton & Co. (Ltd.), S. L. Brunton and A. J. Hodgson. Chelmsford. Improvements in electric arc lamps.*

20,929. W. Peisker, F. Schlomka and H. Kantz. Manchester. Improvements in phonographs and the like instruments.*

20,931. H. E. Evans. Woodford Green. An improved method of illuminating dining tables and the like by electricity.

20,938. W. Peisker, F. Schlomka and H. Kantz. Manchester. Improvements in or applicable to the diaphragms or membranes of phonographs and the like instruments.*

20,942. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of motor-control systems. (M. W. Day, United States.)*

20,943. The British Thomson-Houston Co. (Ltd.). London. Improvements in safety devices for electric motor control systems. (M. W. Day, United States.)*

20,945. C. Adams-Randall. London. Improvements in electric telegraphs.

20,946. C. Adams-Randall. London. Improvements in electric telephony.

20,960. T. A. Edison. London. Reversible galvanic cells or so-called storage batteries.*

20,961. D. Cook. London. Improvements in electric cables.

20,967. H. H. Lake. London. Improvements relating to incandescent electric lamps. (W. P. Pinchard, United States.)

20,982. F. Moore. London. Improved construction of electric meter.

November 21, 1900.

20,995. E. W. Serrell. London. Improvements in poles for electric railways, electric lights and telephone and telegraph lines.*

21,004. R. F. Hall. Birmingham. Improvements in primary batteries.

21,017. J. D. White. Redhill. Improvements in typewriters and in printing telegraphs.

21,022. J. R. Blaikie. London. Improvement relating to the excitation of the field magnets of electric generators and electric motors.

21,025. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railway systems and switches therefor. (F. W. Hill, United States.)*

21,026. The British Thomson-Houston Co (Ltd.). London. Improvements in electric railway systems. (W. B. Potter, United States.)*

21,027. The British Thomson-Houston Co. (Ltd.). London. Improvements in ground detectors for electric circuits. (W. H. Pratt, United States.)*

21,028. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railways. (P. Farnsworth, United States.)*

21,029. The British Thomson-Houston Co. (Ltd.). London. Improvements in tachometers. (C. D. Haskins, United States.)*

21,030. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railways. (W. P. Potter, United States.)*

21,031. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electric motor control. (A. H. Armstrong, United States.)*

21,036. H. M. Salmony. London. Improvements in switches for electric lamps and the like.

21,042. T. A. Rose and A. Barnes. London. Improvements in electric arc lamp carbons.

November 22, 1900.

21,086. G. Sperryn and W. H. Wood. Birmingham. Improvements in electrical ceiling roses for suspended and like fittings.

21,100. J. P. Hall. Manchester. Improvements in or applicable to electric converters or transformers.

21,135. T. Pescatore and The Tudor Accumulator Co. (Ltd.). London. Improvements in the manufacture of plates for secondary batteries.

21,144. W. Watson and E. Preece. London. Improvements in electric motor starting apparatus.

21,149. J. Meurant. London. Electrolytic process for the precipitation of metals and alloys from their solutions, as also for the deposit of metals or alloys on other metals or alloys or on other substances.*

## SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

21,656. British Thomson-Houston Co. (Ltd.) (Sperry). Controlling electric motors and electrically-propelled railway trains.

22,535. British Thomson-Houston Co. (Ltd.) (Potter). Electrical distribution and starting rotary electric converters.

24,126. Wright and Mutual Electric Trust (Ltd.). Electrical maximum demand indicators.

24,645. Rosenqvist, Berothell and Young. Automatic load-starting apparatus applicable to synchronous alternating-current motors.

24,887. Digby. Electric arc lamps.

25,350. Scholtz. Electric incandescent lamps.

1900.

81. Whiteley and Whiteley, Jun. Electrically operated clip to be employed in machines for tentering and stretching fabrics.

163. McFarlane and Reid. Automatic make-and-break for electric circuits.

216. Rodman. Manufacture of active mass for accumulator batteries.

267. Cranshaw, Cranshaw and Cranshaw. Means for adjusting or regulating the shades or covers employed in connection with electric lights, gas lights, and others for the purpose of concentrating and diffusing the light therefrom in any desired or required direction and apparatus for effecting the same.

838. Lake. (Sharman.) Incandescence electric lamps.

3,158. Wainwright. Fluid pressure thermo-dynamic engines.

8,061. Pochè. Lightning conductors and arresters for overhead electric conductors.

10,142. Murray. Printing telegraph apparatus.

13,765. Shoecraft and Gardiner. Automatic electric blocks systems for railroads.

14,101. Heys. (Scott, Varley and Anderson.) Coils or helices for electrical purposes.

16,656. Ryan. Electrically-propelled motor vehicle.

16,698. British Thomson-Houston Co. (Ltd.) (Hoffmann). Conduit flows for electric railways.

## COMPANIES' MEETINGS AND REPORTS.

### Brush Electrical Engineering Co. (Ltd.).

An extraordinary general meeting of the shareholders of this Company was held on Monday to consider and adopt an agreement with the British Electric Traction Co. (Ltd.). Mr. J. B. Braithwaite, junior (Chairman of the Company) presided.

The SECRETARY (Mr. B. Broadhurst) having read the notice convening the meeting.

The CHAIRMAN said: Gentlemen, we are met on this occasion because the agreement, which we recommend for your adoption between this Company and the British Electric Traction Co. is one of such importance that we did not feel justified in entering into it without your sanction; and, inasmuch as it involves, if adopted, the retirement of some of your

Directors, we have felt it necessary to take you, in the fullest manner possible, into our confidence. This agreement is one which we regard as being decidedly in the interests of the Brush Company, and that, I think, will be obvious to you at once when you consider that we have been engaged for the last two or three years in making large extensions to our works at Loughborough, in developing every class of traction plant, so that now we alone among English manufacturers are in a position to supply everything necessary in connection with electric tramways. We not only build the generators and the engines for driving them, but we also build the motors, the controllers, and the car bodies, and we are now also building the trucks, so that at the present time the Falcon works can turn out all the plant connected with electric tramways from beginning to end of British manufacture. The British Electric Traction Co., on the other hand, is, without doubt, the leading British company that is engaged in the business of electric traction. It is the most powerful organisation of the kind we have in this country, and it seems, at first blush, very desirable that the leading British traction company should ally itself with the leading manufacturing company for their mutual benefit. This agreement which you are asked to adopt to-day will have the effect of securing for us the whole of the orders for electrical plant which the British Electric Traction Co. may have to give out—a very large share, in fact, of the electric traction work which will be going in this country—and of rendering the capital we have expended in putting down motor shops, truck shops, and other additions to our works, immediately remunerative, and securing a certain and steady stream of orders for our works in those departments. That, in itself, I think you will agree, is desirable from the point of view of this Company. But the British Electric Traction Co. naturally say, "Well, gentlemen, if we are going to give you the whole of our orders we shall require some *quid pro quo*." That *quid pro quo* will take the form of a 5 per cent. rebate on all the orders they place with us, either directly for themselves or on behalf of their associated or affiliated companies. The confidence which the British Electric Traction Co. feel in the Brush Company, and their ability to give us a large amount of profitable work in the near future, is shown by the other clause in the agreement which provides that they shall be represented on the Board of our Company by three gentlemen, and, further than that, with the idea of securing some portion of the manufacturing profits for themselves, they are willing to take as many ordinary shares in this Company as our shareholders choose to let them have at what is apparently a fair exchange—their present market price. That is to say, they offer to give to any shareholder who likes, one British Electric Traction share, carrying dividend from April 1, 1900, in exchange for every seven and a-half Brush shares, carrying dividend from Jan. 1, 1900. Of course, this offer to take your shares is a purely optional one as far as you are concerned, but it is not optional on the part of the Traction Company, because they undertake to take any quantity of the ordinary shares which may be offered on those terms to them. To you it is optional whether you prefer to keep your shares as now or exchange them for Traction shares on the terms of the circular, so that you see the Traction Company in this agreement give the strongest possible proof of their faith in the future of the Brush Company when they practically offer to buy the whole of your ordinary capital. And, I suppose, for the satisfactory working of this agreement, we ought almost to hope that there will be a considerable number of Brush shareholders willing to exchange their shares, or, in other words, sell them to the Traction Company on the terms mentioned, because it will be obvious to you that the larger the interest which the Traction Company have in our ordinary shares, and therefore in our manufacturing profits, the more likely they are to continue this agreement beyond the period at which it is possible to terminate it. It would never do for the Directors to hand over the Brush Company bound hand and foot to a Traction company, no matter how powerful, and therefore you will notice there is a provision inserted in the agreement that it can be terminated at the end of one year by either party. That is to say, if we of the Brush Company consider at the end of a year that the Traction Company have not given us the full volume of orders they undertook to do, or if we are for any other reason dissatisfied with the working of the agreement, we can end it. If, on the other hand, the Traction Company are dissatisfied with the agreement, they also can end it. That is, it is an agreement which will depend for its success in working largely upon the goodwill which the two parties put into it. We have received a considerable number of letters of inquiry from shareholders who appear to have misunderstood the agreement, inasmuch as they seem to think that if it is adopted to-day they will be bound to exchange their shares for shares of the British Electric Traction Co. That is not the case at all. If this agreement is adopted what will happen will be this: Some of your Directors will resign, and the Traction Company will pay them a certain compensation for their doing so, in order to make way for three gentlemen nominated by the Traction Company to represent them on our Board. Then we shall receive a large block of orders for electrical plant from the Traction Company, and we shall naturally manufacture that plant to the best of our ability. Then every shareholder in the Brush Company will, for a certain specified period of 21 days after notice have the option, if he is so inclined, of accepting one British Electric Traction share, carrying dividend from April 1, 1900, in exchange for every seven and a-half Brush ordinary shares that he now holds, carrying dividend from January 1, 1900. You will see, therefore, there are two things which will inevitably happen, and one thing which is optional. It may happen that not a single shareholder decides to exchange his shares on these terms. It may so happen, on the other hand, that nearly all our shareholders decide to do so. Therefore, the one thing uncertain with regard to this agreement, if adopted, is the extent of the interest in your ordinary shares which will be acquired by the Traction Company. That is a matter no one can foresee. It will depend on the individual preference of shareholders. No doubt those who think they will do better to be interested in a Traction company which is engaged in promoting, working, and running electrical trams in different parts of this country, will accept the exchange. Those who think that the Brush shares will be more valuable than ever, now that we are in alliance with the most powerful Traction company, that we shall have a large mass of orders secured, and that the expenses will be reduced consequently—those who take that view and consider that their shares will be worth more when the agreement has been passed than previously, will hold on to their shares. It is open to them to adopt which course they prefer. I do not think I need add very much more. The agreement is simple. It merely amounts to an active alliance, as I pointed out at the commencement, between the most completely-equipped British electric manufacturing company and the most powerful British company which is financing, promoting, and working electrical tramways in this country. That that agreement will be mutually advantageous we all believe, if it is worked with goodwill, and to secure that it shall be worked with mutual goodwill, we propose to elect to seats on our Board three nominees of the Traction Company in place of some of your own Directors, who have been willing to facilitate this arrangement by placing their seats at the disposal of the shareholders. If you adopt this agreement, and accept the resignation of those of your Directors, the Traction Company will, on their part, compensate those Directors for resigning their seats to the extent mentioned in the agreement. A sum of £2,250 will be divided amongst them as compensation for loss of office. In their place you will be asked to elect three gentlemen nominated by the Traction Company—Lord Vaux of Harrowden, Mr. Clarence Shirreff Hilton, and our present general manager, Mr. R. Percy Sellon. I will conclude by moving—

"*That the agreement made with the British Electric Traction Co.* (*Ltd.*), *dated January* 3, 1901, *be and is hereby approved and adopted.*"

Mr. J. S. RAWORTH (a Director of the British Electric Traction Co.) said: The Chairman has so fully, accurately, and clearly explained this agreement to you that it is scarcely necessary for me to say a word in support of the motion. I think, however, as I have been associated with you in this business for 14 years, and as I am your representative on the Board of the Traction Company, it is only right on my part to tell you that I have furthered the completion of this agreement in the full belief that it will be executed in your interests. I believe you cannot do better for yourselves or the Company than to carry out the agreement before you. The Traction Company is already a large shareholder in the Brush Company, and I know that it has a very strong desire to become a still larger shareholder. I may say that their holding principally consists of preference shares, but they show their desire by this agreement to take some of the risk of the undertaking, and to participate also in some of the profits which, they believe, will accrue owing to the very large influx of business that must arise from the agreement if it should be carried into effect. I have very much pleasure in seconding the resolution.

The CHAIRMAN: I should mention one thing here. I wish to make it clear that the proposal for the exchange of shares has reference only to our ordinary shares. The preference shares remain exactly as they are. The only shares for which there is an option of exchange into Traction shares are the ordinary shares.

After sundry questions had been asked by shareholders and answered by the Chairman, the Resolution was agreed to.

The CHAIRMAN: I now move

"*That the resignations of Mr. Arthur Ayres, M.I.C.E., Mr. Aymor Holloway Sanderson, Col. Frederick George Stewart, and Mr. Edward Woods be accepted.*"

Mr. HODGKIN seconded, and the resolution was carried.

The CHAIRMAN: I will now ask a shareholder to move the election of the new Directors.

Mr. LAMONT: I have been asked to move—

"*That Lord Vaux of Harrowden, Mr. Clarence Shirreff Bayard Hilton, and Mr. Robert Percy Sellon be and are hereby elected Directors of the Company.*"

Mr. GREIG seconded.

The resolution was carried with one dissentient, and a vote of thanks to the Chairman terminated the proceedings.

## General Electric Co. (1900), Ltd.

The statutory general meeting of this company was held on Wednesday, under the presidency of Mr. HUGO HIRST, who said:—I wish to express my regret that our chairman, Mr. Gustav Byng, cannot be here to preside. As most of you here are aware, he has been absent for some considerable time endeavouring to regain his health, which broke down under the necessary strain and worry of work to which the head of a concern like ours is subject. If, however, he has not been amongst us during this present season, he has been near enough to give us the advantage of his valuable advice, knowledge, and experience; and the latest news from him is such that we have every reason to expect him back to work some time this spring, when I hope he will face you with our first successful yearly report.

This meeting is a statutory meeting only, and the requirements of the law are very modest. If the information we have prepared should not be complete, I shall be glad to answer any questions afterwards. The whole of the share capital as well as the debentures has been subscribed, issued and allotted. All the calls for the whole of the debenture issue have been paid up, and though the last call on the preference shares is only due on April 1, out of 18,000, 13,342 have paid up fully £10, and 3,901 have paid up £7. 10s. each. The debentures are held by 153 subscribers, the biggest holding by one person or party being £15,000. The preference shares are held by 422 persons, the highest holding being 651 shares. The whole of the properties purchased by the new company, with the exception of a few leaseholds held on rack rent, have been duly transferred to them by the vendors. The debentures of the old company have been paid off, and the mortgage of the new debenture stock has been executed, and the deeds

handed over to the trustees. An application has been made to the Stock Exchange for a quotation of the preference shares and debenture stock, and application will be made at Manchester and Glasgow in due course. A very large proportion of our preference capital has been applied for and allotted to numerous customers of the firm. A fact no less gratifying is that the staff of the General Electric Co. and their friends have invested quite a considerable amount in our business. A considerable portion of the unissued part of the ordinary shares has been put aside for gradual allotment to the principal members of the staff. Mr. Warburton, our adviser, has assisted us in developing a simple scheme which we expect will shortly come into operation. Electricity still affords great fields for the enterprising, and with that conviction we have had no hesitation in acquiring 60 acres of additional land adjoining the property mentioned in our prospectus. We have placed the contract for our very large engineering works, a central power house for a large quantity of most up-to-date machinery, and within a very short period we hope to have supplemented our present overcrowded works at Manchester and Birmingham with new additional works which will enable us to undertake at a profit any and every kind of electrical engineering work that has ever been attempted in this country. We are about to build roads and goods sidings, so as to be able to enjoy the advantages of cheap freights and raw materials, and we are on the point of closing contracts for the manufacture of a number of articles that we have been in the habit of buying. Finally, I would like to say a few words about our business. In an organisation like ours, with so many branches and works and interests, it is impossible to watch daily or even monthly the exact results of trade. Output is fairly regular, but expenses, such as rents, salaries, advertising, catalogues, &c., are irregular and spasmodic, and it would be easy to deceive oneself. I am pleased to state however, that there has been a considerable increase in sales for every month during the nine months that we have been in existence as a new company compared with the respective months of the previous year. It has been particularly pleasant to see that our young engineering department has succeeded in pulling off some of the largest and most interesting orders that have been offered to manufacturers by the Government, municipalities and leading electric light companies. One of our oldest departments, in which we consider ourselves leading manufacturers in this country—the telephone department—is receiving a most satisfactory impetus through the competition that is now springing up between the Government, telephone companies, and municipal authorities in the erection of telephones. As regards our incandescent lamp business, I believe the "Robertson" lamp is made in larger quantities than any other lamp in this country. In this connection I may add that it has struck many investors and customers as peculiar that the Robertson Lamp Works were not specifically mentioned in the assets taken over by the new company. Though this has been corrected in the technical Press, I wish to state here that the Incandescent Electric Lamp Works making the "Robertson" lamp are identified as closely with us as ever, but as in that enterprise we have some colleagues outside our own firm—the General Electric Co.—the works are carried on as a separate company, and appear in the list of investments in the prospectus, and not in the freehold property and assets. With these remarks, gentlemen, I invite you to put any question you may think advisable.

Mr. FREDERICK WALKER asked whether there was any prospect of any of the ordinary shares in the company being offered to the public, so that they might have a quotation. He also asked whether there was any prospect of those who had put money, as he had, in the debentures being given an opportunity of subscribing for any of such ordinary shares.

The CHAIRMAN: I think I can answer these questions very easily, because they have had our consideration. No doubt, if we ever issue ordinary shares to the public—or whenever we do so—those investors who have supported us at present will, as a matter of course, be considered first. As to issuing ordinary shares, we have been a private business, and we are all at once absorbing a lot of capital—or taking up a lot of capital—from the public which must necessarily for a few years be unremunerative. Until that capital works we cannot possibly increase our profits very much over what we have shown in the prospectus; but this new capital is actually an additional charge on our present profits, and until it is in working order—until we know to what basis this new capital has brought us—we think that the holders of the present ordinary shares should take all the risks. That is one reason against the issue of ordinary shares, but there are various others into which I do not think it is necessary to go at present.

Some other questions were asked, and the proceedings terminated.

---

**NERNST ELECTRIC LIGHT LTD.**—The adjourned meeting of this company will be held to-day (Friday) to afford an opportunity to Mr. E. M. Drake, the managing director, to place before the shareholders his reply to charges brought by Mr. Zusman, a co-director, as to Mr. Drake's management of the company's affairs. Mr. Zusman's charges cover a wide ground, and Mr. Drake has circulated amongst the shareholders a printed circular setting out his replies. A full report of the proceedings at the general meeting of the company on Dec. 19 appeared in *The Electrician* of Dec. 21.) Accompanying Mr. Drake's circular is another signed by Sir Henry Mance and Messrs. J. G. Fort and J. D. Dalzell, who, with Mr. Drake and Mr. Zusman, form the board of the Nernst Electric Light (Ltd.). This circular states that, in the view of these members of the board, Mr. Zusman's charges are unfounded and calculated to injure the company; and further states that Mr. Drake's services to the company have deserved the highest commendation, both from his co-directors and the shareholders that these services have, in fact, been practically invaluable. The shareholders are asked to support the board of directors in their cordial agreement with Mr. Drake's justification for his past management. In Mr. Drake's circular Mr. Zusman's charges are numbered 1 to 12 and in every case are emphatically refuted, and evidence furnished to justify this refutation. Mr. Drake's circular contains statements of interest to others than shareholders in the Nernst Electric Light (Ltd.), and forms an interesting review of the steps which have been taken to develop the Nernst lamp since the establishment of the company.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**AUTOMOBILE MUTUAL PROTECTION ASSOCIATION (LTD.)**—Registered on Jan. 10, with 10 members, each liable for 5s., to support and protect the business of engineers, manufacturers and proprietors of, agents for, and dealers in automobiles, motor cars, parts and accessories, electricians, machinists, suppliers of motive power, &c. The management is vested in a committee.

**FERMOY AND DISTRICT ELECTRICITY CO. (LTD.)**—Registered Dec. 28, with a capital of £7,500 in £1 shares (3,000 preference), to supply electricity in Fermoy (Co. Cork) and surrounding district, and to carry on the business of electricians, &c. The subscribers are: W. Fennell, electrical engineer; C. J. Inder, engineer; W. W. Norman; F. J. Warden-Stevens, consulting engineer; H. Briff, electrician; Mrs. J. Spring and A. C. Hertel.

**SAUNDER'S PATENT LAUNCH BUILDING SYNDICATE (LTD.)**—Registered Dec. 28, with a capital of £20,000 in £1 shares, to adopt an agreement with S. E. Saunders for the acquisition of certain property at Goring on Thames and Cowes, Isle of Wight, and to carry on the business of ship, yacht, launch, and boat builders and fitters, engineers, motor manufacturers, suppliers of electric and other motive power, &c. Mr. S. E. Saunders is to be managing director.

---

**CAPE ELECTRIC TRAMWAYS (LTD.)**—The annual return to Nov. 28, 1900, which has just been filed, gives the capital as £500,000 in £1 shares, 400,000 of which have been taken up, all being considered as fully paid.

**MACKEY'S ELECTRIC LAMP CO. (LTD.)**—The annual return to Oct. 13, 1900, was filed on Jan. 3, 1901. The capital is £2,000 in £1 shares, all of which have been taken up; £1 per share has been called up and paid on seven shares, and 1,993 are considered as fully paid.

## CITY NOTES.

**MEMORANDA.**—Bank rate 5 per cent. (since Jan. 3, 1901). Price of silver 29 1/16d. per oz. (Jan. 17). Consols (2¾ per cent.) 96⅞–96⅞ for money, 96⅞–97 for account; 2½ per cent. 97–97½ (Jan. 17). Consols Pay Day Feb. 1. Stocks and Shares Continuation Days, Jan. 29 and Feb. 12; Ticket Days, Jan. 30 and Feb. 13; Pay Days, Jan. 31 and Feb. 14; Mining Share Carry-over Day, Jan. 28.

---

**BRITISH ELECTRIC TRACTION CO. (LTD.)**—An appreciative article on the value as an investment of British Electric Traction Co.'s shares appears in the *Joint Stock Companies' Journal* for Jan. 16.

In view of the fact that several companies have lately been registered having titles similar to that of the British Electric Traction Co. (Ltd.), the directors desire it to be known that the company has no connection or association whatever with any other company whose title contains the words "British Electric."

**BRITISH INSULATED WIRE CO. (LTD.)**—Dividend warrants on the 6 per cent. preference shares, for the half year ended Dec. 31, less tax, have been posted.

**BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)**—An extraordinary meeting was held on Thursday last, when the resolution passed on the 20th ult. for increasing the capital of the company by

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900 1 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Jan. 12 | 555 | + 24 | 31 | 22,620 | + 3,202 |
| *Birmingham Tramways. | " 12 | 3,769 | – 164 | 1 | 3,769 | – 164 |
| Blackburn Corporation. | " 11 | 379 | + 22 | † 1 | 649 | + 54 |
| Blackpool Corporation... | " 10 | 153 | + 30 | 41 | 28,572 | + 7,614 |
| Blackpool and Fleetwood | " 12 | 122 | – 29 | 2 | 264 | – 19 |
| Bolton Corporation ...... | " 13 | 1,191 | ... | 41 | 55,832 | ... |
| Bradford Corporation... | " 13 | 754 | + 400 | 41 | 24,132 | + 8,183 |
| Brisbane Trams ......... | ... | ... | ... | ... | ... | ... |
| *Bristol Trams & Carriage | " 11 | 3,386 | + 705 | 2 | 7,071 | + 1,623 |
| *Buenos Ayres & Belgrano | Dec. 16 | 2,881 | + 415 | 24 | 60,660 | + 6,144 |
| Central London Railway | Jan. 12 | 5,676 | ... | 24 | 128,003 | ... |
| City & South London Ry. | " 13 | 2,041 | + 917 | 1 | 4,059 | + 1,791 |
| Cork Elec. Trams ......... | ... | ... | ... | ... | ... | ... |
| Dover Corporation ...... | " 12 | 153 | + 7 | 41 | 9,014 | + 580 |
| Dublin & Lucan Rly. .. | " 12 | 67 | + 14 | 2 | 137 | + 28 |
| Dublin United ........... | " 11 | 3,242 | + 377 | 2 | 6,703 | + 802 |
| Dublin Southern Dist.... | " 11 | 651 | + 72 | 2 | 1,387 | |
| *Dundee Corporation ... | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation ... | " 12 | 8,525 | + 246 | 2 | 21,060 | + 1,963 |
| Hull Corporation......... | " 12 | 1,522 | + 857 | 23 | 39,955 | + 21,579 |
| *Liverpool Corporation... | " 5 | 8,477 | + 1,704 | 1 | 8,477 | + 1,704 |
| Liverpool Overhead Rly. | " 13 | 1,512 | – 17 | 2 | 5,065 | – 71 |
| *Sheffield Tramways .... | " 13 | 2,571 | + 7[illegible] | 2 | 5,152 | + 1,814 |

* Partly electrical. † And four days.

£100,500 by the creation of 20,100 additional shares of £5 each, 8,000 to be preference shares and 12,100 to be ordinary shares, was confirmed.

**CITY AND SOUTH LONDON RAILWAY CO.** The accounts for the half-year ended Dec. 31 shows a balance, after providing for debenture stock interest and the full dividends on the 5 per cent. preference stocks 1891 and 1896, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¼ per cent. per annum, carrying forward a balance of £1,248. The dividend for the corresponding period last year was at the rate of 1½ per cent. per annum, the balance forward being £1,267.

**DIRECT UNITED STATES CABLE CO. (LTD.)**—An interim dividend of 3s. per share, tax free (at the rate of 3 per cent. per annum) for the quarter ended Dec. 31 (payable on and after 31st inst.) has been declared, £10,000 has been put to reserve, and about £5,255. 13s. 2d. carried forward. The transfer books are closed from 15th to 29th inst. inclusive.

**EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)**—The interest on this company's 4 per cent. mortgage debenture stock for the half year ended Jan 31, will be paid on Feb. 1. The stock register of these debentures will be closed from 26th to 31st inst. inclusive.

**EDMUNDSON'S ELECTRICITY CORPORATION (LTD.)**—An interim dividend of 5 per cent. for the half-year ended Sept. 30 has been declared.

**ELECTRICAL CONSTRUCTION CO. (LTD.)**—The transfer books of the ordinary shares are closed from the 18th to 31st inst., inclusive, for payment of the second half of the dividend of 6 per cent. per annum, declared on July 12 last.

**GLOBE TELEGRAPH AND TRUST CO. (LTD.)**—An interim dividend of 1s. 9d. per share on the ordinary shares has been declared.

**MUNICIPAL FINANCE.**—The Sheffield Corporation invite applications for loans for the extension of the electric tramways and electric lighting undertakings. Offers to city accountant, Town Hall, Sheffield.

**NEW ST HELENS AND DISTRICT TRAMWAYS CO. (LTD.)**—Warrants for payment of the preference dividend for the six months ended Dec. 31 have been posted.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee have appointed January 30 a special settling day in £73,009 4 per cent. debenture stock of the *Kensington and Knightsbridge Electric Lighting Co. and the Notting Hill Electric Lighting Co. (Ltd.)*, and the stock has been ordered to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in and to grant a quotation to £75,000 ordinary £5 shares, 75,000 5 per cent. £5 cumulative preference shares and £400,000 4½ per cent. first debenture stock of the *Brisbane Electric Tramways Investment Co. (Ltd.)*.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Jan. 9. | Price Wednesday, Jan. 16. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Jan. 16. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅞ 1 | ⅞ 1 | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | | 71 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ 13½ | 12½ 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | [illegible] | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½ | Do. 4½ per Cent. Debenture Stock (red.) | 101 103 | 101 103 | 4 7 6 | ... | 102 | ... |
| 19,461 | [illegible] | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 8 | 7 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | March and September | ... | ... |
| 30,000 | 5 | 1/0 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ 6¾ | 6¼ 6¾ | ... | ... | ... | ... |
| 10,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ 10½ | 9½ 10½ | 4 5 1 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ 5¾ | 5¼ 5¾ | 3 18 3 | " " | 5⅝ | 5½ |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ 7 | 6½ 7 | 4 5 9 | March | 6¾ | 6½ |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 110 | 100 110 | 4 10 11 | April and October | ... | ... |
| 70,879 | 10 | 8/0 | City of London Electric Lighting Ord. | 9 10 | 8½ 9½ | 4 4 3 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 14 | 13 14 | 4 5 9 | January and July | 13½ | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 127 | 122 127 | 3 18 9 | June and December | ... | ... |
| £100,000 | Stock | | Do. 4½% 2nd Deb. Stock Certs. (60% pd.) (red.) | 61 63 | 61 63 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ 9½ | 8½ 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ 12½ | 11½ 12½ | 4 16 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½% Deb. Stock (certs., all pd.) (red.) | 106 109 | 106 109 | 4 2 7 | ... | ... | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ 6 | 5½ 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ 8½ | 7½ 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 13 | 12 13 | 4 0 9 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ 7 | 6½ 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ 2 | 1½ 2 | ... | ... | 1½ | ... |
| 49,840 | 5 | 6/0 | Do. 6 per Cent. Preference | 4 5 | 4 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 101 | 98 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 65,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 13 | 12 13 | 4 4 7 | April and October | 12½ | 12¼ |
| £320,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | 111 | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 90 93 | 90 93 | 3 10 8 | ... | ... | ... |
| 6,432 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ 15½ | 14½ 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ 6½ | 5½ 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/0 | Rand Electric | [illegible] | [illegible] | 13 5 8 | ... | ... | ... |
| £185,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 75 85 | 80 85 | 6 9 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 180 | 170 180 | 4 8 11 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 104 | 102 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 16 | 15 16 | 4 10 8 | February and August | 15½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 3½ 0 | Do. 3½ per Cent. Debenture Stock (red.) | 94 101 | 94 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 85 95 | 80 90 | 4 19 11 | ... | 80½ | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 6/0 | Westminster Electric Supply Ordinary | 12 13 | 12 13 | 5 6 0 | March and September | 12¾ | 12½ |
| 29,618 | 5 | ... | Do. Do. | 11½ 12½ | 11½ 12 | ... | ... | 12⅛ | 12½ |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 16 | 14 16 | 2 10 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 106 | 104 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 25 | 24 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ 11½ | 10½ 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 118 118 | 115 119 | 3 6 1 | February and August | ... | ... |
| 11,600 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ 10½ | 9½ 10½ | 4 17 6 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 12½ 13½ | 12½ 13½ | 6 5 11 | ... | 13½ | 13¼ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 13 | 11½ 12½ | 4 16 0 | February and August | 12⅛ | 12 |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 123 | 120 123 | 4 1 6 | ... | 122 | [illegible] |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ 5½ | 4½ 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 1½ 4½ | 4½ 4½ | ... | ... | 4½ | 4 |
| £310,000 | Stock | 5% | Do. 5 per Cent. Debentures | 103 108 | 103 107 | 4 13 6 | ... | 103 | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 91 97 | 95 98 | 5 2 0 | ... | ... | ... |
| 200,297 | 10 | 3/0 | Central London Ordinary | 9½ 9½ | 9½ 9½ | 3 4 7 | June and December | 9 | 8½ |
| £344,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 62 66 | 61 68 | 2 0 7 | February and August | ... | ... |
| 37,500 | 10 | 1/3 | Do. Ordinary (Nos. 22,501 to 60,000) | 4½ 5½ | 4½ 5½ | 2 11 9 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 143 | 138 144 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 135 | 130 135 | 3 14 1 | ... | ... | ... |
| £241,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 115 120 | 115 120 | 3 18 11 | May and November | ... | ... |
| 60,000 | 1 | ... | Dublin United Tramways (1896) Ltd., Ordinary | 17 19 | 17 19 | ... | ... | ... | ... |
| 50,187 | 1 | ... | Do. 6 per Cent. Preference | 15½ 16½ | 15½ 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 4½ per Cent. Mort. Debs. (red.) | 102 105 | 102 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 21½ 23½ | 21½ 23½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ 15 | 14½ 16 | 3 19 8 | " " | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 113 115 | 113 115 | 3 18 11 | January and July | ... | ... |
| 20,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | 9½ 10½ | 9½ 10½ | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8½ 9½ | 8½ 9½ | 4 9 6 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 12½ 13½ | 12½ 13½ | 3 14 1 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 16 10 | January and July | ... | ... |
| $340,000 | $1,000 | 5% | London St. Railway (Ont.) 1st Mort. 5% Bonds (red.) | 102 104 | 102 104 | 4 17 7 | ... | ... | ... |
| £525,744 | Stock | ... | London United Tramways 1st Mt. Deb. Stk. Prov. Certs. | ... | 61 64 | ... | ... | ... | ... |
| £260,000 | 100 | 5% | Montreal Street Railway 5% Mort. Debs. (1908) | 103 105 | 103 105 | 4 18 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 103 105 | 103 105 | 4 0 9 | ... | ... | ... |
| 24,000 | [illegible] | ... | New General Traction Ordinary | 3½ 4 | 3½ 4 | ... | ... | ... | ... |
| 60,000 | [illegible] | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ 5½ | 4½ 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 16 17 | 16 17 | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | 10½ 11½ | 10½ 10½ | 4 13 0 | " " | ... | ... |
| 12,324 | 10 | ... | Potteries Electric Traction Ordinary | 10½ 11½ | 10½ 11½ | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 10 | February and August | 10½ | ... |
| £135,000 | Stock | 37 0 | Do. 4½ per Cent. Debenture Stock | 103 105 | 103 105 | 4 5 7 | ... | ... | ... |
| £40,000 | Stock | 3% | Waterloo and City Ordinary | 94 97 | 94 97 | 3 2 9 | June and December | ... | ... |

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,184. [No. 14. Vol. XLVI.] FRIDAY, JANUARY 25, 1901. PRICE SIXPENCE (by post, 6½d.), Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

LONG LIVE THE KING!

IT is with the most profound sorrow that we record in these pages the death of our beloved and revered QUEEN VICTORIA, an event that has already plunged the entire world into heartfelt mourning. World-engaging, indeed, has been this terrible and sudden calamity! In VICTORIA THE GOOD every Briton had, not only a wise and benevolent ruler, but also a loving Mother; in her, too, every human being could find a sympathetic and generous friend. Unparalleled in history has been her Imperial rule; unmatched by any event in history is her lamentable loss. Noblest, wisest, and best of rulers the world has ever known, humanity becomes infinitely the poorer by her passing. Unconsolable grief is in the flowing tears of her world-wide Empire: her people weep and will not be comforted.

VICTORIA THE GREAT, as well as VICTORIA THE GOOD, it is matter for wonder by which of these lofty yet equally-deserved titles posterity will perpetuate her memory. The Golden Age of VICTORIA stands unrivalled by any similar period known to history. Britons justly claim, and the civilised nations of the world agree, that the last six decades of the nineteenth century will universally and for ever be characterised as the Victorian Age. Students of science and workers in the scientific arts owe to her wise and beneficent reign the stimulating influence which has elevated the sciences to their present high level. Dead, alas! as regards mortal presence in our midst, VICTORIA THE GOOD AND GREAT, of Blessed Memory, will live for ever in the hearts of her people.

IN its "Twentieth Century Number" our contemporary, the *Electrical World* of New York, gives the result of a ballot among nearly 300 members of the American Institute of Electrical Engineers, held to decide the 25 names most famous in nineteenth-century electrical development. At the head of the list stands FARADAY, placed there by votes nearly twice as many as are given to any other. KELVIN, EDISON and BELL follow in order. Further down we find that MORSE and TESLA precede MAXWELL and SIEMENS, WHEATSTONE and HELMHOLTZ, and that HOPKINSON and HEAVISIDE are quite unmentioned. But from this list, based on the votes of the crowd, two other lists of 25 great names have been compiled—the one by selecting the ballot papers of 25 of the most prominent engineering members of the Institute, the other by choosing the papers of 25 leading professors of electrical engineering. The engineers' list is headed by FARADAY, who is followed by MAXWELL and KELVIN; and HENRY, BELL, and EDISON follow in order. MORSE still precedes SIEMENS and TESLA, HELMHOLTZ and WHEATSTONE, while

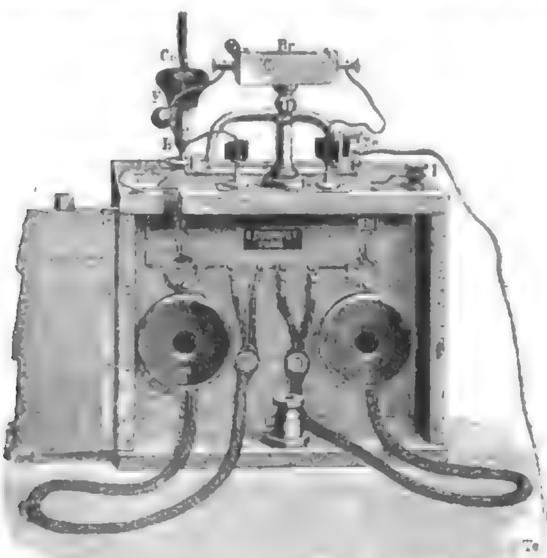
## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Efficiency of Acetylene Flame.*—Experiments carried out at Cornell University by E. L. Nichols show that the total efficiency of the acetylene flame is superior to that of any other except the magnesium flame. The total efficiency is compounded of the luminous and the thermo-chemical efficiency. The luminous efficiency is the percentage of the total radiation which consists of visible light. That percentage is 1·5 in the paraffin candle, 2·6 in the oil lamp, 1·2 to 2·4 in the gas jet, 5 to 6 in the glow lamp, 2 to 7 in the incandescent gas lamp, 12·5 in the magnesium band, and 82 in the vacuum tube. The arc light has a luminous efficiency of 10·4 and the acetylene lamp of 10·5. The thermo-chemical efficiency of the acetylene lamp (*i.e.*, the ratio of radiation calories to total calories due to chemical combination) is 0·225. Hence the total efficiency is $0·225 \times 0·105 = 0·0236$. Another experiment carried out with a larger flame ("normal" size) gave 0·0190. This is at least double the total efficiency of the arc light, though, of course, this total efficiency has nothing to do with "financial" efficiency or cheapness. Otherwise the magnesium light, with its wonderful efficiency of 0·1025, would be the cheapest source of light.

[E. L. Nichols, *Phys. Zeitschr.*, January 12, 1901.]

*Telephonic Receiver for Space Telegraphy.*—MM. Popoff and Ducretet describe a receiver which dispenses with a relay and a decohering device, the messages being read by means



of a telephone receiver. The apparatus (see diagram) is very portable. Br is the coherer, filled with grains of hard carbon or other substance, which can be given any inclination. During transport it is mounted in the block C. Co is the air-wire, which need only be a couple of feet long if there is a good earth connection at Te. Dry cells are used for the circuit. TT' are the telephones. The apparatus is exceedingly sensitive.

[Popoff and Ducretet, *Comptes Rendus*, December 31, 1900.]

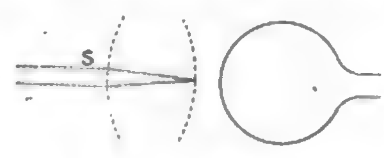
*Polarisation by Alternating Currents.*—If a voltameter is introduced into an alternate-current circuit, the quantity of electricity passing the voltameter during a semi-period may produce three different effects—it may produce small polarisations; it may produce polarisations approaching the maximum; or it may saturate the electrodes and produce electrolysis. In the first case, the polarisation shows a sinusoidal course, in the second it is approximately sinusoidal, with curves flattened at the apex, and in the third case the curve consists of straight lines representing the maxima joined by portions of sinusoidal curves. F. Oliveri has proved this behaviour experimentally by means of Joubert's method of momentary contact, in which the terminals of the voltameter are brought instantaneously into connection with a quadrant electrometer at definite phases of the current. The occurrence of electrolysis depends not only upon the difference of potential, but also upon the period, since the passage of a definite quantity of electricity is required in each semi-period to annul the polarisation of the previous semi-periods. The current intensity is 90deg. ahead of the electric polarisation. The author describes a new method of measuring this phase-difference. With small polarisations, a voltameter behaves like a capacity.

[F. Oliveri, *Phys. Zeitschr.*, January 12, 1900.]

*Stratified Discharge.*—E. Riecke is of opinion that the explanation of the stratified discharge must not be sought in the analogy of any wave motion like Kundt's dust figures, but rather in the analogy of a fluid jet which periodically expands and contracts as its distance from the orifice increases. Cathode rays, proceeding as they do by projection from the cathode, may behave substantially like a jet, as they leave the cathode with a definite initial velocity. He attempts a mathematical investigation based upon the supposition that the electrons move in the direction of the lines of force of a uniform electric field in a jet in which all the electrons throughout a cross section have the same velocity, and he supposes also that the electro-dynamical forces between the electrons are governed by the law of Clausius, and that the space through which the jet moves is filled with a neutral substance exerting a viscous retardation upon the jet. The curve of velocities then becomes a periodic one, and consists of an exponential curve and a sine curve of increasing amplitude superimposed. When there is no viscosity, the periodicity disappears. The same thing happens if the initial velocity is very small. This would cover the cases of high vacua and of feeble discharges. No allowance is made for the formation and decomposition of neutral molecules, as in Thomson's theory. G. T. Walker has, however, arrived at similar conclusions from the kinetic theory of gases.

[E. Riecke, *Phys. Zeitschr.*, January 12, 1901.]

*Preparation of Glass Bulbs.*—V. Dvorák has discovered a simple and safe method of perforating thin-walled glass bulbs. Take an electric-light carbon S (see figure) about 4mm. thick,



introduce its point into a blow-pipe flame, and place the bulb beside it. When the point is white-hot push it softly, with slight torsion, into the bulb, and retract it at once. The small opening thus created has a rim projecting inside, and does not produce cracks. A bulb can thus be perforated like a sieve, and it does not crack for months.

[V. Dvorák, *Phys. Zeitschr.*, January 12, 1901.]

*Daily Variation of Atmospheric Electricity.*—Like all periodic phenomena, the diurnal variation of potential at any point in the atmosphere may be represented by the superposition of sinusoidal curves having a day, half a day, one-third of a day, and so on, for their periods. But such a Fourier series does not necessarily correspond to natural periods, but rather tends to disguise them. It is, therefore, more fruitful to arrive in same way at the probable periods and then to determine their relative amplitudes. As a matter of fact, it is necessary to proceed to the fifth term at least of a Fourier series before a fairly satisfactory representation of the actual curve of atmospheric potential is arrived at. A. B. Chauveau, therefore, confines his attention to the diurnal period, and superimposes upon that a "disturbing wave," which is the resultant of all the smaller terms. Each of these curves has equal areas above and below the medium line. The area of the disturbing curve is about 0·35 of the main curve at the Paris Central Bureau, and 0·20 on the Eiffel tower in summer, and 0·10 in winter. The irregular disturbances are probably confined to points below the 100ft. level.

[A. B. Chauveau, *Comptes Rendus*, December 31, 1900.]

# SOUTHAMPTON CORPORATION ELECTRIC TRAMWAY AND LIGHTING SYSTEM.

BY H. G. NICHOLSON.

(*Concluded from page 425.*)

From the accompanying map of Southampton (Fig. 10), showing the tramway routes, it will be seen that Prospect-place junction is the centre of the system which is at present working. From this junction the electric cars run to Shirley, a distance of 1¾ miles; the docks, 1¼ miles; and to Portswood, 1¾ miles. The extensions, which are also shown, will be commenced early next spring. There are five different feeders from the power station to the overhead trolley line, which is of 00 B. and S. gauge, hard-drawn copper wire, as well as distributors to the switch pillars at intervals of every half-mile. By this means a steady pressure is obtained on the trolley wire, and hardly any flicker of the car lights can be observed. In deciding the size of a trolley wire it is desirable to use it depends more on the maximum current which is required to be collected for the heaviest motor car than the number of cars on any section at one time, and it is certainly a disadvantage to use a heavy trolley wire such as 000 or 0000, with a proportionally lesser number of feeders, where the lighter size wire is of sufficient section for the trolley wheel to collect the current without undue sparking. Side pole-bracket arm construction is mostly in use, with the swivelling trolley head, and in places where the bracket arms would require to be more than 20ft. long, the average length being about 15ft., centre poles are used with double bracket-arms 6ft. long, which are mostly in use in the town for this reason. On the side-pole construction the variation from the trolley wire to the centre of the track is in some cases as much as 7ft. 2in., and at a speed of 20 miles an hour the trolley pole will safely follow the wire. The pressure of the wheel on wire is 24lb., and the trolley standard, which is of a neat and reliable design, with internal springs, is arranged so that this pressure is maintained irrespective of the height of trolley head from the ground, which is especially necessary at the Bargate. A section of this standard is shown in Fig. 18, and is made by Messrs. R. W. Blackwell & Co. The overhead equipment at Prospect-place junction can be automatically isolated from the rest of the system, by means of circuit-breakers placed on the first pole of each of the routes, so that if a fault occurs on any of the three routes it is isolated from the other two, the advantage of this being to instantly show the attendant in the power-house which route the fault is on, when the circuit-breakers on the feeders to the faulty route can be again put in so as to blow the fuse in the switch pillars at each end of the half-mile section of the faulty line. By this means it is extremely easy to find a fault on the overhead equipment in Southampton, as the section automatically becomes dead, and the rest of the system is uninterrupted. The question if a combined switch fuse or only a switch should be used in the switch pillars depends upon whether it is necessary to earth to the rails any of the standards carrying the trolley wire. If the standards are not earthed, when an insulator breaks down a leakage current of about 150 amperes will result if the earth is wet, and then, of course, a fuse is not necessary. Switch fuses have been discarded on some systems, through the fuse not being of ample size for working conditions, and in my opinion they

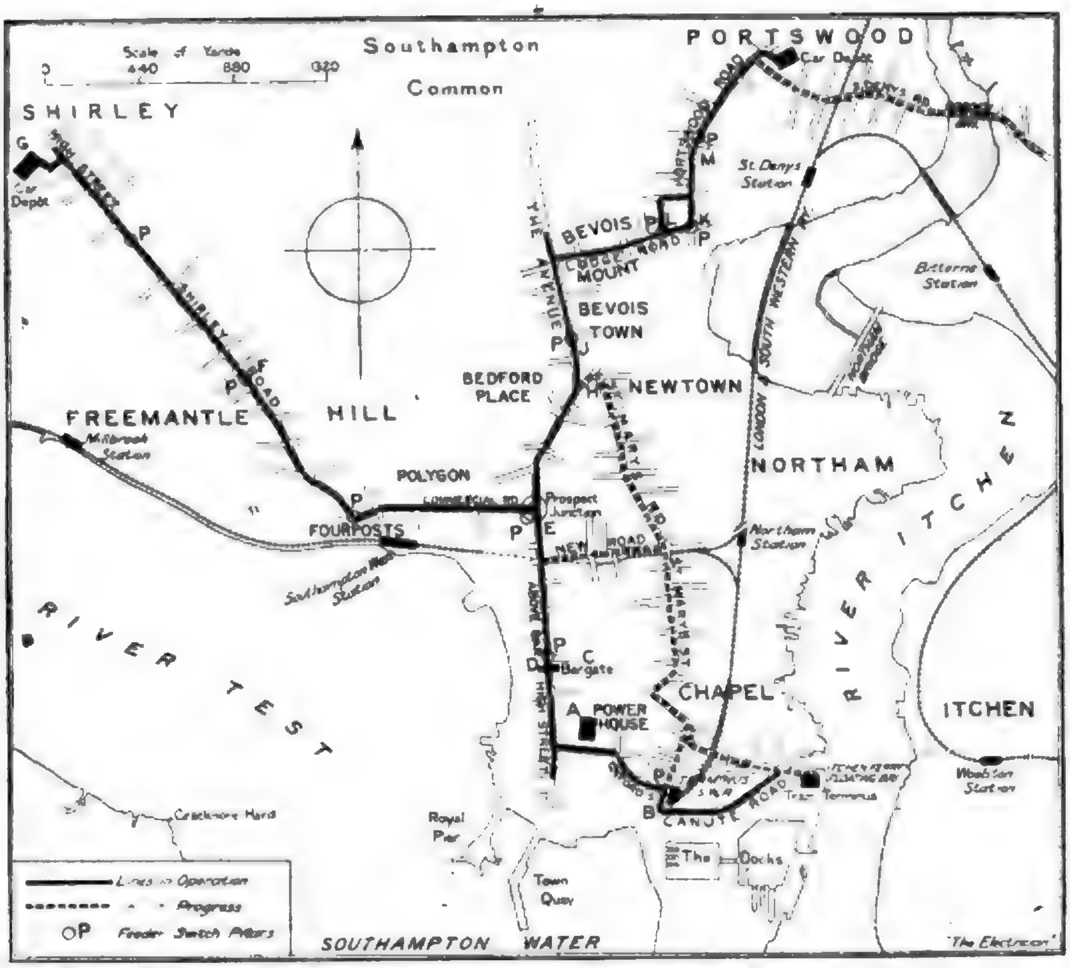


Fig. 10.—Map of the Southampton Electric Tramway System.

**Feeders** No. 1, A to B 0·100 sq. in. No. 2, A to D 0·079 sq. in. No. 3, A to E 0·225 sq. in. No. 4, A to F 0·300 sq. in. No. 5, A to L 0·300 sq. in.
**Pilot and Telephone.** 2-core, C to D, H to J and K to L. 3-core, A to B, E to G and E to M. 4-core, A to E.

can be used with advantage on any system, especially where high-tension arc lamps are used on tramway poles, as in this case the poles must be earthed to the rails. It is a noteworthy fact that if a fuse wire which will blow at 250 amperes is placed in series with a circuit breaker set for 500 amperes, and then a short circuit is made, the circuit breaker will open and the fuse will remain intact, owing to the time of short circuit not being sufficient to melt the fuse wire. If

Fig. 11.—Prospect Place Junction.

Fig. 12.—The Ancient Bargate.

this principle is borne in mind there is no trouble with switch fuses in the feeder pillars. It might be thought that these precautions are unnecessary, but the old idea that a cheap article is good enough has been thrashed out long ago, and it is on this principle that there have been less break-downs on the service in Southampton than in the majority of other towns. The tramway standards are of steel and with a lateral load of 900lb. at the top, the temporary deflection is about 5in. The side standards are set in the ground with a rake of about 4in., and the pull-off poles about 6in. to 7in., this being found sufficient to ensure the standard coming up vertical

Fig. 13.—Section of Enclosed Spring Trolley Standard.

when the strain on the wire is on same. All the standards are fitted with wrought-iron scroll work with an ornamental design. A view of the Bargate (Fig. 12) shows the overhead construction, a single trolley wire being run through the arch, and the height of this from the ground is 14·4ft. An automatic switch is used which causes the wire under the Bargate to be always dead except when an electric car is going through it, this method being adopted to prevent accidents from shock, by persons on the top of high waggons or 'buses. From the plan of the connections, Fig. 11, it will be seen that current to this section is switched on or off by means of a rotary switch, which has a magnet coil giving the necessary motion to the switch, and when a trolley head passes one of the special sectional insulators on either side of the Bargate it gives current to the magnet coil, and so actuates the rotary switch, putting current on to the section. When the trolley head passes the special insulator on the other side, current is again switched off. It should be noted that no current is opened by the rotary switch, so that there is no trouble with the contacts. On the sides of these special section insulators a copper plate of springy material is secured longitudinally, the plates being insulated from one another, one being connected to the 500 volts and the other to the coil which actuates the switch. The fact of the trolley head rubbing on these two plates when passing over one of these special insulators gives current to the coil and so works the rotary switch. It is also interesting to note that it is unnecessary for the drivers to switch off the current to the motors on cars when going over these special section insulators, as when the trolley wheel is on the wooden running piece the current is taken for the motors by the trolley head rubbing against the previously-mentioned side plate, which is fed with 500 volts. These section insulators are now being made for ordinary use with the plates not insulated from one another, but each fed with the tramway current, and they are found particularly useful on hills. The ordinary source of trouble in wear on the insulated running piece is avoided, and the current can be kept on over the section insulator.

A point which must be of interest to a great many readers is whether it is best to adopt the side-running system with a swivelling head, or a centre-running trolley with a fixed head, and there are so many points in favour of the swivelling head that it is certainly the most advantageous system. With a swivelling head there is a much better contact made on the trolley wire as a groove is formed in the trolley wheel which exactly fits nearly half the section of trolley wire, and in the case of a fixed head the wheel only touches the wire in just one point, the groove in the wheel wearing so wide that it is practically flat on the bottom, and as the deterioration of the trolley wire is chiefly due to sparking and not friction, it must mean that the wire will last longer with a swivelling head. Also, the cost of the overhead equipment is much less where span wire construction is necessary with the centre running trolley, besides being more agreeable to the eye.

An automatic switch frog, which has been designed by the writer, is used on all junctions where the electric cars are required to branch off on to the different routes. The usual method which has hitherto been employed to make the trolley follow the right wire, has been effected by means of a cord attached to some movable part of the frog. This had to be worked by either a point boy or the conductor, but in this frog it is done automatically by means of the trolley pole. These automatic frogs are equally well adapted for both the swivel and the fixed head, as the trolley wire can be placed in any position over the track which is immaterial to the working of the frog, and they have been in use in Southampton for the last six months, and are found to work very reliably. They are also in use and are being manufactured for a number of other towns, and when they are used on the overhead equipment to the entrance to car sheds, no trouble is experienced by the pole coming off, a trouble which has been put up with for a long time with the ordinary type of frog.

The insulation of the trolley wire is double throughout, and is of the Dirego pattern, and this insulation has been found very satisfactory and reliable. The whole of the work on the overhead equipment has been carried out by Messrs. Macartney, McElroy & Co.

The contractors for the permanent way on the section from Prospect-place to Shirley, were Messrs. Krauss & Sons, of Bristol, and the other sections were carried out by Mr. F. Osman, of Southampton. The majority of the work is of double track construction, only about an eighth part being of single track. With a gauge of 4ft. 8½in., as in Southampton, double track can be used on any road where the distance from kerb to kerb is not less than 32ft. 9in.; this allows

8ft. 8in. between centres, which is the lowest permissible on account of the clearance necessary for the cars. It also gives 9ft. 6in. from the rail to the kerb on each side. It is necessary to keep the rails not less than 9ft. 6in. from the kerb for any distance over 30ft., otherwise a "frontager" would be created, and the landlord opposite whose property this has been done could have the lines removed, unless it has been

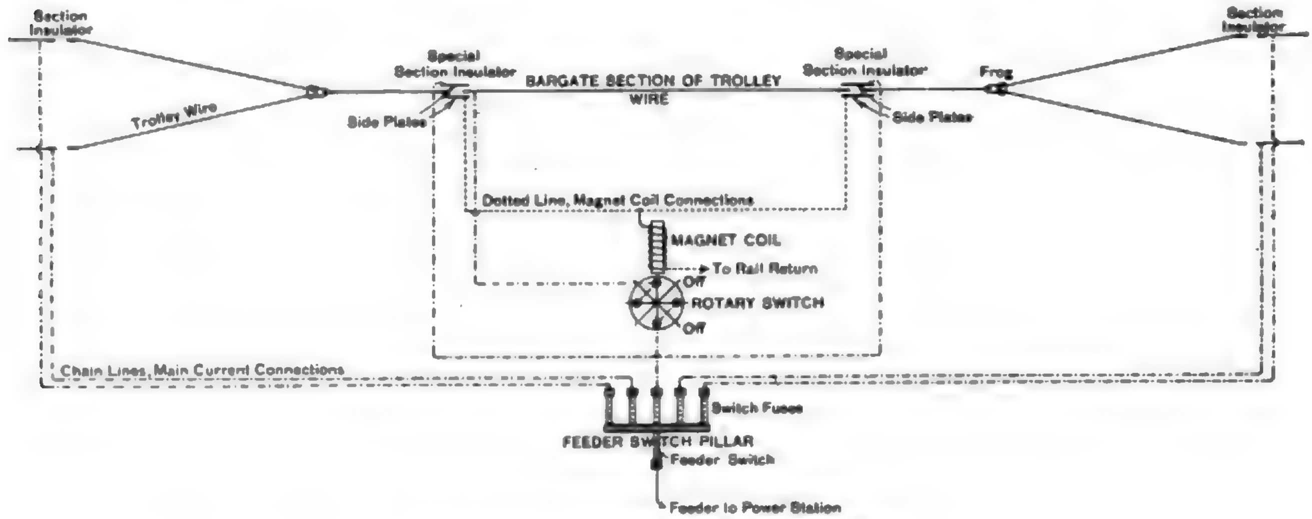


FIG. 14.—DIAGRAM OF CONNECTIONS AT THE BARGATE.

previously passed by the Board of Trade. In places where the road is less than 32ft. 3in., and then only for a short distance of about 20yds., interlacing lines are used, and this does away with the necessity for points, and also gives the

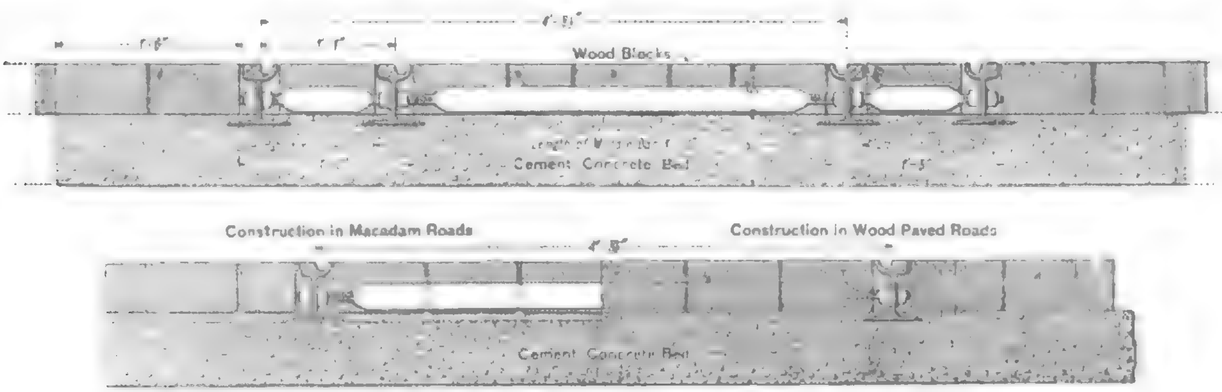


FIG. 15. SECTIONS OF PERMANENT WAY.

9ft. 6in. from rail to kerb. Where centre pole construction is used the track is laid with 10ft. 6in. centres and with side pole 8ft. 8in., but going round curves this is increased to 9ft. 6in. centres. In systems where a gauge of

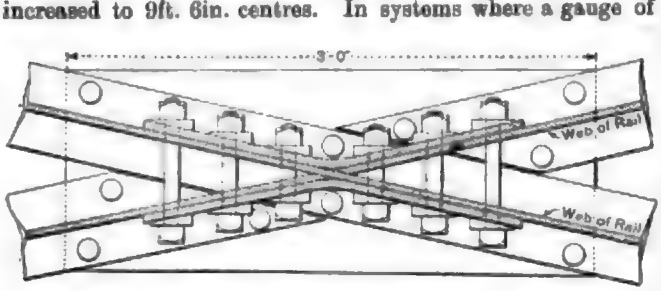


FIG. 16.—TYPE OF CUT CROSSING.

3ft. is adopted the road need only be 30ft. 8in. wide to avoid frontagers when using a double track, but with this narrow gauge the cars are more liable to leave the metals. There are numerous curves at Southampton, the sharpest being 40ft. radius, and no difficulty is experienced going round it with a 5ft. 6in. wheel base. The gauge of the lines round curves of this radius is kept about $\frac{1}{16}$in. tight, which is found to be of great advantage. The steepest gradient is 1 in 17, and the greater portion of the track is fairly flat. A section of the permanent way is shown in Fig. 15, and the rails are laid on a bed of concrete 6in. deep with proportions of four of broken stone, two of clean sharp sand, and one of Portland cement. All the town section is paved with Jarrah wood blocks, and the Shirley and Portswood sections with granite setts 8in. by 5in. by 3in., grouted in with lime. The wood blocks are run in with pitch with $\frac{1}{2}$in. joints. The rails, which were made by the Leeds Steel Works, are steel-grooved girder rails, weighing 86lb. to the yard, and were supplied in 45ft. lengths. The groove in the rail is 1¼in. wide and 1in. deep. It is an important matter not to have the groove less than these dimensions to admit of a sufficiently deep flange on the wheels of the rolling stock, this being a great assistance in preventing the cars from leaving the track.* Two Chicago bonds of 0000 gauge are used at each rail joint. The rails are cross-bonded at every 40yds., with inter-track bonds every 80yds. apart. Crown bonds are used at the points as these are more suitable for bonding with the flange of the point. Spring points are used, of crucible cast steel, manufactured by Messrs. Askham Bros. and Wilson, of Sheffield. At all the junctions, and also on the tracks going into the car-sheds, cut crossings (Fig. 16) are used, which make a much smoother and better job than using cast-steel crossings, where variable angles are required. One of the most important

* The resistance to traction on these rails, taken on one of the Southampton cars up an incline of 1 in 88, was 27·2lbs. per ton, the car attaining a speed of 19·4 miles per hour. When this test was made the rails were dry and sandy, and in wet weather this figure comes out as low as 22lbs. per ton. In going round a curve of 50ft. radius it was 110lbs. per ton.

matters to be considered in laying down a tramway track is to ensure that the levels of the rails are such that when the road is re-macadamised or block paved they will be the most suitable. The levels are often put down as near as possible to that of the old road, which may not be the most desirable. It is really a matter of experience in finding the correct levels, owing to the varying circumstances, but as a general rule the cross fall from the rails in wood paving is ¼in. to the foot, and in macadam road ¾in. to the foot. A swing fall of 4in. is allowed across a double track on curves of about 50ft. radius.

Fig. 17.—Portswood Car Depôt.

There are two car depots, one of which is situated at Portswood (Fig. 17), with accommodation for 26 cars, and the other is at Shirley with room for 12 motor cars and nine trailers. There is a repairing shop at Portswood (Fig. 18) fitted with a full equipment of repairing tools, the lathes, &c., being driven by a 5 h.p. Westinghouse motor. There is also a smaller repair shop at Shirley.

Fig. 18.—Portswood Repair Shop (during construction).

The tramway feeders consists of insulated lead-covered cables, drawn into stoneware ducts, with drawing-in boxes placed about 80 yds. apart. They vary in size from 0·079 sq. in. to 0·3 sq. in. cross section. The high-tension alternating feeders are also drawn into similar ducts, and are lead-covered concentric cables, the longest being 1 sq. in. in section. Test boxes are placed at intervals of every half-mile on the high-tension feeders. The alternating network is for the best part drawn into ducts, but in some cases pitched-in cable is used. There are no fuses on the network, but low-tension fuses are provided in the transformers as well as on the high-tension side. The transformers are placed in pits, and are opened up by means of a cover placed on the footway, House services are connected by breaking into the duct in which the low-tension distribution is drawn, and on this account are also drawn inside; a tee joint box is then connected, and a small brick box with a stone cover is built round the broken duct. All the boxes are filled in with diatrine, except in the test boxes, which are filled in with wax. The continuous current network is mostly bare copper strip carried on porcelain insulators, and has been down since the first supply of current was started in Southampton. Owing to moisture the porcelain insulators are found to rot, which is certainly a disadvantage of this system. The whole of the cables have been supplied, drawn in, and jointed by Messrs. W. T. Glover & Co., and it might be mentioned that diatrine insulation has given good results in Southampton, and there is no doubt that this system of drawing cables into ducts is much more reliable than laying armoured cables into the earth.

Crompton arc lamps are erected on every alternate tramway standard in the town section and every third standard in the Avenue section. These lamps are run from the rectified current circuits, of which there are two, each taken care of by a 50-arc light rectifier. Incandescent lamps are also erected on these standards, which are switched on and off automatically by means of an Edmunds automatic switch fixed in the base of the pole, which is made extra large for this purpose. It might appear that when 50 arc lamps are placed in series there would be a danger of one lamp opening the circuit by the cutout failing to work, but no trouble is experienced in this way. If an earth occurs on two separate lamps on the same circuit it will cut out the intermediate lamps, but switching out one of the faulty lamps will imme-

diately restore the others; this effect is, of course, more marked as the standards are earthed to the rails. A rectified system of arc lamps is only rivalled in towns where five arc lamps are placed in series across a 460-volt continuous supply. Where centre poles are used on the Shirley and Avenue sections two ornamental brackets with 8 c.p. lamps are fixed on each pole, which dispenses with the necessity for oil lighting at the base of the poles.

In conclusion I may state that Sheriff Dunsford is the chairman of the Tramways committee and has rendered valuable assistance in carrying out the work, and he has had the support of the committee in leaving nothing undone to make the tramways a success. Ald. Bone, who is the chairman of the Lighting committee, has also devoted a large amount of time in connection with the work at the electricity station. Mr. F. H. Chaplin is the borough electrical engineer for both the lighting and tramways, and as both systems are rapidly growing he will be kept quite as busy as he has been during the past twelve months. Messrs. Kincaid, Waller and Manville are the engineers for the whole undertaking, to whom my thanks are due as well as to Mr. Chaplin for affording me every opportunity in the preparation of this article.

## SAG AND STRAIN IN TROLLEY-WIRES.

BY B. HOPKINSON.

Some doubt appears to exist as to the tension at which it is permissible to erect trolley-wires. Thus, in his "Electric Traction Pocket Book," Mr. Dawson gives the following table showing the way in which the sag in a copper wire changes with temperature:—

| Temperature (Fahr). | Sag in inches on 125ft. span. |
|---|---|
| 32 | 3·7 |
| 50 | 12 |
| 70 | 17 |
| 90 | 22 |

Mr. Dawson further states that the wire should be so hung that the tension (if it be of No. O.B.& S. gauge) will not, under any temperature likely to occur, exceed 2,000lbs., corresponding to a sag of 3·8in. It follows from the above table that wire put up so that the sag at 50°F. is 12in. will become dangerously tight if the temperature should ever fall below freezing. As a matter of practice, however, wire is now almost always put up tighter than this would imply. Some measurements of recently erected spans on the Leeds City Tramways showed in several cases a sag as small as 8in. on a span of 120ft., the temperature being about 50°F., and tighter spans than this are not uncommon. According to Mr. Dawson's figures, such spans would break or stretch excessively in even a mild frost. Probably those who have to erect trolley-wires do not take account of theory, but haul the wire as tight as a certain number of men pulling on a certain number of blocks and falls can get it. They know roughly from experience how much strain they can put on with safety.

This discrepancy between theory and practice is due, I think, to neglect in the former of the elastic extension of the wire. So far as I can ascertain, the table given above has been calculated on the assumption that the wire is not stretched; from the length of the wire at any one temperature its length at another is obtained simply from the coefficient of expansion, and from the length so obtained and the distance between the supports the sag is calculated. As a fact, of course, the existence of tension implies elastic stretching. The effect of this can easily be seen. Suppose the wire to be an inextensible string whose length varies with the temperature, but instead of fixing the two ends rigidly to the supports include a spiral spring in the span. That spring will be extended by the tension in the wire, and, as the wire shortens on cooling, the spring will extend further so that the total shortening of spring and wire together will be less than that of the wire only. Similarly, if the wire lengthens with increasing temperature, some part of the lengthening will be taken up by contraction in the spring.

Suppose that $2l$ is the distance between the supports, and that $2s$ is the actual length of the wire when hung at a temperature $t$°F above a standard temperature. Let $d$ be the sag and let $2s'$ be the unstretched length of the wire. Let $2s_0$ be the unstretched length at the standard temperature. Then it follows from the properties of the catenary that

$$s/l = 1 + (2d^2/3l^2) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

with sufficient accuracy for present purposes. The elastic extension of the wire is $(s - s')/s'$ and this is proportional to the tension, or to $d$ (the sag). Now $s = s_0(1 + \alpha t)$ where $\alpha$ is the coefficient of linear expansion. Hence $\frac{s}{s_0(1 + \alpha t)} - 1 = \lambda d$ where $\lambda$ is a constant. Or $s - s_0(1 + \alpha t) = \lambda d s_0$ approximately, or from (1)

$$\frac{s_0 \lambda d + s_0(1 + \alpha t)}{l} = 1 + \frac{2d^2}{3l^2}$$

which is the equation connecting the sag and the temperature.

Take the case of a hard-drawn copper wire 0·4in. diameter the supports being 120ft. apart. From some tests on such a wire which Prof. Ewing kindly made for me, it appears that its natural length changes by 0·00085 per cent. per degree Fahrenheit, and that it stretches by very nearly $\frac{1}{2000}$th part of its length for every 1,000lb. of tension up to 8,500lb., when the elasticity begins to become imperfect. The span of wire weighs about 60lb. Thus we get the following table.

| Sag. in. | Tension. lb. | $s/s'$. | $s/l$. | Natural length. ($s'/l$.) | Expnsn. due to temp. ($t$.) | Temp. ($t$.) |
|---|---|---|---|---|---|---|
| 3 | 3,600 | 1·0018 | 1·00001 | 1 – (0·0018) | 0 | 0° |
| 4½ | 2,400 | 1·0012 | 1·00002 | 1 – (0·0012) | 60 | 70 |
| 6 | 1,800 | 1·0009 | 1·00004 | 1 – (0·0009) | 90 | 105° |
| 9 | 1,200 | 1·0006 | 1·00010 | 1 – (0·0005) | 130 | 152° |
| 12 | 900 | 1·00045 | 1·00018 | 1 – (0·00027) | 153 | 180° |
| 18 | 600 | 1·0003 | 1·00041 | 1·00011 | 191 | 220° |

The second column is calculated from the catenary given by the first, and, of course, has nothing to do with the elasticity or temperature of the wire, but depends only on its weight. The third gives the ratio in which the wire is elongated (as compared with its unstretched length at that temperature) in virtue of the tension shown in the second. The fourth is calculated from equation (1) above and gives the stretched length of the wire as compared with the distance between supports. The fifth is the quotient of the third into the fourth or (sufficiently nearly) the difference of the third and fourth plus one; it shows the natural length of the wire at that particular temperature in terms of $l$. The sixth column is the expansion of the wire due to rise of temperature in hundred thousands of its length. The last column is the temperature calculated from the expansion shown in the sixth.

This table shows that wire hung so that the sag on a span of 40 yds. is 6in. at a temperature of 60°F. will never in this country be stretched beyond its limit of elasticity. The tension in it at 25°F. will be 2,400lb. and the sag 4½in. It also reveals the no less important fact that at 107°F. the sag of such a wire will be only 9in. On the other hand, a wire hung so that the sag at 50°F. is 12in. will at 90deg. drop down to 18in.—an excessive amount.

## B.T.H. MOTORS.

We have received from the British Thomson-Houston Co. two pamphlets describing some new types of motors which they are now putting on the market. The first pamphlet deals with their CE type of slow and moderate speed motors, which are built in sizes ranging from 2 H.P. to 10 H.P. for slow speeds, and 3 H.P. to 15 H.P. for moderate speeds. They are especially adapted for direct connection to machinery when the space available is an important consideration. A feature of the motor is that it is symmetrical in form, and can be quickly arranged to run in an upright, inverted or semi-inverted position, so that it can be placed either on the floor, ceiling or wall. Fig. 1 shows one of these motors fixed on a wall. The four-pole construction has been adopted in all sizes down to the 3 H.P. slow-speed motor. The armature core is built up of japanned sheets with the usual air ducts to assist ventilation; the laminations being clamped solidly between two cast-iron spiders extended as flanges to

support the armature coils. The armature body is insulated in the same way as in the company's traction motors. The armature coils are wound on a form, and, after insulation and testing, are placed on the armature core, this plan being found preferable to winding the insulated wire directly on to the core. The coils are embedded in slots punched in the armature discs, and extending over the end flanges, and are bound down with band wires in the usual manner.

The mica insulated commutator and the brush-holders do not differ from those on the company's well-known traction motors. Soft steel of high permeability is employed for the motor frame, which is also the magnet yoke. It is cast in the form of a hollow cylinder, with projecting feet on the outside and seats for the pole-pieces on the inside. The pole-pieces are made of special iron, and are so supported that they can be readily removed from the frame, and the field coils are held in place by the extended tips of the pole-pieces.

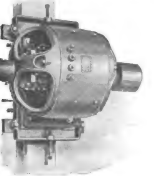


Fig. 1.—CE Motor Installed on Wall.

The bearings are carried by the cast-iron end shields bolted to the frame, and if the motor is to be bolted to the wall or suspended from the ceiling instead of being placed on the floor, these shields are simply turned round. The bearings are lubricated by oil wells, with revolving rings. The liners are of solid gunmetal in one piece, and they rest on the bearings throughout their entire length, being kept from turning by means of dowel screws extended through the bearing castings. The standard motors of this type made by the company are wound as shunt motors for voltages of 115, 230, 400, 440, and 500 volts, and for 200 volts for capacities up to 5 H.P. slow speed and 7½ H.P. moderate speed. Series-wound motors of the same pattern can, of course, be supplied. Two forms are adopted—viz., partially enclosed, as shown in Figs. 1 and 2, and totally enclosed, in which the handholes seen in the illustration are fitted with removable covers.

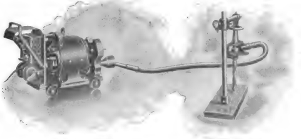


Fig. 2.—CE Motor Driving Drill Through Flexible Shaft.

For many purposes of power application it is convenient to have a gear shaft mounted on the motor itself. For this purpose a motor has been developed, in which the ordinary end shields of the standard CE motor are replaced by special ones carrying bearings in which the secondary shaft revolves. Both the gear and pinion are cut by special machinery, and run together within a gear case. Five standard gear reductions are provided: 3 to 1, 4 to 1, 5 to 1, 6 to 1 and 8 to 1, and these reductions are interchangeable on each size of motor respectively. By rotating the end shields, the position of the shaft relatively to the feet of the motor may be altered, as desired, to be above or below the motor, or to one side or the other.

The standard speeds for which the motors are designed are listed in the pamphlet and vary in the case of the slow speed motors according to the voltage and size of the motor from 1,240 to 635 revs. per min., and in the case of moderate speed motors, the variations are from 1,860 for a 525-volt 4 H.P. or 5 H.P. motor to 975 revs. per min. for a 110-volt motor of 10 H.P. or 15 H.P.

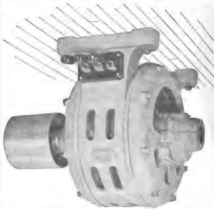


Fig. 3.—Induction Motor mounted in an Inverted Position.

The second pamphlet deals with polyphase induction motors. These are made of single-phase, two-phase and three-phase currents, and for frequeneies of 25, 40 and 60 ∽ per sec. The present pamphlet, however, deals only with two and three-phase motors. The standard sizes for these are for 220 and 440 volts, but, of course, they are manufactured for other voltages if required. These motors can be supplied for slow speeds, the 7½ H.P. running at from 700 to 800 revs. per min., the stator having 4, 6, or 10 poles according to the frequency, and the smaller sizes at correspondingly slower speeds, the 150 H.P. motor being listed at 300 to 360 revs. per min., with 10, 16, or 20 poles according as the frequency is 25, 40, or 60 ∽ per sec. Induction motors for faster speeds are also made of the same pattern, these having fewer poles and being made as small as 1 H.P. All these motors are made in three patterns, K, L and M, these having rotors of different design to suit different purposes for which the motors are intended. The form K has a squirrel-cage rotor in which the conductors are straight copper bars in slots in a laminated core and

joined at the ends by short circuiting rings. With this motor, in all but the smaller sizes, a compensator is employed for starting, which acts like a transformer and reduces the voltage at the terminals of the motor. When the motor attains full speed, the windings of this compensator are disconnected. Motors of this pattern are recommended when the motor is not required to start on heavy loads or where large starting currents will not affect injuriously the voltage regulation of the system. For a combined lighting and power system or in cases where the generator capacity is limited, the L type of motor is to be preferred. In this the rotor has definite or polar windings, the conductors consisting of bars which are first formed and insulated before being laid into the slots of the core. The terminals are connected to a starting resistance mounted within the rotor spider and sliding contacts, actuated by a handle through the hollow shaft, cut out this resistance as the motor gets up to speed. The resistance is usually adjusted so as to give a maximum starting torque at least 50 per cent. greater than the full-load running torque, with a current about 50 per cent. higher than the full-load current. In the third form, M, the rotor winding is similar to the preceding, but the terminals are taken through the hollow shaft to collector rings, and an external rheostat is used. This form is employed for cranes, hoists, pumps, &c., where speed variation is required.

As in the continuous-current motors already described, the bearings are situated in the end shields so that the motor can be used on a wall or inverted, simply by turning these shields through 90deg. or 180deg. Fig. 3 shows one of these induction motors mounted in an inverted position.

## THE CASE FOR ELECTRIC POWER DISTRIBUTION.*

BY W. B. ESSON, M.I.C.E., M.I.E.E.

(*Concluded from page 464.*)

The law governing the steam consumption of the engine now demands attention. How is the steam consumption influenced by the load on the engine, and what is the cost of steam per I.H.P. at various loads? The law connecting the steam consumption with the load has been investigated by several engineers, notably by the late Mr. Willans, who made many interesting and valuable experiments on the subject. Mr. Willans found that in an engine running at a uniform speed and with constant ratio of expansion, the total steam consumption might be expressed with remarkable accuracy in the form $= a + b$ I.H.P. where $a$ and $b$ are constants depending on the construction of the engine. This means that the steam used in the engine is made up of two quantities, one of which is constant and independent of the work being done, the other of which is proportional to the I.H.P. For engines which have a variable ratio of expansion, the law is somewhat different, but it will be sufficient for our purpose to assume that in the engine we have chosen the steam consumption follows the above stated simple law, and the argument is not altered thereby. Taking 20lbs. per I.H.P. per hour as the full-load consumption of steam for working a non-condensing compound engine, and 17lbs. for the same engine condensing; the diagram Fig. 5 shows the results obtained from an engine of 150 I.H.P. Abscissæ give the I.H.P., while ordinates represent the total steam consumption per hour. The line AB gives the results for condensing, and the line CD for those non-condensing. It will be observed from the diagram that the water taken by the engine when doing no work but simply running round at full speed and overcoming its own friction, is, in the case of the non-condensing engine, no less than one-third of the steam it requires for running under full power, while in the case of the condensing engine it is rather over 20 per cent. The figures are from actual practice, so you need not worry about their accuracy. In consequence of there being a certain quantity of steam which is independent of the load, the consumption per I.H.P. increases greatly at light loads in non-condensing engines and less so in condensing engines, consequently the saving in fuel is not, as has been so often assumed, proportional to the saving in I.H.P.

At this stage we may fitly make inquiry as to the capital outlay required for a scheme of electric power distribution. It need scarcely be said that this depends entirely upon the amount of the power and the character of the area over which it is to be distributed. The extent of the works and the number and size of units into which the power is to be divided have all to be considered, so that dealing with general principles my only course is to adopt for the sake of argument a fair average and leave it to you engineers to make the necessary correction for each individual case which comes before you. The cost of generators per H.P. varies with their size and the same holds for motors, the price of the latter running from £5 per H.P. for 50 H.P. sizes to as much as £15 per H.P. for sizes of 3 H.P. For every H.P. delivered at the motor shafts we have to furnish by the generator 1·2 H.P. and as regards the conducting system the cost of this depends upon the extent of the premises and whether the power is delivered in large or small lots. I am going to assume that taken all round the capital expenditure, including generator, switchboard, conductors, motors, and fixing will amount to £20 per H.P. of motors installed, this being in my opinion a fair average. For the moment I am not counting as part of the expenditure, on account of electrical distribution, the cost of the engine, as we require an engine in any case whether we distribute its power mechanically or electrically. If it becomes necessary to consider the cost of the engine it may be taken to be £3. 10s. per I.H.P.

Now if it is difficult to strike an average for the cost of an electric distribution plant, it is still more difficult to get a reliable average of cost for shafting and belting. The figure I give for this must be considered as subject to great variation. It is taken at £5 per H.P. installed. The depreciation in belting we know to be extremely

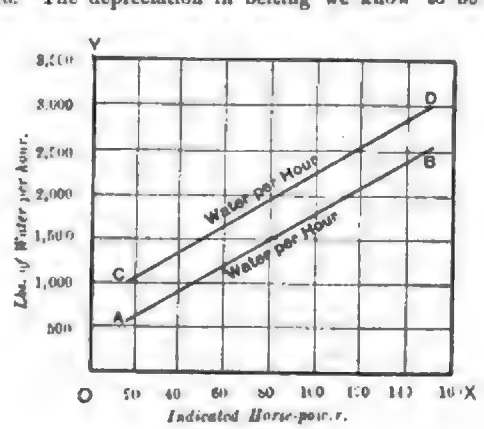


FIG. 5.

high, and for the purpose of this argument I shall assume that the all-round depreciation on the plant required for mechanical distribution, including belts or ropes, may be taken at 15 per cent. That on the plant for electrical distribution may be fairly taken at 5 per cent. Allowing interest at 5 per cent., there requires to be set aside annually, to meet interest and depreciation, for electrical distribution £2 per H.P. installed, and for mechanical distribution £1 per H.P. installed. To make the adoption of electric distribution worth while, then, there must be shown a direct or indirect annual gain in its favour of £1 per H.P., being the difference between those two amounts.

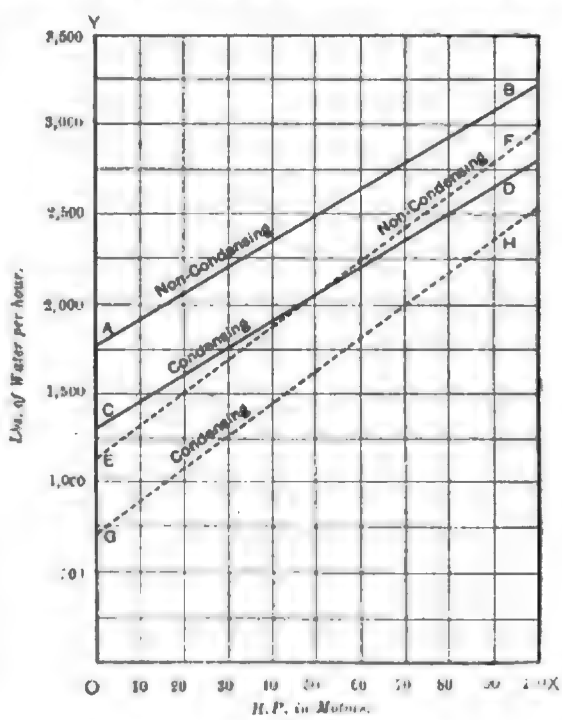


FIG. 6.

We have now got together such data as are available for our purpose of comparing from the economic point of view the different systems of distributing power. Combining Figs. 4 and 5, there is shown in Fig. 6 the total steam consumption in the engine both for mechanical and electrical distribution, and it is upon the results here represented that we shall base our estimates of the fuel cost. I shall take it that the motors installed aggregate 100 H.P., and that we use for driving the generator the 150 I.H.P. engine, for which has been

* Paper read before the Civil and Mechanical Engineers' Society.

given in Fig. 5 the steam consumption. Abscissæ represent the H.P. obtained from the motors and ordinates the steam. The full lines AB and CD represent the consumption per hour for mechanical distribution non-condensing and condensing respectively, while the dotted lines EF and GH represent the consumption for electrical distribution. Now it will be seen that electrical driving has everywhere the advantage over driving by shafting and belting. This saving increases as the power is reduced, so the question arises in getting out our comparison of costs, what proportion of load should we assume to represent the conditions of actual working. Suppose we say that 80 per cent. of the machines run simultaneously, then we save about 10 per cent. of the steam by adopting electric driving, but when running at very light loads—working overtime, for instance—we may, as shown by the diagram, save over 25 per cent. Possibly, if we assume that the load throughout the year averages three-quarters of the full load, we shall not be very far out. On this basis, by employing electrical instead of belt driving it will be seen that we save 13 per cent. in steam. Note that though the saving in power at quarter load is 38 per cent., the saving in fuel is, due to the law of the steam engine, only about 24 per cent.

The cash value of this saving depends upon the price of fuel, having regard to its thermal value. This varies in every district; at the pit's mouth it is low, in the London district it is high. You would, of course, be able from the circumstances to assign the proper value in each case, but for the purpose of the present argument we shall assume that every 100lb. of steam raised costs 1d., this corresponding to a value for coal of about 18s. per ton. Now, on reference to the diagram, Fig. 6, it will be seen that driving electrically at three-quarters load we save 375lb. of water every hour we run. According to the price assumed this is equal in money to 3¾d. per hour, and for 3,000 hours per annum, which allows for some overtime, we get a saving of £46. 17s. 6d. due to electric driving. Note that provided a similar engine is used for electric and belt driving the saving is no greater in a condensing than in a non-condensing engine. From the diagram, Fig. 5, it will be seen that the addition to the steam consumption is per I.H.P. the same for condensing as for non-condensing, though on account of the quantity of steam which is independent of the I.H.P. being in the former case less, the total consumption for a condensing engine of given size is correspondingly diminished. By electric driving, however, we simply reduce the I.H.P., and as the steam to be subtracted for a given reduction of power is the same both for condensing and non-condensing, the fuel saving is not in the least influenced.

It appears then that taking this case of mere substitution of electric for belt driving there is not a large saving in the direction of fuel consumption to be expected. With regard to the belt driving the assumption was made that friction, including that of the engine, accounted for 40 per cent. of the I.H.P., but it must be remembered that though this is a fair average, on occasions friction runs away with as much as 80 per cent., while in some cases only 20 per cent. is lost, and the only way therefore to get at the real waste is to treat specially each particular problem that turns up. It will be readily understood that the balance may, according to circumstances, lie with either method of distribution; it depends largely on the area over which the power is spread.

Again, the saving depends, as we have seen, on the average load. If it is necessary to work a good deal of overtime when only a few of the machines scattered about the various parts of the works have to run, the saving is increased; on the other hand, if full load is the rule, and partial load or overtime the exception, the saving is not so great. Further, in the case considered, the assumption is made that in adopting electric distribution *all* the shafting and belting is dispensed with. This, however, is not at all likely, and the question is, even with the best arrangements made for electric distribution: What proportion of shafting and belting is it necessary to retain? Proposals have come before me which admitted of the shafting being reduced to a negligible quantity; but there are cases, on the other hand, where the shafting and belting could not be appreciably reduced by the introduction of motors. One example comes forcibly to my recollection—that of a cotton mill, in India. It was proposed to drive this electrically, but the mill was all on one floor, and the machinery was so compactly and symmetrically arranged that no point could be found in the distributive system where the introduction of motors would save in friction anything worth speaking of. So far as fuel consumption goes, this is the crux of the matter. Wherever we put in a motor, in the nature of things we lose at once, and between the motor terminals and its shaft, 10 per cent. to 15 per cent. of the power we have delivered to that point. If we continue with shafting and belting we save this loss, and the question, therefore, is: Do we gain by employing electrical distribution up to that point such an advantage over distribution by shafting as will justify us in dropping that 10 per cent. or 15 per cent.? Undoubtedly we do often, but it was not so in the cotton mill referred to. And, from another point of view, this kind of case is the worst for electric driving, as a mill generally runs at full load or is stopped altogether. When slack, half or three-quarter time is worked as the case may be, but they mostly work full load whilst they are at it. Here it may be mentioned that on the Continent, where cheap electrical power is purchased for manufacturing purposes it is customary for such power to be distributed by shafting and belting. A few motors are installed to drive different sections of the works, just as steam engines might be installed, but it is unusual to employ separate motors for individual machines. In America the same holds good. In textile factories either one large motor or a number of smaller ones are installed, say, from 50 H.P. to 130 H.P., as in a cotton mill lately set to work in Carolina. Again, in engineering works it is usual where the machine tools require less than 4 H.P. each to group them on short lines of shafting, each section taking about 24 H.P.

Lastly, there is, of course, the cost of fuel influencing the saving. If the fuel costs per ton less than I have assumed, always having regard to its thermal value, the saving will be less, if it costs more the saving will be greater. Once I was asked to advise a company as to the advantage which might be expected from doing away with the large engines driving different sections of their works, centralising the boiler and engine plant and distributing the power everywhere electrically. As it turned out that the fuel used consisted chiefly of shavings and sawdust, which cost nothing, the conversion would have been, considered from the fuel point of view, the maddest folly; but, as we shall see later, there are other matters to be taken into account besides fuel, and it is just possible that in cases apparently unpromising a consideration of these may sometimes turn the scale. In the meanwhile remember that upon these three factors the saving in fuel depends—they are, the average load, the amount of shafting and belting which can be displaced, and the cost of fuel, and it is necessary to give these their proper value for each case that arises.

Turning to the replacing of small engines by electric driving, there is here no question as to fuel economy. In works divided into sections of considerable size, each driven by a high-class compound engine, it is no doubt more economical, if the distances are not excessive, to distribute steam through carefully lagged pipes than to adopt electricity and substitute for these engines electric motors, but in the case of small steam engines the results all point the other way. From the diagram, Fig. 6, it will be seen that for 75 H.P. delivered, we use about 2,500lb. of steam per hour for electric driving working non-condensing, and it is safe to predict that if this power were given by five single cylinder engines of 15 B.H.P. each, the consumption would not be less than 4,500lb. of steam per hour. This means 2,000lb. excess of steam for every hour worked, or, on the basis we have taken, an expenditure of 1s. 8d., amounting for a year of 3,000 hours to £250. If it were possible to work the generator engine condensing the saving would be £300 per annum. The electrical equipment certainly costs more than the steam equipment, but taking fuel at the price we have assumed it would pay in an existing works to put in an electric plant complete and sell the engines as old iron.

But if this saving can be shown by displacing engines which cannot be considered very bad as things go, what shall be said of the saving effected by displacing the rattletrap engines spoken of in the beginning of this Paper. The waste of steam is here enormous, and if the power were furnished, not by engines of 15 H.P., but by engines of from 2½ H.P. to 5 H.P., running under usual conditions, the water used would be not less than 8,500lbs. per hour. This means that electrical distribution would result in a saving of 5s. for every hour run, and for 3,000 hours this amounts to no less than £750 per annum. This is for fuel, and does not take into account the reduced wear and tear of boilers due to only one-third of the number being required for steam raising. In such cases if the cost of coal were only one-third of what we have assumed it would pay to electrically distribute the power and throw the engines on the scrap heap.

Hitherto we have dealt only with the question of fuel, but there is also the matter of attendance to be considered, and in my opinion electric motors require less attendance than do shafting and belting, even if the latter are looked after properly. But the fact is that while motors are generally under the supervision of an intelligent person, shafting and belting are too often left to the mercies of people who have been in no way trained to think, and consequent on the services of an electrician being sometimes enlisted, it has been thought that the cost of attendance on electric plant must be considerably more than on shafting and belting plant. This is by no means the case, for as there is no machine to compare in mechanical simplicity with an electric motor; it requires very little attention, and the greater part of the belt mending being dispensed with there is, I think, in the matter of attendance, a clear gain for electric distribution. Where electric motors are substituted for small engines, however, there is no question as to the saving in the matter of attendance. The wearing parts of an engine are many, whereas in motors these are reduced to two bearings, and by making them substantial, and providing them with automatic lubrication, their wear may be rendered excessively small. Electric conductors properly insulated will last for many years without the least attention, but this can scarcely be

said of a range of steam pipes erected in the open, and subject to contraction and expansion. There are joints to make and keep right, there are also glands to pack in the engines and working joints to be constantly taken up if such poor efficiency as is possible to the system is to be maintained. But, and this is the melancholy truth, the attention is not given, and for the simple reason that the engines will work without it. Let steam blow from the pipe joints, let the engine piston leak, let water stream through all the glands and still the engine will work. That is the mischief of it. If an engine refused to work with either of these defects it would have to be kept in order and minimum waste would be thus ensured. But it continues to run with all its faults and an enormous coal bill bears witness to its inefficiency and to the fact that because it will run anyhow it does not get the attention that it ought to.

Now it is different with electric motors. These require considerably less attention than engines *should* get and very much less attention than they *do* get, but they insist that the little attention which is required shall be given to them. They must be kept clean and dry, and when we have said this we have said all, as good motors will, working under these conditions, run for an indefinite period without giving trouble. If these conditions are not fulfilled a breakdown is likely to result, with consequent stoppage, for a motor will not run having a defect which renders it inefficient. They run, therefore, at their proper efficiency or not at all; they do not with the lapse of time eat electricity, as engines eat steam; they need but little looking after, and the nature of the attention required is such that everything under this heading can be carried out systematically and at small cost. By keeping an eye on the current indicators we can always tell what is going on in an electric system; but working with small steam engines, there is nothing to indicate when the steam consumption becomes abnormal. Again, the boilers are generally dotted about the works—a couple here, a couple elsewhere, and so on. By centralising the boiler plant we can with electric distribution effect further economies in the attendance, and further reduce losses; whilst, needless to add, there is in electric conductors no waste analogous to that due to condensation in steam pipes, which goes on whether the engines are running or not.

Hitherto we have dealt with direct savings in fuel and attendance, and these appeal principally when proposals are before us for electric installations in existing works. When laying out new works the object, of course, is to adjust exactly the means to the end—that is, to arrange everything so that the particular articles manufactured shall be produced in the best quality at the lowest cost and with the greatest expedition. Now, when shafting was the only means at our disposal for distributing the power the machines had to be located with regard to the most convenient arrangement of driving, and in many instances the position which best suited the shafting did not agree with the position of greatest suitability for the work to be done. With electrical driving it is altogether different; shafting cannot be made to turn corners without cumbrous and noisy gear, but electric conductors can be led anywhere without trouble; while with belt driving, machines must be installed with special regard to the run of the shafting, electric driving places no restrictions as to the position of the machines, and they can be placed with regard only to economy in production. It is conceivable that the advantages secured by electricity under this heading may in many instances be so great as to dwarf the direct savings of which I have already spoken, and this is what was in my mind when I remarked a few minutes ago that fuel was not the only thing to be considered. Quite apart from any saving of labour in the attendance on the distribution plant, we secure the economy of labour in production which results from our being able to place our machines in the positions best suited to secure continuity in the treatment of the raw material, and this is a very great advantage. Again, as regards the cost of plant, having no time-worn machinery to displace, we have not to make for new works any sacrifices of capital. The result of all this, is an increased output proportionally to the capital outlay in machinery, while better lighting of the shops due to the absence of overhead shafting and the greater cleanliness resulting, undoubtedly makes for the same end. He would indeed be behind the times who would think of laying out new works without taking seriously into consideration the advisability of distributing the power by electricity instead of by the ancient method of shafting and belting. It is not contended that increased output will necessarily follow a displacement of small steam engines by electric motors, as here the economies are chiefly in the direction of diminished coal bills and less labour in attendance. In displacing shafting and belting, however, where the saving in the coal bill and attendance is not so marked, we have to look to the increased output as constituting one of the chief advantages.

Whenever electric motors have displaced small steam engines, large savings have resulted, and cases have been known where the whole cost of the electrical plant has been returned in one year as saving in fuel and wages. In dyeing, bleaching, calico printing and paper works, in sugar refineries, in saw-mills, in iron and steel works, in shipbuilding and bridge-building yards and boiler shops, the electric motor has pushed the steam engine out to the great advantage of the producer. As applied to haulage and pumping in mines and collieries electricity has proved invaluable. For driving live rolls, bending rolls, punching machines, shears, portable drills, and the other tools about an iron works, the electric motor is by far the most efficient appliance, while for working cranes, hoists, elevators, turntables, fans, pumps, and performing the like functions, it has no equal. When once an installation is put in it takes very little time to appreciate the possibilities of electricity. Beginning possibly with a small electric light installation, in the course of time two or three motors are requisitioned to drive out-of-the-way machines, by-and-bye more motors are added, and so the development goes on until it is determined to adopt electricity wholesale for driving the machinery. This is history which has repeated itself over and over again.

Electricity, moreover, stimulates expansion on account of the extreme flexibility of the electrical system When a new machine can be planted down anywhere without reference to existing drives it is a very different matter to having to consider how the shafting can be extended, how it can be carried from building to building, whether walls are strong enough to support it, or how steam is to be led to the spot. In this matter of convenience there is really no comparison possible between the electrical and other methods of power distribution, the facility with which electric conductors can be extended and led in any desired direction, and the extreme simplicity of the electric motor placing it far and away beyond rivalry.

Again, not only does electricity save money because it provides us with a better method of distributing power, but consequent upon its having been recognised by the mechanical engineer as a trustworthy agent always available for his use, he has been led to devise entirely new ways of doing things by which the cost of production has been greatly lessened. I need only cite the economies, which, due to the use of electricity, can be derived from the utilisation of blast-furnace gases. The gas is burnt in gas engines, or under boilers for steam engines, the engines driving electric generators from which power is distributed electrically to motors placed all over the works. Such a plant has been running at the rail mills of the North-Eastern Steel Company, of Middlesbrough, for some time now. Steam is generated in gas-fired boilers to supply horizontal compound-condensing engines, having two-phase generators directly mounted on their crank shafts. Part of the current is used at the iron works to drive the motors for working the ram and charger for the coke ovens, with the disintegrator, elevators, and other accessories of the coking plant, and part is transmitted through overhead conductors to the steel works, there to be distributed among motors driving the mechanics' shops, the travelling cranes, saws, rail straighteners, and pumps, and put to all the various uses which can be found for motors in an up-to-date rail mill.

The mechanical engineer should be as keenly alive to the advantages gained by electric distribution as he is to the advantages gained under different circumstances by hydraulic distribution or compressed air. This does not mean that he should be able to design either electric, hydraulic or pneumatic machinery, which is properly left in the hands of competent experts, but he should be thoroughly conversant with the possibilities of all the appliances from which he has to choose. We should say that the engineer who did not know how a steam or gas engine or water motor acted was ignorant of his business—in fact, we should not call him an engineer at all—and no engineer can be considered of the twentieth century who does not possess some notion of magnetic fields and the generation of electric currents. I want to emphasise this because I think that the application of electricity would have gone ahead more if engineers had taken more trouble to understand it, and it is certainly their business as I have said to be familiar with the nature of the tools they have to work with. There is nothing particularly subtle about the construction of an electric generator, and engineers should be as familiar with electric conductors as with steam or water pipes; though they are wrapped in rubber there is no reason why they should be wrapped in mystery.

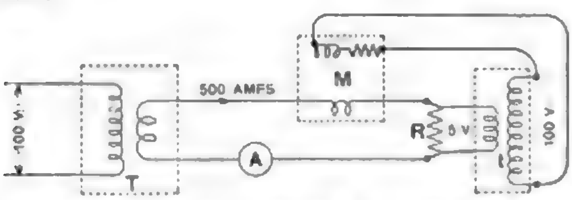
In concluding this Paper I would remind you that I have by no means exhausted the subject, on the contrary, I have been obliged to confine myself to a general treatment, leaving members themselves to fill in the details applicable to each particular case. For the purposes of the argument it has been necessary to make an assumption here and a supposition there, and to adopt hypothetical values elsewhere, but an honest endeavour has been made throughout to present the case fairly. It is nothing to us what vehicle be employed for the achievement of our ends, we have to select the best, but beyond doubt there is an extremely strong case for adopting electricity for the distribution of power in the great majority of industrial operations, and often when, as in many instances, it involves the scrapping of existing plant. I have in this Paper assumed that the aggregate H.P. of the motors installed is equal to the power which the generator can supply. As we have taken the average running load of the motors to be three-quarters of the power installed, obviously the generator would do smaller, but having regard to the temporary loads due to electric cranes, turntables, hoists, &c., we

may as well let the relative proportions stand, as the aggregate capacity of the motors to the capacity of the generator depends entirely upon the nature of the business carried on. In no case need the generator be larger than we have assumed, and if it is too large the difference is against electric distribution both as regards capital outlay and running charges. We are, therefore, on the safe side. And so I bring this somewhat sketchy contribution to a close. If in calling your attention to the great field which is opening up to the engineer in the electrical distribution of power I have been fortunate enough to interest you, I am very well satisfied.

## NOTE ON OBTAINING ALTERNATING CURRENTS AND VOLTAGES IN THE SAME PHASE FOR FICTITIOUS LOADS.*

BY ALBERT CAMPBELL, B.A.

When testing instruments for the measurement of large amounts of electrical power or energy, it is usually desirable to do so by means of fictitious loads, *i.e.*, by applying to the instrument under test current and P.D. representing the required load, but not actually producing the load. The result is easily achieved in the case of direct currents, for the current may be taken from a few large cells, while the voltage may be obtained (with a small current) from a quite separate battery. But with alternating current, to obtain a fictitious non-inductive load, the current and P.D. must be in phase with one another, although they do not belong to the same part of the circuit. I have found the following arrangement convenient for this purpose. Suppose the fictitious load required is 500 amperes at 100 volts.



In the figure, T is a transformer with its primary on 100 volts, its secondary giving out 500 amperes at 5 volts or 6 volts.

Connected in series on the secondary circuit are the series coil of the instrument under test, an ammeter, A, and a non-inductive resistance, R, to take 500 amperes at about 5 volts. Across suitable points of this resistance is connected the low-pressure coil of a closed iron-circuit transformer, *t*, of ratio 1 : 20, such as is commonly used for transforming, say, 1 kw. from 100 volts to 2,000 volts. The high-pressure coil of this transformer furnishes the P.D. (100 volts) required for the shunt coil of the instrument. It will be found that this P.D. is practically in phase with the current of 500 amperes.

## ELECTRICITY WORKS ACCOUNTS.

### Harrogate Municipal Electric Supply Works.

This undertaking made excellent progress in the year ended at March 25th last. A general and substantial reduction in the costs was effected, with the result that the several items stood at very satisfactory values. The collective management and property charges at 0·38d. per unit are especially commendable. The fuel item, though still somewhat high at 0·88d. per unit, can hardly be taken exception to in view of the prices ruling in the coal trade.

During the period the output made the surprising advance of over 81 per cent., and the lamp connections rose by nearly 80 per cent. A slight improvement also took place in the load factor, which was 12 per cent.

Having regard to the moderate total revenue of 4·3d. per unit from all sources, the financial results for the year were very creditable, a surplus of £777 having been cleared after paying capital charges amounting to a total of 5·19 per cent. on the mean capital. This surplus was applied to the reduction of the £2,251 deficit from preceding years.

### St. Helens Municipal Electric Supply Works.

The accounts, to March 31 last, of this undertaking show a much improved state of affairs. During that year 94 additional consumers raised the total lamp connections by no less than 116 per cent. The year's output at 320,106 units sold was nearly five times that of 1898-9. Thanks to the existence of the tramways as a customer, 182,076 units, or nearly 57 per cent. of the total output sold was supplied for traction. The public lighting supply represented 7·8 per cent. of the total output. With a load thus constituted it is rather surprising at first sight that the average load factor was not higher than 8·9 per cent. The low value is due to the very rapid growth of the rate of supply during the year. For instance, the units sold in June, 1899, were 2,065 for lighting, there being none supplied for traction. In the next month (July) the supply for lighting was 2,228 units, and for traction 6,794 units. In the last month of the period covered by the accounts—viz., March, 1900—15,870 units were sold for lighting, and 25,427 units for traction. From the table given below may be derived an idea of the growth of the business during the last three years.

The advantageous change in the conditions of supply has been fully taken advantage of, with the result that in all the costs a great alteration for the better has taken place. All the items of works costs have fallen to values considerably below the average under similar conditions. Exception has to be taken to the management and property charges; these, although much reduced, are still rather too high. However, the total costs exhibit an excellent figure, and with the moderate average total revenue of 3·78d. per unit, a balance to the good has, for the first time, been obtained.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

Aberdeen (Municipal) ...... Oct. 12, 1900
Ayr (Municipal) ...... Nov. 2, 1900
Bath (Municipal) ...... April 20, 1900
Bedford (Municipal) ...... Aug. 3, 1900
Belfast (Municipal) ...... July 6, 1900
Birmingham (Company) ...... Sept. 15, 1899
Blackburn (Municipal) ...... Jan. 19, 1900
Blackpool (Municipal) ...... Oct. 5, 1900
Bournemouth (Company) .. Sept. 7, 1900
Bolton (Municipal) ...... Nov. 30, 1900
Bradford (Municipal) ...... June 22, 1900
Brighton (Municipal) ...... May 4, 1900
Bristol (Municipal) ...... Aug. 24, 1900
Bromley (Kent) (Co.) ...... June 15, 1900
Brompton & Kensington (Co.) Mar. 23, 1900
Burnley (Municipal) ...... Nov. 30, 1900
Burton-upon-Trent (Mun.) April 21, 1899
Bury (Municipal) ...... Sept. 28, 1900
Cambridge (Company) ...... April 13, 1900
Canterbury (Municipal) .... Oct. 26, 1900
Cardiff (Municipal) ...... Jan. 11, 1901
Charing Cross (Company) .. Mar. 9, 1900
Chelsea (London) (Co.) ...... Mar. 23, 1900
Cheltenham (Municipal) .... Nov. 10, 1899
Chester (Municipal) ...... Aug. 3 1900
City of London (Company) .. June 15, 1900
Clerkenwell (Company) .... May 18, 1900
Coventry (Municipal) ...... Feb. 23, 1900
Croydon (Municipal) ...... July 20, 1900
Derby (Municipal) ...... Jan. 26, 1900
Dewsbury (Municipal) ...... Nov. 24, 1899
Dover (Company) ...... April 27, 1900
Dundee (Municipal) ...... Nov. 2, 1900
Eastbourne (Company) ... May 4, 1900
Edinburgh (Municipal) ... Dec. 7, 1900
Exeter (Municipal) ...... Aug. 5, 1898
Folkestone (Company) .... April 27, 1900
Glasgow (Municipal) ...... Sept. 14, 1900
Guildford (Company) ...... Oct. 19, 1900
Halifax (Municipal) ...... Sept. 21, 1900
Hammersmith (Vestry) ... June 29, 1900
Hampstead (Vestry) ...... Oct. 19, 1900
Hanley (Municipal) ...... July 27, 1900
Harrogate (Municipal) ... Oct. 20, 1899
Harrow (Company) ...... Dec. 21, 1900
Hast'gs & St. Leonards (Mun.) Sept. 7, 1900
Hove (Company) ...... July 6, 1900
Huddersfield (Municipal) ... Aug. 17, 1900
Islington (Vestry) ...... Nov. 23, 1900
Kensi'gton & Knightsbr'(Co.) Mar. 16, 1900
Kingston-upon-Hull (Mun.) July 13, 1900
Kingston-on-Thames (Mun.) July 20, 1900
Lancaster (Municipal) ...... Jan. 19, 1900
Leeds (Municipal) ...... Dec. 7, 1900
Leicester (Municipal) ...... Jan. 26, 1900
Leyton (Municipal) ...... Jan. 18, 1901
Liverpool (Municipal) ...... June 22, 1900
London (Company) ...... June 8, 1900
Londonderry (Municipal) .. Feb. 16, 1900
Manchester (Municipal) .... Sept. 14, 1900
Newcastle and District (Co.) Oct. 6, 1899
Newcastle-upon-Tyne (Co.) Dec. 14, 1900
Newport (Mon.) (Municipal) Jan. 11, 1901
Northampton (Company) .. Oct. 20, 1899
Norwich (Company) ...... Dec. 28, 1900
Notting Hill (Company) ... Mar. 16, 1900
Nottingham (Municipal) .. Sept. 21, 1900
Oldham (Municipal) ...... Dec. 1, 1899
Oxford (Company) ...... April 13, 1900
Pontypool (Company) ...... Sept. 28, 1900
Portsmouth (Municipal) .... Aug. 24, 1900
Prescot (Company) ...... Dec. 8, 1899
Preston (Company) ...... Dec. 11, 1900
Reading (Company) ...... Dec. 21, 1900
Richmond (Company) ...... June 29, 1900
Salford (Municipal) ...... Feb. 23, 1900
Scarborough (Company) .... July 13, 1900
St. Helens (Municipal) .. Dec. 8, 1899
St. James' & Pall Mall (Co.) .. Feb. 16, 1900
St. Pancras (Vestry) ...... June 8, 1900
Sheffield (Municipal) ...... Dec. 29, 1899
Shoreditch (Vestry) ...... Nov. 23, 1900
Southampton (Municipal) .. Nov. 10, 1899
Southport (Municipal) ...... July 7, 1899
South Shields (Municipal) .. Nov. 9, 1900
Stafford (Municipal) ...... Aug. 17, 1900
Sunderland (Municipal) .... Nov. 9, 1900
Taunton (Municipal) ...... June 16, 1899
Tunbridge Wells (Mun.) .. Jan. 18, 1901
Wakefield (Municipal) .... Dec. 1, 1899
Walsall (Municipal) ...... June 23, 1899
Wandsworth (Company) ... May 18, 1900
Westminster (Company) ... Mar. 9, 1900
Whitehaven (Municipal) .. July 28, 1899
Winchester (Company) .... Oct. 26, 1900
Windsor (Company) ...... Dec. 22, 1899
Woking (Company) ...... Dec. 22, 1899
Wolverhampton (Municipal) July 27, 1900
Woolwich (Company) ...... Jan. 13, 1899
Worcester (Municipal) ... April 20, 1900
Great Yarmouth (Mun.) .... Dec. 21, 1900

| | 1898. | | | | | 1899. | | | | | 1900. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan. to March. | April to June. | July to Sept. | Oct. to Dec. | Total. | Jan. to March. | April to June. | July to Sept. | Oct. to Dec. | Total. | Jan. to Mar. | April to June. | July to Sept. | Oct. to Dec. | Total. |
| Units sold for lighting | 14,030 | 6,711 | 7,049 | 27,102 | 54,892 | 24,228 | 9,552 | 13,030 | 44,223 | 91,033 | 46,364 | 25,912 | 29,857 | 76,574 | 178,737 |
| Ditto motors. | — | — | — | — | — | — | — | 971 | 3,665 | 4,636 | 20,225 | 21,678 | 23,985 | 26,385 | 92,277 |
| Ditto traction | — | — | — | — | — | — | — | 45,892 | 64,864 | 110,756 | 71,320 | 118,407 | 132,041 | 167,633 | 489,401 |
| Total units sold ........ | 14,030 | 6,711 | 7,049 | 27,102 | 54,892 | 24,228 | 9,552 | 59,893 | 112,752 | 206,425 | 137,909 | 166,027 | 185,886 | 270,593 | 760,415 |
| Equiv. lamps connected | 4,550 | 4,766 | 5,364 | 6,167 | — | 6,468 | 6,697 | 10,318 | 12,395 | — | 13,981 | 14,713 | 15,727 | 19,696 | — |
| H.P. private motors ... | — | — | — | — | — | — | — | 50 | 50 | — | 71 | 79 | 90 | 185 | — |

* Paper read before the Physical Society.

| | HARROGATE. | | ST. HELENS. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Harrogate Corporation. | | St. Helens Corporation. | |
| *Date of Commencement of Supply* | April, 1897. | | October, 1896. | |
| *System of Supply* | Alternating-current transformer sub-stations. | | Alt.-current trans. 2 and 3-wire and 3 wire con. current. | |
| *Chief Engineer* | G. Wilkinson. | | J. S. Highfield. | |

| **YEAR ENDED** | MAR. 25, **1899.**[a] | | MAR. 25, **1900.** | | MAR. 31, **1899.** | | MAR. 31, **1900.** | |
|---|---|---|---|---|---|---|---|---|
| **QUANTITIES—** | | | | | | | | |
| Units generated | 304,810 | | 515,360 | | 105,709 | | 389,069 | |
| „ **SOLD (TOTAL)** | **201,364** | | **365,404** | | **55,091** | | **320,106** | |
| „ sold to consumers | 199,621 | | 322,115 | | 60,296 | | 294,996[e] | |
| „ sold for public lighting, &c. | 1,743 | | 43,289 | | 4,795 | | 25,110 | |
| „ used on works | 10,249 | | 7,914 | | 7,209 | | 14,275 | |
| **UNITS SOLD PER 8 C.P. LAMP CAPACITY** | **23·4** | | **20·3** | | **11·7** | | **15·4** | |
| Maximum supply demanded | 198 kilowatts | | 348 kilowatts | | 108 kilowatts | | 410 kilowatts | |
| Number of public lamps | 1 arc, 1 (32 c.p.) glow | | 31 arc, 13 incan.[e] | | 4 arc | | 35 arc, 72 (16 c.p.) glow | |
| Number of consumers | 209 | | 430 | | 79 | | 173 | |
| Connections to mains in 8-c.p. lamps | 15,300 | | 27,473 | | 6,463 | | 13,981 | |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | **8,600** | | **17,980** | | **4,690** | | **20,600** | |
| **CAPACITY OF PLANT IN KILOWATTS** | **275** | | **575** | | **150**[a] | | **660** | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | **£40,996** | **£149** | **£68,724** | **£120** | **£51,500** | **£313** | **£99,665** | **£151** |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 40,996 | 149 | 68,724 | 120 | 51,500 | 343 | 99,665 | 151 |
| **RECEIVED (TOTAL)** | **25,235** | **91·8** | **40,985** | **71·3** | **9,646**[b] | **64·3** | **51,500**[b] | **78·0** |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 25,235 | 91·8 | 40,985 | 71·3 | 9,646[b] | 64·3 | 51,500[b] | 78·0 |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | **15,761** | **57·3** | **27,739** | **48·3** | **41,500** | **277** | **48,165** | **72·9** |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | 15,761 | 57·3 | 27,739 | 48·3 | 41,500 | 277 | 48,165 | 72·9 |
| **REPAID (TOTAL)** | — | — | **2,441** | **4·25** | — | — | 697 | 1·06 |
| **RESERVE OR SINKING FUND** | 1,152 | 4·19 | — | — | — | — | — | — |
| **DEPRECIATION FUND** | — | — | — | — | — | — | — | — |
| **EXPENDED (TOTAL)** | **38,730** | **141** | **50,270** | **87·0** | **21,770** | **145** | **69,157** | **105** |
| Lands and buildings | 7,713 | 28·0 | 7,977 | 13·9 | — | — | — | — |
| Plant | 21,358[b] | 77·7 | 29,133[g] | 50·7 | — | — | — | — |
| Mains | 9,460 | 34·4 | 12,917 | 22·5 | — | — | — | — |
| Miscellaneous | 199 | 0·724 | 244 | 0·424 | — | — | — | — |
| **BALANCE OF CAPITAL ACCOUNT** | - 13,495[c] | - 49·1 | - 9,285[c] | - 16·2 | - 12,124[c] | - 80·8 | - 18,708[c] | - 28·3 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| **TOTAL** | **£4,672** | **5·565d.** | **£6,534** | **4·290d.** | **£1,559** | **5·750d.** | **£5,044** | **3·782d.** |
| Revenue from supply | 4,557 | 5·430d. | 5,931 | 3·895d. | 1,500 | 5·532d. | 3,269 | 2·450d. |
| „ meters, &c. | 84 | 0·100d. | 129 | 0·085d. | 37 | 0·135d. | 97 | 0·073d. |
| „ public lighting | 25 | 0·030d. | 341 | 0·224d. | 22 | 0·081d. | 136 | 0·102d. |
| „ sale of lamps, &c. | — | — | 133 | 0·087d. | — | — | 135 | 0·100d. |
| „ miscellaneous sources | 6 | 0·007d. | — | — | — | — | 1,408[f] | 1·056d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| **TOTAL COSTS** | **£2,803** | **3·340d.** | **£3,448** | **2·265d.** | **£1,217** | **4·490d.** | **£2,829** | **2·120d.** |
| **WORKS COSTS** | **2,262** | **2·694d.** | **2,873** | **1·887d.** | **877** | **[illegible]** | **1,839** | **1·379d.** |
| *Generation of electricity* | *2,154* | *2·567d.* | *2,558* | *1·680d.* | *823* | *3·035d.* | *1,750* | *1·312d.* |
| Fuel (including cartage, &c.) | 1,027 | 1·224d. | 1,339 | 0·880d. | 163 | 0·601d. | 667 | 0·500d. |
| Oil, waste, water, stores | 159 | 0·189d. | 238 | 0·156d. | 30 | 0·111d. | 54 | 0·041d. |
| Wages at station | 688 | 0·820d. | 632 | 0·415d. | 557 | 2·054d. | 795 | 0·595d. |
| Repairs and maintenance at station | 280 | 0·334d. | 350 | 0·236d. | 73 | 0·269d. | 233 | 0·175d. |
| *Distribution of electricity* | *104* | *0·124d.* | *181* | *0·119d.* | *53* | *0·195d.* | *17* | *0·013d.* |
| Wages, &c. | 104 | 0·124d. | 90 | 0·059d. | — | — | 17 | 0·013d. |
| Repairs, renewals of mains, &c. | | | 91 | 0·059d. | 53 | 0·195d. | | |
| *Public lighting* | *4* | *0·005d.* | *133* | *0·087d.* | *1* | *0·004d.* | *72* | *0·054d.* |
| Attendance | 4 | 0·005d. | 81 | 0·053d. | 1 | 0·004d. | 72 | 0·054d. |
| Renewals | | | 52 | 0·034d. | | | | |
| **MANAGEMENT AND PROPERTY CHARGES** | **541** | **0·645d.** | **575** | **0·378d.** | **340** | **1·254d.** | **990** | **0·743d.** |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *128* | *0·153d.* | *106* | *0·070d.* | *153* | *0·564d.* | *321* | *0·241d.* |
| *Management* | *413* | *0·492d.* | *469* | *0·308d.* | *187* | *0·690d.* | *669* | *0·501d.* |
| Salaries | 301 | 0·359d. | 339 | 0·223d. | 104 | 0·333d. | 271 | 0·203d. |
| Stationery, &c. | 40 | 0·048d. | 46 | 0·030d. | 71 | 0·262d. | 355 | 0·266d. |
| Establishment charges | 61 | 0·073d. | 68 | 0·045d. | | | | |
| Law charges, &c. | 11[d] | 0·013d. | 16[h] | 0·011d. | 12[d] | 0·044d. | 43[d] | 0·032d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | **£1,869** | **5·66%** | **£3,085** | **6·93%** | **£342** | **1·91%** | **£1,914**[g] | **4·21%** |
| Sum carried to Depreciation Fund | — | — | — | — | — | — | 2 | 0·004% |
| Sum carried to Reserve or Sinking Fund | 1,152 | 3·49% | 1,289 | 2·90% | 265 | 1·50% | 963 | 2·12% |
| Net interest on loans (incl. Debenture charges) | 1,446 | 4·38% | 1,019 | 2·29% | 417 | 2·36% | 939 | 2·07% |
| **BALANCE FROM LAST ACCOUNT** | **1,523** | **4·61%** | **- 2,251** | **- 5·06%** | **- 377** | **- 1·91%** | — | — |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | — | — | — | — | — | — | 11[h] | 0·024% |
| *Deficit* | *2,251* | *6·82%* | *1,471* | *3·31%* | *677* | *3·83%* | — | — |
| **ORDINARY DIVIDEND PAID** | — | — | — | — | — | — | — | — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 60% | | 52·8% | | 78·1% | | 56·1% | |
| Expenditure per kilowatt capacity | £10. 4s. 0d. | | £6. 0s. 0d. | | £8. 2s. 5d. | | £4. 5s. 5d. | |
| **REVENUE PER KILOWATT CAPACITY** | **£16. 19s. 7d.** | | **£11. 7s. 2d.** | | **£10. 8s. 0d.** | | **£7. 13s. 0d.** | |
| Expenditure per 8-c.p. lamp capacity | 6s. 6½d. | | 3s. 10d. | | 5s. 2½d. | | 2s. 9d. | |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | **10s. 10½d.** | | **7s. 3½d.** | | **6s. 7½d.** | | **4s. 10½d.** | |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | **6s. 1½d.** | | **4s. 9d** | | **4s. 9½d.** | | **7s. 2½d.** | |
| Price charged for lighting, per unit | 6d. | | 6d. to 4d.[f] | | 6d. | | 4½d. | |
| Price charged for power, per unit | 2½d. | | 6d. to 2d.[f] | | 3d. | | 2d. | |
| Price charged for public lighting | 3d. | | 3d. | | 3d. per unit | | £15 per arc per ann. | |

HARROGATE.—REMARKS—*a* Period from January 1, 1898, to March 25, 1899. *b* Includes £[illegible] on arc lamps. *c* Over-expended. *d* Insurance. *e* Chiefly of 32 c.p. *f* Maximum demand system on 1-hour scale. *g* Includes £3,238 on arc lamps. *h* Includes £9 to insurance.

ST. HELENS.—REMARKS—*a* At end of 1898. *b* After deducting £354 premium on stock. *c* Over-expended. *d* To insurance. *e* Includes 152,076 units to tramways. *f* From the new St. Helens Tramway Co. for rent of track, overhead equipment and shed. *g* After deducting £301 to cost of changing from alternating to continuous current supply. *h* Surplus for the year.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence ; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under :—

| | YEAR | | HALF-YEAR | | QUARTER | |
|---|---|---|---|---|---|---|
| United Kingdom | 26s. 0d. | ... | 13s. 6d. | — | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | — | 16s. 0d. | — | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" is published a Supplement Sheet Table of ELECTRICAL RAILWAYS AND TRAMWAYS IN THE UNITED KINGDOM for 1899-1900, which all purchasers of the Paper should receive gratis. Complaints of non-receipt should be promptly made to THE PUBLISHER.

## ELECTRIC TRACTION IN 1900.

We publish as a supplement to this issue of *The Electrician* our annual sheet table of electric railways and tramways of the United Kingdom. As on previous occasions, we have classified the undertakings under (1) lines actually in operation, including those—already started—which are in operation only during a portion of each year; (2) lines in progress, the actual constructive work of which has been commenced; and (3) projected lines, for which powers have been or are now being sought, but the construction of which has not yet begun, the last-named class including a special list of projected underground electric railways in London, for which statutory powers have been acquired. From year to year as we have published this supplement we have been able to point to rapid growth in this branch of electrical engineering, and this progress has been well maintained during the past year. In the corresponding table published last year, we recorded 42 lines in operation, 28 lines in process of construction, 12 projected underground electric railways and 99 projected tramways and light railways. The total number of undertakings tabulated, therefore, was 181. The previous year's grand total was 154. Against these totals for 1899, our present supplement shows 62 lines in operation, 31 in progress, and 127 lines of all classes projected but not yet having commenced construction. The grand total of these is 220, showing an increase of 39 over the aggregate for 1899; and this increase is composed of the following items—viz., 20 new lines put in operation, a net increase of 3 lines under construction, and a net increase of 16 lines projected. It will be understood that a great many undertakings have been transferred from a lower to a higher class; and there have also been a few instances of schemes being abandoned in the early stages, and consequently being omitted entirely from our table. These transfers and defections can readily be examined by comparing the supplements of this and of last year; but the additions to the lines actually running may be of sufficient interest to

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 26 | **Farnworth (Lancs)** | Bolton Corporation......... | Arthur A. Day[1] Harry England[3] | Bolton Act, 1897 | July, 1897 | Jan. 2 1900 | 4'8½" | 3 d | 104 | G |
| 27 | **Giants' Causeway, co. Antrim, Ireland** | Giants' Causeway & Portrush Elec. Tramway Co. | Wm. A. Traill[1/2].. D. Fall[3] | Special Act ...... | 1880 | 1883 | 3' | 8 s | 43 | Vi |
| 28 | **Glasgow** .............. | Glasgow Corporation ...... | J. Young[2]......... W. Clark[1] | Glasgow Corporation Act, 1891 | July 28 1891 | Oct. 13, 1898 | 4'7¾" | 5 d | 100 | Gi |
| 29 | **Guernsey**.............. | Guernsey Railway Co. ... | Alb. L. Davis[1/2/3] | ... | ... | Feb., 1892 | 4'8½" | 3 s | [illegible] | |
| 30 | **Halifax** .............. | Halifax Corporation ...... | H. F. Street[1] F. C. Parsons[2] F. Spence[3] | Tramways Act ... | 1897 | J'ne 29 1898 | 3'6" | 17 mixed | 98 | G |
| | **Hartlepool** ............ | General Electric Tramways Co. | ... | ... | 1895 | May, 1896 | 3'6" | 2¼ s | 65 | G |
| 31 | **Hartlepool West** ... | Hartlepool Electric Tramways Co. | H. W. Pinkerton[2] A. R. Secker[3] | ... | 1896 | March 1899 | 3'6" | ¼ d 2 1/16 s | 78 | G |
| 32 | **Herne Bay Pier** ... | Herne Bay Pier Co. ...... | H. C. Dufton[1/2]... | Special Act for Pier Co. | ... | Mar. 31 1899 | 3' | ¼ | 60 | B |
| 33 | **Hull** .................... | Hull Corporation ......... | A. E. White[1] A. S. Barnard[1] W. J. McCombie[3] | Hull Tramways Act | ... | July 4, 1899 | 4'8½" | 9 d ½ s | 96 | [illegible] |
| 34 | **Kidderminster — Stourport** | Kidderminster & Stourport Electric Tramway Co. | J. B. Clarke[2] ... A. Stewart[3] | Special Act ...... | 1896 | May, 1898 | 3'6" | 4½ | 75 | G |
| 35 | **Leeds** ................. | Leeds Corporation ......... | E. Talbot 1 J. Hutchinson 2 W. B. Spaven 3 W. Wharam 3 | ... | 1896 | 1897 Extension Jan., 1900 | 4'8½" | 17½ d 1½ s | 100 | G |
| 36 | **Liverpool** ............. | Liverpool Overhead Railway Co. | S. B. Cottrell[1 2] | Special Act ...... | 1888 | 1893 | 4'8½" | 6½ d | 56 | |
| 37 | **Liverpool** ............ | Liverpool Corporation ... | J. A. Brodie[1] A. Bromley Holmes[1] C. R. Bellamy[3] | Liverpool Corp. Tram. Act, 1897 | 1897 1898 1900 | 1898 | 4'8½" | 38½ d 9½ s | 95 | St |
| 38 | **London (Central)** ... | Central London Railway Co. | Sir Benjamin Baker[1] B. Mott G. C. Cunningham | Special Act ...... | 1891 | July, 1900 | 4'8½" | 6 d | 100 | B |
| 39 | **London (West)** ...... | London United Tramways Co., Ltd. | J. Clifton Robinson[1] | Light Railways Act, Provisional Order, Special list | 1898 1899 1900 | ... | 4'8" | 30 d | 90 | G |
| 40 | **Metropolitan District Railway** | Met. Railway Co. and Met. District Railway Co. | Sir J. Wolfe Barry[1] Sir W. H. Preece[1] | Special Act ...... | 1897 | May, 1900 | 4'8½" | 0·75 d | ... | |
| 41 | **Middlesbro'—Stockton—Thornaby** | Imperial Tramways Co. ... | J. Clifton Robinson[1] C. R. Holmes[2/3] | Special Act ...... | 1897 | July, 1898 | 3'6" | 6¼ d 3 s | 92½ | |
| 42 | **North Staffordshire** | North Staffordshire Tramways Co (purchased by Potteries Electric Traction Co) | W. S. Olver[2] Wm. Scott[3] | Tramway Orders | ... | May 16, 1899 | 4' | 6¼ | 75 | G |
| 43 | **Norwich** ............... | Norwich Electric Tramways Co. | Alan N. Banister[1 2 3] | Special Acts...... | 1897 1898 | July 30 1900 | 3'6" | 10 mixed, 15m. route | 65½ & 90 | |
| 44 | **Nottingham** ......... | Nottingham Corporation... | A. Brown[1] H. Talbot[1] J. Aldworth[3] | Tramway Bill ... | Aug., 1899 | Jan. 1, 1901 | 4'8½" | 2·50 d | 107 | G |
| 45 | **Oldham** .............. | Oldham Corporation ...... | S. A. Pickering[1] | Corporation Tramway Bill | 1899 | Dec., 1900 | 4'8½" | 25 s | 100 | G |
| 46 | **Oldham—Ashton—Hyde** | Oldham, Ashton and Hyde Electric Tramway Ltd. a | J. A. Fraser[2]...... M. Rathborne[3]... | Oldham Ashton-under-Lyne, Hyde & District Tramway Order, 1896 | Aug. 7, 1896 | June 12, 1899 | 4'8½" | 5·83 s 2·30 d | 94 | Gi |
| 47 | **Plymouth** ........... | Plymouth Corporation ... | J. H. Rider[1/2] ... C. R. Everson[3] | Plymouth Tramways Act, 1882 to 1896 | ... | Sept. 22, 1899 | 3'6" | 50yds s 5,700yds. d | 92 | G |
| 48 | **Potteries**............. | Potteries Electric Trac. Co. | W. Slade Olver[2] Wm. Scott[3] | Pot. Ext. Tramways, 1896. Pot. Light Rys., 1897 | 1896 | May, 1899 | 4' | 22·82 s 5·82 d | 87 | G |
| 49 | **Ryde Pier (I. of W.)** | Ryde Pier Co................ | W. D. Stanney[1/3] C. Harrison[3] | ... | ... | Mar., 1886 | 4'8½" | ½ d | 30 | |
| 50 | **Sheffield** ............. | Sheffield Corporation ...... | A. L. C. Fell[1/3]... | Sheffield Corporation Act | July 20, 1896 | Sep. 4, 1899 | 4'8½" | 2½ s 20 d | 108½ | G |
| 51 | **St. Helens** ........... | Undertaking property of Corp., leased for 21 years from 1st Oct., 1898, to the New St. Helens & Dist. Trams. Co. | J. S. Highfield[1]... I. F. Cuttler[3] | St. Helens Corp. Act, 1898 | 1898 | July 15, 1899 | 4'8½" | 20 | 100 | G |
| 52 | **Snaefell Mountain (I. of M.)** | Isle of Man Tramways and Electric Power Co. | Joshua Shaw[2/3] ... | Private arrangement with land owners | ... | Aug., 1895 | 3'6" | 4½ d | 56 65 | |
| 53 | **Southampton** ......... | Southampton Corporation | F. H. Chaplin[1] ... G. S. Carnon[3] | Special Acts...... | 1897 & 1900 | March, 1900 | 4'8½" | 8 | 86 | |
| 54 | **Southend Pier** ...... | Southend-on-Sea Corporation | D. F. Adamson[1]... | ... | ... | 1890 | 3'6" | 1½ s | 40 | Vi |
| 55 | **Southport** ............ | Southport Corporation ... | C. D. Taite[1 2] ... R. J. Wilton[3] ... | Southport Corporation Provisional Order, 1899 | Aug., 1899 | July, 1900 | 4'8½" | 3·66 s 1·00 d | 87·5 | G |
| 56 | **South Staffordshire** | South Staffordshire Tramways (Lessee) Co. | J. J. Robins[1]...... H. Hartley[3] ...... | ... | 1889 | 1893 | 3'6" | Mixed | 76 | G |
| 57 | **Sunderland**............ | Sunderland Corporation ... | J. F. C. Snell[1] ...... J. R. Crisp[2] ........... W. Morrison[3]......... | Sunderland Corporation Act | 1899 | Aug., 1900 | 4'8½" | 23 s | 96 | G |
| 58 | **Swansea** ............. | Swansea Improvements and Tramways Co. | H. M. Sayers[1] ..... F. E. de Guerrier[2] ... P. James[3] | Swansea Improvements and Tramways Act | 1897 | July, 1900 | 4'8½" | 5·46 s 1·91 d | 86 | G |
| 59 | **Walton-on-Naze** ... | Coast Development Co.... | ... | ... | ... | Aug., 1898 | 3'6" | ½ | 36 | Vi |
| 60 | **Waterloo—City** ... | Waterloo and City Railway Co. | W. R. Galbraith A. B. W. Kennedy [1] H. Jones[3] C. J. Owens[3] | Special Act ...... | 1893 | Aug., 1898 | 4'8½" | 3 s | 87 | |
| 61 | **Wigan** ................. | Wigan Corporation ...... | H. C. Bishop[1/2/3] | Tramway Provisional Orders | 1898 & 1900 | Jan., 1901 | 3'6" | 1⅝ s | 105 | Gi |
| 62 | **Wolverhampton—Dudley** | British Electric Traction Co. a | F. Hatch[1]......... | Tramway Orders | 1880 to 1899 | ... | 3'6" | 2·94 | 90 | Gi |

# —1900–1901.

THIS
**TABLE of ELECTRIC RAILWAYS and TRAMWAYS in the UNITED KINGDOM**
Can be obtained separately, as follows:—

| | | |
|---|---|---|
| Ordinary Copies, hard paper, printed both sides | ... | 2s. 6d. |
| On Two Sheets, hard paper | each | 2s. 0d. |
| The whole, Mounted on Linen, on Rollers | ... | 5s. 0d. |
| On Linen, folded, in Cloth Case | ... | 6s. 0d. |
| Map—mounted on Linen, in divisions, in Cloth Case | ... | 8s. 0d. |

*[A print (separate) of the Sketch Map of the Electric Railways and Tramways of the United Kingdom is included in the charge.]*

| BOOSTERS. | | | | | REMARKS. | |
|---|---|---|---|---|---|---|
| ositive. | | Negative. | | | | |
| o. | Kw. | No. | Kw. | | Power House Equipment. | General. |
| one | ... | None | ... | 1 | Worthingto[illegible] feed pumps, steam-driven. No economisers. Hand stoking. Fuel—English [illegible] per ton. Newton forced draught | Lines form part of city tramways to be ultimately electrically equipped. Lines about to be opened. Current also supplied for lighting. |
| one | ... | None | ... | 2 | ...... | No batteries. Each motor car hauls from three to four trailers. |
| one | ... | None | ... | 3 | Worthington pumps. About 500 galls. per hour. 72-tube Green econ. Hand stoking. Fuel—Brereton slack. Natural draught. | 72 Chloride R batteries on each car. In course of reconstruction on the overhd. trolley systm. |
| ... | ... | ... | ... | 4 | ...... | No batteries. Electric energy sold by Elec. Depart. to Tram Depart. at 1.5d. per unit. Current also supplied for lighting. |
| 1 | 11 | 3 | 29 | 5 | Cole, Marchent & Morley surface condensers. Feed and steam-driven condensing pumps. 448 tube Green economiser. B. & W. chain-grate stokers. Fuel—12s. to 22s. per ton. | Same power station and boiler plant as for town supply. Formerly worked on Holroyd Smith conduit. Converted to trolley June, 189[illegible]. Current also supplied for lighting. One battery 2[illegible] cells, [illegible] amp. hours, [illegible] at Central Station & one similar at Marton Sub-Station |
| 2 | 20 | 1 | 20 | 6 | Ledward ejector cond. Weir and Worthington pumps. Green econ. Klein 800 H.P. water coolers. Hand stoking. Natural draught. | Two Chloride accumulator sub stations, each of 180 kw. hours. |
| 1 | 12 | 1 | 12 | 7 | Economiser. Electrically-driven feed pumps ............ | Combined municipal power, lighting, and tramway undertaking; several miles under construction. |
| one | ... | None | ... | 8 | Cole, Marchent & Morley surface cond. Elec. (3-throw) and steam (2 throw) pumps. Green economisers. Hand stoking. Yorkshire nuts 15/5 per ton. Ellis & Eaves forced draught. Babcock & Wilcox chain grate | Lines form part of city tramways. Current supplied for lighting. |
| 1 | 3 | ... | ... | 9 | 80 Tudor HA 7 type accumulator in power house. ...... | Current from Corporation at 230v., Parker rotary transf. converting to 160v., bank of accu. acting as regu. Gas engines. Ruling grad. fairly level. |
| ... | ... | ... | ... | 10 | 270 Tudor cells HA 9 type ................................ | Track laid on sea bed some dist. from shore. 14ft. of water over track at high water. Situated at Brighton as on Volk's Electric Railway. |
| one | ... | 1 | 15 | 11 | No condensers or water coolers. Two Adamson's pumps, 3-throw, electric driven. 128 tube Green economisers. Vicars stokers. Fuel—Welsh washed peanuts. Natural draught. | [illegible] practically the entire remainder of the [illegible]. Extensions opened in [illegible]. No batteries. [illegible] tramway complete on to this station [illegible] |
| ... | ... | ... | ... | 12 | Two Worthington feed pumps. Green 192 tube economiser. Automatic stoking. Fuel—coal dust, 7/6 per ton. Natural draught. | Power taken from municipal lighting station. 260 chloride cells |
| ... | ... | ... | ... | 13 | 100 E.P.S. cells ........................................ | This is a private line for estate traffic only, and is out of use when the owner [illegible]. The accumulators are [illegible] Manane House, near one end of line, and are used also for lighting of house |
| ... | ... | ... | ... | 14 | Surface condenser. Steam-driven Weir and Cameron pumps. No economisers. Klein and Halpin's coolers. Vicars mechanical stokers. Natural draught | Lines run in two tunnels at deep level. Curves and gradient severe. Line now extends from Moorgate Street to Clapham Common. Extension to Islington in progress. |
| one | ... | None | ... | 15 | Wheeler Admiralty condensers. No economiser. Hand stoking. Welsh coal. Natural draught | One battery of 266 Tudor cells, HB 13. One ditto of 228 cells, LB 25. Station also supplies light and power |
| one | ... | None | ... | 16 | Browett & Lindley surface condensers. Worthington feed and condensing pumps, beam-geared to small engines. 2[illegible] tube Green economisers, [illegible]. No water coolers. Bennis automatic stokers and coal conveyor. Fuel—screen [illegible]. Natural draught | ...... |
| ... | ... | ... | ... | 17 | 250 Tudor cells. Current also supplied for lighting. Electric pumps. Economiser. Forced draught | Installing another Lancashire boiler and a 500 H.P. triple-expansion Belliss engine, coupled to a 300kw. dynamo |
| one | ... | None | ... | 18 | Ledward evaporative condenser. Worthington feed and condensing pumps. 96-tube Green economisers. Bennis stokers. Fuel, 15s. 6d. slack. Natural draught | No batteries. |
| 1 | [illegible] | ... | ... | 19 | Mather & Platt jet condensers and steam feed pumps. No economiser. Hand stoking. South Wales coal. Natural draught | Accumulators in sub-station, Chloride R type, 140 amperes for 4 hours. Current supplied for lighting outside the Douglas boundaries. |
| 1 | 16 | ... | ... | 20 | ...... | 280 Tudor LB9 accumulators used as buffers and for running early morning cars. Booster used for charging cells. |
| ... | ... | 1 | 30 | 21 | Two Worthington steam pumps. Green econ. [illegible] 168 cubic ft. No water cooler. Hand stoking. Fuel—W[illegible]. Nat. draught | Power house lights supplied by British Thomson-Houston marine type generating set, high-speed vertical engine connected directly to a 4-pole 10 kw. generator, 650 revs. per min. |
| ... | ... | ... | ... | 22 | Adamson electric pump, B.T.H. motor. 1[illegible]6-tube Green economisers. Vicars stokers. Fuel—nut and slack | 55 Epstein batteries, 600 ampere hours capacity. Track laid on on concrete bed, 4 tie bars to each rail. Part of power transmitted to sub-station by 3 phase at 2,000 volts |
| ... | ... | ... | ... | 23 | ...... | Originally a steam line. |
| one | ... | 2 | 45 | 24 | Blake & Knowles duplex feed pumps. No economisers or water coolers. Hand stoking. Fuel—Rough slack, 10s. per ton at present. Natural draught. | Heavy and long grades. Portions of line sinking constantly, owing to mining operations. No batteries. Lines within Dudley Corpor. boundaries supplied from Cor. elec. works |
| ... | ... | ... | ... | 25 | Small coal, 15/3 per ton. Air condenser. Tangye feed pumps. Economisers. | Energy to be taken from lighting station. |

justify our mentioning them categorically. They are: The Central London Railway, the "experimental" line on the Metropolitan District Railway, the original steam railway between Dublin and Lucan; corporation tramways at Darwen, Dundee, Farnworth (Bolton Corporation), Nottingham, Oldham, Southampton, Southport, Sunderland and Wigan; company-owned tramways at Carlisle, Norwich, Swansea, Wolverhampton-Dudley, and in the West of London. The tramways of West London, by-the-way, are ready to commence running, and their operation is suspended solely on account of the opposition raised by the authorities of Kew Observatory before the Board of Trade. These additional entries, however, must by no means be taken as indicating the full measure of the progress in lines operating. Although the list enumerated includes undertakings of exceptional importance, such as the highly successful Central London Railway, it is probable that the extensions of previously existing lines are as significant an index of progress as are the new undertakings themselves. From comparatively small beginnings in 1899, many systems of city tramways have spread themselves out over large and populous areas. Among these we may note the tramway systems of Bristol, Dublin, Glasgow, the Potteries, and St. Helens. Important extensions have also been completed at both ends of the City and South London Railway—viz., from Stockwell to Clapham Common and from London Bridge to Moorgate-street, while further extension northward is in progress.

Concurrently with the rapid development of electric traction on railways and tramways we must note, however, the growth of several species of opposition, the chief of which relate to (1) electrolysis, (2) magnetic disturbance of observatories and scientific laboratories, and (3) vibration. With regard to the first-named objection, the effect on the growth of the ordinary single trolley system has not been marked, although alarm has from time to time been raised by various speakers and writers, including the President of the Institution of Electrical Engineers. Nowhere as yet has the trolley system been actually supplanted by an insulated return system on any British tramway in operation, although we understand that in the as yet uncompleted plans for the equipment of the London County Council tramways, provision against electrolysis will be made. We believe, however, that in the thus far almost academic protests against uninsulated returns for tramways currents "coming events cast their shadows before," and that very soon the question will be magnified into one of practical and pressing importance. With regard to the opposition of authorities having the control of scientific instruments likely to be affected by electric traction, our readers quite recently have had brought before them, in considerable detail, the action of the Kew Observatory authorities in connection with the tramway system in the West of London. It will be superfluous, therefore, to reopen this disputatious question now; but we may direct attention to two letters in our correspondence columns this week, one from Prof. RÜCKER, the other from Mr. GLAZEBROOK, which are the latest contribution to this unfortunate discussion.

A matter of far more serious moment is the vibration and consequent nuisance and injury to property alleged to be set up by the Central London Railway. It does not concern this particular railway only, for the inference has been drawn by the public that other underground electric railways are likely to develop a similar kind of nuisance. Consequently a number of lines which had been projected are now practically suspended pending the decision of the Board of Trade committee as to the existence and cause of the vibration. We have already expressed the opinion that whatever vibration may occur it is not inherent in either electric traction or the Greathead system of tunnel construction. It is probable that it originates in the use of heavy locomotives, in which the greater part of the weight is unsupported by springs, but, on the contrary, is imposed directly on the axles of the driving-wheels. The remedy lies either in using spring-suspended and geared motors on the locomotives, or else in abandoning the use of separate locomotives and distributing the motive power throughout the train.

These and other obstacles to the development of electric traction are not to be regarded as insuperable. Obstacles and opposition inevitably arise in the early growth of an engineering industry, and electric traction may be expected to afford no exception to the general rule. Yet, in spite of opposition in the past, its history reveals steady and rapid development; and in the face of all difficulties that may be raised in the future that progress will certainly be maintained.

## OBITUARY.

### Z. T. GRAMME.

By the death of M. Zénobe Théophile Gramme, the electrical world loses one of the pioneers to whom the vast developments of the past quarter of a century are largely due.

Born in Belgium, in 1826, he was brought up as a carpenter, but he early manifested a talent for machinery, which was developed by attendance at some scientific lectures at Liège.

It will be remembered how, following the scientific discoveries of Faraday, the production of electric light by the arc became gradually practicable. In England Staite, and in France Foucault, devised mechanism for automatically regulating the carbon pencils. The primitive magneto-electric generators of Nollet in France, and of Holmes in England, gave promise of success. Faraday himself lived to see Holmes's giant machine in the Great Exhibition of 1861, and reported that at last electric light might with safety be applied to lighthouses. In France the "Alliance" machine, constructed by able engineers on the basis of the older designs of Nollet, was also intended for lighthouse illumination. To Paris, and to the "Alliance" factory came Gramme as a simple fitter; with no technical training in electricity, he acquired a practical grasp of the properties of electric currents that led him to suggest valuable improvements. He worked also in the workshops of Ruhmkorff where doubtless he gained an insight, not to be attained at that date in any other way, into the mysteries of making that perfect mechanical insulation so essential in the induction coil.

It was in the sixties, while Gramme was thus working his way upward in Paris, that other improvements were being made in generating machinery in other parts of the world. Pacinotti, then a mere student, now still professor, in the University of Pisa had made and described his magneto-electric machine having a toothed-ring armature. But Pacinotti's ring fell still-born, and his machine was relegated, unheeded though meritorious, to the shelves of the museum. In England, Wilde had broken new ground by showing how, from the minimum of current the most powerful currents could be mechanically generated, by using that minimum to exalt the magnetism of field-magnets of soft iron; and by this principle of multiplication he led up to the so-called self-exciting machines of 1866 and 1867. It is a bare matter of history that the name "dynamo-electric machine" was first applied to the machine of Wilde, and then to the self-exciting forms.

Wilde was himself assiduously developing various types for industrial purposes, when, in 1870, Gramme appeared upon the scene with the simple, uniformly-wound ring armature with which his name will ever be associated. His English

patent has a curious history. It may appear strange that so important an invention should have been protected by so slight a specification—a few lines of description, a single claim, unaccompanied by any drawing: that constitutes the whole of the patent of Gramme and d'Ivernois. The simple fact is that at the date when the filing of the final specification became due Paris was besieged, and it was impossible to send drawings to the London agent, who simply filed the materials that were to hand. The rapid commercial success of Gramme's machine is due to a combination of causes. It was the first practical machine in which were combined the features of the continuity of commutation, the self-exciting arrangement, good lamination in the armature core, and reasonably good proportions in the magnetic circuit. No doubt, also, Gramme was fortunate in having behind him a good firm of mechanical engineers to undertake the construction of his machines. Be that as it may, there is no question that the "Machine Gramme, type A" conquered the industrial world, and gave to its inventor a reputation which British engineers would be the last to belittle.

It is not, moreover, without significance that a good deal of Gramme's success is due to that which at the present day English manufacturers are too prone to decry—the publicity gained in international exhibitions. At Vienna in 1873, at Philadelphia in 1876, and notably at Paris in 1878 Gramme's machines were in evidence. It is said that the Gramme machines at Philadelphia incited the invention of the Brush and of the Thomson-Houston machines for arc lighting. It is certain that the Jablochkoff method of arc lighting, which was a feature of the Paris Exhibition of 1878, was largely made successful by the co-operation of Gramme in designing suitable generators to meet the new requirements. In the Electrical Exhibition at Paris in 1881 Gramme was again to the front with a most interesting series of varied designs, showing in how many directions he had worked at improvements. His ideas seemed to be instinctive. He could not calculate either the sizes of the parts or the numbers of windings. Precise rules were, as we all know, of later origin. But he had that eye for proportion that marks the intuitive engineer. It is related by M. Mascart how, in the Paris Exhibition of 1889, he walked through the machinery hall with M. Gramme to hear the old man's criticisms upon the different forms of dynamo. "There is too much iron," he would remark of one. "There is not enough iron," he would say of another. Before one machine he stopped in admiration, and then whispered: "C'est la perfection." It was the 820 H.P. four-pole machine designed by Mr. C. E. L. Brown for the Oerlikon Company.

Gramme took for some years an active part in the industrial operations of the Société Gramme, which flourishes under the direction of M. Hippolyte Fontaine, but in recent years his connection had been little more than nominal. He lived quietly apart on his little property at Bois de Colombes, outside Paris. The writer remembers seeing the then iron-grey, sturdy little man at the exhibition of 1881, but had never been able to meet him since.

In March, 1897, Gramme was made a Knight Commander of the Order of Leopold, and on this occasion a banquet in his honour was given in Brussels. Two delegates from the Institution of Electrical Engineers—Prof. Ayrton and the present writer—were appointed to join in the celebration to convey the congratulations of their English brethren. The weather, however, was so stormy that cross-channel communication was stopped; and the English delegates had to content themselves with sending telegrams. It is satisfactory to know, however, that "Papa Gramme," as he was affectionately styled, had a splendid reception. A gold medal, recording the event, was struck to commemorate the signal services which Gramme had rendered to the electrical community, and this was presented by M. Mascart in an elegant speech.

Gramme also patented a form of battery, and designed several types of arc lamp. One of these had a break-wheel gear not unlike that of the later Brockie-Pell lamp.

Beside the Belgian decoration above-mentioned, Gramme was an Officer of the Legion of Honour, and a Chevalier of the Order of the Iron Crown of Austria. It is an open secret that his name had already been put forward at the Council of the Institution of Electrical Engineers to be proposed for election as an Honorary Member. Alas, that is no longer possible. He died quietly at his home on January 20, in his 75th year, and was buried in the cemetery of Père Lachaise, Paris, on the 23rd inst. S. P. T.

## CAPACITY IN ALTERNATE-CURRENT WORKING.*

BY W. M. MORDEY.

*(Concluded from page 509.)*

### DESCRIPTION OF CHOKING COIL.

This description is not given as that of a very satisfactory example of design but to show the coil used, and in the hope that it may be of some interest to designers of such apparatus. The main dimensions of the coil used in these tests are given in Fig. 5. It consists of a set of E stampings with a coil wound about the middle projection. The "yoke" is straight and is carried on supports, allowing of adjustment of the gap. Fig. 6 gives the currents with various air-gaps.

The current taken by the coil at 2,000 volts 100 ∼ with various air-gaps is given by Fig. 3. The form was chosen, in preference to the simple straight coil form, as a convenient one for adjustment, and because it gives an external field more suitable for enclosing in an iron core.

The cross-section of the core is about 29·76 sq. in., or 192cm. of actual iron—weight about 190lb.

The winding consists of 756 turns of 0·08in. wire, having a total length of about 2,600ft. and a resistance of about 4·1 ohms.

At 2,050 volts 100 ∼, N = 6,081,000, B = 3,170.

The iron is 0·014in. thick of a quality which would have a loss in a closed-circuit transformer of about 0·55 watt per pound. The iron loss should, therefore, be about 190 × 0·55 = 104·5 watts, with the yoke closed down. With the yoke removed (as used) it should have a loss of about 68 watts if the circuit completed itself through the air.

The copper loss with 6 amperes = $6^2 \times 4·1$ = 148 watts. Total, 216 watts.

The tests, however, show a loss of about 500 watts. The difference must be due to eddies caused by magnetic leakage. The stray power is higher than would be expected, but it answers its purpose very well. Its power factor is 500/12,500 = 0·041.

The weight is about 22lb. per apparent kilowatt.

I know of no published information on the losses in choking coils, and suggest it as a useful subject for study. The principal difficulty is in testing apparatus having such low power factors.

I have said that in reducing the capacity current required to be produced by the generator, something was effected in ordinary practice, but accidentally, or at least not systematically, by the action of all self-induction in the system—for example, that of transformers or motors. In transformers the effective self-induction is very small. The no-load current is small in good closed-circuit transformers, and the power factor is high—usually from about 0·7 to about 0·85. The wattless component available is, therefore, very small—at least, in modern systems having large and efficient transformers. No doubt if the conditions of a circuit are known from the first, the transformers may be so designed as to provide the capacity current, at least at light load; but it would be difficult to do this systematically as the conditions in practice are so variable. With a large number of small transformers it may be that the wattless capacity current may be compensated or more than compensated. I do not think transformers of low power factor should be used. I believe the better plan will be to continue to make transformers with small no-load current and high power factor, and provide separately for any compensation that may be necessary.

When motors are used, their large, idle, lagging current is available to compensate the capacity. Where there is a large motor load the idle current will usually be a lagging rather than a leading current, even on mains of considerable capacity. A synchronous motor, as is well known, acts either as a capacity or a self-induction according to the excitation. When over-excited, it acts as a capacity and takes a leading current from the mains; when under-excited, it acts as a self-induction, taking a lagging current. When excited to take a minimum current it has no idle component—that is to say, its power factor is unity. Such motors running light are now often used for balancing self-induction, but I have never seen them used for balancing capacity. In any case they are a rather expensive remedy, as they have to be practically as large as if they were to do real instead of only apparent work. Their first cost, their working costs, and losses are therefore high. For balancing self-induction they may be necessary. I hope, however, that for this purpose condensers will again be taken up by Mr. Swinburne, or somebody else. Probably their hysteresis loss will not be as great as the losses in motor compensators, nor their working cost or first cost as high. But in any case the running of under-exited synchronous motors is an expensive and clumsy way of compensating capacity, compared with simple choking coils, such as I suggest. Such coils, used with a

* Paper read before the Institution of Electrical Engineers, January 10.

phase-indicator, should be useful in all systems where the capacity current is large enough to deserve attention.*

There is something very disproportionate and anomalous about the two classes of loss in the dielectric—the insignificant losses due to leakage, and the large apparent and actual losses due to capacity and hysteresis. Let me take for illustration a 10,000-volt cable having one-third microfarad capacity per mile, and working at 50 ∿. Its insulation is, say, 2,500 megohms (it may be only a few megohms

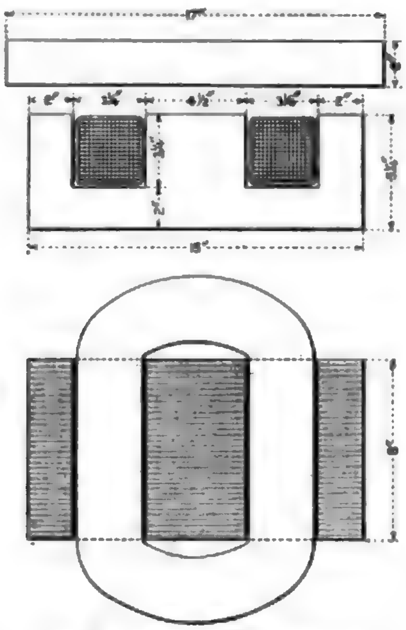
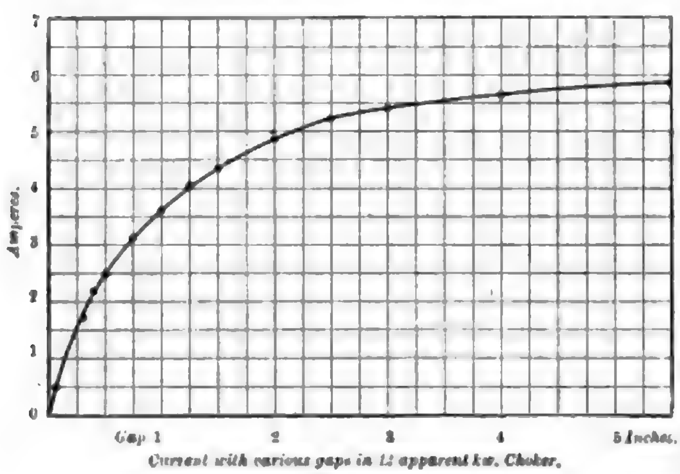


Fig. 5.—Choker for 12 apparent kw.

without affecting the argument). The dielectric has several functions. It acts as a nearly perfect non-conductor. But it does conduct a little; it allows 1/250,000 ampere to pass through it, = 0·04 watt per mile. Then there is the electrostatic action. From Table I. we see the capacity current is 1·05 amperes, the apparent watts 10,500, and the real watts 1,296, or 32,400 times the watts lost by conduction. This is an interesting state of things. Both dielec-



*Current with various gaps in 12 apparent kw. Choker.*

Fig. 6.

tric conduction and dielectric hysteresis waste energy in the same way—by heating the dielectric. We use an insulator which reduces the leakage energy loss to 0·04 watt per mile, but allows another energy loss 32,400 times as great.

* I may mention that when I applied for a patent for this method my attention was drawn by that useful institution, the German Patent Office, to the fact that, so far as concerned the treatment of a long transmission line by choking coils placed at intervals, I was anticipated by Charles Schenck Bradley, the well-known American electrical engineer (British patent 20,493 of 1897). Reference should also be made to the proposals of our president of last year, Prof. S. P. Thompson, to compensate the capacity of submarine and other cables to facilitate signalling by placing high-resistance choking coils at frequent intervals along their length. See his British patents 22,304 of 1891, 13,064 and 15,217 of 1893, and 15,581 of 1894.

So far as loss of energy is concerned we should be just as well off, or as badly, with an insulation resistance of $\frac{10,000}{1·05}$ = 9,524 ohms, instead of 2,500,000,000. The energy spent on our dielectric would be just the same, and I suppose we should have no wattless current at all! I point this out to illustrate an anomaly, not to make a practical suggestion. It may be that no low resistance insulator can be found capable of resisting breakdown under such conditions. I have spoken of the energy component of the capacity current spent on heating as if it were in some way different from the leakage current. It only differs from it in amount. It is not recovered like the true charging current. It does not surge to and fro in the cable. In all practical essentials it is a leakage current. It goes right through the dielectric, and heats it in its passage exactly like the leakage current. The effect of capacity in allowing the passage of this current is precisely as if it reduced the insulation resistance in the proportion I have suggested—viz., from 2,500 megohms to 9,524 ohms. At least this is how it appears to me.

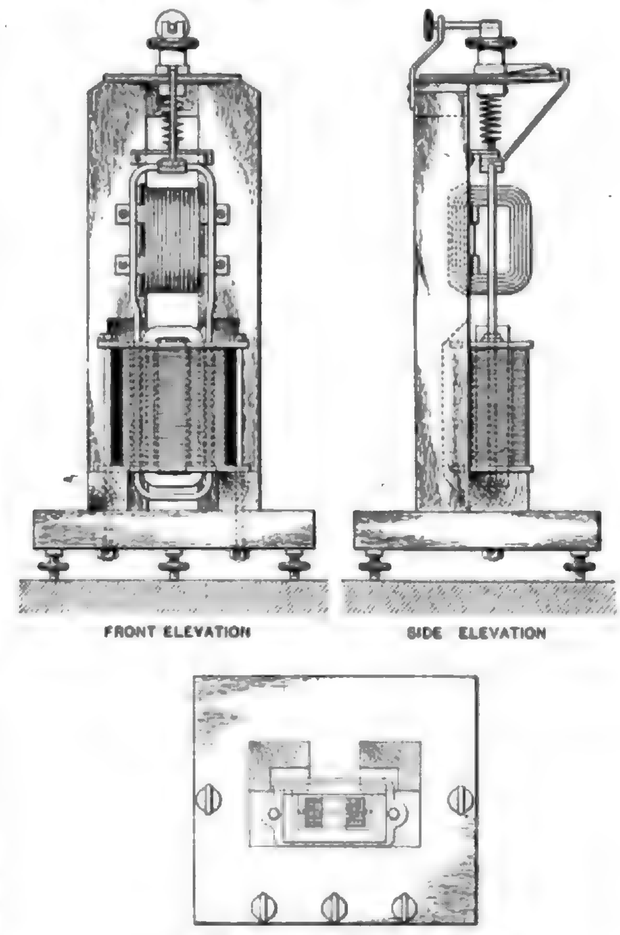


Fig. 7.

With aerial lines capacity effects are comparatively unimportant. For example, with wires of ¼in. diameter, hung 2ft. apart, the capacity per mile is only 0·018 microfarad. Not only is the wattless current therefore small, but there is no "wattful" current.

### An Alternate-Current Wattmeter.

In concluding this Paper I wish to describe an alternate-current wattmeter especially suitable for measurements such as are required in connection with the subjects treated in this Paper. In devising this instrument my aim was to get a simple, strong, reliable wattmeter—one that needed no resistance added in its E.M.F. circuit, and that would absorb very little energy in that circuit even for large E.M.F.s. In such an instrument the E.M.F. coil should have a large force, and at the same time be practically without self-induction, and should be correct with all power factors met with in practice. If possible it should be correct through a considerable range of periodicity. Long and satisfactory experience of the Siemens dynamometer under workshop conditions made me turn to it as the most suitable type of instrument, and to try to devise means by which it should have the qualities just enumerated. Fig. 7 shows the instrument in elevation and plan.

The Siemens dynamometer form is closely followed. The series or current coil is placed in the ordinary position. Under this coil

is a small transformer, the primary winding of which is wound for any required E.M.F. Next to this primary winding a space is left at each side—the space usually occupied in a transformer by the secondary winding. In this space a closed coil of one turn of wire is suspended freely—the wire is platinoid, manganin, or some other conductor having a negligible temperature coefficient. This conductor is suspended and controlled exactly like the suspended coil of a Siemens dynamometer. It acts as the secondary of the transformer. As it is closed on itself no mercury cups are needed. Its circuit external to the transformer consists simply of a loop passing up the front and down the back of the fixed or current coil.

The action will now be understood. A comparatively large current of very low pressure is generated in the secondary coil. This current is in opposite phase to the E.M.F. It passes through the field of the fixed or current coil. The suspended conductor is acted on and deflected by the current in that coil, and is brought back to zero by the tension of the spring as in an ordinary dynamometer.

It will be seen that so long as the iron of the transformer is not forced to too high a density by using too great an E.M.F. or too low a periodicity, the secondary current will be proportional to the E.M.F. and independent of the periodicity. The magnetising component of the primary current and the energy spent in the iron will vary with the E.M.F. and periodicity, but if the self-induction of the secondary coil is sufficiently low this will not affect the proportionality of the secondary current to the primary E.M.F.

The instrument shown on the table is the first I have had made. It has been kindly constructed to my drawings by Messrs. Siemens. By tests made at the Board of Trade Electrical Laboratory (in connection with which I have to thank Mr. Trotter and Mr. Rennie), I find my anticipations have been verified—the instrument has the same constant with power factors of 1 and of 0·1, and it is proportional all round the scale.

This kind of instrument may easily be made for a large range both of E.M.F. and current, as the primary of the transformer as well as the current coils may be variously wound or connected—the suspended secondary conductor being always the same.

In the instrument exhibited the current coils are three in number, of varying section—the transformer primary being suitable for any E.M.F. up to 500 volts at 100 ∿. The range is as follows:—

| | | | | | | |
|---|---|---|---|---|---|---|
| Fine coil, for maximum of about | | | 2·5 amps., | constant | 1·25 watts | per division. |
| Medium | ditto | ditto | 15 | ditto | 6·8 | ditto |
| Thick | ditto | ditto | 90 | ditto | 37 | ditto |

This is at 83 ∿. There are 400 divisions in the circle.

I have not succeeded, in this first attempt, in making the instrument independent of periodicity. The variation is about 10 per cent. between 30 ∿ and 90 ∿. In using the instrument it is, therefore, necessary to know he periodicity. I hope to greatly reduce this variation, or perhaps get rid of it altogether through a sufficient range for practical purposes. Even as it is, it will perhaps not be considered a very serious objection.

The principle of this instrument may be readily applied to other forms, but it would be premature to describe them here.*

In this Paper I have not attempted to treat of several aspects of "capacity in alternate current working"—matters perhaps as important as those I have tried to make clear. I have avoided comparisons between different kinds of cables; I have considered single phase only—not two or three phase. I have said nothing of effects of capacity on regulation, on distribution of potential along lines, on liability to rupture of insulation due to capacity, or on means for reducing such liability. In keeping to one aspect of the subject I have hoped to be of most use to my fellow electrical engineers.

I have to express my thanks for information or facilities afforded me to Mr. Gray and the Silvertown Company, to Mr. Edmunds and Mr. Howard of Messrs. Glover & Co., to Mr. Nisbett and the British Insulated Wire Company, and to Mr. Gavey (Chief Engineer of the Post Office). Also to Mr. Dallas and Mr. Grafton, respectively of the Silvertown and the County Companies, for assistance in experiments. I have already mentioned my indebtedness to Mr. Sparks and the County of London and Brush Provincial Company.

A short discussion followed the reading of the Paper on Thursday, Jan. 10th:

Prof. W. E. AYRTON said that, at the very beginning of the Deptford generating station, when power began to be transmitted from Deptford to the Grosvenor Gallery through 6 miles of underground cable, he was very often at Deptford with Mr. Ferranti. One day Mr. Ferranti asked him to explain the following, acknowledging how hopelessly incomprehensible it was to himself. Mr. Ferranti had found that during the daytime, when there was practically no load on at the Grosvenor Gallery, the ammeter read a fairly large value—some 20 amperes—but when the load came on in the evening the ammeter reading did not go up for a long period. At that time—some 11 years or 12 years ago—he (Prof. Ayrton) had gone into this question in detail with Dr. Sumpner, and together they proved to Mr. Ferranti that what he was doing was measuring the capacity of his cable, and showed him how he was doing it. The current obtained during the day was the very current which Mr. Mordey had referred to in the earlier part of his Paper. They measured the capacity of his cable in the ordinary way, and showed him that the well-known formula, capacity $= \frac{\text{amperes}}{\text{volts} \times \sim \times 2\pi} =$ farads, was applicable and completely correct in his particular case. They measured a considerable number of capacities in this way, and finally, in 1891, they brought a Paper before the Physical Society, and gave not merely formulæ or calculations, but the exact results obtained when using this method. They were not dealing with small capacities such as Mr. Mordey did, but with hundreds of miles of cable as regards capacity. [Prof. Ayrton then proceeded to read extracts from the original MS. of the Paper. An abstract of the Paper appeared in *The Electrician*, Vol. XXVI., p. 572.] Continuing, Prof. Ayrton said that the values obtained in the experiments described in this Paper agreed remarkably well with the ordinary ballistic method. The above Paper was followed in the same year by Major Cardew, who gave at the Institution of Electrical Engineers a long account of experiments on measurement of capacity in this way, and compared it with capacity measured by the ballistic method. He said, "I was also able to test the amount of power taken by these 1 microfarad condensers, using Prof. Ayrton's formula which he has lately given us, and which comes in very usefully for the purpose, and we found with a given condenser, with about 650 volts on it, the power absorbed was only about 5 watts." Then followed a list of experiments from May 11th to May 21st, forming a comparison with the ordinary test by the ballistic method. He (Prof. Ayrton) had gone further than this, and had asked Mr. Swinburne to make him a set of condensers which could be graduated, not in microfarads, but in amperes, at a pressure of 2,000 volts and a frequency of 100 ∿ per sec. Altogether there were eight graduations, and these were the very condensers which Mr. Duddell has used for his experiments recently described before the Institution. The condensers were supposed to take 0·75, 1·5, 1·5, and 3·75 amperes respectively, and the actual currents obtained were 0·769, 1·442, 1·438, and 3·168 amperes, the capacities being 0·612, 1·442, 1·438, and 3·162 microfarads. He mentioned these figures because of this double method of measurement, and on account of the energy loss, which had been very carefully measured at the time of these 1893 experiments, not merely because they dealt with what Mr. Mordey was now, in 1901, impressing upon central station engineers to think about using.

Mr. MORDEY explained that he did not claim to have invented the capacity current, and pointed out that in Prof. Ayrton's book this simple practical method was not given. It was an engineering method, and probably would not occur to people writing books of that class.

Prof. AYRTON said this statement was absolutely irrelevant. Vol. I. of his book dealt with direct currents, and did not say a word about alternate

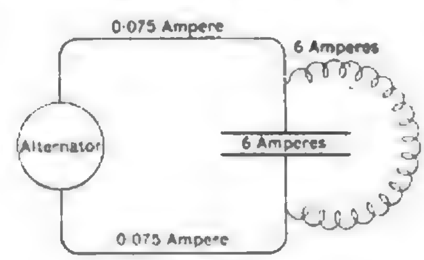


FIG. 8.

currents. The 1891 Paper to the Physical Society to which he had referred was entitled "Interference with Alternate Currents," because it dealt also with the combination of self-induction with a capacity. It gave numerical results actually obtained. Taking Mr. Mordey's experiment, and comparing it with the actual values given in this 1891 Physical Society Paper, he (Prof. Ayrton) could enormously improve the result. If F be the capacity of a condenser, or cable, in farads, $p$ be $2\pi$ times the frequency of an alternator sending current into the cable, V the R.M.S. value of the P.D. produced by the alternator, and $\sigma$ the resistance in ohms of an inductive resistance placed as a shunt to the condenser, then the current in the alternator circuit would be a *minimum* and equal to $VF\sigma p$ when $h$, the self-induction of the inductor shunt, had the value $\frac{1+\sqrt{1-4F^2p^2\sigma^2}}{2Fp^2}$ henry. In Mr. Mordey's case this test value of $h$ became 0·53, and, with a shunt to his cable having this self-induction, the alternator current would reduce itself to only 0·075 ampere when V was 2,000 volts and the current due to dielectric hysteresis was inappreciable. The currents in the three circuits would, in fact, be approximately as shown in Fig. 8, when the dielectric hysteresis loss was small. What he proposed to do was to supply Mr. Mordey with a coil in place of the choking coil in Fig. 4, and he would find the current very much less than 1·5 amperes. Mr. Mordey should have used a choker with no iron at all, and one with less wire than at present, so that it would have a less resistance and a far less energy consumption. He now came to what he considered the most serious part of Mr. Mordey's Paper—*i.e.*, the loss in the cable, and he would like to ask Mr. Mordey whether he had sufficiently tested either the cable or what he called the Thomson "*recording wattmeter*," to feel at all sure that the low power-factor he was dealing with was read correctly. Mr. Mordey had very rightly said that he had not used an ordinary wattmeter because with such a low power-factor it was very difficult to get accurate, but he seemed to forget in that remark that the error

* I should mention that some years ago Mr. Swinburne proposed or made an instrument in which he pivoted a closed circuit conductor; this had a current induced in it and was deflected by the flux in an air gap in which it hung.

in the Thomson *watt-hour meter* (as it ought to be called) was identically the same. If they took that formula which he worked out years ago for a wattmeter and applied it to Mr. Mordey's low power factor watt-hour meter it would be found—unless he was very much mistaken—that the measured power might be considerably greater than the true power. The matter was of enormous importance. It was not merely a question between Mr. Mordey and himself. He was not now dealing with any question of priority, but what was the true loss in a cable. He meant the loss due to this so-called dielectric hysteresis. In all the previous measurements he (Prof. Ayrton) had been referring to, the power-factor had been far smaller than Mr. Mordey now said was the case, the power-factor being, of course, the ratio of the true power wasted in dielectric hysteresis to the apparent power given to the cable. For instance, in the case of Mr. Swinburne's own condensers it was something of the order 0·01, and the highest value in Major Cardew's experiments was 0·063, which was far less than Mr. Mordey's. Referring to experiments which had been made by Lombardi on this particular subject of hysteresis loss of various dielectrics, this investigator had obtained the value 0·008 for paraffin wax, for gutta percha 0·042, which was higher than he himself had obtained; and values of 0·04 and 0·01 had also been obtained. The results seemed to be, therefore, that if the cable which Mr. Mordey had tested had really a power-factor of 0·124—*i.e.*, that nearly one-eighth of the whole watts was wasted—then the cable was made most unnecessarily bad. It was a matter which should be very carefully tested.

Mr. MORDEY said that he did not claim any novelty in connection with the Paper. It was a matter of indifference to him whether Prof. Ayrton knew Ohm's law in 1891. He believed he did. It was, however, a matter of importance to all that he should say before the meeting closed that the figure he had put forward that evening, viz., the power-factor of 0·124, he believed to be correctly determined. The wattmeter had been very carefully calibrated especially with a view to finding its constant. He was startled at the result himself, but if he had had any doubt as to it, and had not felt convinced that it was confirmed by other experiments, he would not have dreamt of saying anything about it all. The other part of the Paper was sufficiently interesting to have enabled him to leave this out, but he had not any doubt whatever that the power-factor in cables of that class was of that order. It might not be right to 1 per cent., and he did not care much, but he did not want them to go away and think that he had put a figure of that sort before them—a figure which was very very important indeed—without having a reasonable belief that it was based on actual fact. However, the instrument could easily be calibrated, and before the discussion was resumed he would have an official calibration—not by Prof. Ayrton.

The discussion will be resumed on Thursday, Feb. 14th.

## ON A METHOD OF MEASURING POWER IN ALTERNATING CURRENT CIRCUITS.*

BY ALBERT CAMPBELL, B.A.

The method of measuring power commonly known as the three voltmeter method, although convenient and accurate when used with discrimination, is sometimes liable to serious error, particularly when only one voltmeter is used and when the auxiliary resistance is not large enough for the circuit which is under test. In the usual way

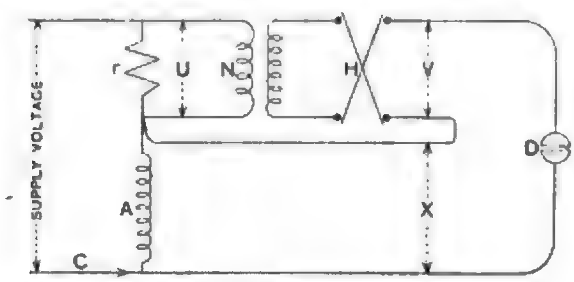


FIG. 1.

of carrying out the method, the auxiliary non-inductive resistance has to be so large as to take a considerable fraction of the total available voltage, and this is sometimes most inconvenient and liable to alter the conditions of the circuit tested. In the method which I here describe, this difficulty is entirely got rid of, for the volts lost in the auxiliary resistance need not be more than 1 per cent. of the total available voltage.†

In Fig. 1 are shown the connections. A is the circuit in which the power is to be measured. It is connected in series with a small non-inductive resistance $r$ across the supply circuit, which, for simplicity, we may suppose to be at 100 volts (no direct-current component being present). $r$ is of such a magnitude as to take $U \doteq 1$ volt, when A takes $X = 100$ volts. The small voltage on $r$ is transformed to V by a small transformer N of high transformation ratio (say 1 : 20). By suitably choosing this transformer the primary current may be made negligible in comparison with C (the current in A), and also the power phase of V will be practically 180deg. behind U. By means of the reversing switch H and the electrostatic voltmeter D the effective resultants of X with V reversed and direct can be obtained. Let P and Q be these resultants and let $\beta$ = the transformation ratio of N. Hence

$$V = \beta U = \beta C r.$$

Also the $\phi$ power lag between V and X may be taken as equal to the angle of idleness between C and X. Then, as I have shown in my Paper on "Phase-Turning Apparatus,"

$$4XV \cos\phi = P^2 - Q^2,$$

whence power in A $\doteq CX\cos\phi$

$$\doteq \frac{XV}{\beta r}\cos\phi \doteq \frac{P^2 - Q^2}{4\beta r}.$$

In order to obtain accurate results with this formula it is desirable to be able to vary either $\beta$ or $r$. The latter, which is a low resistance, is conveniently built up from a number of wires or strips in parallel adjusted to give, say, $1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{10}$.........ohm respectively. Thus a combination suitable for any current above 1 ampere can be obtained.

The above method fails in the case of a circuit with mixed current (alternating and direct), for it is not difficult to see that no direct-current component present has any influence on the result. The arrangement used, however, suggested the following way of finding the direct-current component by means of an electrostatic voltmeter and a set of small cells.

*Finding Direct-current Component.*

Let a mixed voltage be represented by

$$x = y + a\sin pt + b\sin 3pt + \quad . \quad . \quad . \quad .$$
$$= y + x_1$$

where $y$ is constant; and let $e$ be a direct-current voltage (given by the small cells).

Let $P$ = effective value of $(x + e)$

$Q$ = ditto $(x - e)$

$X_1$ = ditto $x_1$.

Then
$$P^2 = \int_0^{\frac{2\pi}{p}} (y + x_1 + e)dt,$$
$$= (y+e)^2 + X_1^2,$$

and
$$Q^2 = (y-e)^2 + X_1^2.$$

Hence
$$ye = \frac{P^2 - Q^2}{4},$$

or
$$y = \frac{P^2 - Q^2}{4e}$$

Thus, if we have any mixed voltage X, we can find its direct-current component by using an auxiliary direct-current voltage V, finding the resultants of X with V and —V on an electrostatic voltmeter, and calculating $y$ from the equation $y = \frac{P^2 - Q^2}{4e}$. A mixed current may be similarly treated by using its voltage drop on a non-inductive resistance.

But a much simpler way of measuring direct-current components is by the aid of a moving-coil instrument with permanent magnets. I have found a low-reading Weston voltmeter very convenient for the purpose, a shunt being used for the current measurements, and an added resistance for the voltage tests. When the direct-current component is relatively small, great care must be taken not to overload the instrument by the alternating component. The total current or voltage should be kept well within the range of the instrument. The safest and best plan is to protect the instrument by a highly inductive coil of low resistance (which must be taken into account in the calibration).

For example, by this method it is easy to measure the direct components which are known to occur in the currents taken by certain arcs run on purely alternating circuits. A carbon copper arc thus shows a component of 5 amperes direct current in a total of about 10 amperes. In a simple carbon-carbon arc I have found as much as 0·7 ampere direct current out of a total of 9 amperes. It is interesting to notice that in these cases the total power spent by the direct-current component in the whole circuit is zero. Thus with the carbon-copper arc about half the power spent in the added resistance is drawn from the arc itself.

* Paper read before the Physical Society.

† This method of measuring power may be considered as the inverse of a somewhat similar method published by Mr. M. B. Field in the *Electrical Review*, Nov. 25 and Dec. 2, 1898.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

LECTURE I.—ELECTRIC OSCILLATIONS.

The study of electric oscillations and electric waves has of late years borne fruit in practical developments which embrace matters of more than purely scientific interest. Hence it is, perhaps, not an inappropriate subject for discussion in a short course of Cantor lectures. Very briefly, an electric oscillation may be defined as an alternating electric current of exceedingly high frequency, a frequency reckoned not in hundreds or even thousands per second, but generally in millions and hundreds of millions. Hence we may expect to find that the laws which govern the behaviour and production of electric oscillations are very different from those which prevail when we are considering continuous or unvarying currents.

Everyone who has made the smallest acquaintance with the phenomena of alternating electric currents is well aware of the great influence which their frequency or period of alternation has upon the observed effects. As long as we confine our attention to continuous or very slowly periodic currents, the chief attribute of the circuit which claims our attention is its *resistance*. The moment, however, that we begin to employ alternating currents of even moderate periodicity we find that another quality of the circuit, viz., the *inductance*, begins to be important. As the frequency rises we find that a third property, viz., the *capacity* of the circuit makes its presence felt. At high frequencies the distribution of currents in conductors is almost entirely determined by the last two qualities, and the ohmic resistance becomes less and less influential. We have in the first place to consider the practical method of producing electrical oscillations. Up to the present moment we know only of one method. It need hardly be said that the ordinary process of producing a low frequency alternating current by moving bobbins of wire to and from magnets, or otherwise inserting and withdrawing magnetic flux from conducting circuits, ceases to be applicable above a frequency of a few thousand because we cannot create the requisite mechanical movements with sufficient speed. If, however, two conductors are brought to a large difference of potential and then very suddenly connected together by a conductor of low resistance, we have set up in this conductor an alternating current of very high frequency which gradually dies away. This very rapidly alternating but decadent current constitutes a train of electrical oscillations.

Two conditions are necessary for the production of electrical oscillations in the above manner. In the first place, the release of the two opposite electric charges must be very sudden, and in the next place the circuit in which the oscillations take place must have a very small *time constant*, which condition is generally only fulfilled when it has a very low resistance. We may employ a mechanical illustration to make plain the meaning of these conditions. Suppose a glass U-tube to be partly filled with mercury, and the mercury to be displaced so as to be higher in one limb than the other. There is then a force due to the difference of level urging the fluid to return to an equal height in the two limbs. Let the mercury be allowed to return, but be constrained so that it is released slowly; it goes back to its original positions without oscillations. If, however, the constraint is suddenly removed, owing to inertia, it overshoots the mark and oscillations are created. If the tube is rough in the interior or the liquid viscous, these oscillations will quickly subside, being damped out by friction, but other things being equal the denser the liquid the more prolonged will be the time of the oscillations. Thus we see that density or inertia in the vibrating matter corresponds in effect with the inductance of an electric circuit in the case of the electric oscillations, and the frictional resistance experienced by the liquid in moving in the tube, with the electric resistance of the circuit. If we suppose the U-tube to include air above the mercury and to be closed up at its ends, the compressibility of the enclosed air corresponds to the electrical capacity of the conductors.

Hence the necessary conditions for the creation of mechanical oscillations in a material system or substance are that there must be a self recovering displaceability of some kind, and the matter displaced must possess density or inertia; in other words, the thing moved must tend to go back to its original position when the disturbing force is withdrawn, and to overshoot the mark in so doing. Frictional resistance acts merely in an antagonistic manner and causes decay in the amplitude of the oscillation. We have these conditions realised in the familiar case of a violin string or a tuning-fork, and in them we can create mechanical oscillations when they are displayed and suddenly released. In the same way the condition for establishing electrical oscillations in a circuit is that it must connect two bodies having electrical capacity with respect to one another, such as the plates of a condenser, and the circuit must itself possess inductance and low resistance. Under these conditions the sudden release of the electrical strain results in the production of an oscillatory electric current in the circuit, provided the resistance is less than a certain critical value. We have these conditions present in every Leyden jar when the two coatings of the charged jar are connected by a thick copper wire.

It was long ago suspected that the discharge of a Leyden jar did not always consist in the flow of a transient unidirectional current through the discharging circuit, but was in some cases an oscillatory current diminishing gradually in strength. Joseph Henry, in 1842, came to this conclusion, guided to it, no doubt, by his observations on the irregular effects attending the magnetisation of steel needles by Leyden jar discharges. He remarked:—*

> The discharge (that is of a Leyden jar), whatever may be its nature, is not correctly represented by a single transfer of imponderable fluid from one side of the jar to the other. The phenomena require us to admit the existence of a principal discharge in one direction and then several reflex actions backwards and forwards, each more feeble than the preceding, until the equilibrium is obtained. All the facts are shown to be in accordance with this hypothesis, and a ready explanation is afforded by it of a number of phenomena which are found to be described in the older works on electricity, but which have until this time remained unexplained.

Von Helmholtz, whose penetrating genius opened up so many new ideas, in his celebrated essay, "Die Erhaltung der Kraft," said in it:—

> We assume that the discharge of a jar is not a simple motion of the electricity in one direction, but a backward and forward motion between the coatings in oscillation, which become continually smaller until the entire *vis viva* is destroyed by the sum of the resistances.

Lord Kelvin, in 1855, published a classical Paper on "Transient Electric Currents,"† in which the discharge of the Leyden jar was mathematically treated in a manner which elucidated important facts. He recognised the influence which the "electro-dynamic capacity," or as we now call it the "inductance," of the discharge circuit had upon the effects, and he established an equation of energy which expresses the fact that the energy of the charged jar at any instant is partly being dissipated as heat in the discharging circuit, and partly conserved as current energy in that circuit. At any moment the rate of release from the energy of the jar is equal to the rate of dissipation of energy in the discharging circuit plus the rate of change of the kinetic energy associated with the circuit.

If the capacity of the jar is represented by C, the resistance of the discharge circuit by R, and the inductance of that circuit by L, then the above equality may be stated mathematically as follows:—

$$-\frac{d}{dt}\left[\frac{1}{2}\frac{q^2}{C}\right]=\frac{d}{dt}\left[\frac{1}{2}Li^2\right]+Ri^2,$$

or

$$L\frac{di}{dt}+Ri=-\frac{1}{C}\int i\,dt,$$

or

$$\frac{d^2q}{dt^2}+\frac{L}{R}\frac{dq}{dt}+\frac{1}{LC}=0,$$

or

$$TT_1\ddot{q}+T_1\dot{q}+q=0.$$

Where T is written for $L/R$, $T_1$ for $CR$, and $\dot{q}$ and $\ddot{q}$ for the first and second time differentials of $q$.

The above differential equation belongs to a class which occurs in numerous physical investigations, and its solution in the last form consists in finding the value of the quantity of electricity $q$, or the charge of the jar at any instant in terms of the time and the three constants. An equation of this kind has two solutions according to the relation of the constants C, L, and R.

It is easy to show, following Lord Kelvin, that the nature of the solution of the above equation is determined by the relative values of the quantities $L/R$ and $LC$, or by $L/R$ and $\frac{L}{R}CR$. If $\frac{1}{4}\frac{R^2}{L^2}$ is greater than $\frac{1}{CL}$, that is if R is *greater than* $\sqrt{\frac{4L}{C}}$, that is if $R^2$ is greater than $4L/C$, the charge in the jar dies away gradually as the time increases, in such a manner that the discharge current is always in one direction. The ratio $L/R$ is called the *time constant* (T) of the discharge circuit, and the product CR is called the time-constant ($T_1$) of the condenser. Hence the above condition amounts to saying that the discharge is unidirectional when T is less than $\frac{1}{2}\sqrt{TT_1}$—that is, when the time-constant of the circuit is less than half the geometric mean of the time-constants of the circuit and of the condenser.

On the other hand, if R has a value less than $\sqrt{\frac{4L}{C}}$, or $R^2$ is less than $4L/C$, the solution of the equation shows that the discharge current is oscillatory or alternating, its maximum values in both directions gradually decreasing as time increases.‡

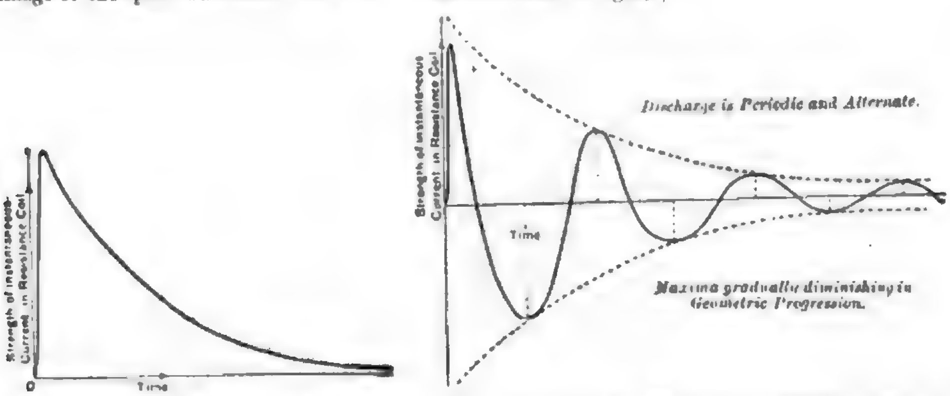
* Cantor lecture delivered before the Society of Arts, November 26 1900.

* "The Scientific Writings of the Late Professor Joseph Henry," Washington, 1886, Vol. I.

† *Phil. Mag.*, 1853, "On Transient Electric Currents."

‡ The above statements are subject to a small modification, to which reference is made later on.

The two cases are represented graphically by the curves in Fig. 1, the ordinates of which show in a diagrammatic manner the value of the discharge current from instant to instant, the ordinates drawn above the horizontal datum line representing currents in one direction, and ordinates drawn below currents in the opposite direction. In the oscillatory case the gradual decrease in maximum ordinate is called the *damping*, and the *damping coefficient* is a factor which represents the rate at which the oscillations of current die away—that is, the rate at which the maximum values of discharge current continually decrease. The prediction that the discharge of a condenser may take place by a series of decreasing alternating currents or electric oscillations has been abundantly verified by experiment. Feddersen and Paalzow, in 1861 and 1863, examined the discharge of a jar in a revolving mirror; Paalzow passed a discharge through a vacuum tube. It was found that if the discharge circuit had a resistance greater than a certain critical value the image of the spark was drawn out into a continuous band of light, and the vacuum tube showed by the different appearance of the glow on the two electrodes that the discharge was unidirectional. If, however, the resistance was less than a certain critical value, then the image of the spark was split up into a series of bars of light, whilst the vacuum tube showed by the identity in the appearance of the glow-light at both terminals that the discharge was bi-directional. Moreover, a magnet then held near the vacuum tube split the discharge into two lines of light.



Curve representing the Discharge of a Condenser through a Large Resistance.

Curve representing the Discharge of a Condenser through a Small Resistance.

FIG. 1.

FIG. 2.—Photographs of Oscillatory Leyden Jar Sparks. (Mr. Vernon Boys.)

Mr. Vernon Boys, whose dexterity in difficult experiments is well known, photographed some years ago the oscillatory discharge of a Leyden jar by means of a rapidly-revolving lens, and showed that with sufficiently low resistance in the circuit the discharge consisted of a series of separate successive spark discharges, each of which left a separate image upon a photographic plate.* One of Mr. Boys' photographs is reproduced in Fig. 2. Prof. J. Trowbridge has obtained remarkably interesting photographs of oscillatory electric sparks taken from the discharge of a large condenser, charged by means of storage cells giving an electromotive force of 20,000 volts. (See *Nature*, August 2, 1900, Vol. LXII., p. 325.) Moreover, by means of a series of condensers charged in parallel and discharged in series when connected with an inductive circuit, he has obtained spark discharges 6ft. or 7ft. in length, representing 3,000,000 volts. By using large inductance the frequency of these oscillations may be kept down as low as 5,000 per sec., or even to 800. Prof. Trowbridge has also obtained photographic proof that these long 7ft. sparks resembling lightning are oscillatory in character. Dr. E. W. Marchant, working in Lord Blythswood's laboratory at Renfrew, has done much interesting work in photographing oscillatory electric sparks with a revolving mirror. (See *Nature*, August 30, 1900, Vol. LXII., p. 413.)

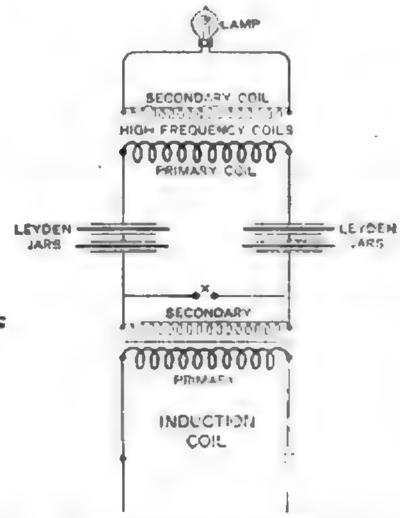


FIG. 3.—Arrangement for Producing Electrical Oscillations.

We must now pass on to notice the most convenient experimental arrangement for producing these electrical oscillations. The single discharge of a Leyden jar would provide us only with a feeble source of such oscillations; a better arrangement, however, is as follows: Two series of Leyden jars are provided, and their inside and outside coatings connected. The inner coatings of the two sets are connected respectively to two adjustable spark balls, *x*, and also to the secondary terminals of a large induction coil, the current in the primary circuit of which is interrupted by a Wehnelt or other high-speed break. (See Fig 3.) To get the best effects this induction coil should be one having a secondary circuit wound with thick wire. Generally speaking, the secondary circuit of an induction coil giving, say, an 8in. spark, is wound with fine wire, perhaps No. 36 wire, and will have a resistance of 10,000 ohms. The outer coatings of the two sets of jars are connected together through a thick copper wire in which the oscillations are to be set up. When the induction coil is in action, the inner coatings of the two sets of jars become charged to opposite potentials, and if the spark balls are then adjusted to be about 2mm. or more apart in distance, the two sets of jars will discharge across this gap, and at each discharge electrical oscillations are set up in the circuit connecting the outer coatings.

The reason that the secondary circuit of the induction coil should have as low a resistance as possible is as follows: When a condenser is charged through a resistance by a certain electromotive force applied for a short time, the charge in the jar does not arrive at its full value corresponding to the capacity and voltage unless the contact endures for a time, at least five to 10 times the *time constant* of the condenser. If C is the capacity of the jar measured in microfarads, and R is the resistance, measured in megohms, of the circuit to which it is charged, then the product CR represents in seconds or fractions of a second the time-constant of the condenser circuit. The capacity of a large Leyden jar, having, say, $1\frac{1}{2}$ sq. ft. of coating surface, may approximate to $\frac{1}{100}$th of a microfarad, hence six such jars in parallel would have a capacity of $\frac{1}{16}$th of a microfarad. It is here necessary to point out that when two condensers are joined in series, the capacity of the two is added by the same rule as that by which we add resistances in parallel. Hence if $C_1$ and $C_2$ are the capacities of two condensers separately, then when joined in series the joint capacity is $\frac{C_1C_2}{C_1+C_2}$. Accordingly the capacity of two equal condensers joined in series is half that of either of them.

If, then, as in our arrangement, six jars are joined in parallel and then two such sets have their outer coatings of the two sets charged

* See *Proceedings* Physical Society, London, Vol. XI., p. 1, November, 1890. In some of Mr. Boys' experiments the condenser discharged had a capacity of about 0·1 of a microfarad, and the discharge circuit an inductance of about 26,000,000cm. or 0·026 of a henry. Hence the oscillation frequency was about 3,000 per second. The photographs showed from 14 to 23 oscillations, and the frequencies as determined by observation and experiment agreed very well.

to opposite potentials, the total capacity with which we are concerned is equal to that of $\frac{1}{2} \times 6 = 3$ of the jars, or to $\frac{1}{100}$th of a microfarad

The secondary circuit of an 8in. spark induction coil, as generally made, has a resistance of 10,000 ohms, or $\frac{1}{100}$th of a megohm; hence the time-constant of the circuit formed when such a coil is used to charge the two sets of six jars is $\frac{1}{10000}$th of a second. The electromotive force charging the jars through the said circuit must therefore be maintained for at least $\frac{1}{1000}$th of a second if the jars are to be charged with a charge corresponding to their capacity and to the maximum value of the electromotive force. If, then, the primary of the induction coil is interrupted by a Wehnelt break, which may give more than 1,000 interruptions per second, it is clear that if the secondary circuit of the induction coil has a resistance greater than 10,000 ohms, the time-constant of the whole circuit formed of the condensers and secondary circuit may limit very much the total quantity of electric charge which can be accumulated in the two sets of jars in the interval between two discharges. Assuming, however, that the proportions are suitable, the result of employing a high-speed break and induction coil with two series of jars in the above manner is that we are able to set up in the circuit connecting the outer coatings—if it does not possess too great a resistance—a series of powerful intermittent oscillations. These oscillations are not continuous, but occur, so to speak, in groups or batches.

*(To be continued.)*

## CORRESPONDENCE.

### BRITISH ELECTRICAL SUPERANNUATION FUND.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of June 29th last you were good enough to publish a short letter of mine dealing with the question of the Superannuation Scheme, which at that date had just been authorised by the shareholders of the British Electric Traction Co., and, as the scheme in its early stages attracted much attention, it is possible that many of your readers may be glad to know that the British Electrical Superannuation Fund is now fully constituted, with Lord Vaux of Harrowden and Mr. George Herring as Investment Trustees, and with a representative committee of six acting as Managing Trustees.

The staff of the British Electric Traction Co. has given the Fund satisfactory support, and our Associated Companies have now been invited to join. As I explained in my previous letter, the rules of the Fund have been drawn up expressly with a view to enable *any* electrical company to participate in the scheme should it wish to do so.

The broad lines of the scheme are as follows:—

The funds will be invested in the names or under the legal control of the Investment Trustees. Careful consideration has been given to the investment clause with a view to secure as high a rate of interest as is compatible with safety. This object has been attained by giving the trustees a very free hand in regard to the character of the investments they may make, but strictly limiting their powers in regard to the proportion of the total funds which they may place in any one company or form of security.

The affairs of the Fund will be under the immediate management of an elective committee equally representative of the Contributing Companies and the Contributing Members. A quinquennial valuation of the Fund by two independent actuaries is provided for, stringent rules ensuring that the report made by the actuaries shall not be disregarded.

Speaking generally, each Contributing Company must make monthly a contribution equal to 3 per cent. of the monthly salary of each Contributing Member on its staff, and the member himself must make monthly a contribution equal to $2\frac{1}{2}$ per cent. of his monthly salary, plus, in the case of those over 24, a certain extra percentage, varying with age.

The "retiring age" is 60, and a member must be of at least 10 years' standing before he is entitled to a pension. Upon retirement a member will receive, for every year of service, $\frac{1}{60}$th of the average annual salary received by him during the seven years preceding retirement, the maximum scale of pension being two-thirds of salary. It is important to note here that service with any and every Contributing Company counts towards pension, so that an officer can pass from the service of one such company to that of another without injury to his pension prospects.

This scheme, I should add, is intended to apply only to those who are on the monthly salary list and who are between the ages of 18 and 45.

For the provisions which exist in regard to members who wish to reckon their back years of service, in regard to members whose percentage contributions are heavy by reason of their age, and in regard to the contributions of and on behalf of the present staff of a Contributing Company, I must refer any firm interested to the Trust Deed and Rules, which are to be had on application at this address to Mr. W. G. Bond, the Secretary of the Fund.—Yours, &c., E. GARCKE.

Donington House, Norfolk-street, W.C., Jan. 23.

### MAGNETIC OBSERVATORIES AND TRACTION DISTURBANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue Mr. Wedmore asks me a question which I have already replied to in my letter to *The Times* of January 3rd and elsewhere. I beg to send you an extract from *The Times'* letter:—

I said at the conference of the Board of Trade, and, having recently examined the records with care, am now in a position to state explicitly, that no disturbance has as yet been observed in the Kew magnetic curves which affects the use of those curves, either for the purpose of determining the daily variation in the magnetic elements or for comparison with the records of other observatories, or for the verification of instruments. These are the purposes for which they are regularly employed. These curves have for some time past been open to the inspection of the representatives of the company.

If the curves be very carefully examined a skilled observer may notice that during a quiet magnetic period the edge of the curve at night time is somewhat more sharply defined than during the day; the difference, however, is extremely slight, and for the purposes for which they are used does not affect the value of the records at all.

By the use of other and much more sensitive apparatus I have detected earth currents near the observatory which have their rise, no doubt, in one or other of the existing railways, but these currents at present are too small to produce an appreciable effect on the standard recording instruments.

As to the other questions raised, they can be discussed better after some experiments now in progress are complete. I may say, however, that in my letter I was referring to observations which had been made on lines running from Chiswick to Brentford. The observatory is not between these points, and is well over a mile from Brentford.—Yours, &c., R. T. GLAZEBROOK.

Richmond, Surrey, Jan. 21.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have only just seen the letters of Dr. Glazebrook and of Mr. Wedmore in your issues of the 4th and 18th inst. respectively. The latter gentleman is mistaken in thinking that I am aware that the theorem that, assuming a homogeneous earth, the leakage currents produce no vertical magnetic force was proved by him some time before I arrived at it. I had proved that theorem and had worked out fully the disturbances produced by lines of different lengths, and for all angles of inclination of the needle to the line, on what I have called the source and sink theory, and had also shown that on certain assumptions the Fourier-bar theory held good, before I knew that anyone else was working at the same subject. The results were shown to Prof. Perry and Dr. Glazebrook.

The first time I heard of Mr. Wedmore's work was at a meeting with the representatives of the Tramways Company. A remark was then dropped—I think by Mr. Trotter—which showed that he was aware of the above theorem. I immediately replied, "We know all about that"; and after the meeting I stated some of my principal results to one of the gentlemen present, who replied that his side had arrived at similar conclusions, and gave me the name of the gentleman who had been working at the problem. I must apologise for having forgotten the name he gave me, but no doubt it was that of Mr. Wedmore.

I had not then worked out the Fourier-bar theory so as to obtain numerical results, but at a subsequent meeting the representatives of the Tramways Company stated that they had obtained, "partly by that theory and partly by experiment,"

a relation between the leakage and the length of the line, which was embodied in certain curves which were shown to us. Nothing was said as to whether the disturbances produced by lines of different lengths had been calculated. I thereupon worked out the problem of leakage on the Fourier-bar theory so as to get numerical results, which I found were in general agreement with the statements made.

These facts I have stated more shortly in my Paper, and I also stated them at the meeting of the Physical Society. I have not a copy of the Paper before me, but the general tenor of the passage is that during the negotiations it became evident that results similar to my own had been obtained by the representatives of the Tramways Company, and that the Fourier-bar theory was only fully developed by me when I learnt from them that it agreed well with the results of experiment. I have also referred to the fact that the Fourier-bar theory was published in your columns by Mr. Parry on Aug. 10, 1900.

But, Sir, while I feel bound to state the above facts, I think that nothing would be more foolish than a contest about priority. I freely admit that Mr. Wedmore's results are independent of my own, as mine, with the single exception I have mentioned, were of those of others. If he will signify to me privately that he accepts my offer, I will send him a proof of my Paper when it is printed, and if he thinks that the statement I have made inadequate I shall be glad to do what I can to meet his views; or, if more agreeable to him and if he can assure me that he has covered the same ground as myself, I shall be glad to unite his name with my own as joint author.—Yours, &c., ARTHUR W. RÜCKER.

London, Jan. 21.

## MR. CAMPBELL'S PHASE-TURNING DEVICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have to thank Mr. Duddell for kindly pointing out and clearly illustrating limitations in the use of my phase turner which I had overlooked when I wrote my Paper. I should like now (*a*) to explain the cause of these limitations and (*b*) to show how the apparatus can be safely used, not only to measure small voltages and "power lags," but also to indicate the occurrence of differences of wave-form.

(*a*) When the auxiliary voltage V has its power phase turned gradually round from 0deg. to 360deg., why is it sometimes impossible to bring it into phase with the voltage X? The answer is simply that *the vector X is in these cases not in the plane of the turning vector V*, but is as represented in Fig. 1, where VVV is in the horizontal plane.

FIG. 1.

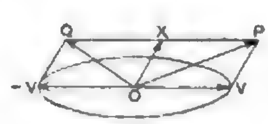


FIG. 2.

As Dr. Sumpner pointed out some years ago, such problems belong to solid geometry, and the vectors cannot be compounded in one plane as I (in common with well-known text books) assumed they could be. When all the wave-forms are sine curves one plane is sufficient.

(*b*) *To measure a small voltage X.* Turn the power-phase of V until P and Q, the maximum and minimum resultants of V with X, are arrived at.

(1) If we find $P+Q=2V$, then X is in the plane of turning, and $X=P-V$.

(2) If $(P+Q-2V)$ is very small but $P-V$ not very small, then X is sufficiently nearly in the plane of turning to take $X=P-V$; this is the case where the wave-forms are not much unlike.

(3) When $(P+Q-2V)$ is not very small, then X makes a considerable angle with the plane of turning, and difference of wave-form is indicated. We can, however, find X by constructing the triangle whose sides are the observed values 2V, P and Q; as in Fig. 3, X is found by drawing the medium for the side 2V.

It should be noticed that the above method is quite safe, the consideration of the magnitude of $(P+Q-2V)$ indicating when the wave-forms require the construction of the triangle in place of the simpler formula. If the results of experiment II. in my Paper be examined, it will be found that $(P+Q-2V)=0{\cdot}6$ volts, thus indicating the alteration in wave-form.

*To measure the power lag between $X_1$ and $X_2$.*

The positions of the vectors $X_1$ and $X_2$ relative to the plane of turning of V can be fixed by the latitudes and longitudes at which $OX_1$ and $OX_2$ cut the hemisphere whose equatorial plane is the plane of turning. The longitude of each can be got accurately by turning V till power quadrature is attained, while latitudes are found by constructing, as in Fig. 3, the triangles with maximum and minimum resultants and 2V. From their latitudes ($\theta_1$ and $\theta_2$) and longitudes ($\psi_1$ and $\psi_2$) the power lag $\phi$ between $X_1$ and $X_2$ can be obtained by the formula

$$\cos\phi = \cos\theta_1\cos\theta_2 + \sin\theta_1\sin\theta_2\cos(\psi_2-\psi_1).$$

If both latitudes are zero, the differences of wave-form are inappreciable, and $\phi$ = the angle between the two quadrature positions of V.

In the 13th line from the end of my Paper "$\phi$" should be read for "Q," and in the fourth line from the end "$X\cos\phi$" should be read for "$\phi$." From what has been said above the last sentence of the Paper no longer holds.

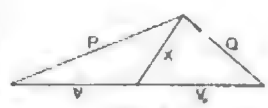


FIG. 3.

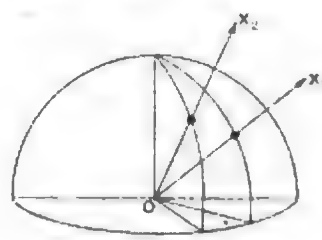


FIG. 4.

In the above I have assumed that the voltage vector of the phase-turner turns in one plane (or to put it in other words, may be consistently represented in the same plane in all its positions). As the two component voltages used in the apparatus may be of different wave-forms it is necessary to prove this assumption, and it may be done as follows:—

Let
$$u_1 = a\sin pt + b\sin 3pt + \quad .\ .\ .\ .$$
$$u_2 = a\sin(pt+\alpha_1) + b\sin 3(pt+\beta_1) + \quad .\ .\ .\ .$$

where $u_1$ and $u_2$ have equal effective values—*i.e.*, $U_1=U_2=V$.

Also let $u_1$ and $u_2$ be set to power quadrature—*i.e.*,

$$\int_0^T u_1u_2\,dt = 0.$$

If we use these voltages in the phase-turner, two positions of the turned voltage will be given by

$$y = u_1\sin\psi_1 + u_2\cos\psi_1$$
$$z = u_1\sin\psi_2 + u_2\cos\psi_2.$$

To find the power-lag between $y$ and $z$—

$$\int_0^T yz\,dt = \int_0^T (u_1^2\sin\psi_1\sin\psi_2 + u_2^2\cos\psi_1\cos\psi_2)dt$$
$$+ \int_0^T u_1u_2\sin(\psi_1+\psi_2)dt$$
$$= TV^2\cos(\psi_2-\psi_1).$$

Hence the power-lag between $y$ and $z$

$$= \psi_2 - \psi_1.$$

$\therefore$ the voltage vector of the phase-turner turns in a plane whatever the difference of the component curves.

In conclusion, I would again emphasise the fact that the phase-turner affords a means of indicating the occurrence of differences of wave-form.—Yours, &c.,

London, Jan. 21. ALBERT CAMPBELL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There is one point in connection with Mr. Campbell's phase-turning device which has not yet been mentioned. When using the apparatus to determine the phase difference between two voltages $X_1$ and $X_2$, the voltage V in the "phase-turner" is first adjusted until it is in power quadrature with $X_1$. With symmetrical waves, such as occur in the majority of instances, the phase of V corresponding to power quadrature with $X_1$ also corresponds to time quadrature. As Mr. Duddell points out, "the power-factor is zero when V has its maximum value at the same time that $X_1$ crosses the zero line." Similarly with V and $X_2$, the phase of V corresponding with power quadrature also corresponds with time quadrature. The change in phase of V necessary to obtain power (and time) quadrature with the two waves is a measure therefore of the *time* lag of $X_1$ behind $X_2$ (although it may not be a measure of the power lag), provided all the wave-forms are symmetrical.—Yours, &c.,
E. W. MARCHANT.

London, Jan. 22.

## CAPACITY IN ALTERNATE-CURRENT WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with Mr. Mordey's Paper under the above title, might I suggest that a far better way of measuring dielectric hysteresis loss than the one he employed is to put the dielectric of the cable *in series with* a suitable choking coil *without iron*, and arrange matters so that the current through them is approximately in phase with the P.D. of the alternator. An ordinary wattmeter would then measure the power spent in cable and choker with fair accuracy. The watts spent in this ironless choker can be determined by $C^2r$, and deducted from the wattmeter reading. Prof. Ayrton agrees with me in thinking that the method here described is even better than the one he suggested in last week's *Electrician*, in which the cable and ironless choker were in parallel.

As the P.D. of the alternator would only require to be a small fraction of that between the inner and outer conductors of the cable, there would be no need to use transformers for reducing the P.D. on the pressure-coil of the wattmeter, or to extend the experiment over several hours to get a reading. An electrostatic voltmeter would, of course, be used to measure the pressure to which the cable is subjected.

I hope to give a description of a choker of variable inductance, *without iron*, in the discussion on Mr. Mordey's Paper.

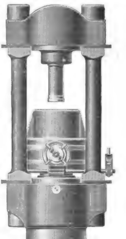
Before concluding, I may remind you that the method here suggested enables cables to be tested to much higher pressure than that produced by the alternator used, and this without the use of step-up transformers.—Yours, &c.,

London, Jan. 23. T. MATHER.

## MACHINERY FOR COVERING ELECTRIC CABLES WITH LEAD.

From the time of the very earliest experiments made by investigators in the transmission of electric currents, the great advantges offered by the provision of a lead protecting covering encasing the insulating material has been recognised wherever circumstances made it desirable that bare conductors should not be employed. As early as 1845 we find Messrs. Wheatstone and Cooke taking out a patent for protecting wires covered by a variety of insulating material and having an outer protecting coating of lead, this coating being in the form of a lead strip wound spirally along the conductor and afterwards soldered along the edges. Since that time, when the lack of appliances for providing a continuous covering made this expedient necessary, to the present time, when cable manufacturers use large hydraulic presses giving up to 4,000 tons effective pressure, the lead protecting covering has stood highly in the estimation of all electricians to whom the use of conductors covered with insulating materials has been necessary. Besides being impervious to moisture, the covering of lead has the other equally desirable advantages that it does not impair the flexibility of the cable, that the cable can be jointed easily, and that in ordinary circumstances the covering does not readily deteriorate when laid underground.

With the rapid development of electrical science following upon Messrs. Wheatstone and Cooke's inventions, the need for suitably protected conductors became more and more pressing, and the patent records, both of this country and America, give evidence of many serious attempts to provide suitable appliances for the production of a homogeneous and seamless covering in the form of an extruded lead pipe, such as was made at that time by hydraulic pressure. One method adopted was to fasten one end of the conductor to be covered with lead to the end of the core in the hydraulic press upon which lead pipe was made, the core being somewhat larger in diameter than the cable to be covered. The conductor was laid out on a long bench having conveying rollers spaced at suitable intervals along its surface, and, as the lead from the pipe press was forced out in the form of a pipe, it travelled along encasing loosely the conductor. When the length of cable laid out was covered the end next to the pipe press was cut off and the lead pipe formed was tightened on the cable by being passed through a die such as is used for drawing pipes, or through rollers. This system was both slow and cumbersome, and failed in many respects to satisfy the requirements of the time. Only comparatively short lengths of cables could be covered in this way, necessitating frequent jointing and consequent increased risk of failure of the cable at these points. The lead pipe was made at a temperature of nearly 400°F., which destroyed insulating materials in most cases and rendered the cable useless. An improvement was effected by substituting a wire a few yards long for fixing to the core of the lead press. The cable being fixed to the free end of this wire it was possible to pass the lead pipe through a water trough and cool the outside before it passed over the cable. Even with this improvement, however, the process had only a limited application, both as to the length and size of the cable to be covered. It was also common among manufacturers of conductors to purchase lead pipes made in the ordinary way and draw the cable to be protected through these, tightening them by means of rollers or a die as described above.



The very rapid development of electrical appliances which followed upon the introduction of electric lighting, and, latterly, of the telephone, made other methods imperative if cable manufacturers were to be able to cope with the demands made upon them, both in respect to the length and the size or number of the conductors. Cables were required up to 3in. and 4in. diameter, and in lengths which were quite impossible of production by any of the older methods. Mr. Alexander Wylie, of Johnstone, who had for many years been associated with the late Mr. John Weems, of Johnstone, the patentee of an improved type of hydraulic lead press, was consulted on the subject by some of the more important cable manufacturers of the country, and, after a considerable time had been passed in experiment, he succeeded in inventing a hydraulic lead press for covering cables with lead, which practically met the very exacting requirements of users of cables. One of the foremost conditions was that the lead covering should be made in any length required without joint. Another was that the tube should be con-

centric and put on the cable in such a way as neither to fit too loosely nor to compress the cable and thus impair the value of the insulating material used. It was also necessary that the cable to be covered should not take so long in its passage through the lead press that the high temperature of the press destroyed the insulating material. And all these conditions had to be fulfilled by a machine which would work at a rate of speed and cost approximating to the speed and cost at which ordinary lead pipes were made. Another important essential point is the rapidity by which a change from one size of cable to another can be effected, and this can now be done within a quarter-of-an-hour.

All of these conditions, after many years of experiment and practical working of lead cable presses, has Mr. Wylie been able to meet satisfactorily in the latest type of lead press illustrated on opposite page, which are specially applicable for the covering of cables with a lead tube of any desired thickness. The cables, after being finished and insulated, are passed through the hollow core or point and the die of the lead press. These cores and dies are easily interchangeable, and the cable maker has a complete set of these for cables of different diameter and different thicknesses of lead. The arrangement of the core protects the cable from the pressure which is necessary to squeeze the lead on to the cables, and the lead tube can be made to fit tightly or slackly as may be desired. The lead is melted in a lead-pot, and flows into the container in a molten state. Any oxidation or impurities are skimmed off the surface and allowed to solidify under a slight pressure of the press to expel any air collecting therein, due to contraction of the molten metal in cooling. When the lead is sufficiently set, the pressure is supplied to the hydraulic ram of press by hydraulic pumps driven by electric motors or any other power, and this raises the container containing the lead up against the top lead ram. The lead having no means of escape is forced out as a tube between the core and die, clasping the cable. When the container is half empty or empty the hydraulic ram is reversed, the container is refilled with molten lead, and the same operation is repeated, covering cables in any lengths. The lead containers, core and die boxes are steam heated or cooled by water, and therefore they can be regulated in temperature. This is of the utmost importance in the covering of cables with lead, to ensure uniform flow of lead all round the cores and dies, and equal thickness of lead all round the circumference of the lead pipe produced on the cables.

That Mr. Wylie has been successful in the results he aimed at is amply testified to by the fact that there is no cable manufactory of any great importance in the country that has not these lead presses at work. One firm have no less than eight presses, varying in size from 13in. diameter of ram giving a gross pressure of 260 tons, to 33in. diameter of ram giving a total pressure of 2,600 tons. One of the largest hydraulic presses in this country used for any purpose was a cable-covering lead press recently made by Mr. Wylie's firm with a 33in. diameter ram, capable of being worked up to a pressure of 5 tons per square inch, and giving a gross pressure of 4,000 tons. This press could turn out a pipe over 16 cwts. in weight at one charge. The pipe formed in the various charges were of course made in one continuous length. Cable covered with lead pipes on this principle are made from ½in. to 4in. diameter, and of thicknesses varying from $\frac{1}{16}$in. up to ½in. thick, according to the size of the pipe required to suit the cables to be covered. The presses are made under Mr. Wylie's supervision by Messrs. John Wilson & Son, of Johnstone, who also manufacture all the necessary auxiliary machinery, including hydraulic cranes for lifting and removing the portions off the machine which require to be handled, and specially-strong hydraulic pumps with forged-steel pump barrels, gunmetal lined, made for being driven directly by a steam engine fixed on throw shaft or by electric motor.

## LEGAL INTELLIGENCE.

### City of London Electric Lighting Co. (Ltd.) v. Corporation of London.

This case came before the Court of Appeal (the Master of the Rolls and Lords Justices Collins and Romer, on Monday and Tuesday on the appeal of defendants from the order of Mr. Justice Farwell of May 3, 1900.

Mr. SWINFEN EADY, Q.C., for the appellants, said plaintiffs, the City of London Electric Lighting Co., Ltd., by their statement of claim sought a declaration that defendants were bound by certain electric lighting agreements. That was the whole relief claimed. Defendants' case was that the Corporation were not bound, as certain members of the Commissioners of Sewers, to whose position the Corporation were successors, were interested in the contracts contrary to the statute, and that the contracts were thereby voided. Mr. Justice Farwell decided in favour of the company on the grounds that the class of contracts which the statute made void if the Commissioners were interested in them were contracts for works as distinguished from contracts to supply gas, water or electric energy, and that the persons interested were only interested as shareholders in the company. The contention on behalf of the appellants was that the learned judge in the Court below was wrong on both points. The question turned on the construction of the Commissioners of Sewers Acts of 1848 and 1851. The contracts in question were entered into in 1890 or 1891 with the Brush Electrical Engineering Co., of which the plaintiffs were assignees, and had been acted upon by both parties. There were three separate contracts for the lighting of the central, eastern and western areas of the City of London. As regarded the central and western parts, at the time the contracts were made there were among the Commissioners of Sewers certain aldermen and common councillors who were also shareholders in the Brush Electrical Engineering Co. (Ltd.) with whom the contracts were made, the suggestion being that if they were members of the company which entered into the contract, the contract was null and void. The third contract was entered into when no member of the Commissioners of Sewers or aldermen or common councillors was a member of the contracting company, but subsequently certain shares were taken in the plaintiff company by members of the Corporation, and the suggestion was that even that fact rendered the contract null and void. In the case of the eastern district the original contract became vested later in the plaintiff company, of which some members of the Corporation were shareholders, and the case for the defendants was that they made the contract null and void *ab initio*. The case for the appellants was that, under the Commissioners of Sewers Act of 1848, if any alderman or common councilman was directly or indirectly interested in any contract for works, &c., with the Commissioners, such contracts became null and void. The learned counsel contended that a shareholder in a company was a person interested in the company. These contracts were not merely contracts to supply electricity, but contracts to execute "works" in respect of which there was a detailed specification which was not to be departed from.

Mr. DANCKWERTS, Q.C., argued on the same side.

Mr. CRIPPS, Q.C., for respondents, upheld the decision of Mr. Justice Farwell, contending that the prohibition applied only to contracts for works, and not of supply, as otherwise it would be in the power of any common councilman, by taking shares in the contracting company, to plunge the City in darkness.

Mr. SWINFEN EADY, Q.C., having been heard in reply, their lordships reserved judgment.

### Lane v. Elliott Bros.

Mr. Justice Ridley gave judgment last week in this interpleader issue. The case was reported in *The Electrician*, of Jan. 18.

Mr. Justice RIDLEY said the point argued in the case turned upon the particular description of the company. The company of Fowler-Lancaster was originally constituted in 1894 as the Fowler-Lancaster Co. (Ltd.). It was wound up in 1897. Then the New Fowler-Lancaster (Ltd.) was formed and debentures were issued. On Jan. 31, 1893, it was intended that the name of the New Fowler-Lancaster (Ltd.) should be dropped so far as the word "New" was concerned, and a special resolution to that effect was passed. By some omission on the part of the secretary of the company he did not obtain the approval of the Board of Trade to the change, and the result was that, in point of fact, the name technically remained as that of the New Fowler-Lancaster (Ltd.). In the meantime the goods in respect to which the defendants in this action, Messrs. Elliott Bros., set up their claim, had been ordered by Fowler and Lancaster in the name of the Fowler-Lancaster Co. (Ltd.). On Jan. 20, 1900, the plaintiff was appointed receiver for the debenture-holders and the question arose as to whether he was entitled to claim on behalf of the debenture-holders the debt which was due from the Brighton Corporation. His lordship, having reviewed the different decisions on the point, was of opinion that the debenture-holders had a right to take the money in question, and accordingly entered judgment for plaintiffs.

It was arranged that the money should remain in Court for a fortnight pending notice of appeal.

### Winding-up Order.

Mr. Justice Wright yesterday granted an order for the voluntary winding up of the Coventry Gas Fittings, Electrical and Engineering Co. (Ltd. under the supervision of the Court. A scheme of reconstruction is before the shareholders, which, it is hoped, may be carried through.

### Reduction of Capital.

A scheme was placed before Mr. Justice Wright yesterday for a reduction in the capital of the Electricity Supply Co. for Spain, and the scheme received his lordship's approval. An order on the terms asked for by the company was granted.

## BOOKS RECEIVED.

**Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.**

"Practical Electro-Chemistry." By Bertram Blount. (London: Archibald Constable & Co.) 15s.

"*Proceedings* of the Royal Society." No. 440, Vol. LXVII. (London: Harrison & Sons.) 2s.

"Electricity." By J. D. Everett, F.R.S. An expansion of Everett's "Deschanel," Part III., on the lines of modern electrical theory. (London: Blackie & Son.) 4s. 6d.

"The 26th Report of the Purdue University for the year ended June 30, 1900." (Indianapolis: W. B. Burford.)

"The London Manual." Edited by Robert Donald. (London: Edward Lloyd, Ltd.) 1s. 6d.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Ayr Corporation invite applications for the position of manager of tramways. An advertisement contains further particulars, and applications must be sent in to the town clerk (Mr. A. G. Young), Council Chambers, Ayr, by Feb. 2.

Devonport Corporation require a chief assistant engineer to the borough electrical engineer. An advertisement gives further particulars, and applications must be sent to the town clerk (Mr. A. B. Pilling), Municipal Offices, Ker-street, Devonport, by Feb. 17.

Paisley Corporation require an engineer to take charge of the working and management of their electricity works. An advertisement contains further particulars, and applications must be lodged with the town clerk, Municipal Buildings, Paisley, by 31st. inst.

A draughtsman, with a good training in a mechanical engineering works, is required for the Bradford Electricity Department. Applications to city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford. See advertisement.

Charge electricians and switchboard attendants are required for extra high-tension power station and sub-stations operating electric tramways. See advertisement.

Manchester Electricity committee require an assistant mains engineer. An advertisement gives further particulars, and applications (addressed to chairman) must be delivered at the Town Hall, Manchester, by Feb. 5.

East Ham District Council require an outdoor assistant for their electric lighting and tramway department. Applications to engineer (Mr. W. C. Ullmann), 94, High-street, East Ham, London, E. See advertisement.

Jandus Electric Co. (Ltd.), Hartham works, Hartham-road, Holloway, N., require an assistant tester. See advertisement.

Sunderland Borough Council require a principal for their municipal technical college. Salary £500 per annum. Applications by 4 p.m. of Feb. 28.

Major F. G. Bowles, R.E., has been appointed superintending engineer of the Southern District of the Post Office.

Mr. L. R. Lee has been promoted from assistant mains engineer to mains engineer at Manchester, at a salary of £300 per annum.

**Alleged Theft of Telephone Wire.**—At the Marlborough-street (London) Police Court a labourer named Conolly was charged with stealing 23 lengths of telephone wire, each measuring 110yds. (value £3), the property of the National Telephone Co. Mr. A. Newton, who prosecuted for the company, said thefts of the company's wire from public places were of frequent occurrence, and the matter was serious, as communication was stopped from point to point. In the present case the wire stretched from Carburton-street to Clipstone-street, W., and communication between King's Cross and Paddington was in consequence stopped. Prisoner had been employed in putting the wire up, and therefore understood how to get it down. He wore a cap like those worn by the men in the employ of the company, and was allowed to go on roofs of houses. Remanded on bail of £50.

**Ayr.**—The Burgh electrical engineer (Mr. Arthur J. Fuller) has been authorised to complete the arrangements for the supply of electric current to the Glasgow and South Western Railway for lighting their station, engine sheds, &c., at Ayr.

**Baker-street and Waterloo Railway.**—Mr. T. L. Johnson, of Cleveland, Ohio, denies that he has acquired this undertaking from the London and Globe.

**Bangor (Ireland).**—A deputation, consisting of Dr. Todd and Mr. W. P. Adams, the solicitor and electrical engineer of the North Down Tramway Co., gave particulars to the Council last week regarding the company's electric lighting scheme. The Council were favourable to the principle of the scheme, and sanction is likely to be given.

**Barnes.**—The Council have decided to oppose the London United Tramway's scheme to construct electric tramways from Hammersmith Bridge across Barnes Common. The line from Putney to Richmond through Barnes and Mortlake was approved, but objection is raised to the proposed terms of purchase. The Surrey County Council are also to be invited to assist in opposing the scheme.

**Barnsley.**—Arc lighting is to be adopted in seven additional thoroughfares, and 20 Bray's and 28 ordinary gas lamps are to be removed.

**Blackpool.**—A Board of Trade inquiry was held here on Monday by Mr. A. P. Trotter into the application of the Council to borrow £76,780 for the construction of a portion of the electric tramways authorised by the Corporation's tramway order (1899) and also of £5,500 for building an accumulator house, offices, and car shed. The tramway is to run round the district of Marton, and will be over 2 miles in length. Technical details were supplied by the borough electrical and tramway engineer (Mr. R. C. Quin) and the borough engineer and surveyor (Mr. J. S. Brodie). There was no opposition.

**Bradford.**—An inquiry was held here last week into the application of the City Council to borrow £140,000 for electric lighting extensions. The town clerk (Mr. F. Stevens) appeared in support of the application, and plans and technical details were supplied by the city electrical engineer (Mr. R. A. Chattock). From the estimates it appeared that £28,700 of the sum required was for engine and boiler houses, coal stores and a coal siding; £2,800 for a new chimney; £1,400 for additions to offices, stores, meters and mains departments: £14,400 for six boilers fitted with superheaters and mechanical stokers; £2,000 for economiser, brick work and foundations; £2,500 for steam, exhaust, and feed piping, valves and tanks; £300 for feed pumps and fittings; £4,400 for coal and ash conveyors and elevators: £19,000 for two steam engines, fittings and foundations; £11,000 for two 1,000kw. electric generators; £6,000 for condensing plant and foundations; £1,200 for an overhead 30-ton travelling crane; £690 for machinery for repair shop; £1,800 for switchboard and instruments; £30,000 for mains; £10,000 for meters; £2,000 for public lighting of tram routes; and £1,810 for alterations to existing generating machinery. There was no opposition.

**Brighton.**—After considering the report of the town clerk (Mr. F. J. Tillstone) on the application of the Brighton and Rottingdean Seashore Electric Tramroad Co. for authority to construct a tramroad in continuation of Mr. Magnus Volk's electric railway, the Works committee recommend that the permission be not granted, and that as the company have not complied with the notice from the Corporation of Sept. 1 last, they be informed that the Corporation will proceed to exercise the statutory power conferred upon them to remove so much of the company's tramroad as may be necessary to enable the construction of an additional groyne and extend the existing groynes as described in the said notice.

**Bristol.**—The salary of the borough electrical engineer (Mr. H. Faraday Proctor) has been increased to £600 per annum, with a further increase to £700 on Jan. 1, 1902, on condition that the engagement is for two years from Jan. 1 last, a condition to which Mr. Proctor has agreed.

**Croydon.**—At a meeting of the Borough Council last week the Lighting and Electricity committee recommended that the borough electrical engineer (Mr. T. H. Minshall) be granted leave of absence to pay a visit to the United States in the spring to investigate electrical progress in that country. The matter was referred back.

**Customs Charges.**—Machinery and component parts thereof to be worked by electric power, and including belting of all materials for driving machinery, is admitted free into India, the component parts being only such as are indispensable for the working of the machinery and not adapted for any other purpose. This regulation applies only to machinery and component parts made of metal. A duty of 5 per cent. *ad val.* is imposed upon instruments, apparatus, and appliances and parts thereof used in electric lighting, galvanic, telegraphic, and telephonic working, except upon telegraphic instruments and apparatus and parts thereof when imported by or under the orders of a railway company or as part of a passenger's personal luggage.

**Dublin.**—The Electric Lighting committee further considered the question of the amendment of Mr. Hammond's specification of the proposed generating station at the Pigeon House. The chairman (Mr. Richard Jones) protested that the reduction of the estimates would not be in accord with the dignity of the Corporation, and it was finally decided to invite the Council to make application for a supplementary loan.

**Eastbourne.**—Application has been made for power to borrow £50,802 further for the erection of new electricity works at Roselands, and for new transformers, plant, mains, public arc lighting, &c. The extensions are to be carried out under the direction of the consulting engineer (Mr. W. C. C. Hawtayne). The cost of the original extension scheme was £33,412.

**Edinburgh.**—The Electric Lighting committee reiterate their recommendation that a deputation of five be appointed to visit English towns (London, Oldham, Bolton, and Brighton) to obtain information in connection with condensing plant at the McDonald-road station.

**Farnworth.**—The District Council have placed a contract for tram cars to the specification of Messrs. Lacey, Clirehugh and Sillar.

**Fatality on the Central London Railway.**—At Westminster, on Friday last, Mr. John Troutbeck held an inquest on Albert Pantling, a ganger of the Central London Railway Co., who died in King's College Hospital from injuries sustained on Dec. 25.

HENRY WELLS, permanent way inspector, said he was pointing out to deceased a little job he wanted him to do that night. He was standing near the crossing, about 2yd. from deceased, who was on a piece of timber when he (witness) accidentally touched the current rail with his 2ft. rule

which was "metalled" down all the way. In a moment there was a flash, which temporarily blinded witness, and he could not see the deceased, although he heard him fall. He really caught the two rails with his rule at the same time.

Mr. HOLT, engineer-in-charge of the permanent way, said if a man stood with one foot on the current rail and the other on the running rail the current would go through him, but, the voltage being only 500, would not necessarily kill him.

Mr. E. M. MALEK, assistant power engineer, said he did not think deceased's clothing was set alight by the flash which Wells had spoken of. He thought that was only an instantaneous spark, and he did not believe that that flash set fire to Pantling. The deceased must have stumbled perhaps through being startled, and made a second short circuit. There was no section of the line cut out on this particular night. The permanent way was inspected, and he believed no actual work was done on it until the current was cut off. At that very point the permanent way inspector was telling deceased, who was the ganger, what he wanted done somewhere else; but he was demonstrating what the job was when this happened. Anybody might receive a shock.

Medical evidence was given to the effect that only a few of the burns were the result of the clothing catching fire, the others having been caused by electricity. The man's hands and forearms were charred.

The CORONER said the case was an important one. As to whether any alteration could be made, that was beyond them as a jury, and was a matter for the Board of Trade, which had already had its attention called to the matter. A verdict of accidental death was returned.

**Fulham (London).**—The electricity supply works are nearing completion, and the contractors were, in accordance with custom, to have entertained the councillors and others to a banquet. The death of our Queen has, however, caused the abandonment of the function.

**Glasgow.**—The general manager of the tramways department (Mr. John Young) presided over the annual social gathering of a section of the employés of the department on Thursday evening last, and in the course of some remarks predicted that they would have 400 electric cars running by May next.

**Greenock.**—There are at present 172 customers of the electricity department, representing an equivalent of 13,784 lamps connected.

**Hendon (Middlesex).**—The Hampstead Electric Lighting committee are considering a communication from Hendon as to the supply by Hampstead to the Hendon district of electric current for a number of years, and asking the terms upon which such supply would be given.

**Leith.**—The Council have agreed to bear the cost of bonding the tramway rails in Leith-walk and Constitution-street, provided the Edinburgh Street Tramways Co. agree to widen the space between the two lines of rails in Leith-walk, and on condition that "if and when the tramways are required by the Corporation, the cost of such bonding shall be held as already paid."

**Maidenhead.**—The adjourned meeting of ratepayers to consider the electric lighting scheme of the Council was held last week, and after much discussion a resolution that it was inadvisable to expend £25,000 on electric lighting was declared lost by the mayor on a show of hands.

**Manchester.**—The Tramways committee recommend the Council to increase the salary of the general manager of the tramways department (Mr. J. McElroy) from £400 to £500 per annum.

**Mansfield.**—The Council have purchased the site for electricity works from the Duke of Portland.

**Mexico.**—The imports of electrical goods into Mexico in 1899 showed an increase of £4,500 in favour of that year over 1898, owing to the introduction of electric lighting in many of the large stores and private lighting both in the city of Mexico and in many of the towns of the different States of the Republic. There is a demand for all kinds of machinery and tools used in mining. The extension of the telegraph service throughout the Republic is proceeding steadily.

**Middleton.**—A contract for feed pump, steam pipes, superheaters, economisers, &c., has been placed on the recommendation of the engineers, Messrs. Lacey, Clirehugh and Sillar.

**Municipal Issues.**—Eastbourne Corporation have decided to issue £132,700 new corporation three per cent. stock for electric lighting and other works.

Sutton Coldfield Town Council require to borrow £25,896 for electric lighting purposes; offers to town clerk.

**Municipal Telephony.**—A report has been received from Mr. A. R. Bennett by the Sunderland Corporation on the question of establishing a municipal telephone service. It is estimated in the report that with a subscription of 300 members the service would be remunerative.

The town clerk of Hull (Mr. E. Laverack) has issued a circular to the effect that, "in view of the high charges now made and the indifferent services rendered by the National Telephone Co. within the Hull telephone area," the Corporation are prepared to establish and maintain a municipal telephone exchange for Hull and the adjoining districts, including Beverley, Cottingham, Brough, Elloughton, and Hessle, "if a sufficient number of persons are prepared to become subscribers." It is proposed to charge an inclusive rate of £6. 6s. per annum or a "toll" rate of £3 per annum, and one penny for each call, other subscribers without any charge. The advantages offered by the Corporation are "speedy connection, clear and distinct speech, no disturbance by other voices, nor by crackling, rasping, or other disagreeable noises, and private conversation—*i.e.*, the subscriber's voice, will be heard only by the person in communication with him." Details of this ideal system are wanting.

**Nairn.**—A preliminary meeting to consider electric lighting matters was held here last week, and unanimously decided to call a ratepayers' meeting, and to invite the engineer (Mr. Purvis) to attend to give particulars of his scheme.

**Nottingham.**—The Health committee recommended the Council last week to authorise the building of a 12-cell refuse destructor at Radford instead of a 6-cell one as originally proposed, and that application be made for borrowing £5,000 additional for the purpose. An amendment by Sir John Turney (chairman of the Electric Lighting committee) that a joint committee of the Health and Electricity committees consider and report upon the matter was carried.

**Paisley.**—A special meeting of the Council was held on Monday to consider Mr. W. M. Murphy's proposals for the construction of electric tramways in the district. After discussion the meeting was adjourned to enable Mr. Murphy to submit some modifications of his latest scheme.

**Peterborough.**—On Friday the Council decided to apply for sanction to borrow £11,000 further for electric lighting.

**Private Bills Legislation.**—The promoters of the North-East London Electric Railway scheme, which was unopposed on standing orders stage, have complied with the standing order of the House of Commons.

The Piccadilly and City Electric Railway Bill being unopposed, has been passed by the examiners.

In the case of the West and South London Junction Railway Bill a memorial alleging non-compliance with the standing orders was presented on behalf of the Duke of Northumberland and others. The bill proposes the construction of an underground electric line from Paddington to Kennington via Marble Arch, Hyde Park Corner and Victoria. The matter has been referred to the Standing Orders Committee.

The Metropolitan Railway Bill and the Metropolitan Electric Supply Bill have been passed by the examiners.

The consideration of the London County Council (Tramways and Street Widenings) Bill, which is opposed, has been postponed until February.

The memorials against the Brompton and Piccadilly Circus Railway (Extensions) Bill and Metropolitan District Railway Bill have been withdrawn.

The Brighton Corporation Bill, the City and South London Railway Bill, the Islington and Euston Railway Bill, and the Shannon Water and Electric Power Bill have also been passed by the examiners. In the case of the Kingston-upon-Thames Corporation Bill, there being no appearance, the measure was marked "dead."

The engineers of the proposed Manchester and Liverpool Electric Express Railway have issued estimates of the cost of the scheme. The total length of the line from Deansgate, Manchester, to its termination in Liverpool is 34 miles 3 furlongs. The estimated cost of construction is £1,776,821, compared with £1,718,940, the estimate of last year's scheme. The cost per mile for laying the permanent way, which was last year was put at £18,000 per mile, is now reduced to £13,500, and the cost of the stations, which was estimated at £67,000, is now brought down to £30,000. The cost of viaducts, which under last year's scheme would have absorbed £175,300, is now put at only £72,868, whilst tunnelling is also reduced from £61,200 to £55,360. The savings effected by these alterations are more than absorbed by public improvements. Thus in place of 48 bridges over or under public roads, estimated to cost £36,200, it is now proposed to provide 108 bridges at a cost of £120,410, whilst accommodation bridges, which were estimated to require the expenditure of £14,340, will now be put up at a cost of £50,750. Although 30 acres less land will be required for the new scheme, the cost of acquiring it is estimated to absorb £558,515, compared with £451,600. The capital required to be raised for the new scheme is £2,100,000, an increase of £100,000 compared with the rejected scheme.

**Protection of Switchboards.**—At Greenwich (London) Police Court on Friday last, before Mr. Kennedy, the Blackheath and Greenwich District Electric Lighting Co. (Ltd.) were summoned, at the instance of Mr. J. Owner, one of Her Majesty's Inspectors of Factories, on the ground that at their works at River-terrace, East Greenwich, a person named Robinson was killed in consequence of the company having neglected to fence securely certain dangerous machinery upon the premises; with having failed, as occupiers of such premises, to enter an accident in the register of accidents within one week of its occurrence; and that certain machinery dangerous to persons employed there was not securely fenced. The inquest on

the deceased man Robinson, a carpenter, was fully reported in *The Electrician* for Oct. 26 and Nov. 2, 1900. Robinson was killed on Oct. 22 last by an electric shock, which, the jury found, occurred through the absence of proper supervision on the part of the Blackheath Company.

Mr. GRAY, for the Treasury, said the defendant company supplied electric current for light and power at a voltage of 2,750. The circumstances of the case were that the company thought it right to put a hand rail—he suggested that it was a ridiculous thing—round the switchboard. The man Robinson had taken one bolt out of the switchboard—the switch being then "live"—and then came to another bolt, the distance between which and the "live" metal was about 3½in. The deceased, he contended, would in all probability have refused to touch the bolt had he been aware of the great danger. He had his left hand on the bolt, and endeavouring to rise his right hand came against the bar, the result being his instantaneous death. The position was aggravated by the fact that there had previously been a death through this very switchboard. The summons in the present case was taken out under the Factory Act, 1878, sec. 5, sub-sec. 3, as amended by sec. 6, sub-sec. 2, of the Act of 1891, setting out that all dangerous parts of machinery shall be either securely fenced or be in such a position or of such construction as to be equally safe to every person as they would be if securely fenced. He thought that all he had to do was to bring the case within that section.

Mr. WONTNER, for the defence, said that the first death referred to was that of the person who actually made the switchboard, and who was actually taken into the employ of the defendant company to look after it. He contended that the act was not in any way intended to protect those persons who were supposed to be skilled and actually working upon the machinery. The switchboard in question was placed in a raised gallery, to which no one was allowed to go but persons who had to work it. It was isolated. With regard to the deceased man Robinson, his instructions were that a new plan was to be adopted, and between the time of the two accidents every precaution was taken to guard people employed upon this particular gallery, as well as other persons. The floor was enlarged, and it was decided to put up this second handrail close to the panels, and it was while engaged upon this latter work that Robinson, who was in the employ of the master carpenter employed by the company, met his death. The danger was explained to him, and in order that the work might be done with absolute safety Robinson was instructed to do it on Sunday morning. It was in absolute disobedience to orders that he touched the switchboard. The question to decide was whether, under the act, it was absolutely necessary that the switchboard should be protected when every possible precaution was taken. The company were most anxious that everything proper should be done, and had gone to Sir Frederick Bramwell, who was giving them a new design for a board.

Mr. JOSEPH OWNER, examined as to the construction of the switchboard, said the handles had been raised 14in. after the first fatality.

Prof. C. V. BOYS said that the switchboard was an inherent and essential part of the whole machinery, and could be, in his opinion, properly called a dangerous part of the machinery. The protection of the switchboard was feasible; it was not at all necessary that exposed highly charged metal should be dotted about all over the face of a switchboard. If there had been no bare copper parts on the front of the switchboard the accident could not have happened.

Mr. JAMES SWINBURNE said it was impossible for all the exposed metal parts to be "dead." Any individual panel might be made safe. It was not necessary to have bare parts that were dangerous on a switchboard, and he thought it was a mistake to have them. In his opinion, the precautions taken—such as having the board in the most inaccessible part of the building, a railing round it, an indiarubber mat, and the warning of people not to go there—were not sufficient. They were good extra precautions, but the right way to begin was by making the switchboard itself safe, and there would be no difficulty whatever in doing so—it was merely a question of arranging the switchboard so that no highly charged metal was exposed, not only to the passers by but to persons working the switchboard. He did not think a switchboard constructed on the principle of the one in question was safe even to a skilled man, as even the most skilled had moments of inadvertence. He did not say that this switchboard was particularly bad, he thought that the fault was very general in switchboards. A switchboard should be so made that the operator could work it in safety. This switchboard was ordinarily safe, but it was dangerous to those working it, and exceedingly dangerous to men repairing it.

The case was then adjourned for a fortnight.

**St. Vincent.**—The revenue of the telephone department on this island for the year 1899, just announced, was £429, expenditure £359, excluding capital charges for the construction of the system. In the great hurricane of 1898 the overhead telephone lines suffered severely, necessitating a considerable expenditure upon their replacement.

**Salford.**—An arrangement has been come to with the Manchester Corporation in regard to the tramway question. From April 28 next to May 31, 1902, the Salford Corporation are to have the right to run cars with horse traction over the tramways from the borough boundaries on Regent, Albert, and Blackfriars Bridges to the junction of Deansgate and St. Mary's Gate at the rental per mile of single track now paid by the Manchester Carriage and Tramways Co. to the Manchester Corporation, with the addition of 4d. per car mile of the traffic of the Salford Corporation over such tramways. The Manchester Corporation are to construct and electrically equip before the end of April next, at the cost of the Salford Corporation, the tramways in Bury New-road between the boundary of the city and Salford, and between the Salford boundary and Prestwich. An arrangement for working the cars has also been come to.

**Scarborough.**—Last week the sub-committee appointed to consider the acquisition of the undertaking of the Scarborough Electric Supply Co. (Ltd.) presented a report recommending that the purchase be made upon the terms settled by the committee. It was, however, resolved that the matter be deferred for further consideration.

**Seoul (Corea).**—An American syndicate has placed with Messrs. Collbran and Bostwich, of Seoul, a contract for the supply of lighting plant for a supply station with a capacity of 2,000 16 c.p. lights and 15 arcs. The station is now in course of construction. In our issue of Aug. 24 we gave some particulars of the street railways of Seoul. Some extensions of these lines is now in course of construction to the extent of 14 miles of track, and a full duplicate plant equipment is now en route to Corea, including 15 additional cars. The plant is wholly American. Already 15 cars are running—12 motor cars and three trailers. The Seoul Electric Co. which owns the railway lines, has also a private telephone service consisting of 10 miles of line and 15 stations. The correspondent who supplies the above information informs us that all demands for electrical supplies in Corea are met by local agents established at Seoul.

The charge for local telegrams over the lines owned by the Imperial Corean Government is a uniform one of 10c. (about 2½d.) per word to any part of the country. The State owns 1,700 miles of telegraph lines, and there are 22 telegraph offices in the country.

**Serious Charge.**—At Arundel, last week, Walter Vernon Scott and Charles Willis were charged with unlawfully conspiring to defraud their employers, the Brush Electrical Engineering Co., of moneys amounting in all to about £135, and with making certain false entries in the books and sheets of the company. The nature of the charge was that Scott and Willis had conspired to insert in the weekly wages sheets fictitious names purporting to represent workmen employed on outside jobs, with the result that the company had been called upon to pay considerable sums of money. Prisoners were committed for trial, bail of £50 being allowed in each case.

**Shanklin (I.W.)**—Some time ago the local gas company refused to reduce the price of gas. The Isle of Wight Electric Light Co. were asked to send in estimates for lighting the district electrically, and alternative tenders were submitted. When it seemed likely the Council would accept one of these tenders the gas company submitted a revised tender. At a meeting of the Council in committee last week Mr. J. Holling said they were asked to consider the offer of the Electric Light Company, but instead the letter of the gas company had been thrust on the meeting. The two schemes from the Electric Light Company ought to be dealt with. They had been paying £507 per annum to the gas company, and now the Electric Light Company had offered to light the town much better and at a saving of £84 per annum, the gas company, anxious to preserve their monopoly, had come down in price. The offer of the Electric Light Company was an excellent one inasmuch as the lamp standards after seven years would be the absolute property of the Council, and this at an expenditure of £10. 11s. per annum for seven years. The Electric Light Company also in their second scheme proposed for £492 to supply 10 arc lamps and 149 50 c.p. lamps. The Shanklin Council should follow the example of Ventnor and Sandown, and adopt the electric light. He proposed that a meeting of ratepayers be held to decide the question once and for all. The matter was then referred back.

**Sheffield.** A trial trip on the Owlerton electric tramway took place on Tuesday.

**Smethwick.**—At a meeting of ratepayers last week, the Council's electric lighting and tramway proposals were approved.

**Southampton.**—The Tramways committee are in future to have full control of the working of the tramways and the maintenance of the equipment, other than the supply of electric energy, subject to the Tramways committee re-imbursing the Electric committee in respect to all expenses incurred and to the Tramway committee taking over all stores and giving credit therefor.

At the meeting of the Council last week, Ald. Bone said he had received a report from the electrical engineer (Mr. F. H. Chaplin) on the recent interruption to the supply of electric current. Mr. Chaplin's report stated that an interruption occurred on the north arc circuit on Sunday last, which extinguished alternate lamps in Above Bar, East-street, and St. Mary-street. The faults were found, one at the corner of Coleman-street and St. Mary-street, and the other on one of the new lamps in the Avenue. In the first case the arc and incandescent cables are run in wood troughing, filled with pitch. At the faulty point the current had leaked from the arc cable to earth, via the lead covering of the incandescent street lighting cable. The wood casing was broken above the fault, the damage having apparently been done by a pick, but did not appear very recent. He (Mr. Chaplin) considered the fault was due to damp getting into the troughing through the pick-hole, and gradually destroying the insulation of the cable, thus causing the short

circuit. The voltage on this arc circuit was about 2,400, and consequently when a fault developed near the end of a circuit there was considerable strain on the cable, lamps, and fittings near the opposite end. In the present case the second fault developed on the fittings of one of the lamps in the Avenue. The automatic switches there were very unreliable, and much of the work had had to be done again. When he took over the supervision of this work he found that it was in a most unsatisfactory state, and he immediately condemned the whole of the automatic switches supplied. The makers agreed to replace them by a switch of a better pattern, but meanwhile the faulty switches are used in order that the lighting might not be further delayed. Much of the material for this work was undelivered or mislaid, and the greatest difficulty had been experienced in tracing the various consignments, and in finding out what was further required. It was probable that the Avenue lighting would be somewhat irregular until the proper switches were supplied. When the arc lighting was first carried out he had the lamps connected alternately on opposite mains, so that in the event of a fault occurring only every alternate lamp would be affected, as was the case on Sunday night, the intermediate poles being lit by incandescents, which are automatically switched on if the arc goes out. After discussion this was agreed to.

**Stockholm.**—The construction of a turbine-driven electric generating works is contemplated at Stockholm, the Swedish Minister of Finance and the Waterfall Commission having requested Major W. Gagner, an army engineer, to prepare the necessary plans. Major Gagner proposes to utilise the eastern arm of the Alfkarleby Falls, which have a head of 14·5 metres, and afford a constant supply of 150 cubic metres per second, equal to quite 20,000 effective H.P. The current so generated is to be utilised in the lighting of the Swedish capital and will involve a capital outlay of 15,000,000kr. (about £800,000). It is estimated that the net revenue will provide a 4 per cent. return upon this capital expenditure. Major Gagner's plans provide for the water being drawn into a bay adjacent to the falls, passing through a tunnel on to the turbines, the electric energy being thence transmitted to a station to be erected at Carl XIII. Bridge, Stockholm, thence to be distributed to all parts of the capital.

Another engineer (Herr J. Richert) has also, at the request of the Waterfall Commission, prepared plans providing for the waters of the same falls to be taken through an open canal to turbines erected below the falls, in this way effecting a great saving in the cost of construction of works, &c. It is suggested that a lease to a private company should be effected, and we understand that three offers have already been tendered for this. The municipality of Stockholm is, however, to be afforded an opportunity of submitting a tender.

**Suez Canal Lighting.**—The Egyptian Government are putting down at the Port Said lighthouse a two-wire continuous-current plant for lighting the shipping to the East through the Suez Canal. From this point the voltage of this supply will be at 110 volts. The plant consists of Westinghouse multipolar machines of 30kw. total capacity, coupled to high-speed Westinghouse engines of an aggregate of 60 I.H.P.; 58 Tudor cells of 250 ampere-hour capacity are installed. The plant is to be ready for working at the end of the present year. The engineer-in-chief is Mr. Alexander Ashton.

**Surbiton.**—Acting upon the advice of their consulting engineers (Messrs. Hopkinson and Talbot), the Council have applied for sanction to borrow £50,000 for electric lighting.

**Sydney (N.S.W.).**—The Minister of Public Works recently published various documents in connection with the proposal to utilise the waters of the Grose, Colo and Warragamba rivers in the generation of electricity, including a report from the engineer to the Public Works Department (Mr. T. Raw). This report states that electric current can be supplied at a remarkably low cost, and asserts that approximately 25,000 H.P. would be required for the train and tram services of Sydney during busy times. Major Cardew advised the City Council to provide generating plant equal to 2,500 H.P. to be ultimately increased to 10,500 H.P., and as the towns between the Nepean and Sydney were to be served in addition, Mr. Raw estimates that nothing less than 35,000 H.P. would be sufficient. To meet such a heavy demand it would be necessary to provide for water storage on a comprehensive scale. He is satisfied that in wet weather enough water can be stored to keep the generating plant going at its utmost capacity for about 150 days. The generating plant would have to be specially designed, and of the most modern and efficient type, and in order to fully utilise the generating plant during the hours of least demand it would be necessary to provide storage batteries on a large scale. He proposes to utilise the water flowing through a tunnel to be cut through the mountain ridge separating the Kanimbla and Grose Valley, to generate electricity for lighting the mountain resorts, and in propelling lifts or trams. The total cost of the scheme, including the whole of the generating and transforming plant is estimated at £1,450,000, while the total annual cost of working, including interest, is set down at £158,000. A differential rate of charge for current is recommended based on the quantity of current taken. Mr. Raw bases his figures on an average demand of three-fifths of the full capacity of the works, calculating that the income would amount to £639,000 per annum, showing an annual profit of £481,000.

**Tasmania.**—The supply of current in the Zeehan district was commenced in November last by the Zeehan Electric Light and Power Co. (Ltd.), which operates under a special Act of Parliament, by which certain territories and privileges are conserved to the company. The station and its equipment have been constructed under the supervision of Mr. A. H. Warden, engineer-in-chief and secretary to the company. At the commencement of supply there was an equivalent of 1,400 8 c.p. lamps connected. The population of the district is 10,000. The supply is on the continuous-current three-wire system at 440 volts. The plant is American. Current is supplied at 1s. per kilowatt-hour for lighting and 6d. for power. The township of Zeehan was founded in 1890.

The telephone system of the Zeehan district is owned by the Tasmanian Government, and at Nov. 1 had 109 subscribers. The charge for private connections is £6 per annum, with 10s. extra per quarter-mile distance from the exchange. The charge for private residences is £4. 10s. per annum, and for call-office messages 6d. per five minutes' conversation.

Carbide of calcium works are projected at Launceston to utilise the day-load from the station there established, and for this purpose a Thompson vortex turbine has been erected under 110ft. effective head of water, the flow of which is estimated at 35,000 H.P.

**Taunton.**—The Electric Lighting committee reported to the Council last week that the proceedings in the action, Rucker *v.* London Electric Supply Corporation, were now at an end, the plaintiff having entered into arrangements with the committee representing the associated corporations (of which the Taunton Corporation was one) and companies which raised a fund to defend the proceedings. The plaintiff had not only withdrawn his appeal, but had entered into a deed of covenant under which he had covenanted not to sue any of the associated corporations or companies, and also to indemnify them should any other person or persons bring any proceedings whatsoever in respect of the letters patent upon which the plaintiff's action was brought. A final statement of account had been presented to the Defence committee and £8. 1s. returned to the Council, being the Corporation's proportion of the amount contributed for the defence and not now required.

The committee also reported that the economiser and condensing plant were working satisfactorily and were effecting a considerable saving in fuel. The connections to the mains during the past quarter were equivalent to 486 8 c.p. for lighting, 120 8 c.p. for radiators, 1,200 8 c.p. for motors—total, 1,806 8 c.p. lamps. The report was adopted.

**United States Philippine Islands Cables.**—The United States c.s. "Burnside," with a cargo of 500 knots of deep sea cable and 250 knots of shallow water cable, is engaged in connecting-up the islands forming the Philippines group, starting from Manilla.

**York.**—The Council are to be asked to approve the following scale of charges for electric current: 7d. per unit for one hour's maximum demand spread over the half-year, and 2d. per unit for all electricity beyond that amount, unless the amount consumed exceeds 1,500 units per half-year, when the price is to be 1½d. per unit. The price for current for places of worship is to be 3d. per unit, and for power and heating 1½d. Meter rents are to be abolished. These rates are to come into operation from Jan. 1, 1901.

**Dinner.**—The third annual dinner of the Langdon-Davies Electric Motor Co. (Ltd.) was held on the 12th inst., under the presidency of Mr. A. Soames, managing director. The gathering numbered about 50.

## NEW BOOKS AND EDITIONS.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Extension of Time—Launceston* (*Tasmania*) Corporation invite tenders for the supply of 500 electric meters. Specifications, &c., of Mr. W. Corin, city electrical engineer, Launceston, or from Messrs. John Terry & Co., 7, Great Winchester-street, London, E.C. Tenders direct to Mr. C. W. Rocher, town clerk, Town Hall, Launceston (or c/o Messrs. Terry & Co., as above), by 12 noon of *April 22* (*not April 8* as previously announced). See Advertisement. (The post to Launceston occupies about six weeks.)

Borough of *Southwark* (London) require tenders for the supply and erection of a 400kw. high-speed engine and dynamo and accessories, two water-tube boilers, with mechanical stokers, &c. Specifications can be obtained at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, and tenders must be delivered to the town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, S.E., by noon, Feb. 13. An advertisement gives further particulars.

*London County Council* invite tenders for the supply of two blocks of water-tube boilers required for the electrical power generating station at the Camberwell depot of the Council's tramways. Drawings may be inspected, and specifications obtained, from the engineer's department, County Hall, Spring Gardens, S.W. An advertisement contains further particulars, and tenders, addressed to the clerk (Mr. G. L. Gomme), should be delivered at the County Hall by 10 a.m. on Feb. 19.

*London County Council* Asylums committee require tenders for electric lighting sundries for their Claybury and Heath asylums. Tenders to clerk, 6, Waterloo-place, S.W., by Feb. 13.

The managers of the *Poplar and Stepney* Sick Asylum District invite tenders for sundry work in connection with the installation of the electric light at the Sick Asylum. Specification, &c., may be had from the offices of Mr. Robert Foskett, clerk to the Managers, Bromley, Middlesex, E., and tenders are to be delivered to Mr. Foskett, at the Asylum, by 10 a.m. of Tuesday, Feb. 12. An advertisement contains further particulars.

*Beckenham* District Council require tenders for boilers, steam alternator, and combined engine-dynamo and motor, pipe work, battery, and switchboard. Specifications from the office of the consulting engineer (Mr. Reginald P. Wilson), 66, Victoria-street, London, S.W., and tenders, addressed to the clerk (Mr. F. Stevens), Council Offices, Beckenham, by Feb. 25. An advertisement contains additional particulars.

*Wallasey* District Council require tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. An advertisement contains further particulars, and specifications, &c., may be obtained from the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead. Tenders must be sent to Mr. H. W. Cook, Public Offices, Egremont, by 21st inst.

*Wallasey* District Council also invite tenders for the erection and completion of car sheds, stores, workshops, and dwellings at their tramway depot, Sea View-road, Liscard. Drawings can be seen at the offices of the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead, from whom specifications, &c., can also be obtained. An advertisement contains further particulars, and tenders must be sent into Mr. H. W. Cook, Public Offices, Egremont, by Feb. 21.

*Southampton* Corporation invite tenders for the supply and erection of car bodies and trucks and motor equipments. Specifications may be obtained (after 28th inst.) at the offices of the borough engineer. An advertisement gives further particulars, and tenders must be sent in to the town clerk (Mr. R. R. Linthorne), Municipal Offices, Southampton, before noon Feb. 11.

*Bristol* Electrical committee invite tenders for coal conveyors and elevators, coal discharging plant, including hoist, automatic weighing machine, tower and bridge over roadway. Specifications from city electrical engineer (Mr. H. Faraday Proctor), Temple Back, Bristol. Tenders by noon of Feb. 21. See advertisement.

*Hull* Corporation Works committee require tenders for the supply of a multipolar generator to be coupled direct to a Belliss high-speed engine. Specifications from the city treasurer, Town Hall, Hull, and tenders (addressed to chairman) to be delivered at town clerk's office before noon on Feb. 8.

*Long Eaton* District Council require tenders for the following work in connection with their electricity station: (*a*) Producers, gas engines, dynamos, and switchboard, and (*b*) feeder and distribution cables and conversion of street lamps. An advertisement gives further particulars, and tenders must be in to the Council Offices by noon of Feb. 18.

*Stirling* Town Council require tenders for engines and dynamos (two sets, each of about 350 H.P.) and Lancashire boilers. An advertisement contains further particulars, and specifications and drawings may be seen at, but not obtained from, the offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W. Specifications can be obtained from the town clerk (Mr. Thomas L. Galbraith), Town Clerk's Office, Stirling, where tenders must be delivered by Feb. 15.

The Corporation of the royal burgh of *Kirkcaldy* require tenders for dry-back marine boilers, with mountings, &c., but alternative tenders for water-tube boilers will be considered. Specifications can be seen (but not obtained) at the offices of consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W., and tenders must be sent to the town clerk (Mr. Wm. L. Macindoe), Council Offices, Kirkcaldy, by 10 a.m. of Feb. 15. An advertisement contains further particulars.

*Edinburgh* Corporation invite tenders for an electric lighting installation at the public baths, Portobello. An advertisement gives further particulars, and specifications may be obtained of the resident electrical engineer (Mr. F. A. Newington), Dewar-place, Edinburgh. Tenders to town clerk (Mr. Thos. Hunter, W.S.), City Chambers, Edinburgh, by 11 a.m. Feb. 6.

*Edinburgh* Corporation invite tenders for engine and dynamo for McDonald-road electricity station. Tenders to town clerk by Feb. 9.

*Brighton* Corporation require tenders for the supply, delivery, drawing-in and jointing complete of feeder, distributing, test and telephone cables. Tenders to town clerk (Mr. Francis J. Tillstone), Town Hall, Brighton, by 4 p.m., Feb. 14.

*Brighton* Corporation also invite tenders for the supply and erection of overhead trolley construction and equipment of tramway routes. Tenders to town clerk by 4 p.m. Feb. 14.

*Brighton* County Borough Council invite tenders for the supply and erection, by 31st Aug., of tramway plant, including (1) three direct-coupled compound-wound steam dynamos (Willans engines), (2) tramway switchboard, (3) negative booster. Tenders to town clerk by 10 a.m. 28th inst.

*Wigan* Electric Lighting and Tramways committee invite tenders for two 210kw. steam dynamos, two Korting condensers, and cast-iron piping, lap-welded flange steam piping, switchboards, feeder boosters and battery milker. Tenders to borough electrical engineer by Feb. 2.

*Wigan* Corporation require tenders for the supply of general stores, including electrical accessories, carbons, &c., for their electric lighting and tramway department. Tenders by Feb. 2.

*Aberdeen* Tramways committee require tenders for the electrical equipment for their Bathing Station tramway route, comprising the supply and erection of all overhead material (poles being provided by the Corporation), and the supply and laying of lead-covered, paper or fibre insulated cables. Tenders to city electrical engineer, electricity works, Cotton-street, Aberdeen, by noon, Feb. 13.

*Aberdeen* Electric Lighting committee require tenders for surface condensers, air and circulating pumps. Tenders to city electrical engineer by noon of Feb. 8.

*Wimbledon* Urban District Council invite tenders for steam and exhaust pipes, &c., and moving two boilers, feed-pumps, feedwater heater and storage tank; independent surface condensing plant; and the supply and erection of two water-tube boilers. Tenders (addressed Chairman Electric Lighting committee) must be delivered to clerk (Mr. R. H. S. Butterworth), by noon Feb. 18.

*Poplar* (London) Guardians invite tenders for brickwork, flues and settings, &c., for two Lancashire boilers and an economiser. Tenders to clerk (Mr. G. H. Lough), 45, Upper North-street, Poplar, London, E., by 6 p.m., Feb. 6.

*Bournemouth* Corporation require three dynamos and two steam-driven surface condensers, &c., also 42 electric tramcars. Tenders by noon March 2.

*Great Yarmouth* Corporation invite tenders for two water-tube boilers and two 200kw. high-speed continuous-current steam dynamos for electric traction. Tenders to town clerk's office, Town Hall, by noon Feb. 5.

*Great Yarmouth* Corporation also require tenders for about 800 tons of steel girder tramway rails. Tenders by Feb. 6.

*Southport* Tramways committee require tenders for material for electric tramways, including poles, brackets, and scrolls, bases, trolley wire, trolley wire attachments, galvanised steel wire, and section boxes. Tenders to town clerk, by 21st inst.

*Sunderland* Corporation invite tenders for condensing plant and cooling tower, secondary battery, main switchboard, and travelling crane. Tenders (addressed chairman of Lighting committee) to the town clerk by noon Feb. 1.

*Oldham* Corporation require tenders for two 600 I.H.P. engines and four 1,200 I.H.P. engines, each direct coupled to a continuous-current dynamo. Tenders to Mr. A. Andrew, Gas and Water offices, Oldham, by Jan. 29.

*Glasgow* Corporation invite tenders for steel straight track rails, curved rails, fish-plates, and steel tie-bars. Tenders to clerk by 5 p.m. Feb. 22.

*Darwen* Corporation require tenders for sinking a bore hole at their electricity works for supplying about 30,000 gallons of water per hour. Tenders by noon 28th inst.

*Islington* (London) Borough Council invite tenders for erection of water tower, tanks, &c., at their electricity works, Eden Grove, Holloway, N. Tenders by Feb. 12.

*Luton* Town Council require tenders for wiring the council chamber, town hall, free library, corn exchange and baths. Tenders to town clerk (Mr. Geo. Sell) by 4 p.m. March 4.

*Batley* Corporation invite tenders for three high-speed triple expansion steam dynamos, one balancer, and one motor generator. Tenders to town clerk by Feb. 9.

*Battersea* (London) Borough Council invite tenders for ordinary and prepayment electricity meters. Tenders to town clerk, Municipal Buildings, Lavender-hill, S.W., before noon Feb. 1.

*Canterbury* Lighting committee invite tenders for boiler and engine-house plant, condensing apparatus and pipework, and extension of switchboard. Tenders to town clerk by 4 p.m. 30th inst.

*London School Board* invite tenders for electrical supplies for their training ship "Shaftesbury." Tenders by 2 p.m. Feb. 6.

*Eastbourne* Electric Light committee require tenders for the erection of electricity station buildings. Tenders by Feb. 4.

The Management committee of *Ballinasloe* (Ireland) Asylum invite tenders for electric lighting at new hospital block. Tenders by Feb. 9.

Tenders are required for the erection of electricity supply station buildings by the *Whitby* Council. Tenders by Feb. 12.

*Barnes* District Council invite tenders for wiring their electricity works. Tenders by Feb. 11.

*Burnley* Corporation require tenders for a traction switchboard, Tenders by Feb. 7.

*Southend* Corporation require tenders for four electric motor cars. Tenders by Feb. 6.

*Tynemouth* Corporation invite tenders for a 450kw. steam dynamo. Tenders to town clerk by 31st inst.

*Ilford* District Council invite tenders for the electric lighting of the town hall and public offices. Tenders to chairman by 31st inst.

*Leeds* Tramway committee require tenders for poles and bracket arms for carrying overhead electric wires. Tenders by Feb. 6.

*New South Wales* Government will receive tenders up to 2:15 p.m. of Feb. 22, for telegraph, telephone, and electric light material for the years 1901-2. The conditions of contract can be examined at the Commercial Intelligence Branch of the Board of Trade, 50, Parliament-street, London, S.W. Tenders are to be sent to the Public Service Board, 42, Young-st., Sydney.

*New South Wales* Government also invite tenders for supply, delivery, and laying of about 29 miles of 6,600-volt, three-core, lead-sheathed cable, together with the necessary troughing, filling-in compound, &c. Specifications, &c., can be obtained at the electrical engineer's office, Phillip-street, Sydney, and tenders, addressed to the Railway Commissioners' Office, Bridge-street, Sydney, have to be delivered by noon of March 4.

Tenders are again invited until Feb. 6 by the *Seraing* (Belgium) Municipal Council for the concession for constructing and operating an electric tramway between La Chatqueue and Val-st. Lambert.

Tenders are invited until Feb. 15 for the supply of 75,000 arc lamp carbons by the Receiver and Director-General of Contracts (Mr. C. Gatt), *Valetta*, Malta.

Tenders are invited until 28th prox., by the *Alcaraz* (Albacete, Spain) Municipality for the concession for electric lighting.

The Director-General of Marine, *Lisbon*, requires tenders for 59km. of galvanized wire of 4mm. diameter, and 2½km. of 3mm. diameter; also telegraphic accessories, including Leclanché jars, &c. Tenders by 30th inst.

## TENDERS RECEIVED AND ACCEPTED.

Harrogate Town Council have accepted the tender of Messrs. Holdsworth & Sons, Bradford, for the supply and erection of two Lancashire boilers, with fittings complete and economiser: Boilers £1,532, gangway £19, settings £240, economiser £484, economiser settings £120, total £2,395. The following firms also tendered: Danks & Co. £2,685, Hawksley, Wild & Co. £2,568, W. Wilson & Co. £2,548, Yates and Thom £2,524, Tetlow Bros. £2,496. 11s., J. and J. Horsfield £2,454, Hick, Hargreaves & Co. £2,410, Davy Bros. £2,410, A. Anderton & Sons £2,345, J. Musgrave & Co. £2,295. 4s., Tinkers Limited £2 239, W. Arnott & Co. £2,200, Daniel Adamson & Co. £2,181, Clayton & Sons £2,056, R. Taylor & Sons £2,028, O. Atkinson £1,632, W. R. Wills (Stirling boilers) £2,537.

Brighton Corporation have accepted the tender of the Union Cable Co. for the supply of cable during the year 1901. The company, whose tender was the lowest submitted, are to "supply, deliver and maintain such quantities of cable of the several sizes and descriptions specified in the amended specification annexed to such tender as may be ordered by the electrical engineer during the year ending Dec. 31, 1901, at £11,986."

Greenock Town Council have accepted the tender of the India Rubber Company for the supply of a 300kw. steam dynamo (Silvertown dynamo direct coupled to Belliss three-cylinder triple-expansion engine) at £3,205.

Ilford School Board have accepted the tender of Messrs. Spurgeon & Co. for wiring the higher-grade school for electric lighting at £195. 8s.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against J. D. F. Andrews & Co. (Ltd.) are to be sent by Feb. 15 to the liquidator, Mr. W. H. King, 13, Basinghall-street, London, E.C.

It has been resolved to wind-up Sax, Slatter, & Co. (Ltd.) voluntarily, and Mr. A. A. Yeatman, 2, Gresham-buildings, Basinghall-street, E.C., is liquidator.

At the Bradford Bankruptcy Court on Wednesday Arthur Hudson, electrical commission agent, Piccadilly, Bradford, underwent public examination. Debtor commenced business eight years ago, and there was now a deficiency of £102 on liabilities amounting to £121. He had had three agencies, two of which had produced a good weekly income, but the third proved unsuccessful, the debtor having lost £200 by it. Examination closed.

---

**Sale by Auction.**—Messrs. Wheatley Kirk, Price & Co. notify the sale by auction on Tuesday and Wednesday, Feb. 5 and 6, upon the works premises Haunch of Vension-yard, Brook-street, London, W., of the entire contents of the works. Details of the plant, machinery, apparatus and accesories included in this sale are given in an advertisement. Catalogues will shortly be ready and will be obtainable of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Messrs. Wheatley Kirk, Price & Co. will, at the conclusion of the above sale on Wednesday, Feb. 6, offer for disposal in one lot a fine 32 N.H.P. Crossley gas engine having two cylinders, two flywheels, auxiliary starting engine, and a complete Dowson gas-producing plant. Some further particulars will be found in an advertisement.

**Plant for Sale.**—Messrs. Wake and Carr, 123, Victoria-road Darlington, have for sale four sets of vertical marine-type triple-expansion engines. An advertisement gives additional information, and further particulars can be obtained from Messrs. Wake and Carr, Darlington, or Mr. Thos. W. Ward, Sheffield.

An advertisement also contains some particulars of eight large locomotive boilers which are for sale. Applications to Messrs. Wake and Carr, Darlington, or to Mr. Thos. W. Ward, Sheffield.

**New and Improved Telephone Instruments.**—At the meeting of the Royal Institution on the 18th inst., Messrs. L. M. Ericsson & Co., of Temple chambers, Temple-avenue, London, E.C., showed a collection of telephone instruments, amongst which were, in addition to many examples of the well-known apparatus in general use in this country, some new instruments. An enclosed magneto table set, with all working parts well protected: a magneto wall set made entirely of metal and vulcanite, for use in India and other tropical countries; and a very compact battery ringing wall set, for office use, were exhibited. Intercommunication instruments both for wall and table, and plug switches for installations up to 60 lines were shown, as well as a number of portable instruments specially adapted for military use. These latter included three patterns, one of which was a very small instrument for sounder telegraphy. These instruments have been in use in South Africa for the past 12 months under trying circumstances, and, we are informed, have given every satisfaction. To reduce the size of this class of instrument to the lowest possible dimensions telescopic hand microphones are employed. An automatic switch was shown in operation for six metallic circuits. This is intended for small outlying places or for toll-rate subscribers in a district where the telephone is only little used. This switch is connected by one line to the nearest exchange. The subscriber calls the exchange in the ordinary way, but the switching is effected from the exchange by means of battery currents and sensitive galvanometers and relay arrangements. A new penny-in-the slot instrument for toll-rate subscribers was also shown. Amongst the switchboard instruments was a combined indicator and jack which acts as a self-restoring indicator, and at the same time does not take up more space than an ordinary indicator. A collection of telephone relays, jacks strips for large exchanges, lightning arresters and fuses, &c., completed the display.

**Inverted Enclosed Arc Lamps.**—In reference to the note which appeared in our issue of the 18th (page 485), on the subject of the inverted arc lamp placed upon the market by Messrs. Johnson and Phillips, the Compagnie des Lampes à Arc Jandus, 35, Rue de Bagnolet, Paris, inform us that from the opening of the Paris Exhibition of 1900 an inverted enclosed arc lamp of the Jandus type was exhibited at the company's stand at the exhibition. The company claim priority for the production of such a lamp.

In reply to our inquiries, Messrs. Johnson and Phillips inform us that some of their inverted enclosed arc lamps were supplied to a London Polytechnic for use in the drawing rooms of the Institution long prior to the commencement of the Paris Exhibition, and that it was only want of time and extreme pressure of work that prevented them publishing earlier information of this interesting development.

**"Teon" Belting.**—Messrs. Fleming, Birkby and Goodall (Ltd.), West Grove Mill, Halifax, forward a new pamphlet on "Teon" belting, which is claimed to be the strongest composite textile belt on the market, and reliable as a heat, steam, oil, acid, alkali and water proof driving band. The pamphlet gives a quantity of information in a small compass on the subject of "Teon" belts, and tabulated statements give particulars of H.P., approximate net weights, tensile tests, &c. A large number of testimonials from users of this belting testify to its suitability for a variety of uses.

**Arc Lamp Carbons and Electric Lighting Accessories.**—The Electrical Co. forward price lists Nos. 6 and 7. No. 6 deals with arc lamp carbons for "Luna" lamps, and No. 7 with safety fuses, cutouts, fuse boards, ceiling roses and fuse wires. The lists are well got up, and are admirably arranged for facilities of reference.

**Epstein Batteries.**—Messrs. W. O. Rooper and Robins, of Stafford, issue a price list of Epstein electric storage batteries for which they are the sole licensees. Special attention is called in connection with these batteries to Rooper's patent battery connection by which it is claimed that any plate in any cell can be removed and renewed in a few minutes. Each plate has a jaw formed on its lug and through the jaws is passed a lead-coated pin, while spacing washers keep the jaws in position, and the whole is tightened up by patent nuts impervious to any action of the acid. We have received a sample of the battery connecting bolt with patent nuts which are used in place of the ordinary brass bolts. It is certainly an improvement on the latter, a feature being that the end of the screw is not exposed, but is covered by a head in the centre of the nut. The nuts, it is said, can be left in strong acid without fear of corrosion.

**Water-Power Electrical Installations.**—In a well-got-up publication issued by Messrs. Gilbert Gilkes & Co., Canal Ironworks, Kendal, are given illustrated descriptions of a number of installations carried out by this firm in connection with the development of water-power. As our readers are aware, Messrs. Gilbert Gilkes & Co. have been actively engaged for many years in designing and carrying out works in connection with this development, and of late the company's business has felt the impulse of the increased use of electricity as a means of providing light and of transmitting power. In many instances the adoption of electric lighting and the application of electric driving would have been unthought of but for the facilities of water-power generation, and the object of the present pamphlet is to place before the public particulars of the many important installations which have been effected chiefly with turbines as the generating machinery, although the firm's operations have not by any means been confined to this class of work. A large number of excellent photo illustrations are given, and while the greater number of the installations described have been carried out for private persons the works at Ingleton and Carlow (Ireland) are of a public character.

**Calendars.**—A useful metal desk stand calendar has been forwarded by the Electrical Supply Co., 59 and 61, Hatton-garden, London, E.C. The calendar is printed on the face of the metal, and will doubtless stand a full year's use.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 16 to Jan. 22, with the ports of destination:—

*Africa*—Alexandria, £15; Cape Town, £153; Durban, £731; Delagoa Bay £130; Port Elizabeth, £152 (telegraph material). *Australasia*—Adelaide, £1,300 (telegraph material); Fremantle, £14; Launceston, £365; Lyttleton, £49; Melbourne, £451; Port Chalmers, £194; Sydney, £1,590 (including £164 telegraph wire). *Belgium*—Ostend, £75. *Brazil*—Bahia, £139 (telegraph apparatus). *Ceylon*—Colombo, £76. *China*—Shanghai, £192. *Germany*—Hamburg, £68. *Holland*—Amsterdam, £35. *India*—Calcutta, £2,145 (including £134 telegraph wire). *Japan*—Kobe, £2,898; Nagasaki, £632; Yokohama, £3,959 (including £47 telegraph material). *Malta*—£15. *Stacho*—£2,740 (telegraph cable). *Straits Settlements*—Singapore, £40. Total £18,461, against £9,183 in the corresponding week last year (Jan. 17 to Jan. 23).

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by Messrs. J. C. Chapman & Co. Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

November 23, 1900.

21,179. A. Whalley. Warrington. Improvements in telephone switch jacks.

21,190. F. J. Pringle. Sidcup. An excess electric current indicator controller and cut out.

21,192. M. F. Hawkes (of Thrift and Enterprise Co.). Birmingham. Improvements in gas pendants, chandeliers, electroliers, and the like.

12,196. G. L. Martin. New York. Improvements in marine electric light fixtures and switches therefor.

21,216. P. M. Justice. London. Improvements in method of graphitising electrodes. (The International Acheson Graphite Co., United States.)*

21,217. P. M. Justice. London. Improvements in current regulators. (The Erie Exploration Co., United States.)*

21,223. The Bastian Meter Co. (Ltd.) and C. O. Bastian. London. Improvements in or relating to electrodes or the wires or conductors connected thereto in electrolytic cells, meters, or other electrolytic apparatus.

21,233. Theodore Pescatore and The Tudor Accumulator Co. (Ltd.). London. Improvements in secondary batteries.

November 24, 1900.

21,252. C. M. Johnson. Redhill. Improved means of eliminating and retarding certain electric and other rays for surgical, medical and other purposes.

21,255. C. V. de Falbe (trading as The Electrical and General Contracting Co.) and T. Harden. London. Improvement in methods of jointing electrical conductors.

21,292. The British Thomson-Houston Co. (Ltd.). London. Improvements in means for obtaining magnetic adhesion of locomotives or motor cars in electric railways. (The Union Elektricitäts Gesellschaft, Germany.)*

21,293. The British Thomson-Houston Co. (Ltd.). London. Improvements in insulated electric conductors and method of making the same. (C. P. Steinmetz, United States.)*

21,294. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

21,304. F. Lux. London. Improvements relating to electric meters.*

21,311. H. C. King. London. Improvements relating ty electric traction.

November 26, 1900.

21,333. L. Connor. Liverpool. An improved illuminated advertising device for attachment to incandescent electric lamps and the like.

21,336. R. J. Fawcett. London. An improved method of and means for joining the ends of lengths of telegraph wires and other wires.

21,374. H. H. Lake. London. Improvements relating to electric incandescent lamps. (The Firm Electrische Gluhlampen-Fabrik "Watt" Scharf & Co., Austria.)

21,399. F. G. Sharp. London. Improvements in variable resistance electric contacts.

November 27, 1900.

21,409. S. B. Dobbie. London. Improvements in conduits for electrical conductors.

21,447. The British Thomson-Houston Co. (Ltd.). London. Improvements in electric railways. (G. T. Woods, United States.)*

21,448. The British Thomson-Houston Co. (Ltd.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

21,844. Holden. Portable telephonic apparatus.

22,163. Shattner. Continuous current electricity meters.

23,753. Rimington. Maximum electrical current indicators.

24,450. Deverlove and Brown. Electric telegraph apparatus.

24,521. Leve and Moseley. Accumulator Syndicate (Ltd.). Electric accumulators.

24,663. Punnett and Punnett, jun. Means to be employed in connection with the electro deposition of metals upon iron and steel.

24,805. Siemens Bros. & Co. (Ltd.). (Siemens and Halske Aktiengesellschaft. Appliances for reversing the current in continuous current dynamos.

24,942. Tingley. Electric brakes. (Date applied for under International Convention, May 18, 1899.)

25,053. Sowerbutts. Connectors for electrical wires or cables.

25,200. Johnson. Electricity meters.

25,353. Mov. Bastie and Ernest F. Moy (Ltd.). Liquid resistances for electrical circuits.

25,628. Lindroos. Electric fishing apparatus.

# COMPANIES' MEETINGS AND REPORTS.

## Nernst Electric Lamp (Ltd.).

The adjourned meeting of the shareholders of this company was held on Friday last, under the presidency of Sir H. C. MANCE. The proceedings were of a protracted nature.

The CHAIRMAN called upon Mr. Bernard M. Drake to resume the proceedings.

Mr. DRAKE said it would be remembered that at their previous meeting Mr. Zusman, a director of the company, had made serious charges against him, and he had circulated his reply amongst the shareholders. It was clear that after what had occurred he and Mr. Zusman could not both sit at the same board, and he, therefore, made the following suggestions: That the issue raised by Mr. Zusman should be submitted to the decision of the Right Hon. W. H. Asquith, Q.C., M.P., who should be asked to give his finding upon each of the issues raised by Mr. Zusman after hearing evidence and counsel for both parties. In the event of Mr. Asquith deciding that he (Mr. Drake) had, on the whole, been unable to answer satisfactorily Mr. Zusman's charges, he would pay that gentleman's costs; but if, on the other hand, Mr. Asquith held that he had successfully repelled Mr. Zusman's attacks, he would not ask that gentleman to pay a single penny of his (Mr. Drake's) costs. He was exceedingly anxious to clear his reputation in the quickest possible time, and he would prefer Mr. Asquith, or, failing Mr. Asquith, Sir Robert Reid, Q.C., M.P., to deal with the matter rather than it should go to the Courts, as it would be, in that way, more quickly decided, and the company's interest would be likely to suffer less than from a public hearing of the matter. Of course, if Mr. Zusman preferred a public hearing, he (Mr. Drake) was quite agreeable. He further undertook, in addition to bearing the costs of the inquiry, if Mr. Zusman's charges were substantiated, to retire immediately from the board of directors, Mr. Zusman, on the other hand, giving an undertaking that, in the event of his failing to substantiate his charges, he would immediately retire, as he was bound in honour to do. He had hoped that Mr. Zusman, having read his explanations, would have appreciated that he had been mistaken in his facts, and would have offered him an apology; but instead of taking this straightforward course, he had issued a further circular. It was true that in this circular Mr. Zusman had shifted his ground on many important points, but he had bolstered up the remainder, and had asked the shareholders to accept his statements as true and accurate. The speaker then dealt *seriatim* with the charges brought by Mr. Zusman, and pointed out, with regard to the main charge, that he had acted against the interest of the Nernst Electric Lamp (Ltd.), that his own holding in this company was 6,000 shares, and it was hardly likely that he would be such a fool as to jeopardise this large holding by any action calculated to depreciate its value. Many of Mr. Zusman's charges were only excusable on the ground that he knew nothing of the technical points connected with the electrical profession and the preparation of the Nernst lamp for the market. Mr. Zusman evidently laboured under the impression that the success or failure of the company's operations depended upon office routine, but this was an error. He (the speaker) had worked to place upon the market a lamp which would become a permanent source of revenue to the company, and, although it was only six months since Dr. von Recklinghausen had left them, he (Mr. Drake) had been able to produce a lamp which he considered good enough to start their business. Great progress had been made. He had been able to find a staff of workers in whom he had perfect confidence, and, in fact, everything was advancing most satisfactorily. He could not, therefore, believe that the shareholders would allow this organisation to be broken up. With regard to his action having led to the resignation of Prof. Nernst, that gentleman's letter would itself be a sufficient refutation of the charge. As a matter of fact, the directors held Dr. Nernst's proxy. He would especially call the attention of the shareholders to Prof. Nernst's letter in which was the expression "that their lamp was now lastingly good." He would conclude by saying that there was no more justification in Mr. Zusman's charges in the other matters in dispute than there was in regard to his (the speaker's) tactlessness having brought about Prof. Nernst's resignation. In conclusion, he would say that he had refrained from attacking Mr. Zusman. He only considered it necessary to clear his own reputation and personal honour from this unjust attack, and he asked them as impartial and business-like persons to carefully consider all he had said, and by their voting support the directors in their efforts to make the company a success.

Mr. B. ZUSMAN said that with regard to his resignation of the position of director, his charges against Mr. Drake were not of a personal nature; his action had been taken with a view of promoting the best interests of the company, and he must, therefore, refuse to accept Mr. Drake's proposal with regard to placing the matters in dispute before Mr. Asquith or Sir Robert Reid. He had put his hand to the plough and would not turn back. He had devoted three years to the company's business, and was responsible, more than any other individual, for the subscription of its capital. He was convinced that under fair conditions and proper direction and management a great future was before the company.

The CHAIRMAN said he thought the shareholders had heard enough of this matter. Mr. Zusman had posed as an honest hard working director, and had claimed unrestricted access to the books. He had taken copies of documents in order, as he said, that he might do his duty to the shareholders. If that were so he had acted very strangely in not bringing the matter before the directors, and so getting any supposed irregularities put right.

Mr. Zusman's chief supporter at the meeting here stated that he held £2,500 shares, and if Mr. Drake remained on the board he should sell them. This statement brought Mr. Drake to the front, and he, there and then, we are informed, purchased the whole 2,500 shares.

The CHAIRMAN announced that the directors held proxies for nearly 100,000 shares. He then put the original motion to the meeting, and this was carried by 30 votes to 11.

Mr. ZUSMAN demanded a poll, and after the re-election of the retiring directors, this was taken and resulted as follows: In favour of the resolution for the adoption of the report and accounts 120,776 shares, against 46,871 shares.

---

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I send you herewith a copy of my printed speech, which has not been fully reported. You will doubtless form your own conclusions from the unwillingness shown by Mr. Zusman and his party to have the charges alleged against me tried on their merits. As mentioned in the report, Mr. Zusman has given his word of honour as a gentleman on several occasions at board meetings that if he were beaten at the annual meeting he would immediately retire, so that this incident may presumably be taken as closed so far as the Nernst Company is concerned.

The fact, however, remains that if electrical engineers are to be subject to violent attacks of this kind, which involve serious waste of time and money, it will be difficult to induce them to join the board of any company established for working undeveloped inventions.—Yours, &c.,

B. M. DRAKE.

---

We learn that, after Mr. Zusman's defeat at the adjourned meeting on Friday last, he resigned his position as a director of the Nernst Electric Light (Ltd.), and has distributed a circular to the shareholders to this effect.

It only remains to add that it is claimed by Mr. Drake's supporters that the attack made upon him has not been directed by those who had invested any money in the undertaking, and the shareholders, therefore, are to be congratulated that the attack has been defeated.

## Eastern Telegraph Co. (Ltd.).

The report of the directors for the half-year ended Sept. 30 last states that the revenue for the period amounted to £642,145. 17s. 10d., from which are deducted £131,862. 13s. 8d. for ordinary expenses and £45,582. 0s. 4d. for expenditure on repairs and renewals of cables, &c. After providing £6,572. 1s. 4d. for depreciation of spare cable and £10,526. 10s. 2d. for income tax, there remains a balance of £447,602. 12s. 4d., to which is added £1,924. 17s. 6d. brought forward, making £449,527. 9s. 10d. available balance. From this there has been paid: Interest on mortgage debenture stock, £27,275. 0s. 7d.: dividends on preference stock, £31,319. 19s. 4d.; and two interim dividends of 1¼ per cent. each on ordinary stock, £100,000, equal together to £158,594. 19s. 11d. After carrying £10,000 to reserve for maintenance ships, and £250,000 to general reserve, there remains £30,932. 9s. 11d., which is carried forward to the next account. The revenue includes £23,225 5s. 8d. dividends for the half-year upon the company's investments in other telegraph companies.

The large sum placed to reserve is to provide for the payment of certain instalments on account of cables now being laid by the company between Great Britain, the Cape and Mauritius, which, in conjunction with the cables undertaken by the Eastern Extension, Australasia and China Telegraph Co., will form the new through route between Great Britain and Australasia. One of these cables (that from Porthcurnow, Cornwall, to Madeira) has been lately opened for traffic, and the Madeira-St. Vincent section is in course of being laid. When this section is completed the third route to South Africa will be materially strengthened. Of the three routes, one is triplicated as far as Aden, and the other two, in conjunction with the cables of the Western Telegraph Co., will be triplicated as far as St. Vincent. The tariff to South Africa was reduced from 4s. to 3s. 6d. per word on Jan. 1.

The "standard revenue" fixed by the Cape-Australian cable agreement, for regulating the Australasian tariffs, having been maintained, further reductions were brought into force on Jan. 1 for telegrams exchanged with South Australia, Western Australia, and Tasmania, as follows: 3s. 6d. per word for ordinary telegrams, 2s. 6d. per word for Government telegrams. Since that date the Government of New South Wales has accepted the agreement, and messages exchanged with that State will, therefore, be entitled to similar reductions on and after Feb. 1.

It having been found necessary, from time to time, to nominate directors of this company on boards of associated companies, the shareholders will be asked to amend the articles by passing a resolution set forth in a notice convening an extraordinary general meeting to be held immediately after the ordinary general meeting at Winchester House, London, E.C., on Monday, Jan. 28, at 1 p.m.

## Direct United States Cable Co. (Ltd.)

The report of the directors for the six months ended Dec. 31 last states that the half year's revenue after deducting out-payments amounted to £50,533. 16s. 1d., compared with £56,800. 2s. 5d. for the corresponding period of 1899, a decrease of £6,266. 6s. 4d. The working and other expenses, including income tax, but exclusive of cost of cable repairs, amounted to £20,826. 11s. 5d., leaving £29,707. 4s. 8d. as net profit, making, with £3,761. 8s. 6d. brought forward, £33,468. 13s. 2d. For the corresponding period of 1899, the working expenses and other payments amounted to £20,416. 10s. 5d. Interim dividends of 3s. per share for the quarter ended Sept. 30 and of 3s. per share for the quarter ended Dec. 31 (payable Jan. 31), together amounting to £18,213, have been declared, and after setting aside £10,000 to reserve the balance of £5,255. 13s. 2d. on revenue account has been carried forward. The reserve fund has been debited with £2,500 for cost of cable repairs, and after being credited with interest on investment and amount set aside from revenue, the reserve fund, taking investments at cost price, now amounts to £433,105. 13s. 8d.

## City and South London Railway Co.

The directors' report for the half year ended Dec. 31 states that the receipts from all sources for the past half year have amounted to £46,470. 5s. 3d., and the cost of working has been £26,280. 14s. 10d., leaving a profit of £20,459. 10s. 5d. Inclusive of the balance brought forward, the net revenue shows an aggregate of £22,988. 16s. 4d. After making provision for the debenture interest a balance remains available for dividend of £15,342. 9s. 7d. Out of this the directors recommend that the full dividend of 5 per cent per annum be paid on the preference stocks 1891 and 1896, and that a dividend at the rate of 1½ per cent per annum be paid upon the Consolidated ordinary stock, leaving £1 248. 14s. 7d. to be carried forward.

The number of passengers, exclusive of season ticket holders, carried during the half-year was 5,018,842, the receipts being £44,716. 3s. 11d. This compares with 3,442,942 passengers and £26,197. 14s. receipts in the half-year to Dec. 31, 1899, the 1899 figures representing a falling off compared with the 1898 figures. There has been a steadily growing increase in the receipts during the past half year, which still continues, and when the extension to Islington is opened and the connections with the other railways are completed much more satisfactory results may be expected. There has been a considerable increase in the working expenses owing to increased mileage of the trains due to the longer length of line, and this has been further added to by the high price of coal and other materials. Considering that the whole of the preference dividend and the interest on the debenture stock has been charged against revenue, and the traffic during the early part of the half year had not had time to develop, the result of the half-year's working may be considered fairly satisfactory.

The extension to Islington has made rapid progress, and the tunnels and other underground works are very nearly completed. The building of the surface stations at Old street and City road have been commenced and the lifts are being prepared. It is hoped that this extension will be opened for traffic in about six months from the present time.

The subway at London Bridge, constructed jointly with the Brighton Company, has made considerable progress.

The exchange of traffic with the Central London Railway by means of the special subway at the Bank is growing steadily, and, as the convenience it affords becomes more widely known, is likely to assume considerable proportions.

The buildings at the generating station, required in connection with the working of the Islington line, are completed, and the new engine and boilers are being supplied.

The arbitration to decide the amount to be paid in connection with St. Mary Woolnoth church for the occupation of the churchyard and the easement under the church has been held, and it is hoped that the arbitrator's award will shortly be given.

The additional locomotives referred to in the last report are in course of delivery. To meet the traffic expected on the opening of the Islington extension, the directors have ordered 10 more locomotives, which are under contract to be delivered within the current half-year.

The 10,000 ordinary shares recently offered to the proprietors were all subscribed. The directors regret the shares were issued at so large a discount, but the present value of the ordinary stock obviously precluded them from making the issue price higher.

The proprietors will, at the forthcoming meeting, be asked to approve a bill in Parliament for powers to construct a subway from the terminus at the "Angel," Islington, to the Agricultural Hall, and to raise additional capital for that and other purposes. A bill has been deposited to connect the Islington station of this company with the Euston station of the Hampstead and Charing Cross Railway. As this line would be a great public convenience, and connect this railway with the Great Northern, Midland, and London and North Western railways at their respective termini, the directors have agreed that, if the bill receives the sanction of Parliament, they will undertake to work the line and provide the electrical power required subject to a satisfactory agreement, the terms of which will be submitted to the proprietors for their approval at a later date.

## Anglo-American Telegraph Co. (Ltd.).

The report of the directors of the company for the half-year to Dec. 31 last, states that the receipts, including £8,742. 7s. 7d. brought forward, amounted to £197,282. 6s. 4d., a decrease in the traffic of £16,182 compared with the half year to Dec. 31, 1899. The total expenses of the half year, including the repair of cables, &c., amounted to £70,376. 4s. 11d., an increase of £3,204. 19s. 5d. The directors have set apart £12,000 to the renewal fund, leaving £114,905. 1s. 5d. Interim quarterly dividends of 15s. per cent. on the ordinary and £1. 10s. per cent on the preferred stock, were paid on Nov. 1, absorbing £52,500, and leaving £62,406. 1s. 5d., out of which the directors recommend final dividends of 17s. 6d. per cent. on the ordinary, £1. 10s. per cent. on the preferred, and 5s. per cent. on the deferred stock, amounting to £61,250, making a total distribution for the year to Dec. 31 of £3. 2s. 6d. per cent. on the ordinary, £6 per cent. on the preferred, and 5s. per cent. on the deferred stock. The balance £1,156. 1s. 5d. will be carried forward.

The cables and land lines of the company are in good working order.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ELECTRIC TRACTION CONSTRUCTION AND EQUIPMENT CO. LTD.**—Registered Dec. 29 with a capital of £20,000 in £100 shares, to construct or acquire railways, tramways, vehicles, launches, steamboats, and other means of conveyance, and to carry on the business of railway, tramway, boat, and vehicle contractors, suppliers of electricity, electric and other motor manufacturers, &c.

**LAWSON'S NON-CONDUCTING COMPOSITION (LTD.)**—Registered Jan. 15, with a capital of £2,000 in £5 shares, to acquire and carry on so much of the business of George Angus & Co. (Ltd.) as relates to the manufacture of dealing in improved asbestos compound non-conducting composition for covering steam-pipes, tanks, &c., and to manufacture and deal in fireproof materials, insulating materials and appliances for electric cables, wires, and electrical insulation generally, engineers' requisites, &c.

**MIDDLETON ELECTRIC TRACTION CO. (LTD.)**—Registered Dec. 29, with a capital of £100,000 in £5 shares, to carry on the business of carriers of passengers and goods, electrical engineers, electricians, manufacturer of and dealers in rail, tram, electric, and other apparatus, mechanical and chemical engineers, &c., and to acquire patents relating to the propulsion of rail and tramcars, boats, vehicles, &c. The subscribers are E. Garcke, C. S. Hilton, J. Devonshire (electrical engineer), E. Hopwood, H. M. Sayers (electrical engineer), G. J. Somerville (electrical engineer), and A. L. Barber.

**MOON, LOUGHLIN & CO. (LTD.)**—Registered Dec. 29, with a capital of £20,000 in £1 shares, to acquire the business carried on by O. Moon and J. A. Loughlin at Luna Works, Factory-lane, Harpurhey, Manchester, and to carry on the business of electrical and general engineers, electricians, manufacturers of electrical appliances, &c. The subscribers are O. Moon (engineer), J. A. Loughlin (electrical engineer), F. J. Moon, W. McGuffin Greaves (engineer), Mrs. G. M. Zapata, J. Welsh, and H. J. L. Bull (electrical engineer). The first directors are O. Moon and J. A. Loughlin.

**BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. (LTD.)**—The annual return to Dec. 7 has been filed. The capital is £1,750,000 in 200,000 preference shares of £5 each and 75,000 ordinary shares of £10 each, of which 100,000 preference and 45,000 ordinary have been taken up. £5 has been paid on each of the preference shares, and the ordinary shares are considered as fully paid.

## CITY NOTES.

**MEMORANDA.**—Bank rate 5 per cent. (since Jan. 3, 1901). Price of silver 28⅛d. per oz. (Jan. 24). Consols (2¾ per cent.) 96⅛—96⅜ for money, 96$\frac{7}{16}$—96$\frac{11}{16}$ for account; 2½ per cent. 97—97½ (Jan. 24). Consols Pay Day, Feb. 1. Stocks and Shares Continuation Days, Jan. 29 and Feb. 12; Ticket Days, Jan. 30 and Feb. 13; Pay Days, Jan. 31 and Feb. 14; Mining Share Carry-over Days, Jan. 28 and Feb. 11.

**CLAYTON AND SHUTTLEWORTH (LTD.)**—A prospectus of this company has been issued this week, and invites subscriptions to a share capital of £800,000, and a debenture issue of £250,000, making a total of £1,050,000. The prospectus is noticeable for being the first under the new Companies Act, 1900, which came into operation on Jan. 1, 1901. The list closed yesterday (Thursday), and we learn that the issue was largely over subscribed.

**CROWTHER AND CO.'S ELECTRICAL INDUSTRIES (LTD.)**—A prospectus has been registered under the new Companies Act of Crowther & Co.'s Electrical Industries (Ltd.), electrical engineers and contractors for electric light and power plant, &c., of Manchester and Liverpool, and subscriptions are invited for a share capital of £10,000 in £1 shares. No indication is given as to the date of closing of the list.

**EASTERN AND SOUTH AFRICAN TELEGRAPH CO. (LTD.)**—Payment will be made by warrant, on Feb. 1, of the interest on this company's 4 per cent. registered mortgage debentures 1909. The transfer books will be closed from Jan. 26 to Feb. 1 inclusive.

**GREAT NORTHERN AND CITY RAILWAY CO.**—The directors' report for the half-year ended Dec. 31 states that two additional shields have been

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900-1 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways. | Jan. 19 | 4,060 | + 24 | 2 | 7,829 | − 140 |
| Blackburn Corporation.. | " 19 | 411 | + 45 | † 2 | 1,061 | + 101 |
| Blackpool Corporation... | " 17 | 151 | + 22 | 42 | 28,723 | + 7,636 |
| Blackpool and Fleetwood | " 19 | 127 | − 13 | 3 | 391 | − 32 |
| Bolton Corporation ...... | " 20 | 1,194 | ... | 42 | 67,026 | ... |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ......... | Dec. 3 | 1,991 | + 328 | ... | 41,451 | + 7,756 |
| *Bristol Trams & Carriage | Jan. 18 | 3,748 | + 1,033 | 3 | 10,819 | + 2,656 |
| *Buenos Ayres & Belgrano | Dec. 23 | 2,815 | + 505 | 25 | 63,475 | + 6,649 |
| Central London Railway | Jan. 19 | 5,982 | ... | 25 | 133,985 | ... |
| City & South London Ry. | " 20 | 1,995 | + 884 | 3 | 6,054 | + 2,675 |
| Cork Elec. Trams ......... | ... | ... | ... | ... | ... | ... |
| Dover Corporation ...... | " 19 | 163 | + 13 | 42 | 9,247 | + 593 |
| Dublin & Lucan Rly. ... | " 19 | 70 | + 17 | 3 | 206 | + 45 |
| Dublin United ........... | " 18 | 3,251 | + 298 | 3 | 9,964 | + 1,146 |
| Dublin Southern Dist.... | " 18 | 637 | + 78 | 3 | 2,574 | |
| *Dundee Corporation ... | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation ... | " 19 | 8,439 | + 153 | 3 | 29,554 | + 2,116 |
| Hull Corporation ......... | " 19 | 1,535 | + 876 | 29 | 41,490 | + 22,455 |
| *Liverpool Corporation... | " 12 | 7,697 | + 1,066 | 2 | 16,174 | + 2,768 |
| Liverpool Overhead Rly. | " 20 | 1,162 | + 11 | 3 | 4,537 | + 82 |
| *Sheffield Tramways ...... | " 20 | 2,642 | + [illegible] | 3 | 8,095 | + 2,672 |

* Partly electrical. † And four days.

erected and are now working at Drayton Park, where 460 lineal yards of tunnel have been driven. At Essex-road the station tunnels have both been driven to their full length, and the construction of the connecting passage is being proceeded with. At Regent's Canal the up and down-line tunnels have been driven for distances which, together, amount to nearly 2 miles, and through communication is established with Essex-road. Two additional shields to drive southwards will shortly be erected at Old-street, where a shaft has been sunk and the up line station tunnel has been commenced. At Finsbury-pavement a shaft has been sunk to its full depth, and the connecting passage is in course of construction. Tenders have been invited for the supply of electrical plant, and, generally, the progress made with the works is satisfactory.

**LIVERPOOL OVERHEAD RAILWAY COMPANY.**—The accounts of this company for the past half-year show an available balance of £15,329, and the directors recommend payment of a dividend at the rate of 5 per cent. per annum on the preference, and 3½ per cent. per annum on the ordinary shares, against 5 per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward £4,060, against £4,592.

**MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)**—Col. Sir C. Euan Smith, Mr. J. Henniker Heaton, and M. Albert Ochs have joined the board of this company.

**NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)**—This company was recently formed to acquire the provisional orders for the following towns:—South Blyth, Cowpen, Spennymoor, Barnard Castle, Malton, Thirsk, and Sowerby, and the consents from the local authorities for Alnwick, Annfield Plain, Consett, Benfieldside, Shildon, Handsworth, Norton and Pickering. Mr. J. D. Milburn (chairman of the Newcastle and District Electric Lighting Co., Ltd.), is the chairman of the new company.

**ST. JAMES'S AND PALL MALL ELECTRIC LIGHT CO. (LTD.)**—The directors recommend a dividend for the half-year ended 31st ult. of 7s. 6d., together with a bonus of 2s., per share on the ordinary shares, making, with the interim distribution, 12½ per cent. and a bonus of 2 per cent. for the year—the same as for the past four years.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed 30th inst. as a special settling day in the further issue of £100,000 4½ per cent. debenture stock of the *County of London and Brush Provincial Electric Lighting Co. (Ltd.)*, and the stock has been ordered to be quoted in the official list. The committee has also been asked to appoint a special settling day in 5,795 £1 fully-paid shares (Nos. 1 to 496 and 5,308 to 6,135) and 55,000 vendors' £1 fully-paid shares (Nos. 6,136 to 61,135) of the *Mica Manufacturing Co. (Ltd.)*.

# ELECTRICAL COMPANIES' SHARE LIST.

| Paid-up Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Jan. 16. | | Price Tuesday, Jan. 22. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Jan. 22. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅞ | 1⅛ | ⅞ | 1⅛ | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | 70 | 75 | 70 | 75 | ... | — | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13¾ | 12½ | 13½ | 3 16 1 | ... | 13½ | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | 4 7 5 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 18 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 30,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 3 18 3 | " " | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6¾ | 6⅝ |
| £110,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 8½ | 9 | 4 8 11 | February and August | 9⅛ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | 14 | 13¾ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 124 | 127 | 124 | 127 | 3 18 9 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½ 2nd Deb. Stock Certs. (60 % pd.) (red.) | 61 | 63 | 61 | 63 | ... | ... | 62½ | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8¾ | 9¼ | 8¾ | 9¼ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | 12 | ... |
| £200,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | 106½ | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | 5⅞ | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12 | 13 | 4 0 9 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,840 | 5 | 2/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £360,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 8/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 4 7 | April and October | 12½ | 12 |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £310,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 10 8 | ... | 97½ | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6¼ | 6¾ | 6¼ | 6¾ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | 1¼ | 1¾ | 1¼ | 1¾ | 12 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 70 | 80 | 70 | 80 | 6 5 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 180 | 4 8 11 | April and October | ... | ... |
| £215,800 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 60,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 10 8 | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | £3/10 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | — | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 2¾ | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12½ | 13½ | 4 16 4 | March and September | 13 | ... |
| 29,618 | 5 | ... | Do. Do. | 11½ | 12 | 12 | 13 | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | — | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 60,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 10¾ | 10½ | 10¾ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 13,600 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | 10½ | ... |
| 60,000 | 10 | 8/0 | British Elec. Trac. Ord. | 12½ | 13½ | 12½ | 13½ | 6 5 11 | ... | 14⅛ | 13¼ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11½ | 12½ | 11½ | 12½ | 4 15 0 | February and August | 12⅛ | 11⅞ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 122½ | 121½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4¾ | 5¼ | 4¾ | 5¼ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4¾ | 4¾ | 4¾ | 4¾ | ... | ... | 4⅛ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | 105 | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stck Prov. Certs. (all pd.) | 95 | 98 | 95 | 98 | 5 1 0 | ... | ... | ... |
| 206,297 | 10 | 3/0 | Central London Ordinary | 9½ | 9¾ | 9½ | 9 | 3 6 8 | June and December | 9⅛ | 8¾ |
| £865,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 51 | 56 | 52 | 56 | 2 0 7 | February and August | 54 | ... |
| 37,500 | 10 | 1/3½ | Do. Ordinary (Nos. 24,901 to 60,000) | 4½ | 5¼ | 4½ | 5½ | 2 13 9 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 133 | 143 | 133 | 143 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £344,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 115 | 120 | 115 | 120 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896) Ltd., Ordinary | 17 | 18 | 17 | 18 | ... | ... | ... | ... |
| 53,987 | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 23½ | 23½ | 23½ | 24½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 6 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | 9½ | 10½ | | | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 5% | Liverpool Overhead Railway Ordinary | 8½ | 8¾ | 8½ | 8¾ | 4 11 2 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13¼ | 13¾ | 13¼ | 13¾ | 3 14 1 | " " | ... | ... |
| £115,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 16 10 | January and July | ... | ... |
| $350,000 | $1,000 | 5 | London Street R'y. (Ont.) 1st Mort. 5% Debs (red.) | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| £325,744 | Stock | ... | London United Tramways 1st Mt. Db. Stk. Pr. Certs. | x 102 | 04 | 02 | 04 | ... | ... | ... | ... |
| £50,000 | 100 | 5% | Montreal Street R'lw'y St'rl'g 5% Mort. Bonds (1908) | 104 | 106 | 104 | 106 | 4 16 0 | ... | ... | ... |
| £140,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 0 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 16 | 17 | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 6/0 | Do. 5 per Cent. Preference | 10½ | 10¾ | ... | | 4 18 0 | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 10½ | 11½ | 11 | 12 | ... | ... | 11½ | ... |
| 20,000 | 10 | 4/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £135,000 | Stock | 37/0 | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | 103½ | 103¼ |
| £40,000 | Stock | 1% | Waterloo and City Ordinary | 96 | 97 | 96 | 97 | 1 1 2 | June and December | 96 | 96⅛ |

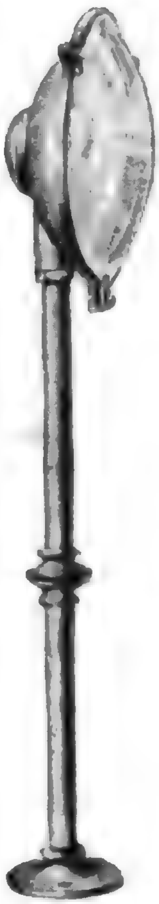
## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | NAME. | Previous Week's Price, Jan. 16. | | Price Tuesday, Jan. 22. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Jan. 22. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 103 | 99 | 102 | 3 18 5 | January and July | ... | ... |
| 35,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 6% | Do. 6 per Cent. Debentures | 85 | 90 | 85 | 90 | 6 11 1 | ... | ... | ... |
| £627,720 | Stock | 16/0 | Anglo-American | 53 | 55 | 51 | 54 | 6 15 3 | Feb., May, Aug., Nov. | ... | ... |
| £3,048,640 | Stock | 30/0 | Do. Preferred | 97 | 99 | 96 | 98 | 6 4 4 | " " | 91½ | 91¼ |
| £3,048,640 | Stock | 27/0 | Do. Deferred | 10 | 10½ | 8½ | 9½ | 14 11 8 | " " | 10½ | 9 |
| 13,333,300 | $100 | 8/1 | Commercial Cable Capital Stock | 170 | 180 | 170 | 180 | 4 9 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,603,073 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 101 | 104 | 3 16 11 | " " | 103½ | 101 |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7 | 8 | 7 | 8 | 6 17 6 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 15½ | 16½ | 16 | 17 | 5 17 8 | " " | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable x d | 10 | 10½ | 10 | 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10⅛ | ... |
| £109,300 | 100 | 4½% | Direct West India Cable 4½% Reg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,002,000 | Stock | 21/0 | Eastern Ordinary x d (to 1,201) (red.) | 138 | 141 | 137 | 142 | 4 18 7 | Jan., Apr., July, Oct. | 139½ | 133 |
| £1,836,466 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock x d | 95 | 98 | 95 | 98 | 3 11 5 | " " | ... | ... |
| £1,431,268 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 100 | 111 | 100 | 113 | 3 11 5 | May and November | 111½ | 111 |
| 260,000 | 10 | 2/6 | Eastern Extension x d | 14 | 14½ | 14 | 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14½ | 11 |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £4 pd, issued at £3 pm, all pd | 11½ | 12 | 11½ | 12 | ... | ... | 11½ | ... |
| £332,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 112 | 117 | 112 | 117 | 3 8 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 100 | 103 | 3 17 8 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 101% | 99% | 102% | 3 18 5 | May and November | ... | ... |
| 150,227 | 10 | 1/0 | Globe Telegraph and Trust | 10½ | 10½ | 10½ | 10½ | 4 17 8 | Jan., Apr., July, Oct. | 10½ | 10⅛ |
| 180,042 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 6 | " " | 15½ | 15½ |
| 180,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 33 | 32 | 34 | 3 13 6 | January and July | ... | ... |
| £82,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (with Nos. | 99 | 103 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European (1 to 1,200) (red. at 5% prem) 55 | 47 | 51 | 47 | 51 | 4 14 0 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brasilian 6 per Cent. Debs., 1896 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | June and December | ... | ... |
| 11,840 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 121 | 123 | 124 | 133 | 4 14 0 | " " | ... | ... |
| 15,600 | 10 | ... | West African Telegraph | 3½ | 3½ | 3½ | 3½ | 4 9 2 | December and July | ... | ... |
| £171,100 | 100 | 6% | * Do. 5 per Cent. Debentures (red.) | 99 | 103 | 99 | 103 | 4 19 6 | March and September | ... | ... |
| 30,006 | 3½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ | ¾ | ½ | ¾ | ... | May and November | ½ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | 6⅛ | 6½ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 103 | 4 14 4 | January and July | ... | ... |
| 307,900 | 10 | 3/0 | Western Telegraph (late Brazil'n S'bm'rine) | 13½ | 14½ | 13½ | 14½ | 4 14 3 | Mar., June, Oct., Dec. | 14½ | 13½ |
| £76,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 13 2 | June and December | ... | ... |
| £244,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 103 | 105 | 103 | 105 | 3 16 3 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 334,850 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 3/0 | 4/0 | 3/0 | 4/0 | 6 6 4 | April and October | ... | ... |
| 72,680 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 6 0 0 | November | ... | ... |
| 96,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | " | ... | ... |
| 690,000 | 5 | 3/0 | National | 4½ | 4½ | 4½ | 4½ | 6 17 2 | February and August | 4⅛ | 4½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 | 14 | 12 | 14 | 4 5 9 | " " | 13½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | " " | ... | ... |
| 350,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | " " | 4½ | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 | 97 | 95 | 97 | 3 13 2 | June and December | 95 | 94½ |
| £200,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 4 0 2 | ... | 99 | ... |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | ¾ | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5½ | 4½ | 5½ | 6 13 4 | July | 4½ | ... |
| 16,439 | 5 | 2/6 | Do. 6% Cumulative Pref. (Nos. 1 to 16,439) | 4½ | 5½ | 4½ | 5½ | 4 16 3 | June and December | ... | ... |
| 73,331 | 5 | 1/3½ | Do. do. (Nos. 16,440 to 90,000) | 4½ | 5½ | 4½ | 5½ | ... | ... | ... | ... |
| £179,917 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 | 105 | 102 | 105 | 4 15 3 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 3d. | Alliance Electrical Co. 5% Cum. Pref. | ½ | 1 | ½ | 1 | 5 0 0 | ... | ... | ... |
| 140,000 | 1 | 1½d. | Aron Electricity Meter 6% Cum. Pref. | 1½ | 1½ | 1½ | 1½ | 7 5 2 | March and September | ... | ... |
| 65,000 | 1 | ... | British Electric Works Co. Ordinary | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| £53,030 | 100 | 4½% | Do. First Mortgage Debentures | 95 | 97 | 95 | 97 | 4 7 8 | ... | ... | ... |
| 75,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ | 11½ | 10½ | 11½ | 5 13 11 | July and February | 11½ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 6½ | 6½ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 4½ | 6 6 4 | ... | ... | ... |
| 90,060 | 2 | 1/2½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 8 4 | September | 1½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 6 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | " | 2½ | 2⅛ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 109 | 111 | 103 | 110 | 4 3 4 | March and September | 103 | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 6 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 13 | 14 | 13 | 14 | 6 7 2 | " " | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | " " | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | 9½ | ... |
| £160,900 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1½ | ¾ | 1½ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 2/4½ | Crompton and Co. (Nos. 1 to 53,000) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | 3½ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 18 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 18 4 | " " | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 85 | 93 | 85 | 93 | 4 9 11 | June and December | ... | ... |
| £100,000 | Stock | 2% 4½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 93 | 100 | 93 | 101 | ... | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. x d | 4½ | 5 | 4½ | 5 | 3 10 0 | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) x d | 10. | 103 | 101 | 103 | 4 7 5 | ... | ... | ... |
| 112,100 | 3 | 1/2½ | Electric Construction Co. (Limited) | 1½ | 2½ | 1½ | 2½ | 5 18 9 | January and July | ... | ... |
| 25,000 | 3 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) x d | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | ... | Giffre Electro-Chemical and Power Co. Ord | ½ | | ½ | | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ | 14½ | 13½ | 14½ | 5 3 5 | February and August | 14½ | 13½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | 5½ | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ | 21½ | 20½ | 21½ | 4 13 0 | " " | 21½ | 20⅛ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 10. | 104 | 101 | 104 | 3 17 8 | March and September | 103 | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | 33 | 42 | 33 | 42 | 4 5 9 | March and July | ... | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 100 | 103 | 100 | 103 | 3 17 8 | January and July | ... | ... |
| 35,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 5 14 2 | ... | 10½ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | 11½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 3 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote them.

# ORIGINATORS FOR TRAMWAY FITTINGS AND TRACTION TELEPHONES.



F 2584.

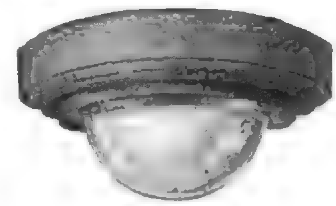
**15s. each.**

Cast Iron Outside Roof Fitting with Ruby Bull's Eye and 4-ft. Rod and Flange.

F 2586.

**57s. each.**

Tramcar Roof Fittings for 2-5 Lamps. Polished or Bronzed Brass, with Planished Silver Reflector.



F 2560.

**28s. each.**

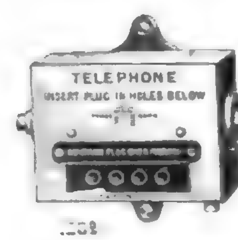
Roof Fitting with Contacts and Spring Lampholder. Ground Glass Shade and Bronzed Bayonet Slotted Ring.

REGD No 339640

No. K 201.

**Price, £3. 15s.**

The complete instrument consisting of 'Hunningscone Deckert' Hand Combination with water-tight transmitter; Switch Key, water tight, containing case with induction coil, for fitting into Feeder Pillars.



No. K 202.

**Price, £1. 17s. 6d.**

The complete Plug Box, consisting of Containing Case with Induction Coil; 4-way plug socket and connecting terminals for fitting in Feeder Pillars, for use in system where Hand Combination is carried on the cars.

---

**The**

# General Electric Co. (1900),

**Limited.**

Head Offices, Warehouses, and Showrooms:

**69, 71, 88 & 92, QUEEN VICTORIA STREET, LONDON, E.C.**

Branches—
- Victoria Bridge, MANCHESTER.
- 71, Waterloo Street, GLASGOW.
- 56, Barwick Street, BIRMINGHAM.
- 13, Westgate Road, NEWCASTLE-ON-TYNE.
- 16, St. Andrew's Street, DUBLIN.
- East Wharf, St. Mary Street, CARDIFF.

Works—
- Peel Works, Adelphi, SALFORD.
- Sherlock Street, BIRMINGHAM.
- Brook Green, HAMMERSMITH.
- Union Street, SOUTHWARK.
- CLERKENWELL.

Agents for the Australian Colonies: LAWRENCE & HANSON, 3, Wynyard St., SYDNEY, & 167, Queen St., MELBOURNE.

REGD TRADE MARK

PERFECTION
TURBINE
STANDS ON
EXPERIENCE

## SALES BY AUCTION.

**TUESDAY and WEDNESDAY, FEBRUARY 5 and 6, 1901.**

**TO ELECTRICAL ENGINEERS, ELECTRIC LIGHT AND INSTALLATION CONTRACTORS, ENGINEERS AND OTHERS.**

MESSRS. WHEATLEY KIRK, PRICE & CO. have been instructed by Messrs. Laing, Wharton & Cunnington to

**SELL BY PUBLIC AUCTION**

on TUESDAY and WEDNESDAY, February 5 and 6, 1901, upon the Works premises, Haunch of Venison Yard, Brook-st., London, W.,

**THE ENTIRE CONTENTS**

including 9 H.P. Otto Gas Engine, 3 Kilowatt Shunt-wound Dynamo, 8in. and 5½in. Slide Surfacing and Screw Cutting Lathes, ten 5in. centres Hand Lathes, 24in. Vertical Pillar Drilling Machine, two 2½in. Screwing Machines, two Milling Machines, Flexible Drilling Machine, 20 Vices, Line Shafting, Belting. The STOCK, which is of a large and extensive nature, includes two 12 H.P. New Continuous Current Motors by Greenwood & Batley, and one 12 H.P. 200 volts ditto by Charlesworth, Hall & Co., and two 3 H.P. Langdon-Davies Alternating Current Motor, and four 5 H.P. 105-volt Lahmeyer Dynamos; 35 gross of plain and key socket Lampholders, concentric and 2-pin Wall Plugs, 10 gross Cut-outs, Nipper Switches with brass and ornamental porcelain covers, 30 gross 2½in. and 3in porcelain Ceiling Roses, 20 Ammeters, high and low-tension switches, automatic Switches and Cut-outs, single and double-pole Distributing Boards up to 12 ways, Motor Starting Boards, 500 Brass Galleries and Guards, 230 handsome Brass Brackets, Standards and Electroliers, 23 Arc Lamps, 1,000 Incandescent Lamps, Telephone Instruments, brass Switch Parts, 2,000 wood Switch Blocks, 400 marble Switch Slabs, lead-covered and other Electric Light Cable, Scrap Brass, Copper, Ebonite, &c., &c.

Catalogues may be obtained on application to the AUCTIONEERS, 46, Watling-street, London, E.C., and Albert-square, Manchester. Telephones: No. 5077 Bank, London. No. 3218 Central, Manchester. Telegrams: "Indices London." "Indicator Manchester."

**38 N.H.P. GAS ENGINE and "DOWSON" GAS-PRODUCING PLANT.**

MESSRS. WHEATLEY KIRK, PRICE & CO. are instructed to SELL BY PUBLIC AUCTION (at the conclusion of the above Sale of the property of Messrs. Laing, Wharton and Cunnington), at the Haunch of Venison Yard, Brook-street, London, W., on WEDNESDAY, 6th February, 1901, in ONE LOT,

**A VERY FINE GAS ENGINE**

by Crossley Brothers, having Two Cylinders on one massive Bed Plate, Two Fly-wheels, Auxiliary Starting Engine, together with a

**COMPLETE "DOWSON" GAS-PRODUCING PLANT.**

The above Plant can be seen daily (by order to be obtained only from the Auctioneers), at the South London Rice Mills of Messrs. T. R. Denny & Sons, 16, Upper Ground Street, Blackfriars, London, S.E. For further particulars see Catalogue.

65, SOUTH AUDLEY STREET, LONDON, W.

MESSRS. PERCY HUDDLESTON & CO.,

In conjunction with

MESSRS. NORMAN & BOWEN have received instructions to SELL BY AUCTION on the Premises as above, on TUESDAY and WEDNESDAY, February 12th and 13th, 1901, and the FIXTURES and FITTINGS on WEDNESDAY, 20th February, 1901, at 1 o'clock precisely, the

VALUABLE STOCK and PLANT of

an

**ELECTRICAL ENGINEER AND LAMP MANUFACTURER.**

Comprising:- Brass, Wrought Iron and Copper Electroliers, Pendants, Standards and Brackets, also 60 Chloride Accumulators in Lead Lined Boxes, 20 Arc Lamps, 3,000 Incandescent Lamps, large quantity of Cable and Wire, Resistances, Switches, Holders, Ceiling Roses, Cut-outs, Voltmeters and Ammeters, and a

**10in RHUMKORFF COIL**

with Tubes and various accessories, also 4-in. Centre Lathe with Compound Rest, Tools, &c., also Massive Wrought Iron and Brass Gasaliers and Chandeliers, Brass and Wrought Iron Candlesticks, Fairy Lamp Holders, Lanterns, Hall Lamps, Standard and Table Lamps, Brackets, &c., Table Ornaments, Plated and China Colza Lamps, and Candelabras, Girandoles and Wall Mirrors, 20 pairs Ormolu Candelabras, and numerous other effects.

On view day previous and mornings of sale, and Catalogues may be had of the Auctioneers, PERCY HUDDLESTON & CO., Electrical and Mechanical Auctioneers and Valuers, 72, Finsbury Pavement, London, E.C.; Telephone 585 London Wall. Telegrams, "Sultanship, London," and NORMAN & BOWEN, Auctioneers and Valuers, 62A, Aldersgate-street, London, E.C.; and on the Premises.

TO ELECTRICAL ENGINEERS.—An opportunity which is rarely met with, to acquire a genuine old established business at the price of the Stock and Book debts. A sum of about £3,000 cash (which is fully represented by Stock, Book debts, Machinery, Plant, Fixtures, Fittings, Furniture, &c.) will purchase an OLD ESTABLISHED BUSINESS of an ELECTRICAL ENGINEER in the South West of London, employing on an average over 20 hands in very profitable work. The Shop and Works are held under a long lease at a low ground rent. The Local Authority are about to lay electric mains throughout the whole district, whereby the business must be largely increased. All the current contracts and work in hand may be taken by the purchaser. Apply to the sole Agent, H. W. SMITH, Auctioneer and Estate Agent, 7, Featherstone Buildings, Bedford Row, W.C.

## TENDERS INVITED.

WALLASEY URBAN DISTRICT COUNCIL.

GAS, WATER, AND ELECTRICITY DEPARTMENT.

**EXTENSION OF ELECTRIC SUPPLY WORKS.**

TO BUILDERS, ELECTRICAL, AND OTHER ENGINEERS, BOILER-MAKERS CABLE-MAKERS, &c., &c.

The Wallasey Urban District Council are prepared to receive TENDERS for the undermentioned WORKS, viz.:

(A) EXTENSION OF ENGINE HOUSE.
(B) LANCASHIRE BOILER.
(C) CONDENSING APPARATUS.
(D) WATER-COOLING TOWER.
(E) OVERHEAD TRAVELLING CRANE.
(F) ENGINES AND DYNAMOS.
(G) CABLES.
(H) ECONOMISERS.
(I) TRANSFORMERS.

Copies of the Specifications (and in the case of Section (A) only, Bills of Quantities) may be obtained, either on personal application to the Engineer, Mr J. H. Crowther, at his office, Great Float, near Birkenhead, or by letter, on payment of the sum of £2 2s. for each copy, the amount paid being in every case returnable on receipt of a bona-fide Tender.

Sealed Tenders, on the Forms embodied in the Specifications, addressed to the undersigned, and endorsed "Tender for Extension of Engine House," or any other Contract as the case may be, to be delivered per post, at my office, as below, not later than THURSDAY morning, the 21st day of February, 1901.

The Contractor will be required to enter into a bond, with approved sureties, for the due performance of the Contract.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
H. W. COOK, Clerk and Solicitor to the Council.

Public Offices, Egremont, Cheshire, January 22nd, 1901.

WALLASEY URBAN DISTRICT COUNCIL.

**ELECTRIC TRACTION.**

TO BUILDERS AND OTHERS.

The Wallasey Urban District Council are prepared to receive TENDERS for the ERECTION and COMPLETION of CAR SHEDS, STORES, WORKSHOPS, and DWELLINGS at their TRAMWAYS DEPOT, SEAVIEW ROAD, LISCARD, in the Parish of Wallasey, in the County of Chester.

The drawings can be seen on application to the Engineer, Mr. J. H. Crowther, at his office, Great Float, near Birkenhead, and a copy of the Specification and Bill of Quantities obtained either on personal application at that address, or by letter, on payment of the sum of £5 5s., which will be returned on receipt of a bona-fide Tender.

Sealed Tenders, on the Form embodied in the Specification, addressed to the undersigned, and endorsed "Tender for Car Sheds," to be delivered per post, at my office, as below, not later than THURSDAY morning, the 21st day of February, 1901.

The Contractor will be required to enter into a bond, with approved sureties, for the due performance of the Contract.

The Council do not bind themselves to accept the lowest or any Tender.

By order,
H. W. COOK, Clerk and Solicitor to the Council.

Public Offices, Egremont, Cheshire, January 22nd, 1901.

MANCHESTER CORPORATION TRAMWAYS.

The Tramways Committee of the Manchester Corporation are prepared to receive TENDERS for the SUPPLY of (a) **CAR TRUCKS** and (b) **PLANT**, Tools and Materials for Overhead Electrical Equipment. Specifications and Forms of Tender may be obtained on application to Mr. J. M. McElroy, General Manager, Tramways Department, Town Hall, Manchester. Tenders are to be addressed to the Chairman of the Tramways Committee, Town Hall, Manchester, and must be received not later than 9 a.m. on TUESDAY, the 5th February, 1901. The Corporation do not bind themselves to accept the lowest or any Tender.

WM. HENRY TALBOT, Town Clerk

Town Hall, Manchester, 25th January, 1901.

## TENDERS INVITED—*continued.*

### ROYAL BURGH OF KIRKCALDY.

The Corporation invite TENDERS for the SUPPLY, DELIVERY, and ERECTION of the following Work:—

SPECIFICATION No. 1.—**DRY BACK MARINE BOILERS**, 11ft. 6in. diameter and 14ft. long, with Mountings, Gangway, Feed and Drain Pipes, &c., complete as required for each of two Blocks of Boilers. Either or both the Blocks can be Tendered for, four Boilers in all being required. Alternative Tenders for Water Tube Boilers will be considered.

Copies of the Specification and Drawings can be obtained from the undersigned on payment of Three Guineas, to be returned on receipt by the Corporation of a bona-fide Tender.

The Specification and Drawings can be seen at, but not obtained from, the Offices of Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W.

Tenders must be sent to the undersigned so as to be received by him before 10 a.m. on 15th FEBRUARY.

The Corporation reserves the right to accept a Tender for any one Section alone or for both Sections. They do not bind themselves to accept the lowest or any Tender, and no allowance whatever will be made for any expense incurred in the preparation of any Tender.

WM. L. MACINDOE, Town Clerk.

Town Clerk's Office, Kirkcaldy, 14th January, 1901.

### LONG EATON URBAN DISTRICT COUNCIL.

The above Council are prepared to receive TENDERS for the following Works in connection with their Electricity Supply Station, namely:—

CONTRACT (A).—PRODUCERS, GAS ENGINES, DYNAMOS and SWITCHBOARD.

CONTRACT (B).—FEEDER and DISTRIBUTION CABLES, and CONVERSION of STREET LAMPS.

Copies of Specification and Conditions may be obtained at the office of the undersigned on deposit of Two Guineas for each Contract, which will be refunded on return of all documents and the receipt of a bona-fine Tender.

Sealed Tenders, properly endorsed, to be delivered at these offices not later than noon on MONDAY, 18th February, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

FRANK WORRALL, Assoc.M.Inst.C.E., District Engineer.

Council Offices, Long Eaton, 22nd January, 1901.

### GLASGOW CORPORATION.

**TRAMWAYS.—CAR EQUIPMENTS.**

The Corporation of Glasgow are prepared to receive TENDERS for the SUPPLY of 100 CAR EQUIPMENTS and spare parts for same.

Specification, with Form of Tender, &c., and all further information can be obtained on application to Mr. John Young, General Manager, 88, Bendield-street, Glasgow. A bank draft for Five Guineas, payable to the General Manager, must be sent along with each application. Deposit will only be returned on receipt of a bona-fide Tender.

Sealed Tenders, marked "Tramways, Tender for Car Equipments," must be lodged with the subscriber not later than 5 p.m. on FRIDAY, 22nd February, 1901.

The Corporation do not bind themselves to accept the lowest or any Tender.

J. D. MARWICK, Town Clerk.

City Chambers, Glasgow, 28th January, 1901.

### CITY OF WAKEFIELD.

The Corporation of the City of Wakefield invite TENDERS for the SUPPLY and ERECTION of an **INDEPENDENT SURFACE CONDENSING PLANT** at the Corporation Electricity Works, Calder Vale, Wakefield.

Specifications and Forms of Tender may be obtained on application to the City Electrical Engineer, at the above Works (upon payment of £1 1s. which will be returned on receipt of a bona fide Tender).

Tenders, under cover, addressed to the Town Clerk, Wakefield, and marked "Tender for Condenser," to be delivered on or before TUESDAY, the 12th February next.

The Corporation do not pledge themselves to accept the lowest or any Tender.

CHAS. JAS. HUDSON, Town Clerk.

Town Hall, Wakefield, 31st January, 1901.

**Official Announcements** *continued on p. xxxii*

PERFORATED EBONITE, XYLONITE, &c.
PERFORATED LEAD STEEL &c.

WIRE WORK of every kind for GUARDS, &c.

**NAME PLATES For Switchboards, &c.**

**METAL FLOORINGS for Generating Stations**
*ZINC BATTERY PLATES, CYLINDERS, RODS, &c.*
**W. BARNS & SON,** CHRISTOPHER WORKS, CHALTON ST., LONDON, N.W.

**ELECTRICAL ENGINEERING TAUGHT BY MAIL**

Thousands are successful and gaining better positions and salaries studying at home by our mail system. We teach Electrical Engineering, Mechanical Engineering, Mechanical Drawing, Electric Lighting, Electric Railways, Short Popular Electrical Course, Elementary Mathematics, &c., by mail. Study in spare time only. Institute endorsed by Thomas A. Edison and other prominent men of U. S. and England. Catalogue free.
Electrical Engineer Institute of Correspondence Instruction, Dept. 8, 240 to 242, West 23rd-st., New York, U.S.A.

## PLANT, &c., FOR SALE.

### COUNTY BOROUGH OF BRIGHTON.

ELECTRICITY DEPARTMENT.

The Lighting Committee have FOR SALE two CONTINUOUS-CURRENT MOTOR-DRIVEN ALTERNATORS of 35kw. capacity each, 70 periods, at 700 revs. per minute, 230 to 260 volts continuous and 2,400 volts alternating, complete with starting resistances and high tension switchboard for two alternators and three feeders. All the above made by the Electric Construction Co., Ltd. This plant is in excellent condition and is only being disposed of on account of the alternating supply being discontinued. It may be inspected at any time by appointment with the Engineer, and offers for same will be received up to SATURDAY, 23rd February, addressed to MANAGER, Electricity Works, North-road, Brighton.

### FOR SALE.—FOUR SETS of VERTICAL MARINE TYPE TRIPLE EXPANSION ENGINES of the Highest Class.

Two Sets with Cylinders, 22in. by 33in. by 49in., 21in. stroke.
Two Sets with Cylinders, 22in. by 34in. by 51in., 21in. stroke.

These Engines are fitted with Copper and Brass surface condensers, air and circulating pumps, and will indicate about 1,800 H.P., with a boiler pressure of 155lbs. per square inch, and running at a speed of 250 revolutions per minute.

They have done very little work, are exceedingly well finished, and are practically equal to new. They are of modern type and very economical in steam consumption, and are splendidly adapted for marine purposes or stationary work, mill driving or large power installations. They were built for the British Admiralty by the Naval Construction and Armaments Co., Barrow, and at the Government Dockyards, Sheerness. These engines will be disposed of for immediate sale at extremely low prices.

For further particulars apply to WAKE and CARR, Darlington, or THOS. W. WARD, Sheffield.

### FOR SALE.—EIGHT LARGE LOCOMOTIVE TYPE STEEL BOILERS,

built for the British Admiralty, for a working pressure of 150lbs. per square inch. These boilers have been indicating up to 500 H.P. each. There are from 302 to 450 tubes in each boiler. Length overall about 16ft., diameter of barrels about 7ft. Grate area 190 square feet. These boilers are in splendid condition. Will sell together or separately, and for immediate sale, very low prices will be accepted.—Apply to WAKE and CARR, Darlington, or THOS. W. WARD, Sheffield.

**AMMETERS & VOLTMETERS.**

JEWELLED BEARINGS. HARDENED PIVOTS.

100 AMPS. FROM £1 - 12 - 0

160 VOLTS FROM £1 - 15 - 0

**JAMES PITKIN,** 56, Red Lion Street, CLERKENWELL.

**C. PASS & SON, LTD.,**
Bedminster Smelting Works, BRISTOL.
SELLERS OF
*ANTIMONIAL LEAD OF ALL GRADES.*
BUYERS OF
LEAD ASHES & LEAD RESIDUES FROM ACCUMULATORS.
Telegrams: "PASS, BRISTOL." Telephone, 475.

# WITTING BROS., Ltd., (ELECTRICITE & HYDRAULIQUE)

## ELECTRIC POWER AND TRACTION ENGINEERS,

Telegrams: "WITTING LONDON."
Telephone: 5795 BANK.

***London Office: 49, CANNON STREET, LONDON, E.C.***

## APPOINTMENTS VACANT.

EAST HAM URBAN DISTRICT COUNCIL.

ELECTRIC LIGHTING AND TRAMWAYS DEPARTMENT

**TRAFFIC ASSISTANT.**

The above-named Council require the services of a TRAFFIC ASSISTANT in connection with their Electric Tramways, salary £150 per annum. Applicants must be fully experienced. Applications, stating age, in candidate's own handwriting, on Forms to be obtained from Mr. W. C. Ullmann, M.I.E.E., the Electrical Engineer, Public Offices, High-street, East Ham, E., and accompanied by copies of three recent testimonials (which will not be returned) to be sent in addressed to "The Chairman" Electric Lighting and Tramways Committee, Public Offices, Wakefield-street, East Ham, E., and endorsed "Traffic Assistant," not later than 12 o'clock noon of THURSDAY, the 14th February, 1901.

Canvassing the members of the Council either directly or indirectly is strictly prohibited and will disqualify any candidate.

By order,
C. E. WILSON, Clerk to the Council.

Public Offices, East Ham,
London, E., 28th January, 1901.

WANTED, CHARGE ELECTRICIANS and SWITCHBOARD ATTENDANTS for large Electric Tramway Installations.

Charge Electricians and Switchboard Attendants are required in connection with extra high-tension power station and substations operating Corporation Electric Tramways. Previous experience with high-tension currents essential.

Applications, giving details as to age, previous experience, and present salary, to be sent to C. S. A. 1,701, *Electrician* Office, Salisbury-court, Fleet-street, London, not later than FEBRUARY 11th, 1901.

## WANTED and FOR SALE.

WANTED immediately, new or Secondhand, TWO 1,500 AMPERE CUT-OUTS for 125-volt circuit. To cut out at a low or reverse current and preferably also at a maximum of 1,000 amperes. Replies should give age, maker's name, price, date of delivery, and drawing or sketch.—3,887, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, good SECONDHAND WILLANS ENGINE and DYNAMO, about 100 H.P., about 110 volts.—Apply, 3,892, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, LAMP TOPS, with Platinum, Scrap Platinum, &c.—Eden & Co., 29, Ludgate-hill, London, E.C.

ACCUMULATOR CHARGING.—C. H. CATHCART and CO., having plant specially adapted for this purpose, Charge Cells of all sizes promptly, thoroughly and cheaply. Terms on application. Accumulators on Hire for temporary lighting, experimental uses, &c. 3, Dorset-buildings, Salisbury-square, Fleet-street, E.C. (Telephone No. 200.)

## SECONDHAND ELECTRICAL MACHINERY.

Messrs. THOMPSON, SON & CO., of New York, have a LARGE QUANTITY of

***DYNAMOS, MOTORS, SWITCHES, ARC LAMPS, ENGINES, BOILERS, &c., &c.,***

in Stock, of Standard makes, for Immediate Delivery.

*COMPLETE EQUIPMENT FOR ELECTRIC LIGHTING PLANTS OR STREET RAILWAY SERVICE.*

Write for Catalogue and particulars to—

**W. H. MERRIMAN.** 39, Victoria St., LONDON, S.W.

## JOHNSON & PHILLIPS

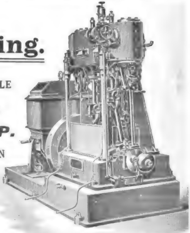
14, UNION COURT, OLD BROAD STREET, E.C., and CHARLTON, KENT.

MAKERS of the most Modern Machines for

| | |
|---|---|
| CABLE MAKING | CABLE LAYING |
| STRANDING | BRAIDING |
| TAPING | WINDING |
| COMPOUNDING | LAPPING |

RUBBER, SILK & COTTON COVERING

# ENGINES FOR Electric Lighting.



**HORIZONTAL or VERTICAL.**

SINGLE CYLINDER, COMPOUND or TRIPLE EXPANSION.

CONDENSING or NON-CONDENSING.

***Sizes up to 1,000 Brake H.P.***

ENGINES OF EITHER CLOSED OR OPEN TYPE.

## ALEX. SHANKS & SON,

LIMITED,

ARBROATH, SCOTLAND,

AND

**Bush Lane House, Cannon St., LONDON.**

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,185. [No. 15. Vol. XLVI.] FRIDAY, FEBRUARY 1, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

WITH this issue we publish, as a supplement, our annual map of electric railways and tramways of the United Kingdom. As on previous occasions, the details of this map are based on the information embodied in our annual statistical table of electric traction undertakings, which we published last week. The map, indeed, furnishes a convenient and interesting adjunct to the table, for it shows at a glance the general distribution of electric railways and tramways over the United Kingdom, as well as the distribution of the various electrical systems. Tramways being still greatly in preponderance over railways—a condition of things that may not always be maintained—there is naturally a greater proportion of the red-indicated overhead trolley system; but the blue dots, representing third-rail systems, are also growing in number. Twenty-three lines are worked by local authorities, the remaining 40—constituting a large majority—are owned and worked by companies.

WE are authorised to state that the rumour is quite unfounded which has appeared in certain newspapers during the past few days to the effect that "a decision with regard to the letting of the contract for the conversion of the District Railway from steam to electric traction" was arrived at last Monday. As a matter of fact the report of Sir WILLIAM PREECE and Mr. THOMAS PARKER will not be considered until early next week, which is accordingly the earliest date at which any decision can be made by the directors. The announcement that Messrs. GANZ & Co., or, indeed, any other firm of contractors, have been chosen for this important work is therefore, premature.

A communication to the press, apparently emanating from the Post Office, refers to its Express Delivery Services as follows: "Notwithstanding the measures taken to disseminate as widely as possible information respecting the various Post Office services, the POSTMASTER-GENERAL has reason to believe that the improved facilities offered by the express delivery service are still not generally known, or at any rate not entirely appreciated by the public." The communication then proceeds to give detailed particulars of the facilities offered for sending single letters by rail, special delivery in advance of ordinary delivery, special delivery in London on Sundays, and (this is rather belated, or is it only premature?) the advantages of special delivery at Christmas. There is, however, one branch of the express delivery service still less known to the general public and yet not mentioned in this announcement. We refer to the facilities for telephoning a message to a post office for transmission as an ordinary letter, express letter or telegram. In London, for instance, we have reason to know, that although a certain number of telegrams are telephoned to the Post Office, the use made of the "telephone letter" service is extremely limited. For some reason, few telephone subscribers seem to have found out that they can telephone 30 words to a post office for delivery by messenger at the ordinary express rate of 3d. per mile, and that the despatch of a telegram telephoned to a post office costs no more than if it were handed in over the counter. Many London business houses, who spend large sums per day in telegraphing at 6d. per dozen words, are unaware that in many cases express letters 2½ times as long could be sent quicker and at half the rate to clients within a mile of metropolitan post offices. These telephonic facilities have only been referred to in the Post Office Guide since the middle of 1899, although they formed part of the agreement between the Post Office and the National Telephone Co. on the acquisition of the trunk lines by the former; and even now the reference to them does not specifically state that they refer to connections through the National Telephone Co., leaving it to be inferred that these services are limited to trunk lines and Post Office exchanges. Perhaps it is not to be expected that the Post Office should advertise the business

of a competitor to both its telegraph and telephone services although this might be to the public convenience. The National Telephone Co. has advertised the matter from time to time we are aware, but neither in its advertisements nor in its directory is it made clear that these extra facilities are free of charge.

In our issue of January 18th, we referred to telegraphic despatches from New York to the effect that the American Telephone and Telegraph Co. had purchased from Dr. Pupin the patent for a method of submarine telephony from which great results were expected, the purchase price being $200,000 plus $7,500 a year during the 17 years' life of the patent. This announcement was quite correct as to the main fact, but in a subsequent inverview with a representative of the *Electrical Review* of New York, Dr. Pupin is reported to have stated that the price paid was "considerably larger," our contemporary adding that it is now "generally understood" that the sums mentioned above were half those actually to be paid, $400,000 having been already received in cash, and the $15,000 a year item to be paid as royalty. Dr. Pupin also stated that none but the American patents had yet been disposed of. It may be added that the American Telephone and Telegraph Co. is the large company which recently absorbed the American Bell Telephone Co., and therefore controls the most important telephone interests in the United States.

As to the invention itself, a full account of it, with an abstract of the patent, was published and commented upon in our columns last August (*The Electrician*, Vol. XLV., pp. 587 and 598). As we pointed out at the time, Dr. Pupin has carried out an experiment on an artificial line, in which self-induction was distributed, Dr. Pupin being a disciple of Oliver Heaviside in this respect. It is surprising that Heaviside's practical suggestions of this improvement to telephone lines of great length and high capacity should so long have been left without being submitted to the practical test of experiment. Perhaps the reward reaped by Dr. Pupin will encourage engineers to pay more attention to the results of mathematical analyses, even if, as unfortunately has been frequently the case with Heaviside's writings, the details of the mathematical treatment of the subject has been beyond the comprehension of many of them. In the meantime we await with interest the actual test of telephony over a real long inductive telephone line.

An American contemporary devotes an editorial article to a consideration of the question: "What should an electric light station sell?" Our contemporary answers, light, not electrical energy. Why, it asks, should an electric light station not benefit by an improvement in electric lamps. If, as is by no means improbable, a lamp twice as efficient as the present one should appear, our contemporary fears that the business of an electric light station would be reduced. This argument is based on the opinion of "no less an authority than Mr. Edison," whom we had not suspected hitherto of having invented a new science of political economy. What our contemporary is advocating is that a middleman should be encouraged to reap a harvest from a new invention rather than its inventor or the public which uses it. The electricity supply industry would not be benefited ultimately by keeping up artificially the price of its product.

**Obituary.**—The death is announced of Hofrath Ottomar Edler v. Volkmer, president of the Austrian Elektrotechnischer Verein, who died on January 20th, in his 62nd year.

**"Wiedemann's Beiblätter."**—It is announced that, beginning with the January number, Prof. Dr. Walter König, of Griefswald, will take over the editorship of the "Beiblätter" to the "Annalen der Physik."

**Personal.**—Mr. G. Noble Partridge, superintending engineer South Wales District Postal Telegraphs, is on account of ill-health retiring from the service, with which he has been associated for over 48 years.

**Presidency of the French Physical Society.**—At the last meeting, held the 18th inst., M. Cornu, who has twice been president, delivered his farewell address on leaving the chair. His successor as president is M. Pellat.

**Opening of the Motherwell Electricity Works.**—Owing to the death of the Queen the celebration of the opening of the new electricity works at Motherwell will not take place to-day. A brief description of the works appeared in our last issue.

**General Electric Co.'s Annual Dinner.**—We are asked to state that the annual dinner of this company's staff, announced for the 2nd inst., has been postponed until March 2nd, on account of the lamented death of Her Majesty Queen Victoria.

**Physical Society.**—At the ordinary meeting, held Jan. 26th, Mr. T. H. Blakesley, Vice-President, in the chair, it was decided to forward a note of condolence to His Majesty the King. The ordinary business of the meeting was postponed.

**Students' Visit to the Metropolitan Co.'s Willesden Works.**—The visit, announced for to-morrow, of the students of the Institution of Electrical Engineers to the Willesden generating station of the Metropolitan Electric Supply Co., has been postponed in consequence of the Queen's funeral.

**New Direct Cable Route between Great Britain and South Africa.**—The Eastern Telegraph Co. notifies that a cable between Porthcurnow (Cornwall) and St. Vincent (Cape Verde) via Madeira, was opened for traffic on Wednesday. This completes the new direct cable route between Great Britain and South Africa.

**Goldsmiths' Institute, New Cross.**—In consequence of the death of the Queen the Right Hon. A. J. Balfour, who should have distributed the prizes and certificates on February 7th, is unable to do so. The Governors have therefore decided to abandon for this year the public distribution. Students may obtain their awards upon application at the Institute office.

**Wigan Corporation Electric Supply and Tramway Works.**—The formal ceremony to celebrate the opening of these works, which it had been intended to hold, has been abandoned, owing to the lamented death of Queen Victoria. The lighting works were started last December, and the tramways during the past week, without ceremony.

**Cable Interruptions.**

| | | Date of Interruption. |
|---|---|---|
| Latakia—Cyprus | | June 21, 1899 |
| Pará—Maranham | | Mar. 2, 1900 |
| Cayenne—Pinheiro | | Nov. 26, 1900 |
| Pernambuco—Ceara | | Nov. 29, 1900 |
| Marseilles—Barcelona | | Jan. 7, 1901 |
| Shanghai—Amoy | | Jan. 17, 1901 |
| Havre—Waterville | | Jan. 19, 1901 |
| Malta—Tripoli | | Jan. 24, 1901 |
| Singapore—Banjoewangie | | Jan. 25, 1901 |
| Shanghai—Foochow | *Repaired* | Jan. 23, 1901 |

**Engineering Professorships.**—It is announced in *Elektrotechnische Mitteilungen* that Herr von Dolivo-Dobrowolski, chief electrician of the Allgemeine Elektricitäts Gesellschaft, is shortly going to St. Petersburg to take over the direction of the new Government electro-technical institute there. The

same journal states that Herr Görges is giving up his position as engineer-in chief of the firm of Siemens and Halske to fill a professorship at the Dresden polytechnic.

**Telegraphic Communication with Tientsin and Pekin.**—The Eastern Extension and Great Northern Telegraph Companies announce that they have constructed landlines between Taku, Tientsin, and Pekin, and opened them for traffic. These land-lines are under the complete control of the companies, and are worked in direct connection with the cables laid by them last autumn between Shanghai, Chefoo, and Taku. The existing tariff to Tientsin and Pekin of 5s. 6d. per word remains unaltered.

**A New German Monthly.**—The first number of a new German monthly publication, *Elektrotechnische Mitteilungen*, has been sent us. It is dedicated, not to the electrical engineer, but to laymen and those engaged in kindred professions and industries who are interested more or less in the progress of matters connected with electricity. The journal is edited by Herr J. Zacharias and published by Wilhem Knapp at Halle, and its subscription price is 2·50m. yearly in Germany and Austria and 3m. in other countries.

**The Rand Central Electric Works.**—We referred in our last issue to the damage done by the Boers to the Brakpan works of the Rand Central Electric Company. Further particulars announce that the damage is estimated at £4,000, being principally done to the dynamos. This assumes, however, that the crank shafts have not been damaged, a fact which has still to be confirmed by a closer examination of them. The telegram received in London on Monday further stated that it was "technically possible" to start one engine in 24 hours, and the two other damaged engines within a fortnight probably.

**Alleged Injury to Water Mains.**—In an action to recover $50,000 damages, brought by the Natural-gas and Water Companies of Indianopolis against the Indianopolis Street Railway Co. for deterioration in pipes and mains caused by electrolysis, the Superior Court holds the complaint good, and considers the tramway company guilty of actionable negligence. The *Western Electrician* of Chicago reports that the defendant company did not contest the facts alleged in the complaint were not true; it simply maintained that the damage resulting from the escape of electricity was incidental to the enjoyment of the franchise granted to the company.

**The Postal Telegraph Service.**—The following amusing letter by "an American" appeared in *The Times* of Wednesday last :—

On December 6th of last year I sent a telegram from London of from 150 to 200 words addressed to Wigmore, a telegraph office in Herefordshire, distant 160 miles. The telegram took exactly four hours in transmission from office to office. Thinking that 40 miles an hour was not a creditable speed for even a British telegraph line, I remonstrated, and after 53 days of patient waiting I have received the enclosed assurance from the Postmaster-General that "it is not thought that the time occupied can be considered excessive." It is not always possible to show by official documents the extraordinary progress made by the British nation, and I ask you to record this official assurance that the British telegraphs can deliver messages at the rate of 40 miles an hour. I may add that the Great Western Railway takes me at exactly the same speed.

**Electrolytic Reduction of Lead.**—The electrical lead reduction company whose premises were destroyed by fire last March has resumed work in its new building at Niagara Falls. According to the New York *Electrical World* the new plant has a capacity about ten-fold that of the plant destroyed by the fire, and the building is 182ft. by 140ft. The electrical machinery equipment consists of two Westinghouse motors of 300 H.P. each direct-connected to a Westinghouse direct-current generator of 250 H.P. The process consists in reducing electrolytically concentrated galena (sulphide of lead), the product being metallic lead in a spongy form. About five days, it is stated, are occupied in the reduction. The sponge is washed, and then, for the most part, converted by roasting into litharge for use in rubber manufacture and in storage batteries. Plant is being put down for rolling and stamping the sponge into storage battery plates. The present capacity of the works is about 10 tons per day, capable of extension to 40 tons per day. Sulphuric acid, it may be mentioned, is a by-product to the extent of 800lb. of acid per ton of lead.

**Telephony in Japan.**—Dr. H. Igarashi, director of the Imperial telephone service in Japan, has recently been in the United States examining the latest improvements in telephonic devices, and was unable to escape the irrepressible interviewer. He is reported to have said that in Tokio, a city, of 1½ million inhabitants, there were only 7,000 telephones but that the Japanese Government had already orders for 10,000 more. The Bell system, he continued, is in use in his country, with overhead construction similar to that employed in the United States, underground cables serving, however, for the junction lines between main and branch exchanges. The Japanese make their own wire, but import the iron billets for the purpose from America, native iron being unsuitable. The tariff is about equivalent to £6 a year. There is one long-distance line 400 miles long from Tokio to Osaka, and more are to be erected shortly. Dr. Igarashi predicts a good future for telephony in his country, in spite of the cheapnes of messenger service.

**American Wiring Rules.**—The Underwriters' National Electric Association has decided on some important alterations in the "National Electric Code" of wiring rules enforced in the United States. The limit of "low tension" has been changed from 300 volts to 550 volts, and the earthing of the middle wire or point in every low-potential circuit is to be permitted, although not made obligatory. This includes the earthing of the middle point of the secondary of an ordinary step down transformer, but apparently does not permit the earthing of one pole of a two-wire system. With regard to the change of limiting pressure, the *Electrical World* points out that hitherto any system in which the dynamo supplied a pressure exceeding 300 volts, was treated in the rules as a high potential system, and the wiring in connection with it had to be open wiring in plain sight, as distinguished from being covered in wooden moulding, or concealed work. The new rule permits the use of 500-volt systems other than trolley systems to be used in buildings with suitable restrictions as to wiring and fittings. As a matter of fact, America has followed in the lead of this country and has already several $2 \times 220$-volt three-wire systems. These, although contrary to the "National Electric Code" existing hitherto, have apparently been winked at, and now they are to be permitted. In addition to these amendments, a committee on "slow-burning" insulation recommended the optional employment of a new class of insulated wire in which one layer of "weather-proof" insulation is placed next to the copper and surrounded in two layers of braiding containing the approved "slow-burning" insulation. This recommendation has been adopted. Another committee on the carrying capacity of aluminum wire had made a long series of tests showing that insulated aluminum wire had a safe carrying capacity 84 per cent that of similarly insulated copper wire of the same size, while bare aluminum wire had only 77 per cent. the capacity of the corresponding size in bare copper. These figures will also be incorporated in the new "code." The full text of the amended rules will be given in *The Electrician* Electrical Trades' Directory and Handbook for 1901.

**The Erie Long Distance Telephone System.**—An article by Mr. A. S. Riggs in the *Electrical Review* of New York is devoted to a description of the Erie Telegraph and Telephone Co.'s long-distance telephone system. An illustration of the growth of this system is given by noting the changes which have taken place at Dallas, Texas. Seven years ago there were only four earth-return iron-wire lines running out of Dallas, and the service was limited to a few towns in the immediate neighbourhood of that city, the traffic being so light that the operator spent half her time on local work. To-day there are 52 metallic circuits, 48 of them copper, radiating from Dallas, and 1,000 stations in Texas and Arkansas are connected to the system, three No. 8 copper circuits being each 1,000 miles long. In Texas and Arkansas there are over 38,000 miles of wire out of a total of 94,200 miles operated by the company, and it is expected that in two years' time this will be increased to 150,000 miles. The territory in which the company operates contains 12 per cent. of the total population of the United States. The poles vary from 25ft. to 50ft. in height, according to the number and size of cross arms to be

carried, and where unusually long poles have been set to get good clearance, particular attention has been paid to grading, thus making an even distribution of strain as well as giving the line a trim appearance. Poles are set 36 and 40 to the mile, and are for the most part of Idaho cedar. On some of the earlier lines built four-pin cross-arms were used, but during the past three years nothing but six-pin and 10-pin cross-arms have been employed, with the exception that 12-pin arms have been adopted in some places where there seemed to be a probability that, in the near future, the traffic would necessitate a particularly large number of circuits. All corners, turns, railway crossings, &c., are double-armed. The switch-board equipment has been constantly remodelled and brought up to date, and at present there are over a dozen places with central battery boards, and underground conduits are used to some extent in the towns. The aggregate length of pole line on the system is 18,106 miles, extending to 2,800 towns and villages. Of the 94,200 miles of wire, 70,500 is of copper, and 23,700 of iron.

**Tramways and Light Railways Association.**—The first meeting of the members of this Association was held at Norfolk House on Friday last, Mr. L. A. Atherley-Jones taking the chair in the absence of Sir C. Rivers Wilson. The meeting was called mainly for business purposes, but in the course of a short speech the Chairman mentioned that the main object of the Association, which was formed some 18 months ago, was to develop means of transit in this country chiefly by the aid of electricity. He commented on the unfavourable progress made in the United Kingdom as compared with the United States, and after pointing out the advantage of electricity as a means of locomotion over horses and steam, said the Association was fully alive to the fact that one of the greatest hindrances in the work of traction development was the old Tramways Act of 1870. With a desire to see this Act abandoned they had been in communication with the Board of Trade, but so far their proposal to amend the Light Railways Act and to abandon the 1870 Tramways Act had not been received favourably. But it was still the intention of the Association to endeavour to obtain some modification of the most objectionable features of this act, chief of which was the question of compulsory purchase, which at present did not give sufficient compensation to those who had invested in such undertakings. In conclusion he referred to a letter which had been received from the Union Internationale Permanente de Tramways (of 85, Rue Potagère, Brussels), intimating that that body was coming over to England in 1902 to hold its annual congress. A resolution was then passed expressing the grief felt by the members of the Association at the death of her late Majesty the Queen, and respectfully offering their condolences to King Edward VII. and the rest of the Royal Family. The election of a number of new members of Council concluded the business of the meeting. The list of officials for the coming year is now constituted as follows:—

Sir C. Rivers Wilson, G.C.M.G., C.B. (President), L. A. Atherley-Jones, K.C., M.P. (Vice-president), W. M. Acworth, Jas. W. Courtenay, Philip Dawson, John Fell, George Flett, George F. Fry, Emile Garcke, J. Barber Green, A. R. Monks, Sydney Morse, William M. Murphy, Stephen P. W. D. Sellon, A. Fisker, R. E. Crompton, W. L. Madgen, E. F. Vesey Knox, R. H. Scotter and C. R. Bellamy.

**Electric Plant at Desloge Mines, Missouri.**—A very complete power and lighting plant has been installed at a lead mine—the first so equipped—at Desloge, and is described in a recent number of the *Engineering and Mining Journal*. The ore being 450ft. down and the lead itself finely disseminated, economy of operation is a vital consideration. The ore is raised in cars holding 1 ton, at a speed of 900ft. per minute, by electric hoists, sifted, and the larger pieces fed into crushers running at 250 rev. per min. There are seven crushers at each mine belted to a shaft driven by a 100 H.P. motor. Each crusher treats 600 tons of ore per day. The crushed material then travels, on a belt conveyor, to the main crushing mill, which treats 1,000 tons per day. The pulverised ore then goes to the water-separators, where it is handled by 12 centrifugal pumps driven by direct-connected motors. The resulting lead concentrates average 70 per cent. of lead, and are passed directly to the roasting furnaces. The central storage bins are at No. 2 mine, which is connected by a trolley line, a mile long, with No. 3 mine, and a line half a mile long with No. 1 mine. On each line there are two trolley wires overhead, positive and negative, to avoid the great liability to grounding which would occur in a mining installation if a single trolley wire and earth return were used. The mineral trains are drawn by 20-ton locomotives, equipped with air brakes and double trolleys. Besides carrying the mineral to the central storage bins, these tramways convey waste rock from the mills, concentrates to the railway siding, and coal from the siding to the power-house. The central power-house furnishes all the power. The boiler room contains four 300 H.P. Babcock and Wilcox water-tube boilers, and the engine room one 350 H.P. cross-compound condensing Corliss engine, direct connected to a 250kw. 500-volt compound-wound generator. There is also a 350 H.P. cross-compound condensing Corliss engine, direct-connected to a 250kw. compound-wound generator, and a cross-compound condensing tandem Corliss valve air compressor capable of compressing 250ft. of free air per minute to 100lb. per square inch. There is, besides, a storage battery of 250 15-plate type F cells, and a booster directly driven by a motor having a capacity of regulating to the extent of 250 amperes on a variable load. This battery gives out from 70 to 80 per cent. of fluctuating load, namely, when a hoist or locomotive starts, and maintains a constant voltage at the main 'bus bars.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO DAY (FRIDAY), February 1st.**

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 *p.m.* General Meeting in the Literary and Philosophical Society's Lecture Hall, Westgate-street, Newcastle-upon-Tyne. Included in the Agenda is Mr. E. L. Orde's reply to the discussion on his Paper on "Liquid Fuel."

**MONDAY, February 4th.**

ROYAL INSTITUTION.

5 *p.m.* General Monthly Meeting.

SOCIETY OF ENGINEERS.

7.30 *p.m.* Ordinary Meeting at the Royal United Service Institution, Whitehall, when the President-elect, Mr. C. Mason, will deliver his inaugural address.

**TUESDAY, February 5th.**

INSTITUTION OF JUNIOR ENGINEERS.

8 *p.m.* Meeting at the Westminster Palace Hotel. Mr. A. H. Barker will give his first lecture on "Works Management."

**WEDNESDAY, February 6th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

8 *p.m.* Students' Meeting at 28, Victoria-street. Paper to be read: "Systems of Distribution and Economy in Mains," by J. T. Irwin.

SOCIETY OF ARTS.

8 *p.m.* Ordinary Meeting. Paper to be read: "Some Experiences of Motor Bicycles," by Joseph Pennell.

**THURSDAY, February 7th.**

RÖNTGEN SOCIETY.

8 *p.m.* Ordinary General Meeting at 20, Hanover-square, W. Paper to be read: "Experiences of X-Ray Work during the Siege of Ladysmith," by Lieut. and Quartermaster F. Brace, R.A.M.C.

**FRIDAY, February 8th.**

PHYSICAL SOCIETY.

5 *p.m.* Annual General Meeting in the Rooms of the Chemical Society, Burlington House, when the President will deliver an address. An Ordinary Meeting will follow, at which Prof. R. W. Wood will read a Paper on "A Mica Echelon Grating."

INSTITUTION OF MECHANICAL ENGINEERS.

8 *p.m.* Extra Meeting at Storey's Gate, to take the adjourned discussion on Mr. H. A. Humphrey's Paper: "Power Gas and Large Gas Engines for Central Stations."

INSTITUTION OF JUNIOR ENGINEERS.

8 *p.m.* Meeting at the Westminster Palace Hotel. Paper to be read: "Electric Power Supply in the Metropolis," by L. F. Awde.

ROYAL INSTITUTION.

9 *p.m.* Evening Discourse by Prof. G. H. Bryan, F.R.S., on "History and Progress of Aerial Locomotion."

**SATURDAY, February 9th**

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to the generating station and depot of the Central London Railway, Shepherd's Bush.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Stratification of Discharges.*—The luminous portions of a stratified discharge are those in which the number of ions per unit volume is a maximum, while it is a minimum in the dark portions. On the anode side of each bright stratum there is a positive surface charge, and on the cathode side there is a negative surface charge. At the electrodes there is a diminution of ionisation by electrolysis, and this diminution is particularly great at the cathode in consequence of the difference in the velocities of the positive and negative ions. In the dark spaces the forces driving the ions are greater than in the bright strata. They are greatest at the cathode. This implies a corresponding variation of the potential gradient. J. Stark sketches the production of stratification as follows: As soon as the discharge has been started, the difference of velocity between the two kinds of ions produces a reduction of the ionisation and hence also of the force at the cathode. The negative particles acquire a great velocity and retain it for considerable distances owing to ionic shooting. The negative glow light is a region of strong ionisation, which reduces the velocity of the negative ions and produces an accumulation of them just beyond it. That accumulation acts as a secondary cathode, and produces similar phenomena.

[J. Stark, *Phys. Zeitschr.*, January 19, 1901.]

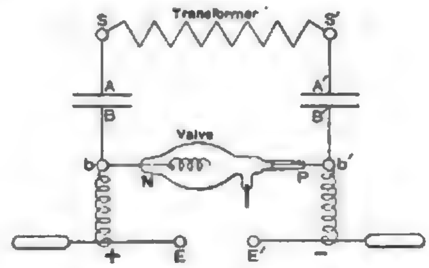
*Luminosity of Gases.*—J. Stark, in continuing his researches on the luminosity of gases under electric discharge, has arrived at some interesting general conclusions. Luminosity is due to the impact of ions upon each other and upon neutral molecules, the luminosity being greater in the former than in the latter case. The greatest amount of luminous energy is evolved where the greatest number of encounters between positive and negative ions takes place—*i.e.*, at the points of maximum ionisation. The gas itself sends out the luminous rays, and the process is intimately connected with the diffused reflection of cathode rays by solid bodies. In these encounters, the place of the solid bodies is occupied by the positive ions. It is in the luminous portions of the discharge that the kinetic energy of ions produced at the cathode is absorbed. The mean velocity of an ion depends not only upon its mean free path, but also upon the degree of ionisation of the gas, for the mutual attraction of the ions brings about a greater number of encounters than would otherwise take place. Luminosity is produced not only by the primary cathode rays, but also by the secondary ones, and, indeed, at a greater number of points by the latter, since, owing to their smaller velocity they are diverted and dispersed to a greater extent by the positive ions.

[J. Stark, *Phys. Zeitschr.*, January 19, 1901.]

*Tempering of Overstrained Iron.*—It is well known that iron hardened by overstrain, such as permanent stretching, may have its original properties restored by annealing. Experiments made by James Muir show, however, that if iron hardened by overstrain be raised to any temperature above 300deg., it may be partially softened in a manner analogous to the ordinary tempering or "letting down" of steel which has been hardened by quenching from a red heat. This tempering from a condition of hardness induced by overstrain, unlike ordinary tempering, is applicable not only to steel, but also to wrought iron, and possibly to other materials which can be hardened by overstrain and softened by annealing. In the author's experiments, the straining was performed by means of a 50-ton testing machine. A rod of semi-mild steel showed a yield-point at about 38 tons per square inch to start with. After overstraining it and laying it aside for 1¾ days, the specimen showed a marked recovery from strain, and after resting for two weeks the curve of strain was found to return nearly upon itself. A perfect restitution could be obtained at once by a few minutes' immersion in boiling water, or an exposure to a temperature of 200deg. At the same time the yield-point rose to 49 tons per square inch, and another similar operation even raised it to 60 tons.

[J. Muir, *Proc. Roy. Soc.*, January 19, 1901.]

*Transformer with Cathode Rectifier.*—P. Villard describes a new high-voltage transformer, in which one of the alternations is suppressed by means of a cathode-ray valve, which, as we know, possesses at a certain exhaustion a resistance capable of opposing 60,000 volts in one direction (when the wire coil is the anode), and a very feeble resistance to a current in the opposite direction. The circuit is interrupted by condensers at A′, B, A, B′, as in Tesla's arrangement, and



the valve is inserted between $b$ and $b'$. It contains a small rod of platinum in a side tube, which is heated to liberate the necessary amount of hydrogen. The same transformer may be made to feed two exciters, and there is a greatly increased voltage in the circuit.

[P. Villard, *Journ. de Physique*, January, 1901.]

*Hot-Wire Instruments.*—At a recent lecture before the Italian Electrochemical Association, C. Olivetti enumerated the requirements to be fulfilled by a satisfactory hot-wire instrument for electromagnetic measurements in which the expansion produced by the heating is measured after amplification. The wire should have a large temperature coefficient of expansion, a high resistance with small temperature coefficient, and a great rigidity, and it should remain unoxidised and unmodified at high temperatures. The best substance so far adopted is an alloy of two parts of silver and one of platinum. The greatest advantages of hot-wire instruments are that they are independent of magnetic fields and independent of the form of the current curve, as they work equally well with continuous and alternating currents. The author describes various windings of the wire by means of which its mechanical strength can be increased and the consumption of energy reduced.

[C. Olivetti, *Att. dell'Ass. El. Ital.* IV., 3, 1900.]

*Charges due to Röntgenised Air.*—E. Dorn attempts to explain Villari's curious observation that Röntgenised air charges metallic bodies positively when it impinges upon them with force, and negatively when it touches them lightly. The author's explanation is based upon the difference in the velocities of the two classes of ions. When the ionised air flows past a metallic surface without perceptible friction, the negative ions are, owing to their swifter motion, the only ones which will touch the surface to any great extent. When there is strong friction, with rapid changes of direction of motion over small distances, the superior mass of the positive ions will enable them to retain their direction of motion to a greater extent than in the case of the negative ions. This differentiation is assisted by the fact that in gases under ordinary pressure the mass of both kinds of ions is much greater than the mass of the unionised molecule. The mixture of the three classes of particles may be compared with that of stone blocks of two sizes, mixed with sand, and allowed to slide down an inclined plane.

[E. Dorn, *Phys. Zeitschr.*, January 19, 1901.]

Wireless Telegraphy in Hawaii.—It is now reported in the American papers that wireless telegraph stations in the Hawaiian Islands were put into operation on January 10, thus practically connecting all the islands except Kauai. Three stations are operating at present, one being at Honolulu, one at Hilo and one on the island of Lanai, that being the connecting station between the two others. By means of cables and the telephone practically all the islands of the group are now in communication.

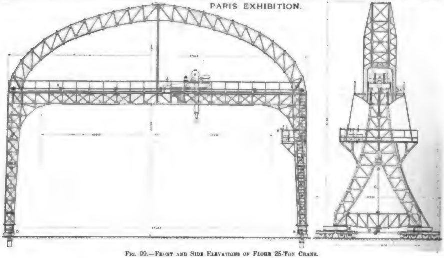
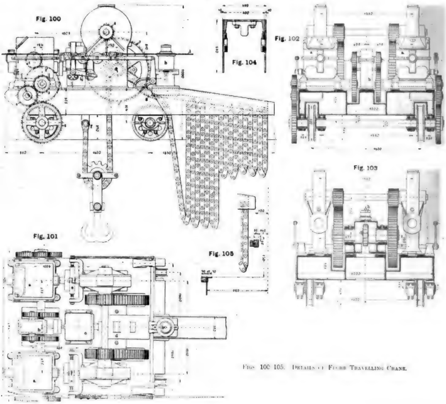


Fig. 99.—Front and Side Elevations of Flohr 25-Ton Crane.



Figs. 100–105. Details of Flohr Travelling Crane.

# THE PARIS EXHIBITION.—XV.*

(BY OUR SPECIAL CORRESPONDENT.)

One of the finest exhibits at the Paris Exhibition, which was unnoticed by a large number of visitors in spite of its being undoubtedly the largest piece of machinery in the Electricity Palace, was the huge travelling crane which had served for the erection of the machinery in the foreign section. This may have been because, in its position at rest, its girder-work harmonised so completely with the general style of the building, or merely because it was inaccessible except by means of a fairly long and steep climb up a ladder, there being no connection between the gallery and the beam of the crane. As seen in Figs. 98 and 99, the traveller differs from other cranes of this type by being arranged for running along rails on the floor instead of on girders, presumably because the structure of the building itself would not have been strong enough to bear the additional weight. Thus it is evident that Messrs. Carl Flohr, of Berlin, the builders of the crane, had no easy task before them, for the height of the beam having to be considerable, provision had to be made against the possibility of the crane tipping over when it stopped while carrying a heavy load at a great elevation; and, in view of the large span also, enormously varying stresses had to be provided for.

FIG. 98.—GENERAL VIEW OF FLOHR TRAVELLING CRANE DURING ERECTION OF THE ELECTRICITY PALACE.

Fig. 99 is an elevation and side elevation of the whole crane, and Figs. 100 to 105 show the details of the crab. The dimensions are marked in millimetres. The crane is rated at 25 tons, has been tested to 30 tons, and, I was informed, was employed to lift 38 tons on one occasion. As seen in Fig. 99, the span is 27·6metres, or about 90ft. 6in. Each of the feet runs on eight wheels placed behind one another in two sets of four, and connected by a stiffened girder framework designed to equalise the load on all the axles. These wheels are central-flanged and run on a track formed of two Vignoles rails placed close together—at 118mm. ($4\frac{5}{8}$in,) centres, the flange running in the gap between the heads of the two rails. The diameter of the wheels is 600mm. (1ft. $11\frac{5}{8}$in.). The four inner wheels are driven for propelling the crane, this being effected by worm gearing, the worm wheel of which is fixed directly on the main axle. The wheel-base—*i.e.*, the distance between the centres of the two sets of four wheels, as marked in the side elevation in Fig. 99, is 8metres (26ft. $2\frac{1}{2}$in.), and this provides against the danger of tipping, it being calculated that a

---

* Previous articles appeared in *The Electrician* of July 20 and 27, August 3, 24 and 31; September 14 and 28; October 5, 12 and 26; and November 2, 16 and 30, 1900; and January 18, 1901.

distance of 88mm. (1½in.) is sufficient to brake the momentum at full load.

The three-motor system was adopted for the crane, and the speeds for which it was designed were as follows:—

| | |
|---|---|
| Longitudinal traverse ...... | 30metres (91·4ft.) per sec. |
| Cross traverse ............... | 18metres (54·9ft.) per sec. |
| Lift (at full load) ............ | 2·4metres (7·3ft.) per sec. |

There was a total length of 107metres (326ft.) of track which the crane traversed in about 8½min. at full load. All the motors are of the Union Elektricitäts Gesellschaft's manufacture, and they are supplied with continuous current at 220 volts, through roller contacts. The longitudinal traversing motor A is rated at 26 H.P., at 115 revs. per min. It is placed in the centre of the beam, and is geared to a horizontal shaft, B (Fig. 99), by a spur gearing with a 1:4 reduction. This horizontal shaft runs the whole length of the beam, and is geared by bevel gearing to a vertical shaft, C, at each end. At the lower end of each of the latter another bevel gear connects to a vertical shaft, D, which actuates the four driving wheels on each foot through worm gearing. In the design of the gearing, great attention has been paid to the prevention of any possibility of locking, as when the motors have been switched off it is of the utmost importance that the crane should be able to travel a little further by itself, so that there should be no risk of tipping. The end bearings run on balls.

The arrangement of the cross-traversing and lifting motors and their gear on the crab is seen in Figs. 100 to 103. The frame of the crab itself is a hollow casting. For lifting, two similar motors $a\,a_1$ are employed, each of 18 H.P., and running at 450 revs. per min. These drive a common countershaft by means of worm gearing, and this is connected through double-reduction spur gearing to the axle of the chain wheel, the total reduction in speed from motor to chain wheel being 1:88. Between the motor and the worm is a coupling, one-half of which is constructed as a brake. The brake shoes are pressed together by a helical spring, which is in compression. The brake is controlled by an electro-magnet, *h*, or by hand by means of a cord, *i*, passing over a pulley.

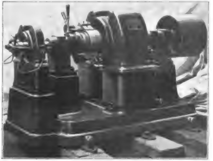


FIG. 106.—GRAMME SERIES ARC LIGHTER.

The cross-traverse is also actuated by worm and spur gearing, in this case from a single 8 H.P. motor running at 500 revs. per min. with a gear ratio from motor to driving-wheel of 1 : 43·4.

A Gall link-chain with 8$\frac{1}{32}$in. pitch is employed for lifting. The detail of the arrangement for disposing of the slack is seen in Figs. 104 and 105.

The following particulars apply to the Gramme electrically-driven slotting machine and forge, and the portable generating set illustrated in my last article (Figs. 90, 91, and 92, p. 459), and were inadvertently omitted. The motor of the slotting machine can be regulated so that the speed of the tool varies from 125 to 550 revs. per min., and a similar machine with a horizontal tool from 225 to 1,000 revs. per min. This is effected entirely by varying the field and the attendant has merely to turn a hand-wheel. The controller is contained within the base of the machine. The fan of the forge is coupled directly to a small motor placed in the lower part of the apparatus, and can be easily got at through the doors below. Finally, the small generating set (Fig. 92) has a normal output of 1,900 watts. The 3 H.P. petroleum motor driving it has water circulation, and is coupled directly to the dynamo by a leather ring coupling. The generator is a perfect little working model of an enclosed four-pole dynamo, with slotted drum winding and ring lubrication. The carburator is fixed on the same bed-plate and is of the evaporative type with constant level and constant density.

Another interesting machine exhibited by the Gramme Co. was the series arc lighter with its direct-connected exciter on the same bedplate, shown in Fig. 106. The dynamo will generate 10 amperes at from 800 to 2,000 volts. It has a smooth ring armature. Forty lamps in series is the load intended for it, and several of these machines are employed for public lighting in Paris.

An armature for an arc lighting machine shown by the Western Electric Co. (U.S.A.) was also of interest, although it occupied a not very prominent position in an exhibit chiefly of telephonic apparatus. It is intended for 150 9·6-ampere arcs in series, and and is therefore built to withstand the working pressure of 8,500 volts. The armature is slotted, the wires being held in place by wedges driven in over the top of the winding. It is ring-wound, and the winding is divided into a large number of coils of comparatively few turns of wire so as to have the minimum difference of potential between the individual coils. The coils are insulated from the core in the slots by a trough which is built up of alternate layers of press board, mica and oiled paper, the sheets of mica being well lapped to avoid any chance of puncturing at the joints. On the inside of the armature the coils are wound in insulating troughs somewhat similar to the troughs in the slots, with the exception that they are narrower and deeper. The ends of the coils are insulated from the core, first, by insulating rings which are placed at the ends of the armature and form rounded corners to wind over as well as affording additional insulation, and then by troughs which overlap and extend in and around the inside and outside troughs. Thus each coil is wound in a separate trough built up of four overlapping troughs, which should insulate it effectually from each of the other coils and from the core.

The commutator is air-insulated. It is built up on a micanite disc mounted on a brass flange at the end of the armature. On the face of this disc all the connections to the armature are made. The working part of the commutator is of the usual cylindrical shape, at right angles to the disc and concentric with the shaft, but there is no insulation but air-space between this part of the commutator bars.

## THE CENTRAL LONDON RAILWAY.

*(Continued from Vol. XLV., p. 826.)*

### PART II.—THE LINE AND ITS ROLLING STOCK.

**Equipment of the Track.**—The entrance to the underground system is shown in Fig. 49, which indicates the manner of bringing the feeders from the power-house cable-way into the tubular tunnel. This illustration is from a photograph taken at the lower end of the cutting, through which passes the single track connecting the underground railways with the surface yards and sheds. In handling the rolling stock into and out of commission, therefore, it must all be brought through the single tunnel shown in Fig. 49. The inner end of this tunnel communicates directly with the tracks and sidings at Shepherd's Bush station, at which point the ordinary service transfers from the down to the up main tunnel are made. In order to expedite these transfers and thus to allow of a still more frequent service of trains, powers are to be sought to construct an underground loop between the two main tunnels, at either end of the line.

For the surface tracks, the ordinary type of rail used on British railways has been laid down, and a somewhat similar type has been adopted at the points and crossings throughout the system. Fig. 50 is a section to scale of the track-rail used

in the tunnels, and Fig. 51 shows a section of the rail at crossings and points. The insulated conducting rail, as we have already stated, is of inverted channel steel, the construction being as shown in section in Fig. 52. There are altogether about 14·7 miles of third-rail on the entire system of tracks. The insulators for this rail are of porcelain, of the section shown in the illustration. They were supplied by Messrs. Borne & Co., and are placed at intervals of 7ft. 6in. Thus there are about 9,000 of these insulators on the railway. The manner of bonding the third-rails and the track is shown in Fig. 53, which is from a photograph taken in the cutting shown in Fig. 49. The middle rail is quadruply bonded with Crown bonds, providing an aggregate copper section of 0·62 sq. in. For the track-rail double bonds are used, one on each side of the rail.


Fig. 49.—Entrance to Tunnel from Railway Yards.


Fig. 55.—Interior of the Carriage Sheds.

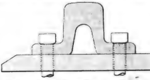


Fig. 50.—Bridge Track-Rail used in Tunnels.
One-fourth full size.

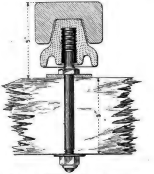


Fig. 52.—Insulated Third-Rail Conductor.
One-fourth full size.

We have already stated that the tracks are laid in separate cast-iron tunnels constructed on the Greathead system. It is not within our province to describe the civil engineering work on this railway, but we may mention that the two separate tunnels, each 11ft. 6in. diameter, which form the up-and-down lines respectively, are principally side by side, but on a portion of the city section they are placed the one over the other. Throughout the railway the stations are super-elevated to a considerable extent. The object of this is to derive the benefits of "switch-backing" in starting and stopping the trains at the stations. When leaving any station every train will start on a down gradient, which supplies by

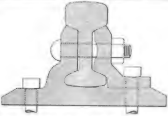


FIG. 51.—BULL-HEADED TRACK-RAIL USED FOR CROSSINGS AND POINTS.
One-fourth full size

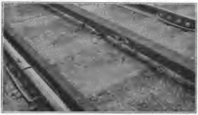


FIG. 53.—SHOWING METHODS OF BONDING THE TRACK AND THIRD RAILS.

FIG. 54.—ENTRANCE TO LOCOMOTIVE SHEDS.

FIG. 55.—INTERIOR OF ONE OF THE LOCOMOTIVE SHEDS.

gravity the bulk of the additional power required for acceleration. This has the effect of diminishing the starting current, and thereby tends to uniformity in the load on the generating plant and motors. When approaching any station a train will be confronted by a length of stiff gradient, the retarding influence of which will diminish the amount of wasteful braking force necessary to stop the train. In this way the kinetic energy of the moving train, instead of being converted into heat by the brakes, is turned into potential energy, ready to be utilised when the train re-starts. The beneficial influence of this method of railway construction has already been felt and recognised, in the locomotive expenses of the railway, a reduction of no less than 30 per cent. in the cost for energy having arisen therefrom.

In our concluding article we shall describe the locomotives and other rolling stock. Preparatory to this, and as illustrating a portion of the equipment of the yards and sheds, we may direct attention to Figs. 54 to 56, which show the locomotive and carriage sheds at the Shepherd's Bush terminal works.

(*To be concluded.*)

## ELECTRICAL ENGINEERING AT McGILL UNIVERSITY, MONTREAL.*

The extensive mineral wealth of Canada, and her abundant water powers, of which Shawinigan Falls, Chambly, Lachine, Hamilton and others recently developed are examples, make her a country splendidly endowed with engineering opportunities and indicate a magnificent field for the engineer. This situation has been grasped by one most interested in Canada's future progress, Sir Wm. C. McDonald, a wealthy manufacturer of Montreal, and an exponent of the doctrine that great wealth implies great benefactions to the public from which it has been derived. As a consequence McGill University, of Montreal, possesses through his liberality one of the most thoroughly equipped of modern engineering schools.

McGill University, founded near the beginning of this century, rapidly assumed the first position among the educational institutions of the Dominion under the strong and efficient guidance of Sir Wm. Dawson. The engineering faculty was organised prior to his death some 12 or 14 years ago, but credit for the subsequent and remarkably complete organisation of all engineering work at McGill is most largely due to Prof. Bovey, now Dean of the Faculty of Applied Science, one of the five faculties of the University. The Faculty of Applied Science consists of the following departments: Mathematics, Prof. Chandler in the chair; physics, President Cox and Prof. Rutherford; chemistry, Profs. Harrington and Walker; applied mechanics and civil engineering, Dr. Bovey, Dean, in the chair; geodesy and surveying, Prof. McLeod; mechanical engineering, Prof. Durley; mining and metallurgy, Prof. Porter; architecture, Prof. Capper; electrical engineering, Prof. Owens. The guiding motive controlling all the work done in the Faculty of Applied Science is to inculcate the general scientific principles involved in engineering operations rather than to teach immediate engineering practice, which must necessarily change from year to year.

The engineering department is mainly located in three buildings, the McDonald chemistry and mining building, the McDonald physics building, and the McDonald engineering building, each of which is magnificently equipped for the objects to be served. One of these is original research, and in this branch an enviable record has already been made, as instance the work of Callender on platinum thermometry; that of Rutherford on the ionisation theory of gas conduction; of Nicholson on cylinder condensation, and of Bovey, the latter covering a wide range, in strength of materials and hydraulics. It may here be remarked that in the equipment of the various laboratories material was not accumulated at random, but always with an eye to definite uses. The controlling idea in the use of the McGill equipment seems to be that of individual work as against class demonstration. The students in electrical laboratories, for example, work in groups of three men each; to illustrate, each group is given, in the dynamo laboratory, a motor and a dynamo with suitable means of connecting them, together with testing tables suitably supplied with instruments and the means of absorbing power; banks of lamps, wire resistances, water rheostats, &c.

When Prof. Owens went to McGill to take full charge of the electrical department in 1898, the generosity of Sir William McDonald supplied funds for a new and complete electrical equipment. As a consequence, the equipment of the electrical department is unique, differing from that of other similar universities which, as a rule, has been gradually accumulated, and can thus contain little of the element of design. To carry out the plan of group work, in both the alternating and direct-current dynamo laboratories the dynamos and driving motors are mounted on parallel benches. Overhead in each laboratory is arranged a hand-operated travelling crane by means of which the position of all machines can be changed in a few minutes. The benches themselves are slotted like the bed of an ordinary planer, and each machine can be fixed in place by suitable wooden pins. Four dynamos in the service plant, three sets of storage batteries having a maximum discharge of 100 amperes each, and two sets of supply circuits give nine independent sources of current supply. Elaborate switchboards are provided in the various departments. The distributing switchboard contains provision for 10 supply circuits and 12 laboratory circuits. The dynamo laboratory circuits are carried in concrete ducts under the floor and along the edge of the testing benches, and are tapped under the benches at points equally spaced, connection being made to any machine through the insulated bayonet joint.

The main generating plant consists of two 75kw. 125-volt direct-current machines, two 30kw direct-current machines and one 7kw 110-40-volt motor-generator. The direct-current dynamo laboratory contains various types of closed and open-coil constant-current machines; simple, shunt and compound-wound bipolar and multipolar machines, of English, Canadian and American manufacture. Among these are two 16 and one 10-light arc dynamos, a 15 H.P. street railway motor and a large number of motors of capacities from 15 H.P. down to 1-20 H.P. In the alternating-current dynamo laboratory there are representatives of single, two and three-phase generators and rotary converters, single-phase and induction motors in sizes from 20kw to 1-5 H.P. Among the alternating-current machines worthy of note are a General Electric revolving field 1-2-3 phase alternator provided with pole-shoes of different shape to obtain different form; a S. K. C. 1-2-3-phase inductor machine provided with different shape inductor lugs; a 12½kw. Mordey machine with the armature coils arranged to be set at different angles, and a 2-3 phase induction motor arranged as a frequency changer. All of the machines in the two dynamo laboratories are driven by direct-current motors. Among the laboratory devices are means for obtaining alternating-current waves by a modification of the Duncan method, and for obtaining leakage coefficient by means of the Duddell oscillograph.

McGill University Engineering Building.

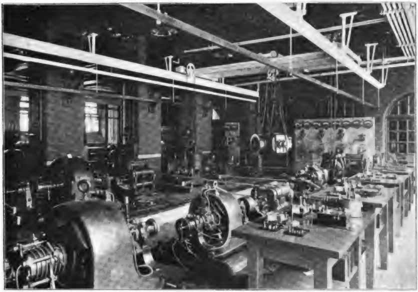
The standardising laboratory is equipped with means for measuring alternating and direct current E.M.F.s to 3,000 volts with all the accuracy obtainable with modern apparatus. Four Kelvin balances ranging to 600 amperes are provided, and an Elliott potentiometer with fixed resistance, giving a range of 15,000 amperes. Among other instruments are Kelvin static and multicellular voltmeters, standard Weston ammeters and voltmeters, and instruments of various kinds made by Crompton, Nalder and Elliott Bros., Carhart-Clark, Muirheads and Hibbert standard cells are represented. Among other apparatus are a Ewing permeability bridge, a Ewing hysteresis meter, a continuously variable voltage transformer for alternating current voltage calibration, and a 110-10-volt motor generator. This laboratory is utilised not only for calibrating something like 200 instruments in daily use in the different electrical laboratories, but arrangements have been made with a number of Canadian electrical companies by which their instruments are periodically checked against McGill standards. In the high-tension laboratory there are four 10kw. 200-50,000-volt Westinghouse transformers; a 15,000-150,000-volt Kelvin electrostatic voltmeter, and a complete equipment

---

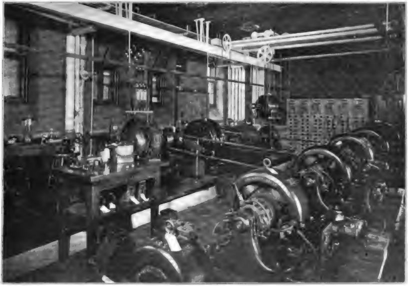
* Abstract from the *Electrical World* of New York.

McGill University: Standardising Laboratory.

McGill University: Laboratory for Special Research.



McGill University: Direct Current Laboratory.



McGill University: Alternating Current Laboratory.

otherwise for high-voltage testing. The research laboratory is equipped with small alternating and direct-current alternators and motors and constant-current and constant-voltage transformers of different types and sizes. Tables for special work are supplied with current of different kinds and at any desired voltage.

For individual student work there is a large collection of measuring instruments, the extent of which may be judged from the fact that it includes no less than 60 Weston ammeters, voltmeters, and wattmeters; 20 Thomson ammeters, voltmeters, and wattmeters, and 25 others of miscellaneous types. There are three sets of 64 cells each Type E chloride accumulators, and 100 cells of Type B for voltmeter calibration.

In the high-tension laboratory investigations are now being conducted on the conditions affecting the striking distance in air and other media; the effect of wave form on striking distance; the effect of continued dielectric stress on the insulating properties of various compounds, and the conduction between electrodes of different forms in air and other media at high alternating and direct-current pressures. In the dynamo laboratories a study is being made of the special conditions affecting the successful parallel operation of synchronous converters; on the wave form of alternators of different types as affected by character and amount of load, and on the effect of wave form on the operation of induction machinery. Third-year men devote themselves largely to direct-current work, fourth-year men to alternating-current work, and graduate men to special investigation. The first two years of the electrical course is devoted mainly to a training in physics, mathematics, chemistry, drawing, and design, the last two years being reserved for electrical work proper.

## A TWO-CYCLE 350 B.H.P. GAS ENGINE.*

The development of large gas engines has raised the question whether it is not possible to construct them double-acting, like a steam engine, work being done on the piston at each stroke. If an and the piston and piston rod should be cooled, but both these details have been sometimes adopted. A stuffing box was applied by Messrs. Körting to their tandem engine, and in a double-acting four-cycle type, introduced two years ago, both piston and rod were cooled with water. Acting on the experience thus gained, this firm has now constructed a two-cycle double-acting engine, resembling a steam engine, which deserves careful study. Prof. Meyer had lately an opportunity, during a trial made by him, of judging of its capacity and efficiency.

In this Körting motor the single working cylinder is double-acting, and has one piston-rod, one crosshead working through guides, and one crank. Plan and elevation are given below. There is one admission lift valve at either end of the cylinder, driven from the crank shaft, and through it the charge passes to one or the other end; the discharge of the burnt products, shown at *s*, is effected through ports on either side of the piston, uncovered by its action at the inner or outer dead point. The length of the double-acting piston is thus equal to the stroke, less the width of the exhaust ports. There is no mixing pump for the gas and air, each having its own pump, shown at *m* and *n*. These two pumps are double-acting, and of equal stroke, and both are driven from an auxiliary crank 110deg. in advance of the motor crank. They have piston valves worked from an eccentric on the crank shaft, and deliver gas and air respectively through two separate pipes into openings in front of the admission valve at either end of the cylinder. Thus the two streams do not mingle till they reach the latter. The working cycle is as follows:—At the end of the expansion and explosion stroke the piston uncovers the exhaust ports, and the pressure in the cylinder falls rapidly. When it is almost reduced to atmospheric, the admission valve at that end of the cylinder opens, and air and gas are delivered to it by their respective pumps, drive out the exhaust products and fill the cylinder. The exhaust ports are closed by the piston on its return stroke. The usual cycle, compression, combustion, expansion, and exhaust is thus carried out in two strokes instead of four. Compression takes place during the return stroke on one face of the piston, ignition follows

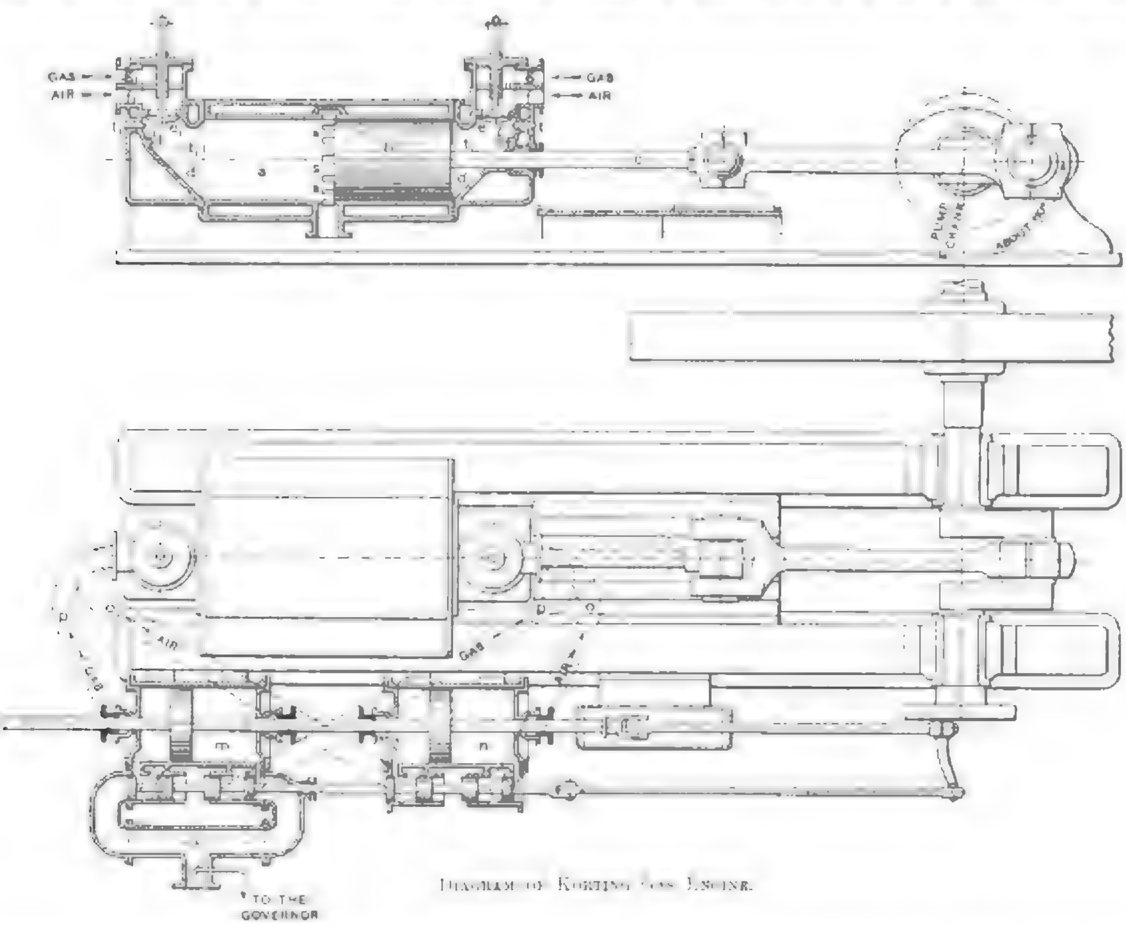


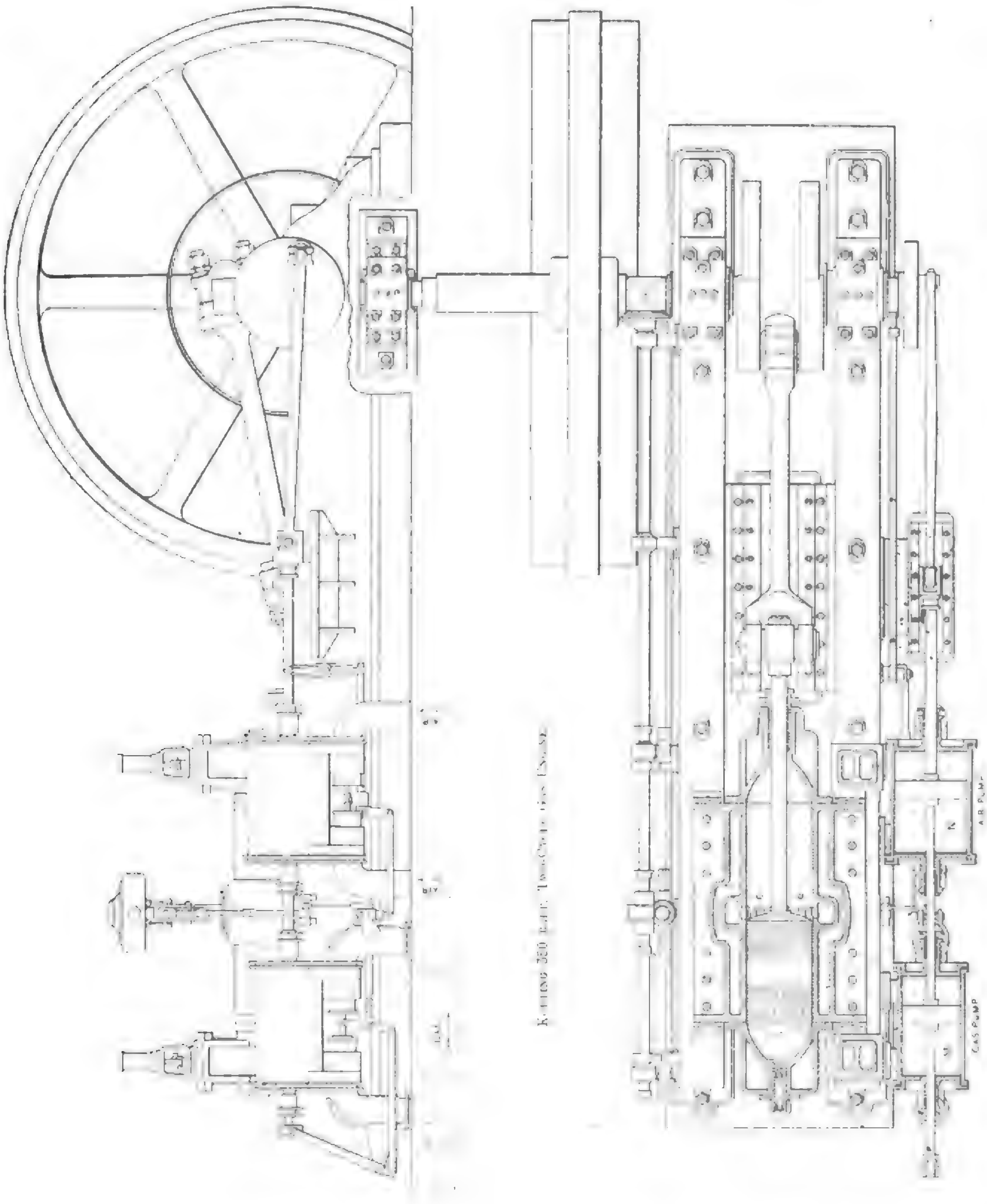
DIAGRAM OF KÖRTING GAS ENGINE.

explosion per revolution instead of per two revolutions be obtained, it should result in a better utilisation of the cylinder space, and a smaller weight of engine per H.P. exerted. The motor would, of necessity, be double acting and of the two-cycle type already used for large gas engines. This working method requires a stuffing box, at the dead point, and the charge is expanded during the out-stroke, until the exhaust ports are reached, when the cycle recommences.

If the burnt products were driven out by the fresh mixture of gas and air coming in immediate contact with them, their high temperature would cause premature ignition, and certainly some waste of the gas through the exhaust ports. To prevent this it is necessary to interpose a scavenger charge of air between the products of com-

* From the *Engineer*.

bustion and the fresh explosive charge. The diameter of the air-pump is therefore increased, so that more air is drawn in than is required to form the charge. The piston valves of the gas pump are so adjusted that part of the gas drawn in during the suction shuts it off, and opens communication with the pipe leading to the cylinder, into which it forces the gas. During all this time, however, the air pump has been delivering air to the pipe connecting it with the cylinder. This air under pressure drives back the gas into



Körting 350 B.H.P. Two-Cycle Gas Engine.

stroke of this pump is returned to the gas main, the connection not being closed till the pump piston has passed through $\frac{1}{10}$ths of its return compression stroke. The action of the piston valve then the gas pipe, and a relatively large quantity of air is forced in front of it, so that at the moment when the admission valve opens the end of the gas pipe is filled only with air, forming a scavenger charge.

F

The gas does not follow till the air has entered the cylinder, and thus both premature ignition and waste of the fresh charge are avoided. The products escape through the exhaust ports all round the circumference of the cylinder, but the charge of gas and air enters only at the admission valves. In the first experiments made it was found that the products were in consequence not wholly driven out by the incoming charge. The latter remained in the lower part of the cylinder, and streamed towards the exhaust ports, while the upper part was full of the gases of combustion. This difficulty was obviated by means of an internal projection just below the admission valve, as shown in the drawing, against which the fresh charge strikes, and by the whirling motion imparted to it drives out the products. That this result was practically obtained was proved by special experiments. To ensure prompt ignition there are two electric ignition ports at both ends of the cylinder, at two different places in the compression space.

The engine was originally governed by throttling the gas admitted, but at light loads the resistance in the pipe was found rather too great for the work of pumping the gas. Another method was, therefore, adopted. At full load the gas pump sends part of the gas back into the gas pipe during $\frac{4}{10}$ths of the stroke, and the rest to the admission valve during the following $\frac{6}{10}$ths. At light loads the gas pump piston valves acted on by the governor hold open the connection with the gas pipe longer, and thus as the load diminishes more gas is returned to the pipe, and less passes to the cylinder. This result is produced by means of a slide worked by the governor, which slips up and down a rod and varies its length, and thus the to-and-fro motion of the piston valves. The stuffing-box has metallic packing, and is carefully cooled. The cooling water for the piston and piston-rod is conveyed, as in the four-cycle double-acting Koerting engine, through tubes of the sliding telescopic type, moving to and fro with the crosshead. Between them an angled joint has now been fixed, with a rotating stuffing-box.

A 350 H.P. engine of this type was tested in June last by Prof. Meyer at MM. Körting's works. The diameter of the motor cylinder was 21·6in.; stroke, 37·7in.; diameter of the air-pump 24·4in.; of the gas pump, 19·6in.; stroke of both pumps, 27·5in. The indicated work was determined by diagrams taken every five minutes from the motor and pump cylinders, the springs being carefully tested. The B.H.P. was determined with an electric brake, the currents from which absorbed the work of the engine. The latter was driven with power gas, made in one of the usual Korting gas producers; the consumption was taken in a large gas meter, and the (lower) heating value frequently ascertained by means of a Junkers' calorimeter. The engine was tested both at full and at half-power. The following were the principal results at full load, in a trial lasting an hour:—

| | | |
|---|---|---|
| Mean (metric) indicated work in the motor cylinder | | 544 H.P. |
| ditto ditto of the pumps alone | | 63 H.P. |
| Mean (metric) indicated work (less negative work of the pumps) | | 481 H.P. |
| Mean (metric) B.H.P., calculated from the electric brake | | 341·5 H.P. |
| Mechanical efficiency | | 71 per cent. |
| Heating value of the gas (lower), B.T.U. per cubic foot | | 129 T.U. |
| Consumption of gas. | Per total I.H.P. hour (including the pumps) | 51 cubic ft. |
| | Per I.H.P. hour (excluding the pumps) | 58 cubic ft. |
| | Per B.H.P. hour | 81·5 cubic ft. |
| Heat efficiency of engine. | Per I.H.P. hour (including the pumps) | 37·9 per cent. |
| | Per I.H.P. hour (excluding the pumps) | 33·5 per cent. |
| | Per B.H.P. | 23·8 per cent. |
| Mean number of revs. per min. | | 101. |

1 metric H.P. is 2 per cent. less than English H.P.

At full load the compression pressure from the indicated diagrams was 12·5 atmospheres—absolute—and the maximum explosion pressure 27·5 atmospheres. As regards the low mechanical efficiency, Prof. Meyer thinks it was really higher, but the electric brake was not very reliable. The heat supplied to the engine was very well utilised, 38 per cent. being converted into indicated work. Such a high percentage is rendered possible by the high compression of the charge, but the gas consumption could not be quite satisfactorily verified, as it was not possible to test the motor. Assuming it was 4 per cent. or 5 per cent. above the figures given the heat utilisation was still very good. This tends to prove that the working conditions in a two-cycle are as favourable as in the usual four-cycle engine; that practically extremely little gas escaped to the exhaust; and that in spite of the very short time allowed for mixing the charge, combustion was almost complete. As regards the power absorbed by the pump, we must remember that the engine tested was the first of its kind, and the resistance in the passages may in the future be overcome by enlarging their area. To convert 24 per cent. of the heat supplied to the engine into useful work on the brake is a satisfactory result. Before final judgment can be passed on this engine time is necessary to see how the double-acting piston and the stuffing-box wear. In any case Prof. Meyer considers the results highly interesting, and that the engine is likely to have a great influence on the future development of large gas engines.

This summary has been made from one of several Papers on "Engines driven with Power and Blast Furnace Gas," contributed by Prof. Meyer to the annual meeting of the German "Verein von Gas- und Wasserfachmännern," 1900, and published by the German gas lighting journal. The drawings are also from the same source.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.

"Science Abstracts." No. 1, Vol. IV. Edited by W. R. Cooper. London: E. and F. N. Spon.) 2s.

"Michael Faraday: his Life and Work." By Prof. S. P. Thompson, F.R.S. (London: Cassell & Co.) Cheap edition, 2s. 6d.

## ELECTRICITY WORKS ACCOUNTS.

### Sheffield Municipal Electric Supply Works.

It may be remembered that although this undertaking was owned by the Sheffield Corporation from the beginning of 1898, yet that during that year it was worked by the late company on behalf of and under agreement with the Corporation. The year 1899, the accounts for which are summarised in the first of our tables, was, therefore, the first under municipal control. The figures displayed in the table show that both in the business and in economy of working material progress was made. The lamp connections and the output both increased by about 35 per cent., while the 1899 load-factor was 10·4 per cent., as against 10·27 per cent. in 1898.

Notwithstanding slight increases in the fuel and repairs items, and also in rents, rates, and taxes, all the several items of costs, and especially the aggregate costs, present most satisfactory figures. We should say that the total costs are quite a halfpenny under the average corresponding costs in 1899 for municipal stations of similar magnitude and conditions of load. In considering the fuel item it is, however, necessary to bear in mind that the accounts cover a period three months earlier than those of municipal undertakings generally, and therefore might be said to be less influenced by the rise in the price of fuel.

### Oldham Municipal Electric Supply Works.

In the adverse circumstances which, in great measure, attended the working at Oldham during the year which ended at March 25 last, it is surprising to find the costs for the period so commendably low as they are. It is true that a very material rise in the expenses took place, but with the sole exception of repairs and maintenance at the station the various items of cost were still all considerably below the average in municipal stations in the same period.

The repairs item owed its high value to the considerable additions and alterations made to the condensing plant which it had not been possible to work during the year. Notwithstanding this latter fact we hear from the engineer that the increase in the coal bill per unit was solely due to the higher price of coal, since the weight of coal consumed per unit had been reduced.

Owing to deficiency of boiler power the increases in the lamp connections and the output were seriously affected. During the winter months not only had all applicants for connection to be refused but it was found impossible to meet the demand for current, and the lighting of the street arcs had to be discontinued. One result of this state of things was that the maximum load on the station (608kw.) occurred as early in the year as October 20.

The lamp connections were increased by 14·5 per cent. and the output by 26·5 per cent. during the year. The maximum output in 24 hours was on December 23, being 3,883 units, as compared with 3,198 in the preceding year.

During the period contracts were let for an engine and dynamo of 360 H.P. capacity, for the extension of the boiler-house and for four additional boilers.

| | SHEFFIELD. | | | | OLDHAM. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Sheffield Corporation. | | | | Oldham Corporation. | | | |
| *Date of Commencement of Supply* | March, 1893. | | | | March 20, 1894. | | | |
| *System of Supply* | Alt.-curr. transformers in sub-stations and [houses. | | | | 3-wire continuous-current. | | | |
| *Chief Engineer* | W. Johnson. | | | | S. Wilmott Newington. | | | |
| **YEAR ENDED** | DEC. 31, **1898.** | | DEC. 31, **1899.** | | MAR. 25, **1899.** | | MAR. 25, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 1,378,292 | | 1,715,931 | | 589,633 | | 679,475 | |
| " SOLD (TOTAL) | 978,088 | | 1,329,881 | | 456,170 | | 576,853 | |
| " sold to consumers | 978,088 | | 1,329,881 | | 437,690 | | 561,442 | |
| " sold for public lighting, &c. | nil | | nil | | 18,480 | | 15,411 | |
| " used on works | —*a* | | —*a* | | 15,543 | | 20,173 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 18·2 | | 18·3 | | 13·2 | | 16·7 | |
| Maximum supply demanded | 1,073 kilowatts | | 1,480 kilowatts | | 542 kilowatts | | 608 kilowatts | |
| Number of public lamps | — | | — | | 26 arc | | 28 arc | |
| Number of consumers | 688 | | 967 | | 323 | | 398 | |
| Connections to mains in 8-c.p. lamps | 73,853 | | 99,670 | | 28,471 | | 32,615 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 53,900 | | 72,700 | | 34,600 | | 34,600 | |
| CAPACITY OF PLANT IN KILOWATTS | 1,725 | | 2,325 | | 1,107 | | 1,107 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | — | — | — | — | £52,000 | £47·0 | £52,000 | £47·0 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | — | — | — | — | 52,000 | 47·0 | 52,000 | 47·0 |
| RECEIVED (TOTAL) | £299,500 | £174 | £300,903 | £129 | 52,000 | 47·0 | 51,300 | 46·3 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 299,500 | 174 | 300,903 | 129 | 52,000 | 47·0 | 51,300 | 46·3 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | nil | — | 700 | 0·63 |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | nil | — | 700 | 0·63 |
| REPAID (TOTAL) | — | — | — | — | 2,400 | 2·17 | 3,400 | 3·07 |
| RESERVE OR SINKING FUND | — | — | 3,997 | 1·72 | 2,034 | 1·84 | 2,593 | 2·34 |
| DEPRECIATION FUND | — | — | — | — | 4,275 | 3·86 | 4,412 | 3·97 |
| EXPENDED (TOTAL) | 299,324 | 174 | 340,406 | 146 | 57,110 | 51·6 | 66,424 | 60·0 |
| Lands and buildings | 32,014 | 18·6 | 35,849 | 15·4 | — | — | — | — |
| Plant | 63,631 | 36·9 | 82,661 | 35·5 | — | — | — | — |
| Mains | 48,905 | 28·3 | 64,838 | 27·9 | — | — | — | — |
| Miscellaneous | 154,774*b* | 89·7 | 157,058*b* | 67·6 | — | — | — | — |
| BALANCE OF CAPITAL ACCOUNT | 176 | 0·102 | - 39,504*e* | - 17·0 | - 5,110*a* | - 4·62 | - 15,124*a* | - 13·7 |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
| TOTAL | £18,902 | 4·640d. | £23,292 | 4·204d. | £6,756 | 3·553d. | £8,431 | 3·507d. |
| Revenue from supply | 16,715 | 4·103d. | 21,597 | 3·896d. | 6,351 | 3·340d. | 7,986 | 3·323d. |
| " meters, &c. | 416 | 0·102d. | 566 | 0·102d. | 212 | 0·112d. | 284 | 0·118d. |
| " public lighting | — | — | — | — | 193 | 0·102d. | 161 | 0·067d. |
| " sale of lamps, &c. | 1,572 | 0·386d. | 989 | 0·178d. | — | — | — | — |
| " miscellaneous sources | 199 | 0·049d. | 140 | 0·025d. | — | — | — | — |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £6,197 | 1·520d. | £8,012 | 1·445d. | £3,194 | 1·680d. | £5,003 | 2·083d. |
| WORKS COSTS | 4,149 | 1·019d. | 5,609 | 1·012d. | 2,356 | 1·239d. | 3,797 | 1·580d. |
| *Generation of electricity* | *3,787* | *0·929d.* | *5,264* | *0·950d.* | *2,159* | *1·136d.* | *3,523* | *1·466d.* |
| Fuel (including cartage, &c.) | 1,228 | 0·302d. | 2,084 | 0·376d. | 1,103 | 0·580d. | 1,660 | 0·691d. |
| Oil, waste, water, stores | 444 | 0·109d. | 367 | 0·066d. | 60 | 0·032d. | 90 | 0·037d. |
| Wages at station | 1,499 | 0·368d. | 1,827 | 0·330d. | 601 | 0·316d. | 843 | 0·351d. |
| Repairs and maintenance at station | 616 | 0·151d. | 986 | 0·178d. | 396 | 0·208d. | 930 | 0·387d. |
| *Distribution of electricity* | *362* | *0·089d.* | *345* | *0·062d.* | *197* | *0·104d.* | *274* | *0·114d.* |
| Wages, &c. | 362 | 0·089d. | 345 | 0·062d. | 17 | 0·009d. | 26 | 0·011d. |
| Repairs, renewals of mains, &c. | | | | | 180 | 0·095d. | 248 | 0·103d. |
| *Public lighting* | — | — | — | — | — | — | — | — |
| Attendance | — | — | — | — | — | — | — | — |
| Renewals | — | — | — | — | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 2,048 | 0·503d. | 2,403 | 0·434d | 838 | 0·441d. | 1,206 | 0·502d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *548* | *0·135d.* | *1,150* | *0·208d.* | *277* | *0·146d.* | *530* | *0·220d.* |
| *Management* | *1,500* | *0·368d.* | *1,253* | *0·226d.* | *561* | *0·295d.* | *676* | *0·281d.* |
| Salaries | 951 | 0·233d. | 809*h* | 0·146d. | 339 | 0·178d. | 369 | 0·154d. |
| Stationery, &c. | 77 | 0·019d. | 111 | 0·020d. | 43 | 0·023d. | 94 | 0·039d. |
| Establishment charges | 195 | 0·048d. | 131 | 0·024d. | 133 | 0·070d. | 110 | 0·046d. |
| Law charges, &c. | 277*c* | 0·068d. | 202*f* | 0·036d. | 46*b* | 0·024d. | 103 | 0·043d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £12,704 | 6·01% | £14,321*g* | 4·48% | £3,561 | 6·71% | £3,428 | 5·55 |
| Sum carried to Depreciation Fund | — | — | — | — | 1,351 | 2·54 | — | — |
| Sum carried to Reserve or Sinking Fund | — | — | 3,997 | 1·25% | 1,280 | 2·41 | 1,126 | 2·31 |
| Net interest on loans (incl. Debenture charges) | 1,660 | 0·786 | 9,410 | 2·94 | 1,347 | 2·53% | 1,777 | [illegible] |
| BALANCE FROM LAST ACCOUNT | — | — | 1,331 | 0·416% | 1,351 | 2·54% | 885 | 1·43 |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 11,044 | 5·23% | 2,246 | 0·702% | 885 | 1·67 | 1,109 | 1·80% |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | 10 *d* | — | — | — | — | — | — | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 32·8% | | 34·4% | | 47·3% | | 59·4% | |
| Expenditure per kilowatt capacity | £3. 11s. 10d. | | £3. 8s. 10d. | | £2. 17s. 8d. | | £4. 10s. 5d. | |
| REVENUE PER KILOWATT CAPACITY | £10. 19s. 0d. | | £10. 0s. 5d. | | £6. 2s. 0d. | | £7. 12s. 2d. | |
| Expenditure per 8-c.p. lamp capacity | 2s. 3½d. | | 2s. 2½d. | | 1s. 10d. | | 2s. 10½d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 7s. 0½d. | | 6s. 5d. | | 3s. 10½d. | | 4s. 10½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 5s. 1½d. | | 4s. 8d. | | 4s. 9d. | | 5s. 2d. | |
| Price charged for lighting, per unit | 4d. net. | | 4d. net. | | 4d. to 2d.*c* | | 4d. to 2d.*d* | |
| Price charged for power, per unit | 2d. net. | | 2d. net. | | | | | |
| Price charged for public lighting | — | | | | 2½ per unit | | 2½ per unit. | |

SHEFFIELD.—REMARKS—*a* Included in units sold and charged against revenue. *b* Includes premium account £113,[illegible] in 1898 and 1899 and trading accounts including amounts written back £6,2[illegible] in 1898 and £6,231 in 1899. *c* Includes £[illegible] to insurance and £[illegible] to auditing. *d* Secured to the late company by agreement for working the undertaking during the year. *e* Over expended. *f* Includes £[illegible] law and professional charges and £[illegible] insurance. *g* After deducting £314 bank commission, £131 stamp duty on mortgages, and £513 commission for procuring loans. *h* Includes directors remuneration late company £150.

OLDHAM.—REMARKS—*a* Over-expended. *b* Includes insurance £[illegible] and auditing £[illegible]. *c* Maximum demand system ([illegible] hour scale). *d* On maximum demand system with [illegible] scale or alternatively, without demand indicators at [illegible] per unit for 1st 1,000 units or under per quarter, at [illegible] for 2nd 1,000 units, at [illegible] for 3rd 1,000 units, at 2d. for 4th 1,000 units, and at [illegible] per unit for the [illegible] units and over. A min. charge is made of [illegible] per quarter for each meter fixed.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence ; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*ll Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | | HALF-YEAR | | QUARTER | |
|---|---|---|---|---|---|---|
| United Kingdom | 26s. 0d. | ... | 13s. 6d. | ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | ... | 16s. 0d. | ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## SPECIAL NOTICE.

With this issue of "THE ELECTRICIAN" is published a Supplement Sketch Map of the ELECTRIC RAILWAYS AND TRAMWAYS OF THE UNITED KINGDOM for 1900-1901, which all purchasers of the Paper should receive gratis. Complaints of non-receipt should be promptly made to THE PUBLISHER.

## GAS POWER FOR CENTRAL STATIONS.

An important contribution to the already much-debated question of the use of gas power for electricity generating works is afforded by a Paper on "Power Gas and Large Gas Engines for Central Stations," read by Mr. H. A. HUMPHREY before the Institution of Mechanical Engineers. The question is an old standing one, and it has assumed from time to time both the literary and the practical form. To review its history at the present moment would occupy too much space; but we may remind our readers that the question first assumed a definite and tangible form, many years ago, in a proposition by the late Mr. DENNY LANE, of Cork, to combine town gas works with electric gas-driven sub-stations. The first actual experiment in this direction, where the gas and electricity works were owned and worked by the same authority, was made by the Belfast Corporation, and it met with a considerable measure of success. Similar efforts to utilise gas in statutory electricity works were made at Morecambe, Coatbridge and, more recently, at Leyton and King's Lynn. These have all, however, been works of comparatively small size, and the experiment has never yet been attempted, of employing a number of gas engines, each of several hundred H.P., in electricity works of the first order of magnitude. It is this experiment that Mr. HUMPHREY advocates in his Paper.

The limitation of gas driven electric power stations to works of small size is explained by Mr. HUMPHREY as having arisen from two causes: (1) the non-existence of a gas generator capable of producing power-gas on a large scale at a cheap rate; and (2) the low power of the largest available gas engine units. These obstacles he considers to have been removed respectively—(1) by the Mond gas-producer, which generates power-gas from cheap bituminous coal in place of the more expensive anthracite required by earlier gas producers; and (2) by the practicability of building gas engines of several hundred, or even 1,000 H.P. to 1,500 H.P. rating, which will work as economically and satisfactorily as the best of smaller sizes. In the main we are in agreement with Mr. HUMPHREY on these two points. The invention of

a gas-generator, capable of cheaply producing gas of fairly high calorific value from ordinary cheap slack coal, is essentially a great advance beyond that stage in power gas production which permitted only of a diluted gas of comparatively low calorific value being produced from a dry fuel, such as anthracite, necessarily destitute of volatile hydrocarbons. Nevertheless, it is only fair to point out that Mr. HUMPHREY's position ignores altogether existing town gasworks, which supply a hydrocarbon gas of very high calorific value—the very *extractum carnis*, as it were, of the fuel; and, if Mr. DENNY LANE's figures are worth anything they tend to show that power can be economically distributed to electrical sub-stations by means of this form of coal gas. As regards the extra facility afforded by the increased size of gas engines, it is impossible to deny that great progress has been made in this direction. As the author truly observes :—

Gas engines of 500 H.P. are already numerous, and one of 650 H.P. has been at work over a year, while others of a 1,000 H.P. and 1,500 H.P. are building. The author has been on the Continent and in America with the special object of studying the question of large gas engines, and has had the opportunity of seeing the easy, comfortable way in which the 650-H.P. Westinghouse engine does its work. Mr. GEORGE WESTINGHOUSE told the author that the Westinghouse Machine Co. had sufficient experience to make them feel quite confident of their ability to build 2,000 H.P. and even 3,000 H.P. engines, and run them with perfect success.

A large number of appendices to the Paper are principally devoted to an elaboration of this contention—viz., that very large gas-engine units are commercially possible. Particulars are given regarding the construction and tests of several large engines, many of which are employed for running electrical plant. For example, the trial of a 400 H.P. Crossley engine, direct-coupled to a Mather and Platt dynamo, showed at full load a combined electrical efficiency of 77·25 per cent., and a thermal efficiency of 25·49 per cent., calculated on the indicated power, or of 19·69 per cent. calculated on the electrical power. It is scarcely necessary to say that no steam-dynamo of 400 H.P., or, indeed, of any power, ever approaches 19 per cent. in its electro-thermal efficiency. The figures obtainable with the gas engine are far in excess of the best steam practice attainable.

It might be supposed that this acknowledged superiority of the gas engine in the matter of efficiency, coupled with the possibility of now building really large engines and of running them with cheap gas, would sound the death knell of steam plant in electric generating works. The supposition would be erroneous; the end of the steam engine is not yet. We will grant that the cheapening of power-gas production, and the building of gas engines in more conveniently large sizes, certainly extend the range of applicability of gas power to electricity works. Their influence be will decidedly in the direction of using gas engines in larger stations than heretofore, and in new stations of moderately large size where the fuel costs are of more importance than usual. But we do not expect to see—at any rate, for some time to come—works comparable in size with those at Deptford, or in Manchester and the chief provincial cities, worked wholly by gas power. To begin with, the large gas-producers necessitated by works of this magnitude, and the enormous volumes of injurious and unpleasant gases exhausted by the engines, would constitute a nuisance of far more serious gravity than is now the case with steam plant. A 100,000 H.P. gas-power electricity works, with its gas-producer attached to it, would be intolerable in the midst of a residential district. It might be argued, however, that large gas-power stations would never be erected in residential districts, nor even within city boundaries, but would be placed in the desolate country surrounding collieries. This proposition would introduce a new factor into the question—viz., the cost of transmitting the electric power from the pit's mouth to the cities; and developments in this direction of electrical engineering are not yet ripe enough to allow of it being confidently discussed from the gas engine point of view. There is, further, another drawback to the use of very large gas-engine units in great numbers for any central station, namely, the difficulty of starting the separate engines and the comparatively long time occupied by the process. The larger the gas engine, the more does this difficulty bring it into contrast with its steam rival; and the importance of being able to start an unit quickly is usually greater in large than in small works. Nevertheless, the prospects of the gas engine were never brighter than they are to-day, and we commend the merits of this type of engine to the careful consideration of electrical engineers. Ignorance of its capabilities has had much to do with its comparatively scanty adoption in works of small or moderately large size. An intelligent appreciation of the advantages and limitations of the gas engine will enable central station engineers to perceive many hitherto overlooked places wherein it would do better service than its steam rival.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price.)

**Jahrbuch fur Elektrochemie.** Edited by Dr. W. NERNST and Dr. W. BORCHERS. 1900. (Halle-a-S.: Wilhelm Knapp.) 16m.

When the "Jahrbuch für Elektrochemie" was first published it may have been regarded as ephemeral. Now the yearly volume is expected. The present example is on the same lines and of the same scope as its predecessors, with their merits and defects. As a compendium of what has been done in electro-chemistry during the year before that which gives the work its date, it is full and thorough; the student or the man of affairs who needs to make a reference will value the book. As an exposition of the best of what has been done it is a failure. An annual may be regarded merely as a register, and if this view be accepted we accept the "Jahrbuch." An annual which claims to be something more than a register is made by excising the rubbish of the year and giving the pith of the good work done. Evidently an abstract (not a mere compression) should be published of the "Jahrbuch für Elektrochemie." This must be presented in English or French, for an abstract in German is unthinkable.

The reader of this work may be encouraged at the outset by the tidings that there are in the present volume 431 pages (including index), as against 496 pages in the "Jahrbuch" of 1899; the thought of 65 pages to the good should sustain him. To condescend upon particulars. The wissenschaftlichen part occupies 250 pages, and includes some things live and of interest, others purely academic. On p. 85 is a description of an elegant method of rectifying alternating currents by taking advantage of the back pressure exerted by a polarised electrode. The process is wholly similar in principle to that which has been used for the charging of accumulators and like purposes with an alternating current by the employment of aluminium electrodes. A good deal of space is allotted to the Wehnelt interrupter, its various modifications and the polemics to which it has given rise. There is the usual mass of physical measurements of the properties of electrolytes. Such measurements and their discussion account for a good part of the 250 pages devoted to theoretical electro-chemistry. It is well that a record should exist somewhere, and regarding the "Jahrbuch" as a register, its utilisation for this purpose may be condoned. An interesting account of Nernst's work on the conductivity of oxides at high temperatures is given, and reasons are adduced for regarding this conductivity as electrolytic, in spite of the fact that no products of electrolysis persist; granting this, it follows that the reduced cathode product—*e.g.*, magnesium—must be oxidised by the surrounding air, or,

if the operation be conducted in a vacuum, that the anode and cathode products must diffuse towards each other so rapidly as to reconstitute the electrolyte without loss, which is absurd. It follows that the Nernst filament, if it will work continuously in a vacuum, cannot conduct electrolytically. Hittorf's researches on the electrolytic behaviour of chromium are duly chronicled. A section on electrolytic analysis is neither better nor worse than similar sections in previous year-books; the ingenuity is vast, the results inconsiderable. An exposure of the errors attending the electrolytical determination of iron and the inclusion of carbon in the precipitated metal is given on p. 250.

The second part of the book deals with applied electrochemistry. There is described one primary cell of interest (Case's ferric chloride cell) in which an endeavour is made to oxidise carbon indirectly by atmospheric oxygen. The chemistry of the description is dubious and the quantitative data for computing the output of the cell are entirely lacking. It is a regrettable fact that a non-lead accumulator in the proper sense has not yet been devised; the nearest approach to it has been made by the zinc—lead peroxide cell, which is useful for special purposes. The electrolytic production of fluorine on a large scale by the copper apparatus of Moissan is mentioned, and now there remains to find a use for fluorine. The manufacture of phosphorus by electrical means still occupies attention, and it is fairly obvious that the difficulties encountered have arisen chiefly from preventing that localisation of heat which is characteristic of electrical methods, whether of the arc or resistance type. A note is made of magnesium—aluminium alloys which have been much advertised; if they have merits we should like to see them in use as a substitute for aluminium, even though they should fail to replace that metal in one of its coming uses, viz., as a conductor. No better proof of the settled state of the electrolytic copper industry could be found than in the section allotted to this metal; it is short because there is little or nothing to say. Copper refiners even in this country are beginning to understand that dry methods are of the same order of interest as a wooden battleship. There is nothing new concerning the electrical smelting of iron other than the Stassano process, which has still to be tried on a manufacturing scale. Calcium nitrite $Ca_3N_2$ is a body chemically interesting and possibly of future industrial importance, as it can be formed by the action of nitrogen on calcium and yields ammonia when treated with water. Perhaps it may serve as an alternative means for obtaining synthetic manures should the direct electrical production of oxides of nitrogen fail to avert the famine in foodstuffs dramatically predicted by Sir William Crookes.

Moissan, who is always the pioneer of electrical furnace processes and products, has shown that calcium carbide, familiar to all when crude as a dark, steely mass, is, when pure, colourless and transparent. On the technical side there is little new to recount. A page (351) is occupied by Borchers' usual claim to have produced this substance previously to those who are regarded by most of us as the true discoverers. Now and then the austerity of style which properly characterises the "Jahrbuch" is pleasantly relieved. Concerning the alkali and chlorine industry, it is said, incidentally, in discussing a patent by one Pond: "Pond will zu viele Fliegen mit einer Klappe schlagen" (*Anglice*: "Pond tries to kill too many flies with one stroke"), and the patent is very properly condemned. Of real advance in this manufacture but little can be recorded. No doubt advance has been made, but it is advance in the works and is not intended for public consumption. The chapter on improvements in apparatus such as leads, diaphragms, electrodes and the like is short, but worth reading. At the end of the book is appended a list of periodicals, with their years and dates, which allows recent references in volumes (a most pernicious method of citation) to be translated into years. A copious index closes the work.

The "Jahrbuch für Elektrochemie" for 1900 cannot be ignored by any electro-chemist who cares to save himself much unpleasant labour. That it is not a monument of industry no one who has attempted a compilation would pretend; that it is not a well-proportioned monument cannot be denied; taking it as it is, we accept it with gratitude. B. B.

**Kalender für Elektrotechniker 1901.** Edited by F. Uppenborn. Munich and Leipsic: R. Oldenbourg. 5m.

Several useful alterations are apparent in the new edition of this excellent pocket-book. An account of the recent work of the "Sicherheitsvorschriftenkommission" has been added, so that the German safety regulations are brought up to date. The section on electric traction has been re-written, and this opportunity might with advantage have been made use of for further amplification of the pages on overhead trolley lines. Other smaller additions have been made, and, in order to make room, the section on Heat in Vol. II. of the book has been taken out.

**Viertalig Electrotechnisch - Werktingkundig Woordenboek.** Edited by G. C. J. Verkerk and G. T. Van de Well. Part IV (Amsterdam: Scheltema and Molkema.)

Eighteen months ago we noticed favourably the first three volumes of this electro-technical dictionary—English-Dutch, French-Dutch, and German-Dutch. We have now received the last volume—Dutch-English-French-German—and it appears to maintain the same standard of excellency as the previous ones. Although chiefly of utility to Dutch engineers, to whom a good technical knowledge of English, French, and German is an absolute necessity, the book will be found indispensable to any Englishman who desires a knowledge of Dutch technical terms. Even if he is proficient in English and German, he will hardly guess that the meaning of "naijling shoek" is angle of lag, or that "nok van den arreteeringshefboom" refers to the detent cam in a Hughes type-printer. A defect in the book is that the German nouns are printed with small instead of capital initial letters.

## THE FENCING OF NEW MACHINERY AND APPLIANCES USED IN FACTORIES.

The following circular on this important subject has been issued by the Home Office:—

The attention of makers of machinery and appliances used in factories is invited to the importance of adequately fencing the dangerous parts in the process of construction and fitting. While much progress has been made in applying guards to existing machinery, it is unsatisfactory to find that new machines, in other respects improved, are still sent out by the makers without due regard to this essential point, and that precautions which are taken as a matter of course in the case of those made for export, are often omitted in the construction of like machinery intended for use in the United Kingdom. Hence many serious and fatal accidents arise, and at best the fencing which can be carried out later by the purchaser is usually less effective and more costly, even apart from the risks attending delay. And further, it is obviously more easy when designing a machine to provide proper places for guards than to have to fit guards on to a machine designed without any provision being made for them. In fact, a machine otherwise well-designed may be made almost valueless for trade purposes by the difficulty or impossibility of adapting to it those means of fencing which the law renders necessary.

Continental and American makers of machinery have lately gone far in the direction of sending out guarded machines, those for printing and lithographing being marked examples, and in this country improvement has occurred of late in certain classes, of which cotton machinery and chaff-cutters are specially mentioned in the official reports.

The statutory responsibility for proper fencing is being pressed upon occupiers of factories, not only by this department but also by accident insurance companies; and it is believed that if in designing machinery regard were had to the necessity of providing for fencing, and if in quotations for making and fixing machinery and appliances adequate fencing were expressly included, the purchaser would not fail to recognise the greater safety and convenience, and also the ultimate economy, to be secured in this way.

These observations apply not only to certain machines a whole, such as woodworking machines and power presses of all kinds, but also to common parts of machinery, such as mill gearing, flywheels of engines and machines, belts, pulleys, ingathering cogwheels, and set screws (which should invariably be countersunk instead of being exposed in couplings, &c.), on anything which revolves, and to the fitting of safety appliances to hoists. Low shafting should be fenced when fitted.

For obvious reasons it is not the practice of the inspectors to give any official approval of methods or appliances which would lend itself to advertisement, but any information or suggestion which the department can supply as to points of danger (general or in the case of special kinds of machinery) or the means of protection, is at the disposal of those interested. Many examples of the kind will be found in the published reports of this department, and a few extracts, bearing more especially upon fencing of new machinery, are appended.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 516.*)

It is worth while, before passing on to consider a little more closely the exact conditions which pertain in the spark-gap when two condensers are being employed as above described. One fact on which the establishment of the oscillations depends is the behaviour of air and other gases under increasing electric pressure. In order that the nature of the operation which gives rise to the oscillation may be understood, it is necessary to notice the peculiar property of gaseous and liquid dielectric when subjected to a gradually increasing electromotive force. In the case of every dielectric subjected to increasing electric stress or voltivity, there is a certain critical value, best measured in kilovolts per centimetre, which causes some molecular or atomic change resulting in the breakdown of the dielectric and the passage of a discharge. If the dielectric is a gas, and if the source of electric supply is only capable of furnishing a very small current, owing to the resistance of the rest of the circuit, the discharge takes the form of a spark.

The sudden passage of a gaseous dielectric from a state of nearly perfect non-conductivity to one of very good conductivity under the action of electric stress may be due to the production or separation of its atoms into smaller masses, variously called gaseous ions, corpuscles, or electrons. The remarkable researches of Prof. J. J. Thomson on electric discharge in vacuo seem to render it probable that masses much smaller than chemical atoms can be detached from molecules, either by their collisions or by the combined operation of their collisions and of an external impressed electric force. Moreover, these gaseous ions convey or are charged with electricity. Whether we can regard these corpuscles as the structural elements of atoms, how they become electrically charged, or whether they are themselves, so to speak, "atoms of electricity," and what is the nature of the difference between positive and negative ions or electrons, are questions as yet not entirely within our power to answer. There are many remarkable qualities which characterise gaseous conductors; one of these is that a finite difference of potential must be created between the electrodes to begin a continuous current through a gas.† In the case of air and some other gases, it has been well established that the electromotive force or potential difference between the discharge surfaces must exceed a value of about 300 volts or 400 volts before any current can take place through the gas at all, and we may perhaps consider this limiting value of the electromotive force to be a factor in some way necessary to create the gaseous electrically charged ions, the subsequent movement of which in the direction with or against the electric force constitutes the electric current through the gas. In any case, the fact remains that below a certain critical value in the potential difference of the electrodes, the gas remains a nearly perfect insulator, but if the difference exceeds a certain amount, the gas passes quite suddenly into a conductive condition along a certain narrow path or paths, and becomes heated by the current passing through it. The conductivity, however, vanishes very quickly when the electromotive force falls again below the critical limit.

One of the most curious facts connected with the dielectric strength of a gas, as first shown by Lord Kelvin, is that a thin film of gas has a greater dielectric strength than a thick film of gas, *i.e.*, it requires a larger number of kilovolts per centimetre to break it down, as shown in Table I.

The electric force or electromotive force per centimetre required to create a spark in a gas varies with the gaseous pressure and with the sparking distance. For spark lengths as small as 0 0003 of an inch it seems to run up to a value of 1,400 C.G.S. units for very low pressures. It is, however, remarkable, as well shown in experiments by Mr. Peace, that for all pressures and for all spark lengths there is a minimum voltage (about 300 volts) below which no spark can be produced. I shall have occasion in another lecture to notice a very similar property of finely-powdered metals—viz., that they remain practical non-conductors until subjected to more than a certain electromotive force. The breakdown of the gaseous dielectric into the conductive condition seems to be assisted by such agencies as ultra violet light and Röntgen rays falling on the terminals, especially the cathode and the space between. It has been shown by Prof. Trowbridge (see *Nature*, Vol. LXII., p. 325) that under an electromotive force of 2,000,000 volts and upwards, air at ordinary pressure becomes conductive. Conductors charged to this pressure emit a luminous discharge to the walls of the room and other earthed conductors; and, in fact, the atmosphere at ordinary pressure behaves electrically under this large electric pressure just as a rarified gas does under lower electromotive forces.

**Table I.**—*Dielectric Strengths of Various Insulators.*

(In kilovolts per centimetre.)

| Material. | Dielectric strength in kilovolts per centimetre, or voltivity required o break down the insulator. |
|---|---|
| Micanite | 4,000 |
| Mica | 2,000 |
| American linen paper paraffined | 540 |
| Ebonite | 538 |
| Indiarubber | 492 |
| Linseed oil | 83 |
| Cotton seed oil | 67 |
| Lubricating oil | 40 |
| Air film 2mm. thick | 57 |
| Air film 1·6cm. thick | 27 |

It will be seen from Table I. that some oils have higher dielectric strength than air; hence it has been proposed to immerse spark balls in oil as a means of creating greater differences of potential between them before discharge can occur. There is, however, a controlling disadvantage, since the breakdown of the oil insulation is apparently less sudden than in the case of gaseous dielectrics.

Returning then to the Leyden jar arrangement, let us consider the actions taking place during one break of the primary current of the induction coil. As the magnetism of the iron coil dies away, it builds up an electromotive force in the secondary circuit of the coil which charges one set of jars with positive electricity and the other with negative, on their interior coatings—*i.e.*, creates a dielectric strain in the glass and at the same time impresses a gradually increasing electric force on the air space between the discharge balls. (See Fig. 4.)

At a certain value of this electric force the air-gap passes into a conductive condition, and at that moment the state of affairs is as follows: The dielectric of each jar is electrically strained, those of the two sets in opposite directions; hence, when the inner coatings are conductively connected on the passage of the spark, we have two strained dielectrics, the metallic coatings on which are united by conductors. (See Fig. 4.) This dielectric strain was produced by an electromotive force, and acts itself in turn as an electromotive force. When the disruptive discharge takes place this strain vanishes, and in its place we have a current in the circuit. Hence the state of the metallic circuit is for the moment exactly as if they connected together two secondary cells joined as shown in Fig 5.

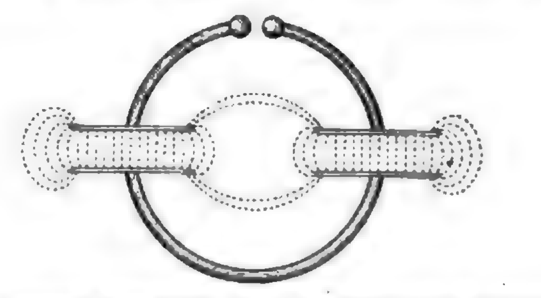


Fig. 4.—Lines of Electrostatic Strain in the Dielectric of the Leyden Jars.

The dielectrics therefore expend their energy in producing an electric current in the circuit; and as that current increases the dielectric strain disappears. The circuit, however, possesses inductance, and the current energy, in so far as it is not frittered away by resistance, would expend itself in again creating electric strain in the dielectrics in an opposite direction, thus building up against itself a counter electromotive force which gradually annuls the current. The operation then repeats itself in the opposite direction, and there is thus set up an oscillatory condition in which the energy is alternately energy of dielectric strain and energy of electric current, until finally it is frittered away or dissipated into heat by the resistance of the circuits. A mechanical analogue may be found in the case of a heavy bar suspended by a flat steel strip. If we twist the bar and impart energy of strain to the spring, it begins to move when the restraint is taken away, and the energy of strain is gradually transformed into the energy of motion. If we cause such an arrangement to vibrate in a liquid, the decadence of the mechanical oscillations by friction corresponds to the gradual damping-out of the electrical oscillations by resistance.

Before we pass on to other matters it is desirable to point out how the frequency of these electrical oscillations can be determined. The discussion of the fundamental equation for the discharge of the

* Cantor lecture delivered before the Society of Arts, November 26 1900.

† For a full discussion of modern views on the transference of electricity through gases the reader is referred to Prof. J. J. Thomson's work, "Recent Researches in Electricity and Magnetism," Chap. II.

Perrot, in 1861, and Giese, in 1882, first suggested that gaseous conductivity might be electrolytic in nature.

Leyden jar shows that in the oscillatory case the oscillations are isochronous, and that the periodic time, $t$, is given by the equation —

$$t=2\pi\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$$

In nearly all practical cases the fraction $R^2/4L^2$ is small compared with $1/LC$, and the periodic time is therefore very approximately represented by the equation

$$t=2\pi L\sqrt{C}$$

In the case of a material body making small vibrations under the operation of mass inertia and elasticity, the time of the vibration is expressed by the equation —

$$t=2\pi\sqrt{\frac{I}{K}}=2\pi\sqrt{IP}$$

where K is the quotient obtained by dividing the mechanical couple causing a small angular displacement by the magnitude of that displacement. It might otherwise be called the force-creating unit displacement, and it would not be inappropriate to name the reciprocal of K or $1/K$ the *elastic pliability* (P) of the body. Hence the periodic time of vibration of the body when executing small vibrations is $2\pi$ times the geometric mean of the moment of inertia (I) round the axis of vibration and its pliability (P).

In the case of electric oscillations, the inductance takes the place of the moment of inertia and capacity of the pliability. Hence the periodic time of an electric oscillation is $2\pi$ times the geometric mean of the inductance of the circuit and the capacity of the condenser or Leyden jar which is discharging. It is necessary for the purposes of calculation to note that in the above formula if L is measured in electromagnetic measure (*i.e.*, in centimetres) then C

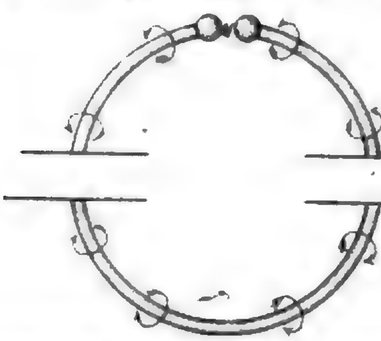


FIG. 5.—Lines of Magnetic Flux round the Circuit of the Leyden Jars.

must be also measured in electromagnetic measure. If C is measured in electrostatic measure (*i.e.*, in centimetres) then the above formula becomes changed to

$$t=\frac{2\pi}{3\times10^{10}}\sqrt{LC}$$

because $9\times10^{20}$ electrostatic units of capacity are equal to one electromagnetic unit. If C is measured in microfarads then L must be in megahenrys—*i.e.*, in centimetres divided by $10^{15}$. It is most convenient to measure the capacity in microfarads, or in centimetres, and it is necessary to remember that one microfarad is $=9\times10^5$ centimetres or units of electrostatic capacity, and

$$t=2\pi\sqrt{\frac{\text{inductance in cms.}\times\text{capacity in mfds.}}{10^{15}}}$$

The frequency $n$ is, of course, the reciprocal of $t$, or of the periodic time. Hence we have approximately

$$n=\frac{5,000,000}{\sqrt{\text{capacity in mfds.}\times\text{inductance in cms.}}}*$$

It is also necessary to be in a position to calculate the inductance of a circular-sectioned wire of given length and coiled into a circuit of various forms. The simplest case is that of a single straight wire of length $l$cm., and diameter $d$cm. If the wire were bent into a closed circuit the inductance can be calculated by a well-known formula due to Neumann—viz. :—

$$L=\int\int\frac{ds\,ds^1\cos\theta}{r}$$

where $ds$ and $ds^1$ are any pair of elements of the circuit separated by a distance $r$, and $\theta$ is the angle between their direction. For a straight wire, supposing the current circulates only on the surface, the above formula gives

$$L=2l\left(\log_e\frac{4l}{d}-1\right)\dagger$$

* If the inductance is given in millihenrys, remember that 1 millihenry = 1,000,000 C.G.S. units or centimetres.

† See Prof. H. Poincare, "Les Oscillations Electrique," p. 45.

Hertz, however, calculated the same quantity on the assumption that the current was uniformly distributed over the cross-section of the wire, and gave the expression

$$L=2l\left(\log_e\frac{4l}{d}-0.75\right)*$$

It is not quite certain that Neumann's formula can properly be applied to open electric circuits, but in any case the inductance (L) of a length $l$ of round wire of diameter $d$ is given by the equation.

$$L=2l\left(\log_e\frac{4l}{d}-a\right)\dagger$$

where $a$ is a quantity not far from unity.

For purposes of the numerical calculation of the frequency of oscillations it is more convenient to employ logarithms to the base 10, and the expression for L may then be stated

$$L=2l\left(2.3026\log_{10}\frac{4l}{d}-1\right)$$

If, for instance, the wire has a diameter of 4mm. and a length of 1m. (=10cm.) then L=1,231cm. Hence, if such a wire is used to short circuit a Leyden jar, having a capacity of $\frac{1}{300}$th of a microfarad, the electrostatic capacity of the jar is 3,000cm., and the inductance of the discharge circuit is 1,230cm. nearly. Accordingly, the periodic time $t$ of the oscillations set up is

$$\frac{2\pi}{3\times10^{10}}\sqrt{3,000\times1,230}=\frac{3.787}{10^{10}}\text{ sec.},$$

and the frequency of the oscillation or number per second is nearly at the rate of $2\frac{1}{2}$ millions per second.

If the wire, instead of being straight, is bent into a rectangle, square, or circle of one turn, the whole length of the wire being $l$cm.,

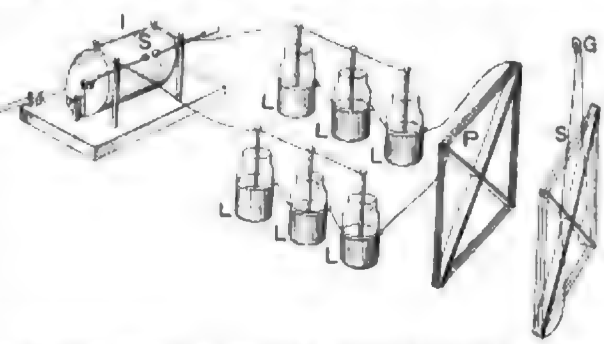


FIG. 6.—Arrangement for Producing Secondary Electrical Oscillations.

and $l$ being very large compared with $d$, we shall not commit a great error by calculating the inductance by the same formula as for a simply straight line—viz. :—

$$L=2l\left(\log_e\frac{4l}{d}-1\right)$$

If the wire is in the form of a large coil of N turns, N not being very great, then the whole inductance of the coil is nearly $N^2$ times that of a single turn.

Hence the inductance L of a large square or circular coil of wire N turns, for present purposes, is sufficiently nearly given by the formula

$$L=2lN^2\left\{2.3026\log_{10}\frac{4l}{d}-1\right\},$$

where $l$ is the length of one turn of the wire, and $d$ is its diameter, both measured in centimetres, provided that $4l$ is large compared with $d$. The above formula can only be applied, however, if the length $l$ is great compared with $d$, and also if the diameter of the square or circle into which the wire is bent is large in comparison with the diameter of the wire; moreover, the turns of the coil must be close together.

Proceeding in the next place to notice the properties of these electric oscillations, it is easy to show that the existence of electrical oscillations in a primary circuit results in the production of secondary oscillations in a secondary circuit held near it. If the wire joining the outsides of the two series of the above-mentioned Leyden jars, L, L, is wound round a square wooden frame, P, and if another wooden frame is held near to it, having wound on it secondary circuits of insulated wire of a few turns, the last circuit being closed by a small incandescent lamp, G, we find on starting the oscillations in the primary circuit that the little lamp in the secondary circuit lights up, even although the distance between the two circuits may be several feet. (See Fig. 6.) We have here constructed a step-down transformer for electrical oscillations with an air core, the

* See collected Papers of H. Hertz, "Electric Waves," translation by D. E. Jones, p. 51.

† See "Absolute Measurements in Electricity and Magnetism." Prof. A. Gray. Vol. II., Part II., p. 787.

primary and secondary circuits being separated by a considerable distance. It is clear, therefore, that the whole space round the primary circuit is full of oscillating magnetic flux—that is to say, magnetic flux the direction of which is rapidly alternating, and the lines of flux of this field inserted into and withdrawn from the secondary circuit give rise to secondary oscillations of the same frequency, but moving under a greater or less electromotive force, according to the relative number of turns on the two circuits.

We can in the same manner make a step-up transformer for electrical oscillations. On an ebonite tube is wound an insulated circuit which connects the two outer coatings of the two series of Leyden jars. This primary circuit is placed in the interior of a tall glass vessel, on the outside of which is wound a circuit of many more turns of gutta-percha wire. Connecting the secondary circuit with two long vacuum tubes we are able to show that the existence of the primary oscillations in the primary circuit is accompanied by the production of secondary oscillations in the secondary circuit, and that these are of a higher electromotive force than that producing the primary oscillations. These secondary electric oscillations cannot only be set up in solid conducting circuits, but, as Prof. J. J. Thomson has shown, we can produce them in circuits consisting wholly of rarefied gas. If a glass bulb, B, exhausted of its air to the point of maximum electric conductivity is surrounded by a loop of wire, P, connecting the outsides of the two series of Leyden jars, it produces in the bulb a brilliant ring of light when the primary oscillations are started. These are due to secondary electric oscillations set up in the rarified gas along a closed path (Fig. 7). This experiment is a beautiful proof of the fact that rarified gases are very good conductors, and, in fact, as Prof. Thomson has shown, are intrinsically—that is to say, molecule for molecule—far better conductors than electrolytic liquids, or even than many metals.

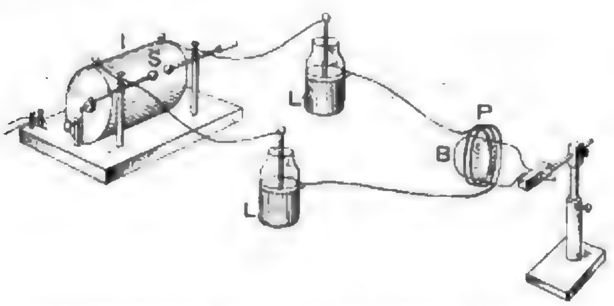


FIG. 7.—Electrodeless Discharge in a Gas Produced by Induction.

The phenomena of secondary oscillations enable us to show most clearly marked the effects of magnetic screening when we are working with extra high frequency alternating electric currents. If we insert between the primary and secondary circuits wound on square frames, which were employed a moment ago, a screen of perforated zinc, we see that this thin metallic screen cuts off all, or nearly all, of the effect of the primary circuit. A thin metallic screen of this description would have no marked effect in annulling the secondary current if the periodicity of the primary alternating current were much lower—that is to say, reckoned in hundreds per second instead of in tens of thousands. It is not unusual to describe the effects of magnetic screening as due to the neutralising action of the secondary current set up in the mass of the screen, but there is another manner of viewing the phenomena, which is not only more suggestive, but perhaps a better physical explanation. The propagation of magnetic flux through and into a conductor is effected by a process which is in every way analogous to the diffusion of liquids into one another, or to the transference of temperature through a conductor—that is, as Lord Kelvin has called it, to the thermometric conductivity. These processes are mathematically described by differential equations of the same form as those which determine the propagation of magnetic flux, or of an electric current into a conductor. In the case of magnetic flux, this rate of diffusion, as shown by Mr. Oliver Heaviside, is inversely as the electric conductivity and inversely as the magnetic permeability of the material.

*(To be concluded.)*

* See "Recent Researches in Electricity and Magnetism," by Prof. J. J. Thomson, p. 101. The maximum conductivity of a rarified gas is there shown to be of the order of that of a 25 per cent. aqueous solution of sulphuric acid, and that molecule for molecule, air when rarified to its maximum conductivity has 7½ million times greater conductivity than a 25 per cent. solution of sulphuric acid. These electrodeless discharges in vacuum bulbs have also been investigated by Mr. E. C. Rimington (see *Proc. Phys. Soc.*, London, Vol. XII., p. 265).

# CORRESPONDENCE.

## MAGNETIC OBSERVATORIES AND TRACTION DISTURBANCES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Prof. Rucker's generous letter in your last issue, and regret that I should have put him to so much trouble. Had I had any doubt as to the facts as stated by me, I would have communicated with him before writing to you, as it was far from my intention to raise any discussion on the matter of precedence.—Yours, &c.,

London, Jan. 28. E. BASIL WEDMORE.

## THE CARDIFF SUB-STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read your comments on the Cardiff transformer sub-stations, which are apparently based on some report submitted by the present electrical engineer to his committee. As anyone would conclude from reading the paragraph that there are many sub-stations in Cardiff in a decidedly dangerous condition, I shall be glad if you will kindly find space in your next issue for the following: There are in Cardiff just 14 sub-stations. Of these two are idle—*i.e.*, contain neither switch-gear nor transformers. Of the remaining 12 six or seven are fitted with modern safe, simple, high-pressure switch fuses for the mains, and the transformer feeds made by the British Insulated Wire Co. All the high-pressure metal is entirely enclosed in cast-iron metal cases, with slate covers, through holes in which the porcelain switch fuses are pushed into place. There is no bare high-pressure metal in any one of these sub-stations. Three of the remainder have somewhat different gear. Mostly, these are switch fuses of the Brush Company's latest protected type, and main switches enclosed in cast-iron cases, all mounted on slate bases on iron framework. All high-pressure cables are concentric with the outer earthed, or are lead-cased twin cables right up to the transformers, and it is practically an impossibility for anyone to inadvertently get a shock in these sub-stations. Of the remaining two or three stations, one contains but one transformer fed by one concentric cable terminating in the case of the transformer itself; the last one or two admittedly contain some temporary gear, but at a safe distance from the entrance. Whether this justifies the sweeping assertions attributed to the present engineer I leave to the common sense of your readers and yourselves. Personally I prefer to think that that gentleman relied more for his facts upon some of his staff than by personal inspection of the lot. It should also be borne in mind that the question of changing over to the low-pressure direct-current system has been under consideration by the Cardiff Corporation for a long time, and is now definitely decided upon, and which has necessarily checked spending capital freely upon sub-stations and other alternating plant.—Yours, &c.,

NEVILLE APPLEBEE.

Ashton-under Lyne, Jan. 28.

[In fairness to Mr. Ellis, the present Corporation electrical engineer at Cardiff, we append an extract from his report to the Electricity Committee, to which we referred in our last issue:—

"I should like to bring before your notice the condition in which I find many of the transformer sub-stations. I am extremely sorry to have to say that I find them in anything but a satisfactory condition. I can only describe them as being veritable death-traps. In many cases there are switches entirely unprotected with a potential of 2,500 volts across the terminals. In one sub-station particularly is this the case, and in this same sub-station there is a pair of high-pressure cables slung across the sub-station and tied up to the metal ladder by which access to the sub-station is made. The whole of the sub-stations will be thoroughly examined with a view of putting them in a state of efficiency and absolute safety. In a tank near St. Mary-street, from which current is distributed to different parts, are cables which, instead of being jointed, are simply twisted together by the ends and protected only by a sheet of rubber, which is tied around them. In their present state the cables have no protection against moisture, nor is it safe for men to work upon them.

—ED. *E.*]

## ACETYLENE LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A great number of papers have lately been treating us to the lecture (to which we are now becoming accustomed) of Germany's easy commercial supremacy, and they give as example the progress made there in acetylene lighting, as evidenced by the Report of Dr. Rose, H.B.M.'s Consul at Stuttgart. Such lectures usually do harm to our national industry, inasmuch as they tend to lead foreign buyers to look to Germany rather than to this country as the best and most up-to-date place to cover their requirements. I trust, therefore, that you will allow me space to point out that, on the whole, Germany is emphatically *not* ahead of this country as regards acetylene lighting.

As regards, in the first place, the statements made that Germany has as usual, led the way, &c., let me point out that acetylene was discovered by an Englishman, Edmund Davy. Calcium carbide again, the raw material for making acetylene, was manufactured in the electric furnace in London in 1891, and the first exhaustive treatise on its manufacture and properties was published in France, not in Germany.

Nor can the latter country at the present time lay claim to possessing the largest European carbide works or the greatest number; the largest belong to my company, the Giffre Electro-Chemical and Power Co. (Ltd.), of London, and France has more power employed in carbide manufactures than any other country.

Again, in the matter of quality, Germany has a much lower standard than either England or France—viz., a yield of 290 litres per kilogramme (4·64ft. per pound) with 5 per cent. dust, whereas in England the standard is a minimum of 4·8ft. and the carbide usually contains than 2½ per cent. of dust.

As regards acetylene plants, British generators are superior to those made in Germany, both as regards sound workmanship and design, and this is clearly enough shown by the fact that accidents have been far and away more numerous in the latter country, in spite of the infinitely more stringent regulations existing there. I am in pretty close touch with German firms, but I do not believe there is one that can truthfully say that it has sold over 3,000 plants, like the English firm Thorn and Hoddle (Ltd.). I sell calcium carbide all over the world, and receive therefore information from absolutely impartial sources, and I can give plenty of instances where British plants, put in at the same time and in the same district as German ones, have far outlasted the latter and given greater satisfaction in every respect. I know of more than one case where a German apparatus has been taken out and replaced by an English one.

Great stress is laid by Dr. Rose upon the question of village lighting by acetylene. Although it is a fact that more villages in Germany are using acetylene than in England, the equipment in England is no way behind that in Germany. There are now eight villages in the United Kingdom using acetylene, as compared with about 24 in Germany, but negotiations are in progress for equipping a considerable additional number, and everything promises that within a year or two we shall have many more village plants in the United Kingdom than Germany.

While thus asserting that the acetylene industry in Great Britain is no way behind that of any other country, it is an undoubted fact that nearly twice as much acetylene is used in Germany for general lighting as here. This is, however, not the fault of the British acetylinists; it is their misfortune. No one who has lived and travelled much on the Continent can have helped being struck by the large number of large villages and small towns unprovided with gas or electric light. Towns of 12,000 inhabitants, like Tata-Tovaros, in Hungary, which was unprovided with a central plant until acetylene was installed, are unheard of in this country.

Again, a vast number of large country houses in this country were equipped with their own electric light, or coal gas, or gasoline plant when acetylene was first introduced; on the Continent the private houses equipped in this manner are few and far between. The price of coal gas and of petroleum is also as a rule 40 per cent. to 50 per cent. lower in England than in Germany and is of better quality.

Lastly, the trade in England has had to suffer from the exorbitant rates charged by English railways. While £16 per ton was being charged at the works in Scotland for carbide, friends of mine were paying over £6 for carriage to the South of England for ton lots. As showing the advantage Continental users have, I may mention that whereas I pay only £2 (40.25f.) per ton for carriage from our works near Geneva to Treport (612 miles), I have to pay £2. 2s. 2d. for the carriage from our Woolwich store to Bath (about 130 miles). Now, however, we have carbide stores all round the British coast, and this evil is righting itself. It speaks thus volumes for the enterprise and ability of British acetylinists that, in spite of all these disadvantages, they have at least held their own as compared with Germans.

In conclusion I wish, on behalf of a great number of members of the acetylene industry in the United Kingdom, to express our best thanks to Dr. Rose for his Paper. Although from the nature of things he is much better acquainted with the German side of the question than the English, he has without doubt done the acetylene industry here an exceedingly great service by calling general attention to the progress this beautiful light is making.—Yours, &c., CHAS. BINGHAM.

London, Jan. 28.

## WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me to inform you of the following experiment. On Friday, January 25th, I established wireless telegraphic communication between the Colonne du Congrès, Brussels, and the spire of the St. Rombaut Church, Malines. The distance between these two monuments, which the Belgian Government had kindly placed at my disposal for these tests, is about 18½ miles. In travelling in a straight line between these two towns, the electric waves passed through the suburbs and the towns of Schaerbeek, Haren, Vilierde, and Eppeghem. The base of the Colonne du Congrès is 48 metres (160ft.) above the level of the sea, and its summit, at which the air wire terminated, 93 metres (310ft.) above sea level. The base of the St. Rombaut spire is 6 metres (20ft.) above sea level, and its summit 105 metres (350ft.), but in this latter case the air wire ended at 94 metres (313ft.) above sea level.

Communication was established on the first trial although the receiving air wire at Malines, having been broken, was hanging to the walls of the spire, and had dropped to 15 metres (50ft.) The usual length of air wire—the visible portion—was 27·50 metres (91½ft.) long. This air wire, both in the case of the transmitting station at Brussels and the receiving station at Malines, consisted, for a length of 10 metres, of a cylinder of 50 parallel wires, the diameter of the cylinder being 50cm. (16in.). This kind of net was so placed in each station that the corresponding portion of the air wire facing it in the other station was a single cable. Thus, while at Brussels the net began at 80 meterss (266ft.), at Malines it only began at 70 metres (233ft.) above sea level. The air wire at Brussels ended at 2 metres (6½ft.) above the ground.

Correspondence was interrupted when, at Malines, the air wire was lowered to 69 metres (230ft.) above the level of the sea—*i.e.*, to the level of the numerous houses in Brussels in the neighbourhood of the Colonne du Congrès, which are about 18 metres (60ft.) high. This proves, first, that the air wire transmits radiations in planes normal to its axis; and, secondly, that obstacles, such as houses, if they are numerous, stop the electric radiations.

The induction coils were of 25cm. (10in.) spark length.

The most interesting observation made in the course of these experiments was that the transmitter and receiving coherer, about which there was nothing particular, were not connected with the earth nor with a capacity. One of the balls of the oscillator on the one hand, and one of the electrodes of the coherer on the other hand, were connected to the air wires, while the other ball of the oscillator and the other electrode of the coherer were completely free. This proves

that electric waves are not propagated by the earth, but by the air, and that they do not follow the curvature of the earth.—Yours, &c., EMILE GUARINI.

Brussels, Jan. 29, 1901.

[We believe that M. Guarini originally intended to communicate between Antwerp and Brussels with the assistance of one of the repeaters (about which he has spoken so much) at Malines. Presumably, this experiment has not been successful, as he only refers to signalling between Brussels and Malines, which is about half the distance. Even for transmission across land, his results are not particularly extraordinary, except, perhaps, that they are over a long distance without the earthing of the air wire. The Marconi Company has, with the earth connection, signalled to a much greater distance across land between Dovercourt (Harwich) and Chelmsford, which is about 40 miles.—ED. *E.*]

## LEGAL INTELLIGENCE.

### Untended Arc Lamps.

At the Westminster (London) County Court last Friday Messrs. Sharp & Co., electrical engineers, brought an action against the Gaiety Bars Co. (Ltd.), Strand, London, for £30 odd for work done and material supplied. Plaintiffs' case was that a number of arc lamps outside defendants' premises caused trouble, and they were called in to see what could be done. The lamps were taken away and repaired and refixed, but again went wrong and were replaced by a new type of lamp, the defence being that if the original lamps had been properly cleaned and repaired by plaintiffs they would have worked properly. Plaintiffs, in reply to this defence, stated that the lamps were very dirty, and had not been properly tended, and that this was the cause of the trouble.

After hearing the evidence the judge took plaintiffs' view of the question, and gave judgment for plaintiffs for the full amount claimed with costs.

### Compensation Claim against the Central London Railway.

At the London Sheriff's Court on Wednesday, before Mr. Under-Sheriff Burchell and a jury, Dr. Purves, of Stratford-place, Oxford-street, W., claimed £4,200 damages against the Central London Railway for injury to his residence alleged to have been caused by the construction of the company's line. Expert witnesses on behalf of the claimant estimated the cost of repairs at £2,294, and the depreciation in the actual value of the house at £500. Plaintiff also claimed £1,000 in respect of personal inconvenience. The company adduced evidence to the effect that about £570 would be a liberal allowance for repairs.

The jury awarded £1,500.

## COURT OF COMMON COUNCIL (CITY OF LONDON).

At a meeting of the Court of Common Council yesterday (Thursday), the debate on the report of the Streets committee with reference to the disposal of the City refuse was resumed.

Mr. J. H. LILE, supporting the amendment to refer the report back, said three years ago it was referred to the committee to consider the practicability of generating electricity from the burning of the refuse, but no reference was made to that in the report.

The amendment was then carried by a large majority.

Mr. D. J. Ross was re-appointed engineer to the Corporation for the ensuing year.

The Streets committee recommended that the resolution of Nov. 29 last, "That works entailing interference with the public ways of the City be carried on continuously day and night until completed," should be varied so as to make it apply to main streets only.

Mr. A. C. MORTON referred to a statement made at the last meeting expressing doubt as to the power of the Court to enforce such regulations, and pointed out that under the Sewers Act, 1885, the Corporation had absolute power. Neither the electric lighting companies nor the Postmaster General had questioned that power, and Sir Courtenay Boyle, speaking on behalf of the Board of Trade, had stated that no further power was required.

The proposed variation of the resolution was then agreed to.

It was decided to inform the London County Council that the City Corporation were unable to consent to that portion of the Council's Tramways and Street Widening Bill seeking powers to lay down and construct a line of tramways within the City boundaries. The Corporation have decided to oppose the bill accordingly. Relative to the notice of application to the Board of Trade for an alteration of the regulations in regard to the supply of electrical energy, the Streets committee recommended, and the Court agreed, that the Board be informed that the Corporation objects to the proposed alterations, and that they be asked to afford the Corporation an opportunity of submitting their views on the subject before coming to a decision in the matter.

## VIBRATION ON THE CENTRAL LONDON RAILWAY.

At the Board of Trade on Thursday last week, Lord Rayleigh (in the chair), Sir John Wolfe Barry, and Prof. J. A. Ewing (with Mr. F. W. Marwood as secretary) opened the inquiry into the question of the alleged damage to frontagers, residents, and others caused by alleged vibration in the working of the traffic of the Central London Railway.

Mr. E. TEWSON (Debenham, Tewson, Farmer and Bridgewater, valuers), said vibration was felt some time before the tube railway was opened, but it had increased in force since then. It was worst in the morning and evening, when the heaviest traffic was being carried. In all these cases of tube railways when arbitrations were held as to the compensation for property taken the engineers of the tube railways told complainants there would be no noise and no vibration, the consequence being that compensation for damage done was obtained. In the surveyors' department of his own firm the vibration did not actually prevent the surveyors from drawing straight lines, but it occasionally caused the lines to be wavy. Other people whom he had consulted stated that they felt no vibration.

The CHAIRMAN said they would have to take measurements so as to get material for comparison between the present state of things and anything that might arise in the future owing to the working of the traffic.

Mr. THRELFALL (chairman of the Residents' committee) said that the disturbance began at five o'clock in the morning, and woke them up with a very good imitation of a small earthquake, which made the bed shake and the windows and all articles in the room rattle. His committee had sent out 300 circulars, and some of the replies stated that the annoyance was not felt: in fact, the replies varied very much—perhaps it was the nature of the soil that made the difference.

The CHAIRMAN said the committee would have to satisfy themselves by personal observation of the facts in a few typical cases. The evidence they had taken would conclude the evidence stage for the present. They intended to depute Mr. Mallock, who had made experiments connected with the trials of locomotives, to carry out the experiments as to the actual amount of vibration, which would be registered with a view to future reference. Those experiments would be made in the proximity of the line and not on the railway itself.

The committee then adjourned *sine die*.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

A traffic assistant is required by the East Ham District Council for their electric tramways department. An advertisement gives further particulars, and applications (addressed Chairman of the Electric Lighting and Tramways committee, Public Offices, Wakefield-street, East Ham, E.) must be in by noon 14th inst.

Charge electricians and switchboard attendants are required for extra high-tension power station and sub-stations operating electric tramways. See advertisement.

Jandus Electric Co. (Ltd.), Hartham works, Hartham-road, Holloway, N., require an assistant tester. See advertisement.

Devonport Corporation require a chief assistant engineer to the borough electrical engineer. Applications to town clerk by Feb. 17.

Manchester Electricity committee require an assistant mains engineer. Applications (addressed to chairman) by Feb. 5.

A mechanical draughtsman is required for the Islington electricity department. Applications by Feb. 5.

Mr. J. W. Donnett, of the County of London and Brush Provincial Co., has been appointed superintendent at the Pinkston tramway power station of Glasgow Corporation.

Mr. John Lambert, assistant engineer at the Dundee electricity works, has been appointed burgh electrical engineer by the Perth Town Council.

Lancaster Corporation have appointed Mr. W. A. Tester, of Messrs. R. W. Blackwell & Co., to be electric tramway engineer at £300 per annum.

**Bath.**—In a recent report the city electrical engineer (Mr. G. F. Metzger) states that the actual number of 8 c.p. lamps connected at the end of 1900 was 25,388, and allowing for the additional street arc lamps, which would be connected to the mains during the present quarter, there would be an equivalent of 27,088 8 c.p. lamps. Based on the same rate of increase in private lighting during 1900, the lamp connections next winter should not be less than 32,000 8 c.p. Their existing engine house plant was capable of supplying current to 30,000 8 c.p. lamps wired, and with high efficiency engines and alternators, their present boilers were able to give sufficient steam for supplying current to 40,000 8 c.p. lamps wired. He suggested replacing two of the 75kw. Brush sets, both of which could supply current to only 5,000 8 c.p. lamps, by two direct-driven 240kw. sets, capable of generating the necessary current to supply 15,000 8 c.p. lamps. The total cost of the proposed altera-

tions would be £8,500. The committee should lose no time in placing the orders as the plant could not be ready for running for several months afterwards. The report also stated that the current carried by the existing cables into the several sub-stations during Christmas week was far in excess of their carrying capacity, a drop in pressure resulting. In addition, they ran considerable risk of breakdown through overloading, and, to avoid trouble in the future Mr. Metzger presented a scheme for supplying their five principal sub-stations with new feeders at an estimated cost of £3,000. The outdoor and office staff at the electricity works is to be reorganised and strengthened, and the following resolution has been passed: "That the best thanks of the committee be tendered to Mr. Metzger and his staff for the efficient manner in which the business of the undertaking has been conducted during the past winter, and particularly during the flood." The entire report was adopted without discussion.

**Birkenhead.**—The new Ferry electric tramway route was officially inspected on behalf of the Board of Trade yesterday (Thursday).

**Blackpool.**—A special meeting of the Council have approved the Corporation Improvement Bill, which seeks powers to construct new electric tramways in the borough.

**Central London Railway.** - *Compensation Claim.*—The executors of the late Lord Herschell recently sued the Central London Railway for damages to houses at Lancaster-gate, alleged to have been caused by the railway works.

Mr. CRIPPS, K.C., for claimants, said the history of the case was a very short one. Certain cracks appeared in the walls, and there was a serious subsidence. The inference was that these circumstances were due to the construction of the Central London Railway. The claimants asked for £1,600 as damages.

Mr. FREEMAN, K.C., for the company, said the case was an important one. It was the first in which any claim for damage by the railway in question had been dealt with. There had been several cases where damage had been alleged to have been caused by the construction of the railway works. In some cases the complainants had failed to make out their claims; in others the defendants had admitted a certain amount of damage; but this was practically the first case in which the question as to actual damage had been raised. His case was that it was impossible from an engineering point of view that the damage complained of could have been caused by the construction of the railway, and that there were other causes which would be sufficient to account for all the injury that had been alleged. The railway was 64ft. below the surface of the road, and no less than 34ft. above the railway was London clay.

After taking some evidence of experts on both sides the hearing was adjourned to Feb. 8.

An official statement is issued that the earnings for the five months ended Dec. 31 are sufficient to pay a dividend at the rate of 2½ per cent. per annum for the half-year. This is equivalent to 3 per cent. per annum for the five months of working. The following dividends will be paid: Ordinary shares, 2½ per cent. per annum; preferred, 4 per cent. per annum; deferred, 1 per cent. per annum.

**Chelmsford.**—The Council have renewed the contract with the Chelmsford Electric Lighting Co. for public lighting for five years from March 25. The charge for arc lamps is to be £25. 5s. per lamp per annum, instead of £22. 10s., and for incandescents £3. 3s., instead of £2. 6s. 10d. A provision of the contract is that if eight arc lamps are extinguished at 11 p.m., the price for every lamp included in the contract shall be reduced to £23. 12s. 6d., and if the hours of lighting of the whole of the arc and incandescent lamps be reduced by one hour per day, the charge shall be further reduced by 5s. per arc lamp and 3s. per incandescent lamp per annum.

**Chorley.**—An enquiry was held here on Tuesday into the application of the Council to borrow £23,000 for electric lighting and £8,000 for refuse destructor works. The latter part of the scheme was opposed, but expert evidence was given in support that no nuisance would be created.

**Coventry.**—At the City Council meeting on Tuesday, the Electric Lighting committee recommended that the salary of the city electrical engineer (Mr. G. S. Ram) be increased to £400 per annum, that in future the services of a consulting engineer be dispensed with, and that Mr. Ram be appointed their adviser in all electrical matters. The report was, however, referred back, as was also a recommendation to raise a further loan of £18,000 for extensions of the electricity works.

**Cromer.**—The Council have acquired a site for an electricity generating station for £800.

**Darlington.**—Owing to friction between the Council and the Imperial Tramways Co., Messrs. Kennedy and Jenkin were recently instructed to prepare a report on the municipalisation of the tramways. This report has been presented, and states that the cost of buying up the present tramway would be £6,500. The net capital cost of laying down 6½ miles of tramway and the necessary plant would be £87,000 for single track and £109,000 for double track. In order that the receipts should balance expenditure there would have to be earned 8·23d. for the single line and 8·65d. for the double line per car mile.

**Dublin.**—The Electric Lighting committee will in future be known as the Lighting committee, and will have charge of both electric and gas lighting.

**Exhibition.**—Mr. Ernest Bade, 110, Fenchurch-street, London, E.C., informs us that he is arranging a section for English exhibitors at the forthcoming automobile exhibition to be held in Hamburg at the beginning of April.

**First!**—There is always something in being first, and sometimes the claim is a peculiar one—the latest is that made by Mr. A. Taylor, jeweller, of Tunbridge Wells, that he is the first tradesman to use a municipally-owned telephone system for business purposes. This epoch-marking event occurred on Jan. 24.

**Fulham (London).**—The electricity works will be inaugurated on 13th inst., when the Mayoress (Mrs. Cornwall) will switch on the current.

**Hammersmith (London).**—At a meeting of the Borough Council on Wednesday, the Law and Parliamentary committee presented a lengthy report with reference to the London United Tramways Bill, 1901. After dealing with the clauses relating to the submission of plans and designs of the proposed tramways, the removing and replacing of the electric lighting standards, &c., the committee recommended the Council to insist that the company should not alter the present overhead trolley system without the Council's previous consent. The Council has decided to oppose the undermentioned bills for clauses and otherwise: Charing Cross, Hammersmith and District Electric Railway, Central London Railway, London County Council (Tramways and Street Widenings), and London United Tramways (Ltd.).

**Heston and Isleworth.**—Mr. James Enwright has been appointed consulting electrical engineer to the District Council of Heston and Isleworth.

**Huddersfield.**—The new Longroyd Bridge and Slaithwaite electric tramway route was inspected on behalf of the Board of Trade on Wednesday.

**Hull.**—The electrical engineer (Mr. A. S. Barnard) has reported to the Electric Light committee that it is advisable to carry out certain alterations at Dagger-lane station, with a view to supplying the increasing number of consumers in the Old Town, increasing the efficiency of the system as a whole, and reducing the amount of smoke produced at the Dagger-lane station. Mr. Barnard recommends that the four smallest steam dynamos (equivalent to 310kw.) should be taken out and sold, and that four transformers (equivalent to 360kw.) should be installed in their place. Having ample boiler power for the remaining steam plant, there would be much less need to force the boilers, and less smoke would be created. The estimated total cost of the work is £17,500. A special meeting of the committee is to consider the report.

**Ilford.**—The resolution recently passed by the Council to adopt a sliding scale of charges for electric current has been rescinded and a fixed charge per unit will now be made.

**Islington (London).**—With a view to stimulating the demand for electric current, the Lighting committee recommend that at the end of the present quarter the price for current for motive power be reduced from 3½d. to 2d. per unit.

**Lancaster.**—Mr. W. Alan Fraser, the borough electrical engineer, has this week returned from the seat of war and has resumed his duties at the electric lighting station. Mr. Fraser was a member of the Middlesex Yeomanry, one of the regiments which provided detachments who volunteered in January last year to serve in South Africa. We are pleased to record that Mr. Fraser has returned in good health.

**Leeds.**—The Kirkgate, from the market to Briggate, is to be lighted electrically.

**Light Railways.**—The Blackpool and Garstang Light Railway Order has been submitted to the Board of Trade for confirmation. Objections by Feb. 22.

A first consignment of steel rails for the Cheltenham and Cleve light (electric) railway has been delivered, and the work of constructing the permanent way will be commenced at once.

The Light Railway Commissioners concluded their inquiry on Wednesday into the application of the Crewe Council to construct light electric railways. Opposition was offered by the London and North Western Railway Co. and the Cheshire County Council. Evidence in support was given by the Chairman of the Electric Lighting committee (Mr. Arthur Hill), Ald. W. M'Neill, Mr. R. Pedley, and the consulting engineer (Mr. C. Hopkinson). The capital expenditure involved for about 8 miles of line was estimated at about £100,000. Decision reserved.

**Lincoln.**—Mr. C. S. Vesey Brown has been appointed joint engineer and manager (with Mr. C. W. Fairweather) to the Northern Counties Electricity Supply Co. (Ltd.), of Newcastle-on-Tyne, and has resigned his position as city electrical engineer at Lincoln.

**Liverpool.**—The Electric Power and Lighting committee propose to charge 1½d. for electric current supplied to the tramways department during 1901. The minimum rate to ordinary consumers for power and heating is to be 1½d. per unit from the end of the present quarter. The accounts for 1900 show a balance profit of £3,496. 10s. 11d., which has been transferred to the renewal account.

The general manager of the Corporation tramways department (Mr. C. Bellamy) has reported that there are at present 270 electric tramcars in regular service. In conjunction with the chairman of the Tramways committee Mr. Bellamy has been investigating the effect upon the present congestion in the centre of the city when 130 further cars, which will be available by June next, are running. The following figures, relative to the business of the department for the past three years, together with those of 1897—being the last year under the management of the late company—are of interest :—

| | Passengers. | Mileage. | Receipts. |
|---|---|---|---|
| 1897 | 38,409,084 | 6,013,182 | £290,743 |
| 1898 | 41,772,034 | 6,279,758 | £314,207 |
| 1899 | 63,771,450 | 7,600,546 | £359,929 |
| 1900 | 82,367,958 | 9,100,866 | £417,574 |

**London County Council.**—At Tuesday's meeting the Highways committee notified that the electric car, with short length of permanent way, &c., purchased by the Council from the British Westinghouse Co., after exhibition at the Agricultural Hall, London, in July last, is now in operation at the Council's Camberwell depôt, and invited the members' inspection. It is stated that the permanent way is, in some respects, not in accordance with the underground conduit system recommended by Prof. Kennedy and approved by the Council for its system of tramways; but, as a practical illustration of Prof. Kennedy's system, there has been laid down at the same depôt a length of line in order that members of the Council may have ocular demonstration of the system. The councils of the metropolitan boroughs are to be invited to inspect this illustration of the Council's proposed tramways, which the Highways committee anticipate will remove, or at least lessen, any objections that may be entertained against the conduit system advised by Prof. Kennedy. It was announced by Mr. Benn, chairman of the committee, that when the Council proceeds to substitute electric traction for horse-driven lines north of the Thames the Aldgate to Stratford section will probably be selected.

Mr. Baker has given notice of the following motion :—

That the Highways committee report whether the Council could not at once proceed to lay down a double line of electric conduit tramway in Rosebery-avenue, energy to be obtained from one of the electric companies in the neighbourhood ; the lines to be worked by the Council and upon the same conditions as to fares and labour as prevail on the Council's southern system of tramways.

Mr. Westacott will also move :—

That the Highways committee report at the earliest possible moment as to the Council's powers to convert the tramways leased to the North Metropolitan Tramways Co. to electric traction, the probable cost thereof, the time it will take to do the work, and the estimated income from the converted lines.

**Lowestoft.**—The electricity works will be formally inaugurated on 12th inst., when the mayoress will switch on the current.

**Manchester.**—At a meeting of the Electricity committee last week, Prof. Kennedy, the recently-appointed consulting electrical engineer, wrote stating that it would be a calamity to the city if the Bloom-street station was not ready to take up its load by September or October next. It was explained that at the Dickinson-street station two special Ferranti generators had been laid down, which would supply current necessary for working the three tramway routes which it is hoped will be opened in the spring. When fully equipped the Bloom-street station will add 14,000 H.P. to the 11,000 H.P. installed at Dickinson-street, bringing up the total to 25,000 H.P.

**Montreal.**—A new company, entitled the Lighting and Power Co. of Montreal, is being organised to acquire all the companies supplying the city with light and power. These include the Royal Electric Co., the Lachine Rapids Hydraulic and Land Co., the Chambly Mfg. Co., and the Montreal Gas Co. The capital of the new company will be $25,000,000.

**Newark.**—The Council have adopted the larger of the two electric lighting schemes prepared by their consulting electrical engineer (Mr. C. S. Vesey Brown) and application has been made for sanction to borrow £30,000 to carry out the work.

**North-East London Electricity Supply Schemes.**—In connection with the East Middlesex Electricity Bill, promoted by the Tottenham, Edmonton, Enfield, Wood Green, and Southgate Councils, a meeting to support the Tottenham local authority was held at Bruce Grove on Friday last, under the presidency of

Mr. JUPP, chairman of the District Council, who pointed out that it was fully agreed that electric light and power would come into the Tottenham district, either as the work of a public company or under municipal management, and it was upon the question of who was to construct the works and to supply current that a great diversity of opinion existed. In this connection it was peculiar that the local gas company exhibited great haste in their desire to press forward their bill in Parliament, seeking power to supply electric current. This pretty conclusively showed that the probability of financial loss in connection with electricity supply did not occur to the directors of the gas company. They had had the best possible expert advice and counsel, and the Council was convinced that it could bring the electricity undertaking to a successful issue. He then moved a resolution pledging the meeting to support the Tottenham Urban District Council in promoting the bill in Parliament which was to give power to the districts of Tottenham, Edmonton, Enfield, Wood Green, and Southgate to establish generating stations and to supply electric energy for all purposes.

Mr. MALONE, another member of the Council, seconded the motion, and said they were convinced that they could secure a better light at a lower price than they had been getting, and that a profit would accrue to the ratepayers from the establishment of electricity works by the Council. Messrs. R. Hammond and W. C. C. Hawtayne, whom they had selected to advise them in this matter, would tender them the best of counsel.

Mr. W. C. C. HAWTAYNE said he had gone carefully into the scheme which was to be placed before Parliament, and had thoroughly examined Tottenham district. Combination and concentration were the order of the day, and there was no difficulty in distributing electric current in bulk over large areas. Centralisation reduced general expenses, and while it would cost a private company to serve the districts embodied in the bill under discussion £200,000, the joint municipal scheme would only cost £126,000. It was proposed to devote £25,000 to a scheme for wiring of premises and the supply of fittings on the instalment system, such as had been adopted at Walthamstow and other places with great success.

Other speakers followed for and against the proposed scheme, and an objection having been made to Mr. Hammond being allowed to speak, on the ground that he was not a ratepayer of Tottenham,

Mr. HAMMOND said he was a native of the district, having been born in Tottenham over 50 years ago. With regard to the comparison of private companies with local authorities in the supply of electricity, he would point out that there were two places in the United Kingdom where current was supplied below 3d. per unit, and both of these were local authorities, and a very large proportion of the districts supplying at the lowest rates were municipally-owned undertakings. The latest Board of Trade returns showed that out of 130 municipal electricity works only two made losses—one of £65, the other of £55. At Leeds, where gas was supplied at 2s. per 1,000ft., the electric light was a great success, and the fact must not be overlooked that the introduction of electricity works attracted large industrial undertakings to a district. In fact, already he had seen the plans of a number of new factories that were to be erected in the district scheduled in the bills they were discussing. There was a great deal of vacant land in the district suitable for the erection of large works.

The motion was then put and carried by a majority of about 2 to 1. A poll was demanded, and will take place on Feb. 16.

The Edmonton Council's action in promoting, in conjunction with the neighbouring Councils, the East Middlesex Electricity Bill, has been approved at a ratepayers' meeting. A poll was also demanded in this case.

A meeting of ratepayers of Enfield was held on Tuesday to consider the East Middlesex Electricity Bill, and reports from Messrs. Robert Hammond and W. C. C. Hawtayne were read. Ultimately, a resolution in support of the Councils' action was carried.

**Perth (W. Australia).**—The Perth Electric Tramways (Ltd. have opened a further 2½ miles of their system.

**Private Bill Legislation.**—The following bills have been passed by the examiners of Private Bills, and will be duly reported for first reading: Piccadilly and City Railway, Metropolitan District Railway, King's-road Railway, Notting Hill Electric Lighting, Charing Cross, Euston and Hampstead Railway (Nos. 1 and 2), City and Brixton (extension of time), Derbyshire and Nottinghamshire Electric Power, Freshwater, Yarmouth and Newport Railway, and the Bournemouth Corporation Bills. In the case of the South Yorkshire Electric Power Bill "non-compliance with standing orders" has been found by the examiners, and no one appeared in support of the Southend Corporation Bill for electric lighting and tramway powers. In the case of the Brompton and Piccadilly Circus Railway (extension) Bill the necessary money deposits in respect of some of the railways contemplated had not been made, and the matter has been referred to the Standing Orders committee. The Willesden District Council Tramway and Improvement Bill was marked "dead."

Watford District Tramways Co. seek powers to construct about 8⅞ miles of electric tramway in Watford, Rickmansworth, and Bushey. It is proposed to erect the generating station in Bushey, and the capital of the company is fixed at £125,000, with power to issue debentures to the extent of one-third of the capital raised. The promoters are Mr. John Fell, Mr. S. Hunter, and Mr. W. J. Kershaw.

Hampstead Borough Council have decided to oppose the Charing Cross, Euston and Hampstead Electric Railway (Extension) Bill with a view to obtaining the insertion of clauses prohibiting the company from generating or supplying electricity within the borough and from erecting a generating station within the boundaries of Hampstead Heath.

**Police.**—At the Southwark (London) Police Court yesterday (Thursday) William Driscoll was committed for trial by Mr. Slade on the charge of stealing £82 belonging to the Diddlum Loan Club, formed of the employés of the City of London Electric Lighting Co., Bankside.

**Ramsgate.**—The Corporation have decided to invite tenders for laying electric cables to supply electric current along the front of the town, and through certain of the leading thoroughfares. The Isle of Thanet Light Railway and Electric Co. is to be approached in order to ascertain their terms for supplying electric current in bulk to the Corporation.

**Smoke Nuisance.**—At the West London Police Court on Friday, the Central London Railway Co. were summoned for creating a nuisance by allowing black smoke to issue from the shafts of the electric generating station, Wood-lane, Shepherd's Bush. The prosecutors were the Hammersmith Borough Council. Evidence was given on behalf of the company showing that the best appliances known to engineers were employed at the works, and that grey smoke might be mistaken for black. The number of economisers in the flues would prevent the issuing of black smoke. The magistrate (Mr. Rose) said he was satisfied that the best appliances were used, but he was not satisfied that the best kind of coal was used on some occasions. He must impose a fine of £5 on each summons (in all £25) with £2. 2s. costs. The payment was ordered to stand over pending the application for the statement of a special case.

**Sunderland.**—An agitation for the extension of the electric tramways to the east end of the town is on foot, and the electrical engineer (Mr. J. F. C. Snell) has been instructed to prepare a report on the matter.

**Wellington (New Zealand).**—The telephone system belonging to the Government has 7,200 subscribers upon its 20 exchanges and 20 sub-exchanges. A charge of £7 per annum is made for business connections within half a mile of any exchange, and £5 per annum for private house connections within 1 mile of an exchange. An extra charge is made of 10s. per additional quarter-mile up to 3 miles. The £7 rate applies only where exchanges are open day and night. The Colonial Government possesses 6,910 miles of aerial telegraph lines and 242 knots subterranean. The charge for local telegrams is 12 words 6d. and 1d. per word after.

**Whitehaven.**—The District Council have approved the West Cumberland Electric Tramway Bill.

**Wimbledon.**—The electrical engineer (Mr. F. Barnes Spencer recently reported that they had 421 consumers on the books, representing an equivalent of 22,180 8 c.p. lamps connected to the mains, and there were other customers awaiting connection.

At the last Council meeting the chairman of the Electric Lighting committee (Mr. Caswell) reported that Mr. Spencer had accepted another position, but only on the understanding that he should be allowed to remain at Wimbledon until various extensions had been carried out, and the undertaking was put into proper order. He felt they would suffer very serious loss, and that they were losing the services of a very valuable man—a man whom they would have great difficulty in replacing. He thought Mr. Spencer had acted very honourably indeed in what he had done.

**Presentation.**—Mr. D. J. Hide, who has just left the service of Callender's Cable and Construction Co. (Liverpool branch) to join Mr. A. Lester Taylor and Mr. A. Kelly as consulting electrical engineers and electricians, was presented on Saturday last with an illuminated address and a box of scientific instruments by the Liverpool staff. The presentation was made by Mr. F. A. Pocklington, chief local engineer of the company.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

"THE MANUFACTURE OF CARBONS FOR ALL ELECTRICAL PURPOSES."—by Francis Jehl. 10s. 6d., post free. This is a practical handbook, giving a complete description of the art of making carbons for electric lighting, electrodes, &c., with particulars of the various gas generators and furnaces used in carbonising. The work also contains particulars of the cost, &c. of erecting and working carbon works, and plans of a model factory.

"MOTIVE POWER AND GEARING FOR ELECTRICAL MACHINERY."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"THE STUDENTS' GUIDE TO SUBMARINE CABLE TESTING."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"THE INCANDESCENT LAMP AND ITS MANUFACTURE."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"MAGNETIC INDUCTION IN IRON AND OTHER METALS."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"ELECTRIC MOTIVE POWER," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free; abroad, 11s.

"ELECTRO-CHEMISTRY."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"SUBMARINE CABLE-LAYING AND REPAIRING.—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"THE ALTERNATE CURRENT TRANSFORMER."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"ARMATURE WINDING OF ELECTRIC MACHINES."—By H. F. Parshall and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"TEMPERATURE COEFFICIENTS OF 'CONDUCTIVITY' COPPER." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 81·9°F. Printed on strong cardboard, 6d. net.

"LABORATORY NOTES AND FORMS."—We have ready a set of 40 Elementary and Advanced Exercises for use with Electrical Engineering classes. These have been prepared by Dr. J. A. Fleming, and will be found of great service to Teachers, Demonstrators, and Students. The object of the series is the saving of the time of the Teacher and his Assistants, and to serve as a record of the work done by the Student. Each Form is supplied either singly at 4d., or 3s. 6d. per dozen net; in sets of any three, 1s. net; or the set of Twenty (Elementary or Advanced) Exercises can be obtained, price 5s. 6d. net. The complete set of Twenty Elementary and Twenty Advanced Exercises are price 10s. 6d. net; or in handy portfolio, price 12s. net; or bound in strong cloth case, price 12s. 6d. net. Strong portfolios can be had, price 1s. each.

**NOW READY.**—The cheaper edition of Dr. J. A. Fleming's "Electrical Laboratory Notes and Forms." These cheaper Forms have been prepared for the use of students and teachers at the Polytechnics and other Science classes throughout the country. The demand for the original set of these Notes and Forms has led to a request for a cheaper set for use at the day and evening classes at many of the technical institutes. These new Forms, which differ only from the higher-priced set in being printed on smaller and cheaper paper, and with less space for tabulated records, are issued at half the price of the original set.

"DRUM ARMATURES AND COMMUTATORS," by Mr. F. Marten Weymouth, also ready. Price 7s. 6d., post free. Prospectus on application. This is a complete treatise on the theory and construction of drum winding, and of commutators for closed coil armatures, together with a *résumé* of the principal points involved in their design, and an exposition of armature reactions and sparking.

"THE POTENTIOMETER AND ITS ADJUNCTS": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"THE ELECTRICIAN" READING CASE.—To hold four numbers of the journal. Strongly bound, 1s. net; post free, 1s. 4d.

"THE STEAM ENGINE INDICATOR AND INDICATOR DIAGRAMS."—Edited and enlarged by W. Worby Beaumont. Price 3s. 6d., post free. This work is a concise guide to the objects, construction, and use of the steam engine indicator and to the interpretation of indicator diagrams.

"THE ELECTRICIAN" PRIMERS.—In Two Volumes. Vol. I., Theory Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"PRACTICAL NOTES FOR ELECTRICAL STUDENTS."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### FINAL NOTICE.

**Additions and corrections to the entries in the Directory division of "THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK (the BIG BLUE BOOK) can still be made if they reach the office by first post on Saturday morning. February 2, at latest.**

**The Big Blue Book will be ready in a few days, corrected complete up to January 31, 1901. Price 12s. 6d., post free 13s. 3d. British Colonies, post free. 14s.; abroad, 14s. 6d.; U.S.A., 15s.**

### TENDERS INVITED.

*Extension of Time—Launceston* (*Tasmania*) Corporation invite tenders for the supply of 500 electric meters. Tenders by 12 noon of *April 22* (*not April 8* as previously announced). See *The Electrician* for Jan. 25.

*Wallasey* District Council require tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. An advertisement contains further particulars, and specifications, &c., may be obtained from the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead. Tenders must be sent to Mr. H. W. Cook, Public Offices, Egremont, by 21st inst.

*Wallasey* District Council also invite tenders for the erection and completion of car sheds, stores, workshops, and dwellings at their tramway depot, Sea View-road, Liscard. Drawings can be seen at the offices of the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead, from whom specifications, &c., can also be obtained. An advertisement contains further particulars, and tenders must be sent into Mr. H. W. Cook, Public Offices, Egremont, by 21st inst.

The Corporation of the royal burgh of *Kirkcaldy* require tenders for dry-back marine boilers, with mountings, &c., but alternative tenders for water-tube boilers will be considered. Specifications can be seen (but not obtained) at the offices of consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W., and tenders must be sent to the town clerk (Mr. Wm. L. Macindoe), Council Offices, Kirkcaldy, by 10 a.m. of Feb. 15. An advertisement contains further particulars.

*Glasgow* Corporation invite tenders for the supply of 100 car equipments and spare parts. Further particulars are given in an advertisement, and specifications can be obtained from the general manager (Mr. John Young), 88, Renfield-street, Glasgow. Tenders must be lodged with the town clerk (Sir J. D. Marwick) by 5 p.m. Feb. 22.

*Glasgow* Corporation invite tenders for steel straight track rails, curved rails, fish-plates, and steel tie-bars. Tenders by 5 p.m. Feb. 22.

*Manchester* Tramways committee require tenders for (*a*) car trucks, and (*b*) plant, tools, and materials for overhead electrical equipment. Specifications, &c., may be obtained from the general manager (Mr. J. M. McElroy), tramways department, Town Hall, Manchester. An advertisement contains additional particulars, and tenders (addressed to chairman) must be in by 9 a.m. of Feb. 5.

*Wakefield* Corporation invite tenders for independent surface-condensing plant at their electricity works. An advertisement contains further particulars, and tenders, addressed to the town clerk (Mr. Chas. Jas. Hudson), Town Hall, Wakefield, must be delivered before 12th inst.

*Brighton* Borough Council require tenders for the construction of a timber dam and concrete weir, wharf and timber piling, and concrete foundations for the electricity station building at Southwick. Tenders by 11th inst.

*Brighton* Corporation require tenders for the supply, delivery, drawing-in and jointing complete of feeder, distributing, test and telephone cables. Tenders to town clerk by 4 p.m., Feb. 14.

*Brighton* Corporation also invite tenders for the supply and erection of overhead trolley construction and equipment of tramway routes. Tenders to town clerk by 4 p.m. Feb. 14.

*Long Eaton* District Council require tenders for the following work in connection with their electricity station: (*a*) Producers, gas engines, dynamos, and switchboard, and (*b*) feeder and distribution cables and conversion of street lamps. An advertisement gives further particulars, and tenders must be in to the Council Offices by noon of Feb. 18.

Borough of *Southwark* (London) require tenders for the supply and erection of a 400kw. high-speed engine and dynamo and accessories, two water-tube boilers, with mechanical stokers, &c. Tenders to town clerk (Mr. J. A. Johnson), Town Hall, Walworth-road, S.E., by noon Feb. 13.

*London County Council* invite tenders for the supply of two blocks of water-tube boilers required for the electrical power generating station at the Camberwell depot of the Council's tramways. Tenders, addressed to the clerk (Mr. G. L. Gomme), by 10 a.m. Feb. 19.

*London County Council* Asylums committee require tenders for electric lighting sundries for Claybury and Heath asylums. Tenders by Feb. 13.

*Aberdeen* Tramways committee require tenders for the electrical equipment for their Bathing Station tramway route and the supply and laying of lead-covered, paper or fibre insulated cables. Tenders to city electrical engineer by noon, Feb. 13.

*Aberdeen* Electric Lighting committee require tenders for surface condensers, air and circulating pumps. Tenders by noon Feb. 8.

*Edinburgh* Corporation invite tenders for an electric lighting installation at the public baths, Portobello. Tenders to town clerk by 11 a.m. Feb. 6.

*Edinburgh* Corporation invite tenders for engine and dynamo for McDonald-road electricity station. Tenders by Feb. 9.

*Great Yarmouth* Corporation invite tenders for two water-tube boilers and two 200kw. high-speed continuous-current steam dynamos for electric traction. Tenders by noon Feb. 5.

*Great Yarmouth* Corporation also require tenders for about 800 tons of steel girder tramway rails. Tenders by Feb. 6.

*Wimbledon* Urban District Council invite tenders for steam and exhaust pipes, &c., and moving two boilers, feed-pumps, feedwater heater and storage tank; independent surface condensing plant; and the supply and erection of two water-tube boilers. Tenders to clerk by noon Feb. 18.

The managers of the *Poplar and Stepney* Sick Asylum District invite tenders for sundry work in connection with the installation of the electric light at the Sick Asylum. Tenders to Mr. Foskett, at the Asylum, Bromley, by 10 a.m. Feb. 12.

*Beckenham* District Council require tenders for boilers, steam alternator, and combined engine-dynamo and motor, pipe work, battery, and switchboard. Tenders to Council Offices, Beckenham, by Feb. 25.

*Bristol* Electrical committee invite tenders for coal conveyors and elevators, coal discharging plant, including hoist, automatic weighing machine, tower and bridge over roadway. Tenders by noon Feb. 21.

*Hull* Corporation Works committee require tenders for the supply of a multipolar generator to be coupled direct to a Belliss high-speed engine. Tenders (addressed to chairman) before noon Feb. 8.

*Southampton* Corporation invite tenders for the supply and erection of car bodies and trucks and motor equipments. Tenders to town clerk before noon Feb. 11.

*Stirling* Town Council require tenders for engines and dynamos (two sets, each of about 350 H.P.) and Lancashire boilers. Tenders by Feb. 15.

*Bournemouth* Corporation require three dynamos and two steam-driven surface condensers, &c., also 42 electric tramcars. Tenders by noon March 2.

Tenders are required for electric lighting and telephone work at the *Fulwood* Hospital, near Preston. Tenders to clerk, 2, Lune-street, Preston, by 7th inst.

*Luton* Town Council require tenders for wiring the council chamber, town hall, free library, corn exchange and baths. Tenders by 4 p.m. March 4.

*Batley* Corporation invite tenders for three high-speed triple expansion steam dynamos, one balancer, and one motor generator. Tenders by Feb. 9.

*Belfast and Northern Counties Railway Company* invite tenders for stores (including telegraph iron-work, batteries, signal fittings, &c.) for the year ending Feb. 28, 1902.

*Wolverhampton* Tramway committee require tenders for a 10-ton electric travelling crane. Tenders to chairman of Tramways committee by 11th inst.

*Shoreditch* (London) Borough Council require tenders for erecting generating station building in Whiston-street. Tenders to clerk by noon 13th inst.

*London School Board* invite tenders for electrical supplies for their training ship "Shaftesbury." Tenders by 2 p.m. Feb. 6.

The Management committee of *Ballinasloe* (Ireland) Asylum invite tenders for electric lighting at new hospital block. Tenders by Feb. 9.

*Barnes* District Council invite tenders for wiring their electricity works. Tenders by Feb. 11.

*Burnley* Corporation require tenders for a traction switchboard, Tenders by Feb. 7.

*Leeds* Tramway committee require tenders for poles and bracket arms for carrying overhead electric wires. Tenders by Feb. 6.

*Islington* (London) Borough Council invite tenders for erection of water tower, tanks, &c. Tenders by Feb. 12.

*Croydon* Corporation require tenders for two dry-back boilers. Tenders by 16th inst.

*Whitby* District Council require tenders for erecting electricity station building. Tenders to clerk by 12th inst.

*New South Wales* Government invite tenders for supply, delivery, and laying of about 29 miles of 6,600-volt, three-core, lead-sheathed cable, together with the necessary troughing, filling-in compound, &c. Tenders to Railway Commissioners' Office, Bridge-street, Sydney, by noon, March 4.

The municipality of *Alcaraz* (Albacete, Spain) require tenders for electric lighting. 120 10 c.p. lamps are required at 23 pesetas each.

## TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board have received the following tenders for the electric lighting of the Tooting Bec Asylum :—

| | | | |
|---|---|---|---|
| Robert Dawson & Co., Staleybridge (*accepted*) | £4,416 | T. Scott Anderson | £6,000 |
| T. H. Wathes | 10,638 | G. F. Cook & Co. | 5,800 |
| Cooper & Co. | 8,256 | Manley & Co. | 5,624 |
| Benham & Sons | 8,230 | Weston & Co. | 5,260 |
| G. Lummis-Paterson & Co. | 8,000 | H. J. Godfrey | 4,713 |
| Donnison, Berlyn, Sillem & Co. | 7,098 | W. J. Fryer & Co. | 4,692 |
| Concentric and General Contract Co. | 7,015 | National Electric Wiring Co. | 4,690 |
| A. Fearnhead | 6,591 | Lea & Warren | 4,625 |
| Geipel and Lange | 6,550 | Hampton & Sons | 4,544 |
| | | Barlow Bros. & Co. | 4,487 |

The consulting engineers' estimate was £5,000.

The following tenders have been accepted by the Pemberton Urban District Council :—

| | |
|---|---|
| (1) Boilers—Tinkers Limited | £2,245* |
| (2) Engine and dynamo—Mather and Platt | 3,150† |
| (3) Accumulators—Tudor Accumulator Co. | 1,927 |
| (4) Switchboard—Dorman and Smith | 435 |
| (5) Crane—Carrick and Ritchie | 161 |
| (6) Conductors—British Insulated Wire Co. | 7,013 |

* Mechanical stokers not included. † Belliss engine.

For (1) 6 firms tendered, for (2) 26, for (3) 8, for (4) 16, for (5) 8, and for (6) 10 firms. The highest tender for (1) was £3,566, for (2) £5,050, for (3) £2,537, for (4) £814, for (5) £225, and for (6) £10,612.

The London County Council has accepted the tender of Mr. J. Strachan for the work of excavation, &c., for the lamp standards to be placed placed along the footways of the Thames Embankment, and trenches for lighting mains at £470. This was the lowest tender, the highest being £1,650.

In our last issue the accepted tender (that of the Union Cable Co.) for the supply of cable to Brighton Corporation during the year 1901 was given. There was an error (we are informed by the successful tenderers) in the amount of this tender, which should have been £13,952, not £11,986. This latter, however, is the figure given in the table below, which is official. Tenders were sent in by the following firms :—Callender's Cable Company, W. F. Dennis & Co., St. Helens Cable Co., Siemens Bros. & Co., British Insulated Wire Co., Witting Bros., Union Cable Co., Telegraph Manufacturing Co., W. T. Glover & Co., Johnson and Phillips, W. T. Henley's Company, Western Electric Co. The tenders of Messrs. Siemens Bros. & Co., Callender's Company, British Insulated Wire Co., Telegraph Manufacturing Co., W. T. Glover & Co., Johnson and Phillips, W. T. Henley's Company, Western Electric Co., W. F. Dennis & Co., and St. Helens Cable Co. were declared not in compliance with the conditions upon which tenders were invited, and (with the exception of the two last-mentioned firms) were declared to be accompanied by conditions which might involve considerable additional cost to the Corporation. These tenders were, therefore, not entertained. The two remaining tenders, those of the Union Cable Co. and Messrs. Witting Bros., complied with the Corporation conditions, and at the meeting of the Council on Jan. 17 it was resolved, on the recommendation of the Lighting committee, that the tender of the Union Cable Co., to supply, deliver and maintain the quantities of cable, of the several sizes and descriptions specified in the amended specification, as may be ordered of them by the electrical engineer during the year ending Dec. 31, 1901, be accepted, subject to the approval of the sureties proposed by the contractors. The following are the prices of cable submitted in the two tenders referred to :—

We are informed that the tender of Mr. C. E. Gritton, 33, King-street, London, W.C., British representative of the Goheen Mfg. Co., Canton, Ohio, U.S.A., has been accepted by the India Office for a large quantity of carbonising coating for protecting iron and steel used on the Indian State railways, &c., and also for quantities of a preparation called "Galvanum," for protecting iron, tin and wood-work.

City of London Union District committee have accepted the tender of Messrs. Platford & Son for supplying telephonic communication between the main block of the isolation hospital, porter's lodge, and master's cottage at £46. 14s. 4d.

Greenwich Guardians have now accepted the tender of Messrs. Robert Dawson & Co., of Stalybridge, for the electric lighting of the Grove Park workhouse. Messrs. Lea and Warren, whose tender was originally accepted, have withdrawn their offer, as a mistake was discovered in their estimate. The amount of Messrs. Dawson & Co.'s tender is £5,014.

Farnworth District Council have accepted the tender of the British Westinghouse Co. for the supply of eight 66-passenger tramcar bodies, motors, undertrucks, controllers, &c. This contract was advertised in our issue of Dec. 21 last.

Salford Corporation have accepted the tender of Messrs. George Hill & Co. for the overhead equipment of electric tramways at £8,600.

The Hart Accumulator Co. (Ltd.) have secured the contract for the supply of storage batteries for the Sutton (Surrey) electricity works.

Bristol Electrical committee have accepted the tender of Messrs. Stevenson & Son for tanks for the Avonbank electricity works.

Southampton Corporation have accepted the offer of Messrs. S. Z. de Ferranti (Ltd.) for a 300kw. steam alternator at £3,000.

## BUSINESS NOTICES.

Messrs. W. S. Sargeant and J. H. Watt (trading as the Thames Electric and Steam Launch Co.), Strand-on-the-Green, Chiswick, have dissolved partnership.

Mr. Herbert Lindley (late of Browett, Lindley & Co., Ltd.) has accepted the position of general manager to Galloways Limited, Manchester, who are taking up the construction of high-speed engines for electric lighting work.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. W. B. Peat, receiver and manager of Easton, Anderson and Goolden (Ltd.), 3, Lothbury, London, E.C., announces that on Jan. 23 he retired from possession of the company's works, which are now being carried on by the new company—Messrs. Easton & Co. (Ltd.).

We learn that the scheme for the reconstruction of the above company provides that certain assets are excluded from the sale to the new company for the purpose of paying a cash dividend to the unsecured creditors. These assets consist of a dividend to be received from the estate of E. T. Hooley, on an admitted claim for breach of contract, and a claim against the Haddenham Level Commissioners for £2,400, which is at present the subject of arbitration. As soon as these assets have been realised a cash dividend will be paid to the unsecured creditors. In addition to the above, the liquidator receives from the purchasing company (Messrs. Easton & Co., Ltd.) 45,000 ordinary shares of £1 each, which have, under the scheme of reconstruction, to be retained by the liquidator for two years, and will, thereafter, be realised and the proceeds divided amongst the unsecured creditors.

Under the terms of the purchase agreement debts due to Mr. Peat, as receiver to the old firm, are payable to Easton & Co., who will discharge all debts, liabilities and obligations of the receiver. Mr. F. Percival Wilson, joint manager of the new company, announces that the business is taken over as a going concern, and that all current contracts will be duly executed. The new company acquires the old business, together with the works, machinery, patents and patterns, and, after full and satisfactory investigation by Prof. J. A. Ewing, has further secured the sole licence for Great Britain and the Colonies for the manufacture of engines, superheaters, economisers and other apparatus under the Schmidt patents for the utilisation of highly superheated steam. The various branches of engineering work carried on by the old firm will be continued, and the staff and officials are retained.

Brighton Corporation Cable Tenders.—*Contract price per mile.*

| — | 1 □ in. | ·6 □ in. | ·2 □ in. | ·1 □ in. | Triple concentric, 2 × ·2 1 · ·1. | Triple concentric, 2 × ·1 1 · ·06. | Concen., 2 · ·025. | 37/22 Pilot wire. | Arm'd., ·06. | Arm'd., ·025. | Triple concen., 3 · ·025. | ·017 I.R. covered. | Total for probable quantity taken. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Union Cable Co. | £1,175 | £777 | £272 | £162 | £737 | £473 | £138 | £91 | £166 | £115 | £291 | £142 | £11,986 |
| Witting Bros. | 1,250 | 820 | 270 | 158 | 735 | 475 | 128 | 60 | 172 | 129 | 270 | 177 | 12,373 |

Messrs. Lewis and Ernest Benjamin, trading as Johnstone, Benjamin & Co., electrical dealers and manufacturers, 10, Ascham-street, Kentish Town, London, N.W., recently called a private meeting of their creditors, when it was resolved that the estate should be wound-up in bankruptcy. The following are amongst the creditors :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cie des Etablissements Lazare Weiller | £867 | 10 | 8 | Dr. Cassirer & Co. | £111 | 12 | 8 |
| Britannia Rubber Co. | 648 | 11 | 8 | Christie & Co. | 109 | 18 | 0 |
| St. Helens Cable Co. | 565 | 15 | 8 | A. W. Richardson | 97 | 18 | 6 |
| Western Electric Co. | 547 | 0 | 10 | Frederick Smith & Co. | 94 | 1 | 0 |
| Shropshire Iron Co. | 295 | 0 | 9 | Silvertown Co. | 91 | 4 | 1 |
| Land und See Kabel Gesellschaft | 269 | 19 | 9 | Fraser and Fraser | 91 | 0 | 0 |
| Ramsden, Camm & Co. | 263 | 8 | 6 | Johnson and Phillips | 83 | 1 | 2 |
| Elliott Bros. | 221 | 5 | 1 | Hooper's Telegraph Wks. | 82 | 16 | 6 |
| T. Bolton & Sons | 213 | 15 | 6 | Conrad Felsing, Jun. | 74 | 0 | 0 |
| Ancoats Vale Rubber Co. | 188 | 9 | 1 | Northern Elec. Wire Co. | 67 | 17 | 6 |
| Anns & Co. | 170 | 3 | 8 | Phosphor Bronze Co. | 56 | 2 | 6 |
| Heddenheimer Kupferwerke | 161 | 1 | 11 | D. F. Tayler & Co. | 49 | 0 | 3 |
| Hawkins & Co. | 144 | 13 | 3 | David Moseley & Son | 45 | 0 | 0 |
| P. & W. MacLellan & Co. | 140 | 12 | 2 | Macintosh & Co. | 29 | 16 | 3 |
| Back and Manson | 124 | 16 | 8 | Selig, Sonnenthal & Co. | 28 | 0 | 7 |
| | | | | Craigpark Co. | 19 | 19 | 11 |
| | | | | Wilkins, Campbell & Co. | 13 | 9 | 4 |

The total liabilities are given as £8,472, and assets at £5,850.

A meeting of the Midland Electrical and General Engineering Co. (Ltd.) will be held at 20, Fletcher-gate, Nottingham, on Feb. 20, to receive an account of the winding-up. Mr. W. B. Winnicott is liquidator.

In the bankruptcy of S. G. Trehearne and A. H. Crump (trading as Trehearne, Son and Crump), electrical engineers and contractors, 155, Fenchurch-street, the trustee (Mr. B. T. Norton, 9, Old Jewry-chambers, London, E.C.) has been released.

C. W. Garrett and G. E. Hedges (trading as G. W. Garton & Co.), electrical engineers, &c., 41, St. John's-road, Clapham, London, S.W., have been adjudicated bankrupts.

A receiving order was made at Leeds on Tuesday against Tom Arthur Flather, electrical engineer, 406, Meanwood-road, lately trading at the Park Electrical Works, Speedwell-street, Leeds.

---

**Sales by Auction.**—Messrs. Wheatley Kirk, Price & Co. notify the sale by auction on Tuesday and Wednesday, Feb. 5 and 6, upon the works premises Haunch of Vension-yard, Brook-street, London, W., of the entire contents of the works. Details of the plant, machinery, apparatus and accesories included in this sale are given in an advertisement. Catalogues are now ready and can be obtained of the auctioneers, 46, Watling-street, London, E.C., and Albert-square, Manchester.

Messrs. Wheatley Kirk, Price & Co. will, at the conclusion of the above sale on Wednesday, Feb. 6, offer for disposal in one lot a fine 32 N.H.P. Crossley gas engine, having two cylinders, two flywheels, auxiliary starting engine, and a complete Dowson gas-producing plant. Some further particulars will be found in an advertisement, and catalogues now ready give additional information.

As announced in an advertisement, Messrs. Percy Huddleston & Co., in conjunction with Messrs. Norman and Bowen, will sell by auction on the premises, 65, South Audley-street, London, W., on Feb. 12 and 13 (the fixtures and fittings on Feb. 20), at one o'clock prompt, the valuable stock and plant of an electrical engineer and lamp manufacturer. Catalogues may be obtained from Messrs. Percy Huddleston & Co., 72, Finsbury-pavement, E.C., or of Messrs. Norman and Bowen, 62A, Aldersgate-street, E.C., London, and on the premises.

**Plant for Sale.**—Messrs. Wake and Carr, 123, Victoria-road, Darlington, have for sale four sets of vertical marine-type triple-expansion engines. An advertisement gives additional information, and further particulars can be obtained from Messrs. Wake and Carr, Darlington, or Mr. Thos. W. Ward, Sheffield.

An advertisement also contains some particulars of eight large locomotive boilers which are for sale. Applications to Messrs. Wake and Carr, Darlington, or to Mr. Thos. W. Ward, Sheffield.

The Brighton Lighting committee have for sale two continuous-current, motor-driven alternators. Some further particulars are given in an advertisement, and the plant may be inspected at any time by appointment with the engineer (Mr. John Christie). Offers to manager, electricity works, North-road, Brighton, by 23rd inst.

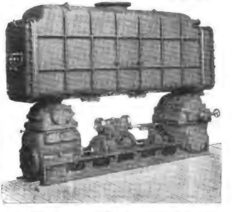
**Business for Sale.**—An old-established electrical engineering business is advertised for sale, for which a sum of about £3,000 cash is required. The sole agent is Mr. H. W. Smith, 7, Featherstone-buildings, Bedford-row, London, W.C.

**Electrical Measuring Instrument List.**—A useful list of wattmeters, ohmmeters, ammeters, voltmeters, galvanometers, bridges and recording instruments is just issued by Messrs. Everett, Edgcumbe & Co., 22, Charterhouse-square, London, E.C.

**"Jackson-Mensing" Arc Lamps.**—A neat pocket list of "Jackson-Mensing" patent arc lamps reaches us from Messrs. P. R. Jackson & Co., Salford Rolling Mills, Manchester. Several types of lamps are shown.

**"Universal" Motors.**—Messrs. R. W. Blackwell & Co., 59, City-road, London, E.C., have issued a pamphlet describing various types of "Universal" motors. These motors are made from ⅓rd. to 75 H.P., open or enclosed, shunt, series or compound-wound. Copies of the list can be obtained on application.

**Condensing Apparatus and Cooling Towers.**—A well illustrated list of condensing machinery, &c., can be obtained of the Wheeler Condenser and Engineering Co., 179, Queen Victoria-street, London, E.C. A number of installations carried out by the company are briefly described. Our illustration shows the rectangular pattern Wheeler standard condenser, mounted over combined air and circulating pump. Many of the illustrations in the pamphlet refer directly to forms of Wheeler condensers specially designed for electricity generating works, while others show these machines with the pumps electrically driven.



**Calendars.**—A neat hanging pad calendar stamped out in the shape of an "Ediswan" bulb and holder reaches us from the Edison and Swan Co. It is very effective both as an advertisement and as a calendar.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 23 to Jan. 29, with the ports of destination :—

*Africa*—Alexandria, £50; Cape Town, £40; Durban, £77; East London, £615; Port Elizabeth, £43. *Argentina*—Buenos Ayres, £493. *Australasia*—Adelaide, £187 (telegraph material); Auckland, £122; Brisbane, £46; Fremantle, £40; Hobart, £107; Newcastle, £35; Perth, £4,092; Sydney, £760; Wellington, £51. *Belgium*—Ostend, £711. *British Guiana*—Demerara, £55. *Chili*—Valparaiso, £233. *China*—Shanghai, £8. *Colombia*—Santos, £337 (telegraph material). *Denmark*—Copenhagen, £173 (telegraph wire). *Germany*—Hamburg, £880 (including £800 telegraph material). *Gibraltar*, £43. *Holland*—Amsterdam, £115. *Hong Kong*, £40. *India*—Bombay, £24; Calcutta, £70. *Japan*—Nagasaki, £2,200 (telegraph cable). *Malta*—£111 (telegraph material). *Spain*—Huelva, £27. *West Indies*—Trinidad, £77. Total £11,859, against £25,522 in the corresponding week last year (Jan. 24 to Jan. 30).

---

Cheap Telephony.—The toll or message rate system of charging and the employment of party lines is extending rapidly in connection with the National Telephone Co.'s provincial exchanges. The three tariff systems—unlimited service rate, message rate, and party-line rate—are analogous to the three methods of transportation. A rich man has his own carriage and subscribes for an unlimited service; others may find it more economical to employ cabs and pay for every journey separately, just as they pay for each message on the message rate; and the poorer man, who travels in omnibuses, may make use of the "party-line" system, in conjunction with his neighbours, and thus have a cheaper, less frequent, and slower service.

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & CO. *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

November 27, 1900.

21,449. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in interrupting devices for electric circuits. (E. W. Rice, jun., United States.)*

21,450. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in methods of transforming alternating electric currents. (J. E. Woodbridge, United States.)*

21,457. S. G. BROWN. London. Improvements in telephony and telegraphy.

21,459. J. SACHS. London. Improvements in safety cutouts for electric circuits.*

21,460. J. SACHS. London. Improvements in lightning arresters for safety cutouts for electric circuits.*

21,478. J. H. BARKER and J. A. EWING. London. Improvements in or relating to electric meters.

21,486. H. T. COTTON, A. T. COTTON, and A. H. REDDELL. London. An improved appliance suitable for removing screw threaded clamping rings from electric incandescent lamp-holders.*

21,490. R. LEHNHOFF. London. Improvements relating to switches for use in electric circuits.

November 28, 1900.

21,497. G. HARRISON, of the firm of D. Young & Co. London. Improvements relating to an electrolytic process and apparatus for the treatment of metalliferous ores and substances for the extraction of precious metals therefrom. (A. C. Lorenz, United States.)

21,501. A. WATSON. Birmingham. Improvements in electrical switches.

21,517. O. REINICKE. Berlin. Improvements in electric bells.

21,533. J. MATTHEWS and W. DAVIES. Birmingham. Improvements in electrolytical apparatus.

21,538. A. J. BOULT. London. Improvements in or relating to plates for electric batteries or the like. (W. J. Jackson, United States.)*

21,540. A. W. HANCOCK, J. LEIGHTON, and R. HACKING. London. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables or the like.

21,547. R. D. SANDERS. London. Improvements in the manufacture of wire strips and the like by electro deposition.

21,566. C. A. VON WELSBACH. London. Improvements in accumulators or secondary batteries.

21,575. A. MUIRHEAD. London. Improvements in electric telegraphs.

November 29, 1900.

21,578. W. J. FRYER. London. Enclosed switch and cutout combined.

21,585. A. HUDSON. Bolton. An improved life guard for electric cars or other motor vehicle.

21,615. E. A. CHAMBERS. London. Improvements in the socket joints of metallic telegraph and like poles.

21,617. C. E. ZIMDARS. London. Improvements in electrical fuse distribution or switchboards.

21,629. W. D. B. DUDDELL. London. Improvements in and connected with means for the conversion of electrical energy derived from a source of direct current into varying or alternating currents.

21,642. J. C. A. WARD. London. Improvements relating to electric fuses.*

21,644. H. R. KENT. London. Improvements in systems of electrical distribution. (Date applied for under Patents, &c., Act. 1883, sec. 103, May 1, 1900, being date of application in United States.)

21,645. CLARKE, CHAPMAN & CO. (LTD.) and A. L. FORSTER. London. Improvements in and relating to electric switches.*

November 30, 1900.

21,660. G. H. IDE. Birmingham. Duplex spring holder for electric globes and shades.

21,669. S. HALL. Manchester. An improved reflector for electric or other lights.

21,674. J. CAMPBELL, A. HIRD, and A. B. BLACKBURN. Sheffield. Improvements in the method of supporting electric motors directly connected to the axles of cars or locomotives for electric railways or tramways.

21,700. L. STERNE. London. Improvements in telephony. (S. B. Fowler, United States.)*

21,701. L. STERNE. London. Improvements in telephony. (S. B. Fowler, United States.)*

21,702. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in operating dynamo-electric machines. (W. le R. Emmet, United States.)*

21,703. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electrical distribution. (R. Fleming, United States.)*

21,704. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electrical distribution. (E. J. Berg, United States.)*

21,716. C. OLIVER. London. Improvements in, and in the arrangements and construction of arc lamps.

21,722. G. E. HEYL DIA. Liverpool. Improvements in, or relating to trolly wire and other conductors for electric traction.

21,732. SIEMENS BROS. & CO. (LTD.). London. Method of automatically cutting out main conductors of powerful electrical currents. (Siemens and Halske, Aktein Gesellschaft, Germany.)*

21,736. A. B. GILL. London. Improvements in apparatus for electrically lighting railway trains.

21,740. W. LANGDON DAVIES and A. SOAMES. London. Improvements in dynamo electric machines.

December 1, 1900.

21,759. S. COWPER COLES. London. An improved process for the electro-deposition of metals.

21,804. E. A. CLAREMONT. London. Improvements in the manufacture of electrical insulating materials.

21,806. P. McCULLOCH. Liverpool. Improvements in or relating to trolleys, switches, and crossings used in connection with overhead wires for electric traction.

21,812. L. W. EMERICK. London. Improvements in and relating to electric arc lamps.*

21,815. V. J. FEENY. London. Improvements in and relating to armatures and inductors. (Allgemeine Elektricitäts Gesellschaft, Germany.)*

### SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

16,889. BERRY. Electrical transformers.

18,664. PURVIS. Electric railways on closed conduit systems.

22,989. HEWER. Electric tramways or railways on the slotted conduit system.

23,141. GODDARD. Controlling arrangements for switches for direct driven cage hoists and general electric and motor work.

23,153. HIRST and HUNT. Switches for use with rheostats for starting and controlling electric motors for lifts or the like.

23,315. WRIGHT AND MUTUAL ELECTRIC TRUST CO. (LTD.). Electrolytic meters.

## COMPANIES' MEETINGS AND REPORTS.

### Eastern Telegraph Co. (Ltd.).

The fifty-seventh half-yearly ordinary general meeting of this company was held on Monday. The chair was taken by Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY read the notice convening the meeting.

The CHAIRMAN said: Ladies and gentlemen, before we commence the formal business of the day I desire to make a few remarks on the peculiar position in which we find ourselves. We are meeting under a condition of gloom, for we have experienced a great national loss in the death of our beloved Queen, and no public meeting, I think, can take place without that fact being present to the minds of all. It is not only a national loss, but I think we may say that to all of us it is an instance of private and personal bereavement. The matter is brought home to the telegraph companies in a special way, seeing that it has been our business, both by night and by day, to forward telegrams relating to this sad subject over our wires to every part of the world. These telegrams were in the first instance notes of warning and they soon became matters of deep anxiety. We then telegraphed flickers of hope, and at last of despair; finally, we are now engaged in telling the whole of the world of the arrangements for the funeral of our beloved Queen. Thus it seems that telegraph companies are mixed up in this matter in a peculiarly intimate way, and that in respect of it we occupy not merely the position of a body of shareholders, but that we fulfil great national duties. We are in touch with every part of the globe, and we knit together our colonies and dependencies in all climes. Perhaps I may say how deeply everybody throughout the world has appreciated our great Queen. We look in vain through the pages of history to find anyone who has been so universally revered, and who has fulfilled her duties to her nation in such an extraordinarily whole-hearted way. She was wise, steadfast, and experienced in all matters of State, and, further, she was completely national and sympathetic with her people in all their joys and sorrows. These were her qualities, ladies and gentlemen, as a monarch and a queen; but words would fail anybody who attempted to do justice to her private virtues. They were experienced by this country for more than 60 years, and she became more beloved, more revered, and more appreciated as years went on, although at no time of her long life was she other than the beloved ruler of these countries. She was loving in her sympathy with the troubles both of individuals and of public bodies, and she was a woman who was most deeply religious. We look back on her as one of the best of wives, the best of mothers, and the most sincere friend that has ever been known to occupy a public position. These were her great qualities as a woman, and we cannot help thinking that we have lost the most renowned and most revered person who has ever been known in the history of the civilised world. She was loved and venerated as the highest lady *par excellence* in the whole world, and she was to us all, both individually and collectively, the true mother of her people. I suppose it will be given to none of us to look on her like again. While we are all thankful for what has gone by, and grateful for the benefits which we have received during the beneficent reign of Queen Victoria, we are at the same time, at this moment, thankful that the King who succeeds her

s the personage that he is. We have known him as the Prince of Wales, and he has endeared himself to the whole of the people of this nation. We may say, then, that we have the most supreme confidence in the son of such a father and of such a mother. He is not only one of the most popular men in the world, but he is highly experienced in public business. He has conducted many very important matters with the most conspicuous success, and we all know that he has been endowed by Providence with very great abilities. He has shown in numberless ways his great love for the people. He has been at the head of all great charitable works, and there has been no matter touching the welfare of this country that has not had the cordial, sagacious, and anxious support of him whom we have known till now as the Prince of Wales. We have also the satisfaction of recognising that he is a universal favourite abroad as well as at home, and, lastly, we know that he is to the very core an Englishmen in the largest sense of the word. We feel sure that he will continue that happy union which has been begun under the reign of his august mother between not only the people of this country and our own Colonial friends and Colonial States, but also with our great dependency of India and with other nations of the world. I think that His Majesty the King will be able to continue this beneficient work more easily and with greater success than possibly any other man could do, for he has had the great advantage of making a personal acquaintance with almost every country, and wherever he has been he has been greatly beloved. We feel confident, then, that he will prove himself in the future the most worthy follower of the greatest queen of any historical retrospect. While then, ladies and gentlemen, we mournfully say and recognise that the Queen is dead, we can with the greatest possible hope, say and pray "Long live and God bless the King," and we can from our hearts wish him every success in his arduous duties. Before I sit down I would ask leave to put this motion to the meeting :—

*"The Eastern Telegraph Company in general meeting assembled, humbly begs leave to express to His Majesty the King their profound grief at the death of his illustrious and universally beloved mother, Queen Victoria, and to offer their deep sympathy with His Majesty and the Royal Family in their bereavement. The Company further asks to be allowed to express their profound and dutiful attachment to the Crown and their heartfelt sense of loyalty to His Majesty."*

The MARQUESS of TWEEDDALE, K.T., seconded the resolution, which was carried unanimously, the stockholders rising in a body.

The SECRETARY read the minutes of the meeting held on Thursday, July 19, 1900, which were signed by the Chairman.

The Directors' report having been taken as read,

The SECRETARY read the Auditors' report as appended to the balance-sheet.

The CHAIRMAN : It is now my duty, ladies and gentlemen, to offer a few remarks upon the report and accounts. You will notice that the gross revenue for the half-year under review shows a very considerable increase. The gross revenue was £642,000—I leave out the hundreds—and for the corresponding period of 1899 it was £475,000, making an increase of £167,000. A few words ought to be said upon this matter, because this important increase is not entirely due to an increase of traffic. It is to a considerable extent due to a re-arrangement of the proportions payable to this Company under the Cape Joint-Purse Agreement, by which, in consequence of our having laid down an additional line of cables of greater carrying capacity between Porthcurnow, in Cornwall, to Madeira, St. Vincent, Ascension, St. Helena, and Cape Town, the Eastern Telegraph Company's share of the joint-purse naturally becomes considerably larger.

It was considered by the Board in former years that it was advisable that this Company should carry out on its own account the important strengthening of its line of communications to which I have referred, and I think that no one can doubt that the decision then arrived at was a sound one, and has greatly strengthened the position of the Company in dealing with the important traffic which is entrusted to it ; but I think that the point to which I have alluded ought to be borne in mind, because, at first sight, it might seem that our traffic had increased by this very large amount, whereas, as a matter of fact, the total traffic has not increased by anything like that proportion. There has, however, been a considerable increase in the volume of traffic with South Africa, which has been no doubt created by the military occupation of the Transvaal and Orange River Colonies. The other classes of traffic also show a satisfactory increase, and especially that due to the military operations of the European Powers in China. Looking at the traffic as a whole, we may be very well satisfied with the result of the half-year's working.

The total ordinary expenses of the half year amounted to £132,000, as against £122,000 in the corresponding period of 1899, and thus show an increase of £10,000. The items making up this additional charge are in the main due to the working of the new cables to South Africa. The working expenses at stations show an increase of £7,447. We have also had to work the Ascension and St. Helena cable, which expense did not occur in 1899. In addition to the charge under abstract B of £5,000 on account of expenses of the Cape Town and other joint stations, there is the usual increase under the heading of salaries and wages. This, as has been explained on former occasions, is accounted for by the automatic working of the classification scale, by which the pay of our employés rises in proportion to their length of service. We also have an addition of 32 members in the staff at our stations. Further, we have an increase of 17 members of the staff at the head office as compared with the corresponding period of last year, and this practically explains the increase of £416 in the head office expenses. The fact will, of course, be easily realised that we cannot carry an increased traffic without some addition to the expenses of the undertaking.

We have the satisfaction of recognising that our staff in South Africa have worked during the war in the most commendable manner, returning to their stations during leave of absence, and, when necessity arose, foregoing it altogether. We have also the satisfaction of knowing that those who represent the Government in Cape Town and other places in South Africa have realised to the full the very self-sacrificing way in which the employés of this Company have done their work, the discretion they have shown, and the general good conduct of all those who serve the Company in South Africa. (Hear, hear.) The gentlemen have not merely done their duty within narrow lines, but they have recognised the immense importance of telegraphy in modern warfare, and have exerted themselves, one and all, to the utmost ; and while having done their duty to the Company, they have done most loyal and useful service to their country. I think we all must recognise the services of these gentlemen. (Hear, hear.) Under the heading of "Staff Pension Fund" you will find an increase of £2,168. This increase is accounted for by the resolution passed by the stockholders, under which the retiring age for our employés has been made 55 instead of 60, as formerly. That naturally produces a larger claim upon that particular fund.

The expenses attending repairs and renewals of cables amounted to £45,000, against, in the correspoding period of 1899, £33,000, or an increase in round figures of £12,000. You will observe, on reference to abstract C, at page 7 of the accounts, that the actual ships' expenses amounted to £49,000, and in the corresponding period of the previous year they were £35,000, making an increase of nearly £15,000. This is largely due to the fact that our new steamer the "John Pender" has been put into commission ; and the expenses of the South African Company's steamer "Duplex," which ship was employed for a short time on the repairs to our cables, have been included in this year's statement. We have got some relief for the expenses of the steamer "John Pender," because she has been employed in laying cables in China for other companies, but the amounts we have received from foreign Governments and other companies for the hire of ships generally have not been so large this year as they were in the corresponding period of 1899, so that the net cost of repairs, including cable used, is about £12,000, as I have already said. Our ships have been fully employed, and full details of the work done will be found on reference to the accounts. We have lately had an anxious time in the repair of cables. There seems to have been almost a fatality against keeping the communications open without great exertions on the part of those who had to execute the repairs ; but, speaking generally, we have been able to keep abreast of requirements, and there has been no serious stoppage of telegraphy in any part of the world served by this Company. I think that that is a matter of great congratulation at an epoch such as this, when we have warlike operations in South Africa and China, in addition to the ordinary traffic of the Company. There is an addition, I am sorry to say, of £3,311 in respect of income tax, principally due to the burdens which fall upon everyone—the rise in the rate to 1s. in the pound from 8d. in the corresponding period of 1899. That is a matter we none of us particularly like, but it cannot be helped, and we have to bear our burden just as all other members of the community.

With reference to the balance-sheet, you will see that there is an additional capital expenditure of £30,000 on account of our investment in "Electra House Limited." The building is now progressing tolerably well, and it is very much to be hoped that we shall be able to occupy some portion of it, at any rate, before the end of this year. Whether our hopes will be realised or not depends upon matters of which we are not the masters—namely, upon the labour market and other matters of that kind ; but when we do take possession I think the stockholders will see that the building is a suitable one, that its situation is good, and that we shall be able to meet all the requirements of our own staff and of the Associated Companies generally in a better way than we have been able to do in this building. I hope also that we shall be able to do that at no very great increase in the expenses, because we do not propose to occupy anything like the whole of the building, and a very considerable part will be let off. We have also charged to capital expenditure an amount equal to the original cost of the old steamship "John Pender" in respect of the new cable repairing steamer, "John Pender," the difference between this sum and the total cost of the new vessel being charged against the maintenance ships' fund.

We have applied from the general reserve fund a further sum of £100,000 in respect of new cables, in accordance with the arrangement fully set forth at the last general meeting. So much for the accounts as far as I think it necessary to allude to them, although, of course, we shall be happy to answer any question which any stockholder may wish to put.

One important matter in the report, you will see, is that the tariff to South Africa has been reduced from 4s. to 3s. 6d. per word for ordinary telegrams from the 1st of this month, and I hope we may look forward to further reductions in this tariff in accordance with the arrangement between this Company, the British Government, and the Governments of Cape Colony, Natal, and others interested. The Cape Government and the Government of Natal will place a land-line at the disposal of this Company in order that Australian traffic may pass direct under the Company's control between Cape Town and Durban, where it will be in direct communication with the new cable which is to cross the ocean direct to Australia. I think I may say that, although the work we have done and are still doing in connection with the war in South Africa has resulted in a temporary increase in our revenue, we prefer very greatly to rely upon the permanent increase of traffic which we have every reason to hope will result from the development of the country after the peace which we all so much desire has been declared. The influence of an enlightened Government will then be properly felt and appreciated, and the great colonies now annexed will form one great union of States, and will develop in a way that it was hopeless to look for under the previous *régime*. You will also see from the report that the Australasian tariffs were reduced to 3s. 6d. per word on the 1st inst., so far as regards telegrams exchanged with South and Western Australia and Tasmania. The Government of New South Wales has also recently accepted the Cape-Australian Cable Agreement, so that messages exchanged with that State will be entitled to this reduction of tariff from February 1 next. The other Governments or States—as I think we should call them now—have had the benefit of the reduction for a con-

siderable time, and those Governments, owing to what I may term an enlightened view of the situation, have been able to give their people a most substantial advantage—viz., a very large money saving in telegraphic charges much earlier than either the Government of New South Wales or, of course, the other Governments that have not yet come into the arrangement. We have every hope that the Government of Victoria will come into an arrangement which has been so advantageous to the other States. Should the standard revenue with South Africa and Australia be maintained, the tariffs will be reduced in January, 1902, to 3s. a word so far as the arrangement relates to the States which accept the Cape-Australian agreement, and they will have a further reduction to 2s. 6d. per word in January, 1903. This, of course, is assuming in both instances that the standard revenue is maintained. It is not contended that this Company can afford to reduce their tariffs unless the standard revenue reaches the figures previously agreed to; but in order to enable the Company to deal expeditiously with the increase of traffic which will have to be carried so as to maintain the standard revenue at these reduced rates, arrangements have been made, as you know, to continue the new direct route between Great Britain and Cape Town to Australasia via Mauritius, Keeling Island and Perth. This is a most arduous undertaking, but it has been grappled with by this Company and the Eastern Extension Company in a vigorous manner. The cables are, I think, almost all in a very forward state of manufacture, and it is to be hoped that the whole undertaking will be completed within the current year. Of course, this entails a very large expenditure, but the Directors of both Companies think that they see their way to undertake the work without laying any undue burden on the stockholders, owing to the very strong financial position of the companies and their reserves. If it had not been for the prudence of our predecessors these reserves would not have been built up, and we should have been face to face with a problem which would have presented very much greater difficulty than it now presents. The fact that we have been able to accumulate these reserves, which now come in so usefully, not only enables us to maintain our position, but also to confer on the public important advantages. It is also to be borne in mind that when we lay these new cables we do not lay cables merely of the carrying capacity of the old cables, but of very much greater capacity, so that we are not only laying cables for the traffic which we know will come from the reductions of tariffs, but we are also providing against the possible deterioration of the other cables of the Company by laying down cables of a capacity very greatly in excess of those which we laid in former years.

Another matter which is of considerable interest is that of the tariff to India, which, as I daresay is known to many here has been a question of discussion for a great many years, and has given rise to a great deal of difficulty. I cannot say that we are as yet entirely out of the difficulty. This Company has always been most anxious not to put any difficulty in the way of reducing the tariff to India, and at the request of the Indian Government we assented last year to reduce the tariff between Europe and India to 2s. 6d. per word, with an eventual reduction, on certain conditions, to 2s. per word. But we are unfortunately not altogether free agents in this matter, because there are other companies and Governments that have to be considered. The Governments of Great Britain and India are signatories to the International Telegraph Convention of St. Petersburg, and under that Convention no tariff can be reduced without the unanimous consent of all the interested parties. The consent of the majority of the interested administrations has been obtained, and the British Government and the Indo-European Telegraph Company are still negotiating with the remainder. All that we can now say is that there will be no difficulty as regards the Eastern Telegraph Company. We have done all that we can in the matter, and we await the completion of the arrangements, which are not in our hands, but in the hands of others, to bring the business to a final issue. When these arrangements are concluded the reductions will take place to which I have referred.

The increased revenue has enabled us to meet the additional working expenses I have alluded to, the usual interest revenue charges, to pay the same dividend as formerly on the ordinary stock, and to carry an exceptionally large sum to the general reserve fund. The large amount we carry to that fund may seem somewhat startling to some who consider the subject merely from a superficial point of view; but the amount is by no means too large looking at the obligations which are upon us in connection with the laying of new cables and keeping up our communications to a proper standard of efficiency. It is most important (and I think that all the stockholders who fairly consider the question will also share this opinion) that this fund should be maintained at as high a figure as possible. I have already referred to the circumstance, and I merely repeat here that I consider that these reserve funds form the backbone to the successful administration of these telegraph companies. (Cheers.)

The adoption of the principle of granting further reductions in accordance with the operation of the standard revenue agreement imposes on us, as I have said, the necessity of being able to increase the carrying capacity of our cables without undue additions to the capital and without creating heavy permanent revenue charges. It is by means of our reserve funds that this can be carried out without pressing hardly on the stockholders' dividend, and although I have seen the question of the reserve fund of the telegraph companies—not of this particular Company, but of other companies as well—criticised, I think, from all the attention I have given to the subject, and looking at it from all points of view, that, as I have said before, it would be a very bad day for this Company if we tried to starve the reserve funds, and were not contented with the dividend which we are now able to pay. It is by no means a bad one, and it enables the stock of the Company to stand in a very good position in the money market.

Before I sit down I should like to refer to an interesting subject, although it is not a matter of great financial importance. The Board have for a long while thought that it presses somewhat hardly on private individuals who have to telegraph on social or family matters from India, Australia, or other parts of the world that they are forced in many cases—though not in all cases—to send their telegrams *in extenso*, and have therefore to pay for telegrams sums which seem very considerable, and which, no doubt, are very considerable to persons who have possibly limited means, but who are forced perhaps unexpectedly by private or family necessities to communicate telegraphically with this country. We have therefore been trying to work out a scheme by which private individuals in addition to registering an address here which they can do now, may have their messages coded at our principal offices all over the globe and decoded at our offices here, or vice versa, so that they would be placed on the same basis of payment, so far as telegraphing is concerned, as merchants and others who have the advantage of telegraphing with codes, and who have a registered address. We think if this can be worked out satisfactorily that it will be a very great benefit to the public at large, and will also remove a great deal of criticism of the rates of the Company, and irritation. It is no doubt a somewhat expensive business to send a private telegram, where you have first of all to incur a considerable expense on the address, and then to write out your telegram *in extenso*, while you also have to take steps that the telegram reaches its addressee by not sparing the number of words in the address. All these matters we think we may be able to arrange satisfactorily, so that the average rate for social messages will not be very different from the average rate for commercial messages. (Hear, hear.) We cannot say that we have precisely arrived as yet at a solution of this question—it is a matter of discussion with other parties; but I think it right to tell the stockholders that the Directors have the matter very much at heart, and if it can be worked out we wish it to be done for the benefit of the public and for the benefit of the stockholders of the Company, for I think that anything that works out for the benefit of the public generally works out for the benefit of those who hold the stock. I do not know that I have anything more to say before I submit the motion:

"*That the Report and Accounts of the Directors to September 30, 1900, submitted to this meeting, be and the same are hereby received and adopted.*"

The VICE-CHAIRMAN: I have the pleasure of seconding that.

The motion was carried unanimously.

The Most Hon. the Marquess of Tweeddale, K.T., and Sir Albert J. Leppoc Cappell, K.C.I.E., were then unanimously re-elected as Directors, and Messrs. Deloitte, Dever, Griffiths & Co. and Messrs. Walton, Jones & Co. were reappointed as Auditors.

---

An extraordinary general meeting followed at which an amendment to the Articles of Association, relating to the duties and remuneration of the Directors of the Company was proposed by the Chairman, and seconded by the Vice-Chairman, and carried unanimously.

A cordial vote of thanks to the Chairman and Directors, proposed by Mr. John Newton, was duly seconded and carried unanimously, and the proceedings terminated.

---

## Direct United States Cable Co. (Ltd.)

The forty-seventh ordinary general meeting of this Company was held on Tuesday under the presidency of Mr. E. M. UNDERDOWN, K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, before we begin the ordinary business of this meeting I do not think that it is out of place that we should put upon our records the feeling of sorrow universally entertained at the loss of Her Most Gracious Majesty the Queen; and I think that this more aptly comes from the direction and the members of a cable company than from almost any other institution coupled with the great interests of this country. In the first place our business is one of worldwide importance. It connects this country, in the first place, with the colonies through Nova Scotia, and afterwards with the United States, and, as I may say, with the whole world. Now, the whole world has felt this loss with acuteness, and has manifested its feeling with respect to that loss in a way which cannot be paralleled by anything in the whole history of this world. The telegraphs of the world have been occupied in sending messages of condolence to this country, and these have been replied to with the thanks and gratitude of King and country, and we can only trust that His Most Gracious Majesty will know how to preserve the relations of this country with the Colonies and, I trust, with the world, and that we shall enjoy in the future all those benefits that we have so long had under the rule of Her late Most Gracious Majesty. I think you will all agree with me that we should express our sorrow on this occasion, and at the same time our hopes for the prosperity of this country under the rule of Edward VII.

The SECRETARY then read the minutes of the last ordinary general meeting, and the report of the auditors, as required by the Companies Act, 1900, and the Directors' Report and Accounts having been taken as read,

The CHAIRMAN then said: It now becomes my duty to move the adoption of the report, and I will, as usual, make a few remarks upon the business of the Company during the past six months. The revenue for the half-year to the 31st ult., after deducting outpayments, amounted to £50,534, while the working and other expenses, including income tax, but excluding the cost of cable repairs, absorbed £20,827, leaving a balance of £29,707 as net profit, making, with £3,761 brought forward, a total of £33,468, which has been appropriated as follows: Interim dividend of 3s. to Sept. 30, £9,106. 10s.; the same dividend to Dec. 31, the same amount; set aside to reserve fund £10,000; carried forward £5,255. The revenue shows a reduction of £6,266 as compared with that for the corresponding period of 1899, and this you may take it has been occasioned principally, if not wholly, by the construction of other cables across the Atlantic. I can therefore say no more but state that fact, and

we can only hope that the general augmentation of traffic will give full employment to the cables, and enable us to reach something like the figures we have had the advantage of putting before you on former occasions. The expenses in London and at the stations are practically the same as in the corresponding period, showing, on the whole, the trifling reduction of £26. The only item exhibiting an appreciable increase is that arising from the income tax. This stands at £1,075, being an increase of £410, naturally owing to the higher rate of the tax; but that is a matter with which we, of course, have no power of dealing. The usual details of all the expenditure are given, as heretofore, in abstracts A and B in the accounts, and, as far as I know, they call for no special remark. The cable repairs during this period have cost £2,500. This, as usual, has been charged to the reserve fund, and, on the other hand, the reserve account has been credited with £6,730 from interest on the investments and £10,000 set aside out of revenue, bringing the balance of this fund up to £433,105. 13s. 8d. The investments have been increased during the half-year by £18,827, and they now stand at a total cost of £420,634, their present market value being about £14,000 to £15,000 in excess of that amount. This is our half-yearly meeting, and no business has to be transacted at it except the report of our progress during the half-year. It is, therefore, I think, unnecessary for me to do more than move this resolution:—

"*That the report of the Directors, dated January 15, 1901, together with the statement of accounts to December 31, 1900, annexed thereto, be and the same are hereby received and adopted.*"

Sir JAMES PENDER, Bart., seconded the motion, which was at once unanimously adopted.

Mr. JOHN NEWTON afterwards proposed, and Mr. GOODSALL seconded a vote of thanks to the Chairman and Directors, which was carried unanimously.

The CHAIRMAN briefly acknowledged the vote, and the proceedings then terminated.

## Pearson Fire Alarm System (Ltd.).

The adjourned ordinary meeting of this company was held on Wednesday, Mr. R. PEARSON presiding.

The CHAIRMAN said that in submitting the report and balance-sheet the directors did so without the slightest idea but that the shareholders would accept and pass them without much discussion. Their's was a "mother" company, the like of which he did not think had ever been placed before any body of shareholders since the first days of the gas boom. He would endeavour to prove to them that the prospects of the company were such as could be shown by no other company in the world, either at this or at any other time. These prospects were thoroughly well-defined. The company was not established to work a patent, but to exploit an absolute rent-earning system. They had for a customer every warehouse, printing works, factory, theatre, &c., in London, and he hoped to have every Government building. In the provinces every town of any size where there was a fire brigade they had numerous customers, and in every city in the world where fire insurance was conducted they had customers. He would trouble them with few figures because the Pearson Company would really be built up upon the figures of fire insurances. The British fire offices lost throughout the world last year a sum of 12 millions of money, and 90 per cent. of this money was lost after the buildings were closed for the night. (The chairman then proceeded to draw a highly-coloured picture of what would happen in the event of fire in certain parts of London, and assuming at the same time that a stiff gale was blowing and other circumstances incidental to a great conflagration were present.) He then proceeded to refer to several of the large fires that have occurred within the past decade, and informed the shareholders that one of the leading insurance men expressed the belief that if at the Cripplegate fire the Pearson system had been installed that fire would have been stopped at the floor at which it originated. He then referred to the order for millions of thermostats which the company had received, and passed over the explanation of this order to Mr. Lewis, another director. He hoped within three months to be able to tell them that the company was at work in Manchester, Liverpool, Birmingham and Leicester, where capital would be locally subscribed; and he believed that every town of any size in Great Britain would start registering local companies before the end of 1901.

Mr. GEORGE LEWIS then alluded to the contract for thermostats. They had delivered to Mr. Adams 40,000 of those on order, and had been paid for these. They were now making from 2,500 to 3,000 per day, which represented a profit of over £60 per day to the company. Doubt had been thrown upon the number of thermostats ordered under this contract. He could assure them there had been no cyphers added to the figures, and that the actual order was for 4,000,000 thermostats. He considered that when the system came thoroughly into use the number would be nearer 40,000,000 instruments than 4,000,000, even if they were required for the railway companies only.

## Waterloo and City Railway Co.

The report of the directors for the half-year ended Dec. 31 states that the capital outlay to that date was £594,791. 16s. 8d., and that a further estimated expenditure of £19,000 is provided for by the capital powers of the company. The gross receipts of the line, less Government duty, amounted to £15,481. 16s. 5d. From this the London and South Western Co. have retained £6,589. 13s. 6d. in respect of working expenses, leaving £8,892. 2s. 11d., payable by them in order to provide, under the agreement of March, 1894, for a dividend at the rate of 3 per cent. per annum on the company's ordinary and borrowed capital. This dividend will be payable on Feb. 9.

The number of passengers carried during the past six months, exclusive of season ticket holders, was 2,038,400, an increase of 268,669 over the corresponding period of 1899. Season ticket holders on Dec. 31 numbered 883, against 776 at Dec. 31, 1899. The number of passengers carried and traffic receipts for each half-year since the opening of the line is as under:—

| Half-year to | Passengers.* | Receipts.† |
|---|---|---|
| Dec. 31, 1898 | 1,442,855 | £10,888 |
| June 30, 1899 | 1,715,826 | 12,815 |
| Dec. 31, 1899 | 1,769,731 | 13,214 |
| June 30, 1900 | 1,868,737 | 14,070 |
| Dec. 31, 1900 | 2,038,400 | 15,304 |

* Exclusive of season ticket holders. † Inclusive of season tickets, but less Government duty.

## Liverpool Overhead Railway Co.

The report of the directors of this company for the half-year to Dec. 31 states that the gross revenue receipts amount to £43,964. 10s. 8d., and the working expenses to £29,187. 9s. 4d. The number of passengers carried during the half-year (including tramway passengers) was 5,655,499, compared with 4,687,862 in the half-year to June 30, 1900, 5,214,957 in the half-year to Dec. 31, 1899, and 4,475,279 in the half-year to June 30, 1899.

The tramway line to Great Crosby, completing the Waterloo-with-Seaforth and Great Crosby extension, was opened on Sept. 1, and the traffic has proved satisfactory. There has, however, been a decrease in the railway traffic compared with the corresponding period of last year, when the receipts were considerably augmented in consequence of the departure of troops for South Africa.

Interest on mortgage debenture has absorbed £3,400, leaving, with £4,452. 12s. brought forward, a balance available for dividend of £15,829. 13s. 4d. The directors now recommend dividends at the following rates (less tax), payable on and after Feb. 15: 5 per cent. per annum on the preference shares (£3,000), and 3½ per cent. per annum on the ordinary shares (£8,750), carrying forward £4,079. 13s. 4d.

**GREAT EASTERN RAILWAY CO.**—At the half-yearly meeting on Tuesday, the chairman (Lord Claud Hamilton) referred to the congestion of suburban traffic on the line at certain periods of the day, and to certain proposals for relieving this congestion. Since the last meeting in July low level tube lines worked by electricity instead of steam had come to the front, and both as regards economy of construction, quickness of transit, and the satisfaction they afforded to the public, appeared without doubt to be best suited for urban and suburban traffic. Therefore the directors had decided to abandon their high level additions, and to make instead low level tube lines, starting, say, at Ilford, and running underneath their existing roads to Liverpool-street, where, instead of forming an underground terminus they would, by means of a huge curve, enable trains to proceed to Walthamstow. Thus, when completed, there could be a continuous service of trains running backwards and forwards between Ilford, Liverpool-street, and Walthamstow, with intermediate stations at such spots as might be selected. The plans for this scheme were prepared by their engineer and submitted in July last to Sir Benjamin Baker, and the scheme as a whole received his approval. They now found that plans had been deposited for parliamentary powers to make an independent tube line from London to Walthamstow, which would be in opposition both to their existing line and to their proposed tube line, and would seriously interfere with their traffic. Of course, it might be possible for them to come to terms with the promoters of that scheme, but failing that they would be compelled to oppose the scheme.

**METROPOLITAN RAILWAY CO.**—At a meeting on Friday Col. J. J. Mellor, who presided, stated that the accounts showed very clearly that the unsatisfactory result of the working of the half-year was due to two circumstances—first, the opening of the tube railway between Shepherd's Bush and the City at a 2d. fare for the maximum distance of 6¾ miles, and, secondly, the high price of coal and other material, which had very largely increased the cost of working. They had had a reduction in the number of passengers of 2,965,842, the whole of the reduction being attributable to the competition of the tube line, and this loss in passengers represented £26,246. The new electric line was working for five months of the half-year, and they were, therefore, now in a position to judge fairly well as to the extent of the loss they were likely to sustain from it. Certain changes in the working had been made, and others were under consideration, by which they hoped—pending the advent of electric traction on the circle—to mitigate, as far as possible, the result to them of this new competition. One direction in which they might look hopefully was the advent of electric traction on the associated lines. They now felt confident that the time was not far distant when this difficult work might be commenced and accomplished; and they believed they would have no cause to regret the delay that had taken place in the application of electric working to their system. The Electric Traction Joint committee had not at present come to a decision upon the tenders which had been received, and they had not yet received the report of the engineers upon the system of working. The electrical installation would, of course, be a difficult work to accomplish, because of the enormous traffic on the Inner Circle lines, the working of which they did not want to interrupt; but they were told by the experts that it was possible to overcome all the obstacles to success, and that when the change was made the railway would be a first-class electric line, working at a less cost, and with

increased carrying capacity. Their tunnels were large, giving plenty of air space: they had numerous openings along the line which could not fail to improve the ventilation; and, further, they were near the surface, so that they would have no need to employ the costly, and not always convenient, machinery of lifts for getting to and from the trains. They had been twitted with dilatoriness in introducing electric traction. The delay would, however, enable them to take advantage of the most recent discoveries and developments in electric science, and it would also enable them to avoid some of the mistakes into which some of their neighbours had fallen. Mr. Newby inquired the cost of the new electric traction as compared with the present. Mr. Plumber referred to the depreciation in the value of the stock, and wished to be assured that the adoption of electric traction would not interfere with the interchange of traffic on the northern lines. The chairman said the cost of adopting electric traction would not be so much as the directors anticipated, and, having installed it, the cost of working and the greater rapidity with which they would move their trains would be a very considerable saving to the company.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ALLAN ELECTRICAL SYNDICATE (LTD.)**—Registered Jan. 24 with a capital of £1,000 in £1 shares, to manufacture, produce and utilise ferro-manganese or other metals, minerals or ores, and to acquire and exploit any electrical processes, machinery, &c. Mr. T. Turkstine is the first sole director.

**ANCHOR CABLE CO. (LTD.)**—Registered Dec. 31, with a capital of £60,000 in £5 shares, to carry on the business of cable makers for electrical and other purposes, wire rope makers, wire drawers, metal workers, electricians, electrical and mechanical engineers, &c.

**BOGOTA TELEPHONE CO. (LTD.)**—Registered Dec. 31 with a capital of £25,000 in £1 shares, to acquire a concession to construct and erect telephones and telephonic apparatus and communications in Bogota, Columbia, South America, and to carry on the business of telephone contractors, &c.

**CLEVELAND AND DURHAM COUNTY ELECTRIC POWER CO. (LTD.)**—Registered Dec. 31 with a capital of £25,000 in £250 shares to carry on the business of producers and suppliers of electric power for all purposes in the North Riding of Yorkshire and in the county of Durham, and the business of railway and tramway contractors, telephone and telegraph constructors, cable manufacturers, and engineers generally. The subscribers are coalowners and ironmasters in the district.

**ELECTRICAL BLEACHING CO. (LTD.)**—Registered Dec. 31, with a capital of £15,000 in £1 shares, to acquire English patents No. 20,214 (1899) and No. 14,104 (1900) for improvements in bleaching cotton yarns, and to carry on the business of bleachers, dyers, manufacturing chemists, &c.

**ELECTRIC TRAMWAYS TRUST (LTD.)**—Registered Dec. 31, with a capital of £100 in £1 shares, to carry on the business of patent owners, motor and other vehicle builders, engineers, promoters, &c.

**GEORGE JENNINGS (LTD.)**—Registered Jan. 14, with a capital of £60,000 in £1 shares (30,000 preference), to acquire the business carried on under the style of George Jennings, and to carry on the business of metal founders and workers, mechanical, electrical and general engineers, &c.

**HERNE BAY AND CANTERBURY LIGHT RAILWAY SYNDICATE (LTD.)**—Registered Dec. 28, with a capital of £2,000 in £1 shares, to adopt an agreement with Mr. R. Warner, to enter into and carry out contracts for making, purchasing, or working railways, tramways, telegraph and telegraph lines, electric and other lighting works, and for the equipment thereof with electrical plant or otherwise, and to carry on the business of contractors generally.

**HOWARD CONDUIT CO. (LTD.)**—Registered Jan. 26, with a capital of £20,000 in £1 shares (1,000 deferred), to acquire a licence to use and exercise a certain invention for improvements in and apparatus for the manufacture of pipes or conduits for electrical conductors, or for conveying liquids or gases, and to carry on the business of pipe and conduit manufacturers, electrical engineers, electricians, contractors, suppliers of electricity, &c. The subscribers are J. E. Latham (engineer), J. H. C. Brooking (engineer), E. J. Flanagan, C. K. Hamilton, A. E. Tanner (engineer), W. C. Munn, and J. B. Hyde (engineer). The first directors are H. Edmunds, W. P. J. Fawcus, A. H. Howard, and E. A. Claremont.

**KERBY BOWEN ELECTRIC SYNDICATE (LTD.)**—Registered Dec. 31, with a capital of £20,000 in £1 shares (10,000 preference), to take over the freehold yacht building and electric works on Eel Pie Island, Twickenham, to adopt an agreement with Mr. K. Bowen, and to carry on the business of ship and launch builders, engineers, electricians, electrical engineers, &c.

**PILE BLOC BATTERY CO. (LTD.)**—Registered Dec. 29, with a capital of £25,000 in £1 shares, to adopt an agreement with Messrs. T. F., H. C., and E. P. Harvey, and to carry on the business of electricians, mechanical and electrical engineers, manufacturers of and dealers in "Pile Bloc" and other batteries and electrical apparatus and appliances, motor generator, fan, transformer, switch, meter, and lamp manufacturers, &c. The subscribers are: J. G. Turney, G. Bargate, H. C. Harvey, T. F. Harvey, C.E., E. P. Harvey (electrical engineer), G. S. Hertslet, and H. W. Knott.

**PRIMITIVA GAS AND ELECTRIC LIGHTING CO. OF BUENOS AYRES (LTD.)**—Registered Jan. 25, with a capital of £1,200,000 in £5 shares (160,000 preference), to adopt an agreement between the Compañia Primitiva de Gas de Buenos Aires, and H. Ward, to acquire gas or electric light works in the River Plate and other countries in South America or elsewhere, and to carry on the business of manufacturers, generators, and suppliers of electricity, gas, and other illuminants, engineers, engine and machinery builders, gas and electric stove makers, &c.

**W. E. SOTHEBY & CO. (LTD.)**—Registered Dec. 31, with a capital of £10,000 in £1 shares (5,000 preferred and 5,000 deferred ordinary), to acquire and to carry on the business of electricians, engineers, suppliers of electric light and power, &c. The subscribers are W. E. Sotheby (electrical engineer), G. J. L. Nicholson (electrical engineer), Miss M. S. Donald, A. J. Angell, S. J. Souter-Robertson, B. Souter-Robertson (civil engineer), and Mrs. M. de Seguudo.

**TRAMWAY TROLLEY CO. (LTD.)**—Registered Dec. 31, with a capital of £100 in £1 shares, to carry on the business of auto-motor car, tramcar, waggon, van, vehicle, truck and cycle manufacturers, tramway contractors, electrical engineers, &c.

**WARATAH MINERALS CO. (LTD.)**—Registered Dec. 31, with a capital of £100,000 in £1 shares, to acquire any mines, mining rights, and other property in Tasmania, to adopt an agreement between the Oesterreichische Gasglühlicht und Electricitäts Gesellschaft, of Vienna, of the first part, the Welsbach Company, of Gloucester (N.Y., U.S.A.), Herr C. A. von Welsbach, and Mr. F. Williams for the acquisition of certain patents relating to improvements in the manufacture of electric lamps, &c., and to acquire from Mr. Williams certain osmium mines on or near the Savage River, Tasmania.

**MONTEVIDEO TELEPHONE CO. (LTD.)**—The annual return to Nov. 4, 1900, gives the capital as £160,000 in 87,000 preference and 73,000 ordinary shares of £1 each, of which 86,492 preference and 72,680 ordinary have been taken up. £159,172 is considered as paid.

## CITY NOTES.

**MEMORANDA.**—Bank rate 5 per cent. (since Jan. 3, 1901). Price of silver 27¼d. per oz. (Jan. 31). Consols (2¾ per cent.) 96¼—96⅜ for money, 96⅝—97⅛, for account; 2½ per cent. 96⅞—97⅛ (Jan. 31). Consols Pay Day Feb. 1. Stocks and Shares Continuation Days, Feb. 12 and 25; Ticket Days, Feb. 13 and 27; Pay Day, Feb. 14; Mining Share Carry-over Days, Feb. 11 and 25.

**AMAZON TELEGRAPH CO. (LTD.)**—A meeting of the holders of debentures in this company will be held at the offices, Moorgate Station-chambers, London, E.C., on Thursday next, to authorise the creation and issue of 6 per cent. debentures to an amount not exceeding £150,000.

**BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)**—In a report, dated Jan. 5, from the general manager it is stated that an unprecedented fall of snow during the previous week had given much trouble and caused heavy expense. Since Dec. 31 over 30in. of snow had fallen in Vancouver, and another snowstorm was then raging. With the exception of New Year's Day, when a fall of 18in. paralysed traffic, they had maintained the railway service, but only with all-night work with cars and snow-ploughs, and the employment of many snow shovellers. The same conditions obtained in Westminster, where 18in. of snow fell on New Year's Day.

**BRITISH ELECTRIC TRANSFORMER MANUFACTURING CO. (LTD.)**—An interim dividend for the half-year ended Dec. 31 at the rate of 10 per cent. per annum has been declared.

**CROMPTON & CO. (LTD.)**—Mr. Ivor Bevan has joined the board of this company.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1900-1 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Jan. 19 | 573 | + 47 | 33 | 23,192 | - 3,249 |
| *Birmingham Tramways | " 26 | 4,251 | + 138 | 3 | 12,060 | - 2 |
| Blackburn Corporation.. | ... | ... | ... | ... | ... | ... |
| Blackpool Corporation... | " 24 | 164 | + 28 | 43 | 28,887 | + 7,665 |
| Blackpool and Fleetwood | " 26 | 141 | - 8 | 4 | 532 | - 41 |
| Bolton Corporation ...... | " 27 | 1,226 | ... | 43 | 58,252 | ... |
| Bradford Corporation... | " 27 | 759 | + 419 | 43 | 25,593 | + 8,970 |
| Brisbane Trams ......... | Dec. 12 | 2,084 | + 268 | 23 | 43,535 | + 8,024 |
| *Bristol Trams & Carriage | Jan. 25 | 3,854 | +1,157 | 4 | 14,673 | + 3,813 |
| *Buenos Ayres & Belgrano | Dec. 30 | 3,061 | + 547 | 26 | 65,536 | + 7,196 |
| Central London Railway | Jan. 26 | 5,951 | ... | 26 | 139,946 | ... |
| City & South London Ry. | " 27 | 1,968 | + 876 | 4 | 8,022 | + 3,551 |
| Cork Elec. Trams ......... | ... | ... | ... | ... | ... | ... |
| Dover Corporation ...... | " 26 | 169 | + 18 | 43 | 9,417 | + 612 |
| Dublin & Lucan Rly. .. | " 26 | 63 | + 12 | 4 | 269 | + 56 |
| Dublin United ............ | " 25 | 3,202 | + 277 | 4 | 13,166 | + 1,490 |
| Dublin Southern Dist.... | " 25 | 654 | + 45 | 4 | 3,228 | |
| *Dundee Corporation ... | " 23 | 441 | + 77 | ... | ... | ... |
| *Glasgow Corporation ... | " 26 | 8,460 | + 127 | 4 | 38,014 | + 2,243 |
| Hull Corporation ......... | " 26 | 1,516 | + 850 | 30 | 43,006 | +23,305 |
| *Liverpool Corporation... | " 19 | 7,635 | +1,213 | 3 | 24,008 | + 3,980 |
| Liverpool Overhead Rly. | " 27 | 1,457 | - 114 | 4 | 5,994 | - 32 |
| *Sheffield Tramways ...... | " 27 | 2,753 | + 835 | 4 | 10,848 | + 3,507 |

* Partly electrical.

**ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.)**—The directors of this company have notified the shareholders that advices have been received from the company's manager in Australia that the purchase of the two Melbourne undertakings has been completed, and the company is, therefore, now in full possession of these properties and their revenue.

**ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.)**—A meeting of the holders of the consolidated debentures of this company will be held on 13th inst. to consider a resolution that the trustees be authorised to concur with the company in the grant of a lease of all its property in Madrid to the Compania General Madrileña de Electricidad on the terms and conditions contained in the draft lease to be submitted at the meeting.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange Committee have ordered the further issue of £177,951 sterling 4 per cent. 600-year debenture stock of the *Commercial Cable Co.*, 10,000 £10 fully-paid shares of the *City and South London Railway Co.*, and 400,000 £1 fully-paid shares, 140,000 5 per cent. mortgage debentures and £3,156 6 per cent. mortgage debentures of the *Cape Electric Tramways (Ltd.)* to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in, and to grant a quotation to 19,900 £5 fully-paid 6 per cent. cumulative preference shares of the *Electric and General Investment Co. (Ltd.)*.

**NATIONAL TELEPHONE CO. (LTD.)**—After paying a dividend of 6 per cent. (less tax) on the first and second preference shares, a distribution of 5 per cent. per annum (less tax) for the half-year is announced on the third preference and on the ordinary shares, £85,000 being placed to reserve and about £6,000 carried forward. At the corresponding period last year the dividend on the ordinary was at the rate of 6 per cent., £80,000 was placed to reserve, and £6,199 carried forward. The transfer books will be closed from the 8th to the 21st inst. inclusive.

**NEW ZEALAND ELECTRIC LIGHTING AND TRACTION CO. LTD.**—The directors have, it is announced, declared a dividend of 60 per cent. for the year 1900.

**WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)**—The directors recommend a dividend for the half-year ended Dec. 31 at the rate of 11 per cent.

**WIGAN AND DISTRICT TRAMWAYS CO.**—The directors' report states that negotiations are pending with the local authorities for the extension of the lease and conversion of the tramways to electric traction. The local authorities outside Wigan have the right to purchase the lines within their areas, and are contemplating the exercise of those powers.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Jan. 23. | | Price Wednesday, Jan. 31. | | Rate per Cent. Yielded | Dividend Due. | Business Done During Eight Days Ending Jan. 30. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'kh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd. | ½ | ½ | ½ | ½ | ... | ... | ... | ... |
| £[illegible] | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red.) and cer. | 73 | 75 | 73 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13½ | 12½ | 13½ | 3 14 1 | ... | 13½ | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | 4 7 5 | ... | ... | ... |
| 19,881 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9¼ | 8¾ | 9¼ | 3 18 9 | March and September | ... | ... |
| 20,000 | 5 | 1/0 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | ... | ... |
| 40,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 3 1 | February and August | 9½ | ... |
| 150,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 3 18 3 | " " | ... | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,679 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9 | 8½ | 9½ | 4 4 3 | February and August | ... | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 123 | 127 | 123 | 127 | 3 18 9 | June and December | ... | ... |
| £[illegible] | Stock | ... | Do. 4½ Deb. Stock Certs. (60% pd.) (red.) | 61 | 63 | 61 | 63 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9¼ | 8½ | 9¼ | 6 6 4 | ... | 9½ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | 108½ | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | 5¾ | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 12 | 13 | 12½ | 13½ | 4 11 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 5 7 | January and July | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 40,840 | 5 | 5/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 99 | 101 | 99 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 65,000 | 10 | 8/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 4 5 | April and October | 12½ | 12½ |
| £720,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 6 | June and December | 111 | 111½ |
| £260,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 90 | 93 | 90 | 93 | 3 10 8 | ... | 92½ | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 10 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6¾ | 6½ | 6¾ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 13 6 9 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 78 | 80 | 78 | 80 | 6 5 0 | January and July | ... | ... |
| 15,000 | $100 | $8 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 180 | 4 5 11 | April and October | ... | ... |
| £115,800 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 45,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 15 | 16 | 15 | 16 | 4 13 [illegible] | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9¼ | 8½ | 9¼ | 3 13 5 | " " | ... | ... |
| £150,000 | Stock | [illegible] | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 90 | 90 | 90 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 3½ | 2½ |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12½ | 13½ | 12½ | 13½ | 4 16 4 | March and September | 13 | 13⅛ |
| 29,618 | 5 | ... | Do. Do. | 12 | 13 | 12 | 13 | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 16,000 | 10 | 6/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £167,500 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 10¾ | 10½ | 10¾ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 19,800 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 6[illegible],000 | 10 | 6/0 | British Elec. Trac. Ord. | 12½ | 13½ | 13 | 14 | 6 1 5 | ... | 11½ | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11½ | 12½ | 12 | 13 | 4 14 4 | February and August | 12⅞ | 12½ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 120½ | ... |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 4¾ | 4½ | 5¼ | 5 14 3 | ... | ... | ... |
| 37,500 | 5 | ... | Do. "B" | 4½ | 4¾ | 4½ | 4¾ | ... | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 5 | ... | 104 | ... |
| £130,000 | Stock | 5 | Do. 5% 2nd Deb. Stck Prov. Certs. (all pd.) | 95 | 98 | 95 | 98 | 5 1 11 | ... | ... | ... |
| 206,297 | 10 | 3/0 | Central London Ordinary | 8½ | 9 | 8½ | 9 | 3 6 8 | June and December | 9½ | 8¾ |
| £556,000 | Stock | 1¼% | City and South London Railway Con. Ordinary | 62 | 66 | 60 | 64 | 2 10 11 | February and August | 64 | 60 |
| 37,500 | 10 | 1½% | Do. Ordinary (Nos. 22,501 to 60,000) | 4½ | 5½ | 4½ | 5½ | 3 11 9 | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1898) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £241,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 115 | 120 | 116 | 120 | 3 16 11 | May and November | 116 | ... |
| 60,30[illegible] | 10 | ... | Dublin United Tramways (1896) Ltd., Ordinary | 17 | 18 | 15 | 18 | ... | ... | ... | ... |
| 59,98[illegible] | 10 | ... | Do. 5 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 24,800 | 10 | 7½% | Imperial Tramways Ordinary | 22½ | 23½ | 22½ | 23½ | 3 12 9 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 18 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 15 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8½ | 8¾ | 8½ | 8¾ | 4 14 2 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13½ | 13¾ | 13½ | 13¾ | 3 14 1 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 16 10 | January and July | ... | ... |
| $350,000 | $1,000 | ... | London Street Ry. (Ont.) 5% Mort. 30 Years (red.) | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| £[illegible],744 | Stock | [illegible] | [illegible] | 61 | 64 | 62 | 64 | ... | ... | ... | ... |
| £[illegible] | 100 | 5% | Montreal Str't R'lw'y Sterling 5% Mort. Debs. (1908) | 103 | 108 | 103 | 105 | 4 16 9 | ... | ... | ... |
| £140,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 6 0 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11 | 12 | 11½ | 12½ | ... | ... | 12½ | 12 |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | [illegible] | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 104 | 106 | 4 3 9 | ... | ... | ... |
| £[illegible]49,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 1 9 | June and December | 94 | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Divi-dend. | Name. | Previous Week's Price, Jan. 23. | | Price Wednesday, Jan. 30. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Eight Days Ending Jan. 30. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | Highest | Lowest |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 101 | 99 | 103 | 3 18 5 | January and July | ... | ... |
| 26,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 90 | 78 | 83 | 6 17 2 | ... | ... | ... |
| £517,720 | Stock | 15/0 | Anglo-American | 51 | 54 | 51 | 54 | 6 15 3 | Feb., May, Aug., Nov. | 51½ | ... |
| £3,068,640 | Stock | 30/0 | Do. Preferred | 96 | 98 | 94 | 98 | 6 4 4 | " " | 97½ | 93½ |
| £3,068,640 | Stock | 27/0 | Do. Deferred | 8½ | 9½ | 8½ | 8½ | 15 6 7 | " " | 8¾ | 8½ |
| 13,333,300 | $100 | 6¾ | Commercial Cable Capital Stock | 170 | 180 | 170 | 180 | 4 5 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,030 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 16 11 | " " | 103½ | 102¾ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7 | 8 | 7½ | 8½ | 6 9 5 | February and August | 8½ | 8 |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | " " | 16½ | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 | 10½ | 10 | 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10 5/16 | 10 3/16 |
| £109,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 to 1,200) (red.) | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 137 | 142 | 139 | 141 | 4 17 11 | Jan., Apr., July, Oct. | 141 | 137½ |
| £1,826,486 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 94 | 95 | 94 | 3 11 5 | " " | ... | ... |
| £1,482,300 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 109 | 113 | 109 | 112 | 3 11 5 | May and November | 111 | 111 |
| 250,000 | 10 | 2/6 | Eastern Extension | 14 | 14½ | 14 | 14½ | 6 16 7 | Jan., Apr., July, Oct. | 14½ | 14 |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £5pd, is'd at £3pm, all pd | 11½ | 12 | 11½ | 12½ | ... | ... | 11½ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 113 | 117 | 112 | 117 | 3 9 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 100 | 103 | 101 | 101 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 99% | 103% | 100% | 103% | 3 19 5 | May and November | 91 | ... |
| 180,237 | 10 | 1/0 | Globe Telegraph and Trust | 10½ | 10½ | 10½ | 10½ | 4 17 8 | Jan., Apr., July, Oct. | 10 5/16 | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 16½ | 15 | 15½ | 3 17 5 | " " | 15½ | 15 5/16 |
| 140,000 | 10 | 5/0 | Great Northern of Copenhagen | 32 | 34 | 32 | 34 | 3 13 6 | January and July | 33½ | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos. 1 to 1,200) (red. | 99 | 102 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 47 | 51 | 47 | 51 | 4 14 0 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1934 | 104 | 107 | 104 | 107 | 5 18 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 19 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 124 | 129 | 4 14 0 | " " | ... | ... |
| 15,609 | 10 | ... | West African Telegraph | 2½ | 3½ | 2½ | 3½ | 4 9 2 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 102 | 99 | 102 | 4 19 5 | March and September | ... | ... |
| 30,000 | 3½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | ... |
| 66,331 | 10 | 6d. | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | 1½ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | 6 5/16 | 6½ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 9 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 307,980 | 10 | 3/0 | Western Telegraph (late Brazil'n S'bm'rine) | 13½ | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14½ | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £944,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | 3½ | ... |
| 324,860 | 10/0 | 3% | Consolidated Telephone Con. and Manfg. | 3/9 | 4/9 | 3/6 | 4/3 | 0 13 4 | April and October | ... | ... |
| 72,880 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 0 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 3/0 | National | 4½ | 4½ | 4½ | 4½ | 3 13 4 | February and August | 4½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 | 14 | 13 | 14 | 4 5 9 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 12 | 11 | 12 | 4 12 4 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | " " | 4½ | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 94 | 97 | 94 | 97 | 3 13 2 | June and December | 96½ | 95 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 4 0 2 | ... | 99½ | 98½ |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5½ | 4½ | 5½ | 6 13 4 | July | ... | ... |
| 16,489 | 5 | 2/6 | Do. 5% Cumulative Pref. (Nos. 1 to 16,633) | 4½ | 5½ | 4½ | 5½ | 4 16 3 | June and December | ... | ... |
| 93,301 | 5 | 1/3½ | Do. do. (Nos. 16,640 to 40,000) | 4½ | 5½ | 4½ | 5½ | ... | ... | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 102 | 105 | 103 | 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 8d. | Alliance Electrical Co. 5% Cum. Pref. | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 149,000 | 1 | 1¼d. | Aron Electricity Meter 6% Cum. Pref. | 1½ | 1¾ | 1½ | 1¾ | 7 3 3 | March and September | 1½ | ... |
| 65,000 | 1 | ... | British Electric Works Co. Ordinary | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 95 | 97 | 95 | 97 | 4 7 8 | ... | ... | ... |
| 73,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ | 11½ | 10½ | 11½ | 8 13 11 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 4 19 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 4½ | 4½ | 4½ | 6 6 4 | ... | ... | ... |
| 90,060 | 3 | 1/3½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 9 4 | September | 1 11/16 | 1½ |
| 16,731 | 3 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 6 6 8 | " | 2 5/16 | 2 |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 105 | 110 | 106 | 111 | 4 3 4 | March and September | ... | ... |
| £135,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 5 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 13 | 14 | 13 | 14 | 5 7 2 | " " | 13½ | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | " " | 5 5/16 | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 112 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | 1 5/16 | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 97 | 100 | 97 | 100 | 4 10 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1½ | ¾ | 1½ | 6 6 6 | ... | ... | ... |
| 81,000 | 3 | 2/4½ | Crompton and Co. (Nos. 1 to 33,098) | 3½ | 4 | 3½ | 4 | 5 12 4 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 15 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 84 | 90 | 88 | 90 | 4 8 11 | June and December | ... | ... |
| £100,000 | Stock | 27/4½ | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 98 | 100 | 98 | 100 | ... | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 8 10 0 | Half-yearly | 4½ | ... |
| £76,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 101 | 103 | 102 | 104 | 4 6 7 | ... | 104 | ... |
| 112,100 | 2 | 1/3½ | Electric Construction Co. (Limited) | 1½ | 2½ | 1½ | 2½ | 5 13 9 | January and July | 2 | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 119,000 | 1 | ... | Giffre Electro Chemical and Power Co. Ord. | ½ | | ½ | | ... | ... | ... | ... |
| 80,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ | 14½ | 13½ | 14½ | 5 8 6 | February and August | 14 | 13½ |
| 80,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | 5½ | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 | 112 | 108 | 112 | 4 0 4 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ | 21½ | 20½ | 21½ | 4 13 0 | " " | 21 | 20½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 9 | March and September | 101 | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | 38 | 42 | 38 | 42 | 4 5 9 | March and July | 39 | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 103 | 101 | 104 | 3 17 0 | January and July | ... | ... |
| 15,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 6 19 2 | ... | 10½ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | 5½ | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 1 9 | " " | 7½ | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 0 | May and November | 105½ | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

c

# BELLISS & MORCOM LTD.

(SUCCESSORS TO G. E. BELLISS & CO., LTD.),

LONDON OFFICE: 9, Victoria Street, S.W. **ENGINEERS,** BIRMINGHAM.

## SPECIALITY: PATENT SELF-LUBRICATING QUICK-REVOLUTION ENGINES FOR ELECTRIC LIGHT, POWER OR TRACTION.

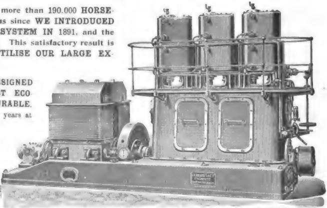
Over 1,400 **SETS**, equal to more than 190,000 **HORSE-POWER**, have been built by us since WE INTRODUCED THIS SELF-LUBRICATING SYSTEM IN 1891, and the demand is rapidly increasing. This satisfactory result is due to the care taken to UTILISE OUR LARGE EXPERIENCE.

Our Engines are **SIMPLY DESIGNED** and **STRONGLY BUILT, MOST ECONOMICAL, EFFICIENT** and **DURABLE**. They run **WITHOUT WEAR** for years at full load.

QUICKER DELIVERY CAN BE GIVEN OF STANDARD SIZES.

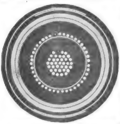
**Established 1852.**

Telegraphic Address:
"BELLISS, BIRMINGHAM."



Representing our TEC/5 STANDARD ENGINE, 450 B.H.P.—*OVER 30 IN USE OF THIS SIZE ALONE.*

---



# SOCIÉTÉ D'EXPLOITATION DES CÂBLES ÉLECTRIQUES

(SYSTEM BERTHOUD, BOREL and CO.)

**CORTAILLOD, SWITZERLAND.**

## PATENTED LEAD-COVERED CABLES

MANUFACTURED FOR

**TELEPHONE, TELEGRAPH, ELECTRIC LIGHT.**

Special highly-insulated **CABLES** for High-Tension Alternate Currents,
As used at Vienna, Insbruck, Lucerne, Vevey, Montreux, Cologne, Monaco, &c.

---

# AYRTON-MATHER ELECTROSTATIC VOLTMETERS

*For Direct or Alternating Currents of any Frequency.*

**Latest Improved Pattern.**

**9" DIAL** (usual size) Price **£10.**

**FOR 1,000, 2,000 and 5,500 VOLT CIRCUITS.**

ACCURACY GUARANTEED.

## NALDER BROTHERS & THOMPSON, Ltd.

(Managing Directors: F. H. NALDER and E. THOMPSON),

**34, Queen Street, LONDON, E.C.**

*Telegrams:—"OCCLUDE LONDON."* *Telephone No. 124 BANK*

## SALES BY AUCTION.

**PRELIMINARY NOTICE.**

WHEATLEY KIRK, PRICE & Co., have received instructions to SELL BY PUBLIC AUCTION, in the Lots of the Catalogue, at an early date (unless previously disposed of by Private Treaty) the modern high-class

**PLANT, MACHINERY, STOCK AND STORES**

of a well-known Firm of Manufacturing Electrical Engineers in London.

Catalogues and further information may be obtained shortly on application to the AUCTIONEERS, 46, Watling street, E.C., or Albert-square, Manchester. Telephone: 5077 Bank. Telegrams: "Indices London."

---

65, SOUTH AUDLEY STREET, LONDON, W.

MESSRS. PERCY HUDDLESTON & CO.,
In conjunction with
MESSRS. NORMAN & BOWEN have received instructions to SELL BY AUCTION on the Premises as above, on TUESDAY and WEDNESDAY, February 12th and 13th, 1901, and the FIXTURES and FITTINGS on WEDNESDAY, 20th February, 1901, at 1 o'clock precisely, the

VALUABLE STOCK and PLANT of
an

**ELECTRICAL ENGINEER AND LAMP MANUFACTURER.**

Comprising: Brass, Wrought Iron and Copper Electroliers, Pendants, Standards and Brackets, also 20 Chloride Accumulators in Lead Lined Boxes, 20 Arc Lamps, 3,000 Incandescent Lamps, large quantity of Cable and Wire, Resistances, Switches, Holders, Ceiling Roses, Cut-outs, Voltmeters and Ammeters, and a

**10in. RHUMKORFF COIL.**

with Tubes and various accessories, also 4½in. Centre Lathe with Compound Rest, Tools, &c.; also Massive Wrought Iron and Brass Gasaliers and Chandeliers, Brass and Wrought Iron Candlesticks, Fairy Lamp Holders, Lanterns, Hall Lamps, Standard and Table Lamps, Brackets, &c., Table Ornaments, Plated and China Colza Lamps, and Candelabras, Girondoles and Wall Mirrors, 20 pairs Ormolu Candelabras, and numerous other effects.

On view day previous and mornings of Sale, and Catalogues may be had of the Auctioneers, PERCY HUDDLESTON & CO., Electrical and Mechanical Auctioneers and Valuers, 77, Finsbury Pavement, London, E.C.; Telephone 585 London Wall. Telegrams, "Sultanship, London," and NORMAN & BOWEN, Auctioneers and Valuers, 62a, Aldersgate-street, London, E.C.; and on the Premises.

---

SECOND AND CLEARANCE SALE.—THE CENTRAL LONDON RAILWAY.

**TO ELECTRIC RAILWAY AND OTHER CONTRACTORS, MINING AND PUMPING ENGINEERS, ELECTRICIANS, BUILDERS, &c.**

MESSRS. HORNE and Co., are instructed by the Electric Traction Company (Limited) to SELL, by AUCTION, on the Premises, Wood-lane, Shepherd's Bush, on TUESDAY, February 26, and following days, at twelve o'clock precisely each day.

The Remainder of the MACHINERY and PLANT recently used in the construction of the Central London Railway, and including one 21ft. and two 12ft. 5in. shields, the larger with valves, piping and erectors, and the smaller with piping only, air-driven hydraulic pump for 12ft. 5in. shield, by Hayward, Tyler, & Co., hydraulic intensifier, 5 H.P. hydraulic driven air pump, 2-ton and 14-ton hydraulic hoists to lift 8ft. and 7ft. respectively, all by Hydraulic Engineering Company, five W.I. air locks, from 4ft. 6in. by 12ft. 6in. to 7ft. by 17ft., six Brotherhood air compressors to compress 500 cubic ft. free air per minute, one Sloe ditto for 250 cubic ft. per minute, 3,000ft. 4in. to 6in. Albion-jointed air pipe, 1½in., 3in., and 5in. hydraulic pressure piping, 20 tons bolts, 12 mining telephones, 60 tons of 20lb. to 60lb. contractors' rails, 12 sets points and crossings, 500 sleepers, 5-ton steam travelling crane, by Smith (of Rodley), 100 tons C.I. segments, 18 spring ballast trucks, 47 trolleys, various, on 1½in. to 4in. axles, 10 contractors tip waggons, five 3ft. to 6ft. Blackman fans, 15 2½in. to 9in. Chapman valves, two 4in. back pressure valves, five 2in. relief valves, numerous cocks and fittings, 3in. pulsometer pump, 3in. and 5in. steam separators, 100 Kilowatt 500-volt generating plant, consisting of 40 N.H.P. semi-portable boiler by Davy, Paxman & Co., with Worthington pump, 150 H.P. engine by Willans and Robinson, driving 4-pole 100 kilowatt dynamo, switchboard and fittings complete, four 5 H.P. and two 10 H.P. Westinghouse motors, four tons of cable, three hand drilling machines, six portable forges, and the contents of electric stores, also a quantity of contractors', builders', and decorators' plant, including two friction hoists by Marshall, Sons & Co., 20 ½, ¾, and 1 yard iron skips, sets of 25 and 10-ton tackle, blocks, falls, chains, single and double purchase crabs, Tangye's hoists, 3in. centrifugal pump, jubilee rails and sleepers, 2 ton "Pooley's" platform weighing machine, two W.I. box girders, five and seven tons, 23ft. and 25ft. long T and L iron, 50 Wells' lights, five tar boilers, 500 scaffold poles, 2,000 boards, 600 putlogs, 100 doz. cords, two ton rope falls, 12 contractors offices, 40 ladders, 40 tarpaulins, 30 pair painters' trestles, rainwater pipes, sieves, pails, pans, corrugated iron, and a large assortment of effects.

May be viewed one week previous to the sale, or by order. Catalogues (when ready) may be obtained of Messrs. Horne & Co., 8, Delahay-street, Westminster, and 85, Gresham-street, E.C.

## TENDERS INVITED.

BOROUGH OF TAUNTON.

ELECTRICITY SUPPLY EXTENSIONS.
CONTRACT No. 4.
**TRAMWAY PLANT.**

The Corporation of Taunton invite TENDERS for the CONSTRUCTION, SUPPLY, and ERECTION, of

TWO 100-KILOWATT TRAMWAY GENERATORS.
ONE ENGINE.
TRAMWAY SWITCHBOARD and CONNECTIONS.

Specifications and Forms of Tender may be obtained on and after Friday next, the 8th inst., at the Municipal Buildings, Taunton, on payment of a fee of Three Guineas, which sum will be returned on receipt of a bona-fide Tender. A copy of the specification may also be seen (but not obtained) at the offices of the Consulting Engineers, Messrs. Kincaid, Waller & Manville, 29, Great George-street, Westminster.

The Corporation do not bind themselves to accept the lowest or any Tender, and the Contractor whose Tender is accepted shall enter into a formal agreement under seal, with sufficient sureties, for the due fulfilment of his Contract.

Sealed Tenders, endorsed "Electricity Supply Extensions, Contract No. 4," must be delivered to me at or before 2 p.m. on MONDAY, the 25th day of February, 1901.

By order,
G. H. KITE, Town Clerk.

Municipal Buildings, Taunton, February, 1901.

---

COUNTY BOROUGH OF BRIGHTON.

**ELECTRIC LIGHTING.**

NOTICE is Hereby Given that the Council of the said County Borough will receive TENDERS from such persons as may be willing to enter into a Contract for the SUPPLY, DELIVERY, and ERECTION of CONTINUOUS-CURRENT ARC LAMPS and ACCESSORIES for street lighting.

The Specifications and Forms of Tender may be obtained at my office at the Town Hall, Brighton, on payment of the sum of One Guinea, which will be refunded on return of the Specifications, &c., accompanied by a bona fide Tender.

Sealed Tenders, addressed to me and endorsed "Tender for Arc Lamps," must be left at my office at the Town Hall before 10 o'clock in the forenoon on MONDAY, the 25th day of FEBRUARY, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

F. J. TILLSTONE, Town Clerk.

Town Hall, Brighton, 4th February, 1901.

---

CLYDE NAVIGATION.

TO CRANE MAKERS AND ELECTRICAL ENGINEERS.

**THREE-TON ELECTRIC WHARF CRANE.**

The Trustees of the Clyde Navigation invite TENDERS for a THREE-TON ELECTRIC WHARF CRANE for Prince's Dock.

Copies of the General Specification, with Form of Tender, are to be had at this office from Mr Geo. H. Baxter, the Mechanical Engineer, or the undersigned, on payment of £1 1s., which will be refunded on receipt of a Tender.

Sealed Tenders, marked "Tender for Electric Crane," to be lodged with the undersigned not later than MONDAY, 11th March, at noon.

The Trustees may not accept the lowest or any Tender.

T. R. MACKENZIE, General Manager and Secretary.

16, Robertson-street, Glasgow,
4th February, 1901.

## TENDERS INVITED—*continued.*

### LONG EATON URBAN DISTRICT COUNCIL.

The above Council are prepared to receive TENDERS for the following Works in connection with their Electricity Supply Station, namely:

CONTRACT (A).—PRODUCERS, GAS ENGINES, DYNAMOS and SWITCHBOARD.

CONTRACT (B).—FEEDER and DISTRIBUTION CABLES, and CONVERSION of STREET LAMPS.

Copies of Specification and Conditions may be obtained at the office of the undersigned on deposit of Two Guineas for each Contract, which will be refunded on return of all documents and the receipt of a bona-fide Tender.

Sealed Tenders, properly endorsed, to be delivered at these offices not later than noon on MONDAY, 18th February, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

FRANK WORRALL, Assoc.M.Inst.C.E., District Engineer.

Council Offices, Long Eaton, 22nd January, 1901.

### METROPOLITAN BOROUGH OF BERMONDSEY.

PARISH OF ST. MARY MAGDALEN.

**DUST DESTRUCTOR AND ELECTRICITY SUPPLY.**

CONTRACT No. 8.

The Council of the above Borough invite TENDERS for the following:—

CONTRACT No. 8.

The CONSTRUCTION, SUPPLY, and ERECTION of
(Section "A"), MAIN SWITCHBOARD and INSTRUMENTS.
(Section "B"), BATTERY of ACCUMULATORS and ACCESSORIES.

Specifications and Forms of Tender can be obtained on and after the 7th inst. at the Town Hall, Spa-road, Bermondsey, on payment of a fee of Three Guineas, which will be returned on receipt of a bona-fide tender. Specifications may also be inspected (but not obtained) at the Offices of the Engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W. The Contractor will be required to pay not less than the minimum standard rate of wages for the time being in each trade during the continuance of the contract, and to pay all labourers a minimum rate of wages of not less than sixpence per hour.

The Council do not bind themselves to accept the lowest or any tender, and the Contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the due performance of his Contract.

Sealed tenders, endorsed "Tender for Contract No. 8, Section 'A' or Section 'B,'" as the case may be, must be forwarded to me at or before noon on the 25th day of February, 1901.

FREDK. RYALL, Town Clerk.

Town Hall, Spa-road, Bermondsey,
February 6th, 1901.

### THE FFALDAU COLLIERIES COMPANY, Limited,

Cardiff, require PLANS, SPECIFICATIONS, and ESTIMATES OF COST of providing SECONDARY HAULAGE by ELECTRICITY from their working faces to the end of their rope haulage, the latter being operated by steam engines near the shaft.

As electric haulage has not yet been successfully applied in South Wales, the Company would require guarantees that the plant will be efficient, absolutely safe from danger of explosion in a gaseous atmosphere, and considerably cheaper than haulage by compressed air.

The collieries are at Pontycymmer, near Bridgend, South Wales, and can be inspected by intending tenderers.

For further information write the Company, Cardiff.

## PLANT, &c., FOR SALE.

### CITY OF ABERDEEN—ELECTRICITY WORKS.

**FOR SALE.** The Electric Lighting Committee are prepared to receive OFFERS for **TWO DIRECT-COUPLED CONTINUOUS-CURRENT WILLANS-ELWELL-PARKER SETS** which they have for disposal. Engines 38 H.P., Dynamos 25kw. (170 amperes at 135 volts), together with spare armature to fit either machine and some engine spare parts.

Particulars, photo, and Form of Tender, can be obtained on application to the undersigned. Sealed Tenders endorsed "Tender for Plant," and addressed to the Engineer, to be delivered at or before noon on FRIDAY the 1st March.

The Corporation do not bind themselves to accept any Tender.

J. ALEX. BELL, City Electrical Engineer.

Cotton-street, Aberdeen.

### THE BLACKBURN CORPORATION are open to receive

OFFERS for two **WILLANS-SIEMENS 45 KILOWATT CONTINUOUS CURRENT DIRECT-COUPLED STEAM DYNAMOS,** voltage 110 to 150, steam pressure 120lbs, together with one spare armature, crank shaft, and other spare engine parts. The plant is in good working order, and is being disposed of to make room for larger units.

Tenders, addressed to the Chairman of the Electricity Committee, endorsed "Sale of Steam Sets," to be delivered at the Town Hall, Blackburn, on or before the 22nd February.

The Corporation do not bind themselves to accept the highest or any tender.

The plant may be inspected by appointment with the undersigned at the Electricity Works, Jubilee-street.

ALFRED S. GILES, Borough Electrical Engineer.

February 5th, 1901.

## PLANT &c., FOR SALE—*continued.*

### GREAT EASTERN RAILWAY.

**FOR SALE.**

**STEAM CRANES, HAND-POWER CRANES, BOILERS, DONKEY PUMP, ENGINES, DYNAMOS, ARC LAMPS AND OLD COPPER, &c.**

The Great Eastern Railway Company are substituting Hydraulic Machinery at their Parkeston Quay in place of steam and installing a new Electric Light Plant, and are therefore prepared to receive TENDERS for the PURCHASE of the whole or any part of the existing STEAM and HAND-POWER CRANES, &c., and also for the present ELECTRIC LIGHT INSTALLATION.

The whole Plant can be seen at work at Parkeston Quay on or before the 6th proximo, when the new machinery will be brought into use, after that the existing Plant, which will not be in use, can be further inspected and possession had as soon as the new Plant is working satisfactorily.

Forms of Tender, with list of articles for disposal, can be obtained from the undersigned, and any further particulars required will be supplied by the Engineer at this Station.

Tenders to be addressed to the undersigned, and to be received not later than 10 a.m. on MONDAY, March 4th, 1901.

The Directors do not bind themselves to accept the highest or any Tender.

W. H. PEPPERCORNE, Secretary.

Secretary's Office,
Liverpool-street Station, London, E.C.

---

FOR SALE.—FOUR SETS of VERTICAL MARINE TYPE TRIPLE EXPANSION ENGINES of the Highest Class.

Two Sets with Cylinders, 22in. by 33in. by 49in., 21in. stroke.

Two Sets with Cylinders, 22in. by 34in. by 51in., 21in. stroke.

These Engines are fitted with Copper and Brass surface condensers, air and circulating pumps, and will indicate about 1,800 H.P., with a boiler pressure of 155lbs. per square inch, and running at a speed of 250 revolutions per minute.

They have done very little work, are exceedingly well finished, and are practically equal to new. They are of modern type and very economical in steam consumption, and are splendidly adapted for marine purposes or stationary work, mill driving or large power installations. They were built for the British Admiralty by the Naval Construction and Armaments Co., Barrow, and at the Government Dockyards, Sheerness. These engines will be disposed of for immediate sale at extremely low prices.

For further particulars apply to WAKE and CARR, Darlington, or THOS. W. WARD, Sheffield.

---

FOR SALE.—EIGHT LARGE LOCOMOTIVE TYPE STEEL BOILERS, built for the British Admiralty, for a working pressure of 150lbs. per square inch. These boilers have been indicating up to 500 H.P. each. There are from 302 to 430 tubes in each boiler. Length overall about 16ft., diameter of barrels about 7ft. Grate area 190 square feet. These boilers are in splendid condition. Will sell together or separately, and for immediate sale, very low prices will be accepted.—Apply to WAKE and CARR, Darlington, or THOS. W. WARD, Sheffield.

## APPOINTMENTS VACANT.

### DUNDEE GAS COMMISSIONERS.

CORPORATION LIGHTING and TRACTION STATION.

VACANCY for **SHIFT ENGINEER**, commencing salary £2 5s. per week. Applicants must have had thorough theoretical training, also experience in Continuous-current Three-wire Generating Station, and be capable of taking charge of a shift and keeping all Station records, &c.

Applications, stating age, past experience and qualifications, together with copies of testimonials, to be sent to the undersigned not later than WEDNESDAY, February 20th, 1901.

WALTER H. TITTENSOR, City Electrical Engineer.

Dudhope Crescent-road, Dundee.

---

**OUTSIDE MANAGER AND ENGINEER.**

AN OUTSIDE MANAGER AND ENGINEER is required for a large power-distribution system in the North of England, supplying three-phase high-tension current.

The duties will comprise the general supervision of all construction work outside the Power House, consisting of the erection of sub-stations, the laying of cables, and the installation of motors in manufacturers' works, together with all correspondence incidental thereto.

Liberal salary and excellent prospects offered.

Applications, stating age, experience and salary required, to be sent to O. S. E., *Electrician* Office, Salisbury-court, Fleet-street, London.

---

WANTED, CHARGE ELECTRICIANS and SWITCHBOARD ATTENDANTS for large Electric Tramway Installations.

Charge Electricians and Switchboard Attendants are required in connection with extra high-tension power station and substations operating Corporation Electric Tramways. Previous experience with high-tension currents essential.

Applications, giving details as to age, previous experience, and present salary, to be sent to C. S. A. 1,701, *Electrician* Office, Salisbury-court Fleet-street London not later than FEBRUARY 11th, 1901

---

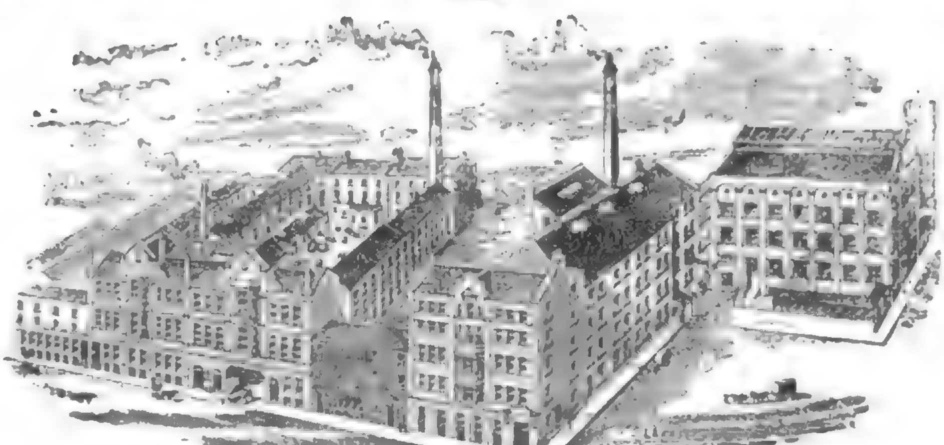
**J. W. BARNARD,**
Offices: 4, GREAT WINCHESTER ST., E.C.
Warehouse: 6, Great Winchester St., E.C.
(*For Recharging and Repairs.*)
SOLE AGENT for
E.P.S. SMALL STORAGE BATTERIES
FOR Sale or Hire,
MANUFACTURED BY THE
ELECTRICAL POWER STORAGE CO., Ld.,
Battery Makers by appointment to H.M. the QUEEN.

---

**VULCANISED INDIARUBBER**

# Electric Light Cables.

Supplied to Corporations, Electric Lighting Companies,



Engineers and Contractors.

GREENGATE RUBBER AND CABLE WORKS, SALFORD.

# I. FRANKENBURG, LTD, MANCHESTER.

**LONDON OFFICE:**
**128a, Queen Victoria St., E.C.**

**GLASGOW: Messrs. J. & A. ANDERSON, 62, Robertson St.,** Agents for Scotland.

**Large Stock. Prompt Delivery.**

Digitized by Google

## CHEAP PREPAID ADVERTISEMENTS

*relating to* **SITUATIONS VACANT AND WANTED, MISCELLANEOUS PLANT WANTED, FOR SALE, AND FOR EXCHANGE,** *are inserted in* "THE ELECTRICIAN" *at the following special low rates:*

| | |
|---|---|
| *Three Lines and under* ... ... ... | **1s. 6d.** |
| *Per Line after* ... ... ... ... | **6d.** |

Nine Words to the Line.

## SITUATIONS VACANT AND WANTED, &c.

MANAGER WANTED with good technical and commercial experience for an incandescent electric lamp business. Knowledge of German an advantage but not essential. Salary from £[illegible] to £500, according to qualifications. Address N. P., care of Fielding's, 43, Old Queen-street, Westminster.

WANTED, for large Colliery in Yorkshire, an ELECTRICIAN, one acquainted with all kinds of Colliery work and well up in wiring. Apply, with references, to COLLIERY, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, an ELECTRICAL TESTING ENGINEER, accustomed to commercial testing of large Generators and Tramway apparatus.—Apply, stating experiences, &c., &c., to TEST, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED ELECTRICIAN to take charge of Gas Engine and Dynamo. Must be steady, with good references: abstainer preferred.—BARNARD'S THEATRE, Woolwich.

WANTED ASSISTANT ELECTRICAL ENGINEER for neighbourhood of Cape Town, South Africa. Must be conversant with high and low tension systems. Salary £[illegible] per month. Second-class passage paid.—Apply by letter, stating qualifications, to DAVIS & SOPER, 54, St. Mary-axe, London.

WANTED a first-class ELECTRICAL MAN to take charge of Electrical Department in firm making Dynamos and Motors up to [illegible] B.H.P., also electrical cranes. Must have had good considerable experience in Works and Drawing Office, and be able to make his own designs and calculations, and to superintend workmen. Applications, which will be treated in confidence, to give age, detailed experience and references. Salary to commence £[illegible] per annum. Address N. T. S., *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, PARTNER, to join present Manager in taking over and extending installation department of one of the oldest established Electrical Contracting and Manufacturing Firms in the North of England.—Apply, 3,891, *Electrician* Office, Salisbury-court, Fleet-street, London.

JUNIOR DRAUGHTSMAN WANTED, capable of plotting mains on maps, and of undertaking general work in the drawing office. One with some technical knowledge of electricity preferred.—Apply, stating age, experience, and salary required, to ENGINEER, 27, Osborn-street, Whitechapel, E.

WANTED DRAUGHTSMAN, one used to the design of small electrical apparatus preferred. Write, stating experience and salary required, to "DORIS," c/o Fielding's, 43, Old Queen-street, S.W.

ELECTRICAL TESTING.—VACANCY for an IMPROVER. No premium required. Salary after first year. Technical knowledge essential. T. V. 41, *Electrician* Office, Salisbury-court, Fleet-street, London.

PERMANENCY.—TRAVELLER, smart active young fellow WANTED for large Electrical Accessories Supply House, London and Suburbs. Preference given to one with actual and good connection. Salary and commission. Letters only, with full particulars as to salary, &c., required, to S. N. P., *Electrician* Office, Salisbury-court, Fleet-street, London.

SEVERAL young men wanted as SWITCHMEN in a direct-current and three-phase sub-station. A good opportunity for gaining experience. Wages 30s. per week. Reply, stating age and experience, to S. Y. 3,025, *Electrician* Office, Salisbury-court, Fleet-street, London.

WIREMAN WANTED at once, with knowledge of electric lighting, bells, &c. Apply, JACKSON BROS., Broadway, Plaistow, E.

REQUIRED at once, WIREMEN-FITTERS. Reply by letter, giving particulars, 3,895, *Electrician* Office, Salisbury-court, Fleet-street, London.

MARINE ENGINEER (33), 12 years' sea service, 7 of which as Chief, 2 years' experience with water tube boilers and Corliss valve gear, wishes post as Mechanical Engineer in electric lighting or power station.—3001, *Electrician* Office, Salisbury-court, Fleet-street, London.

ADVERTISER (aged 38) with eight years' experience in marine and railway electrical engineering work desires a change. Could supervise erection and take charge of country house installation. Thoroughly at home on engines, dynamos, boosters, batteries, arc and search light, &c. Will give bonus of £5.—Address G. E. A., *Electrician* Office, Salisbury-court, Fleet-street, London.

CHARTERED ACCOUNTANT having excellent offices in Victoria-street, Westminster, has room for a Company. Secretarial work could be arranged for. Apply, by letter, to C. A., Kelly's Advertising Offices, 24, Tothill-street, Westminster, S.W.

PRIVATE COACHING given in Electric Light and Power Work by practical station engineer South London.—Address, 3,994, *Electrician* Office, Salisbury-court, Fleet-street, London.

ENGLISHMAN, with extensive offices in Brussels, is open to arrange for one or two additional AGENCIES. Address, LEX, 70, Berners-street, London, W.

A CONTINENTAL WIRE-DRAWING MILL in brass, tombak, bronze and copper require a reliable REPRESENTATIVE for the United Kingdom. Reply, in German, to M. D. O., *Electrician* Office, Salisbury-court, Fleet-street, London.

## THE EASTERN TELEGRAPH COMPANY, LIMITED.

NOTICE is Hereby Given that an EXTRAORDINARY GENERAL MEETING of the Eastern Telegraph Company, Limited, will be held at WINCHESTER HOUSE, Old Broad-street, in the City of London, on WEDNESDAY, the 13th instant, at 2.30 o'clock p.m., for the purpose of confirming as a Special Resolution the subjoined Resolution, which was passed at the Extraordinary General Meeting of the Company held on Monday, the 28th January last.

"That the Articles of Association of the Company be and they are hereby altered in manner following, that is to say:—There shall be added on to the end of the 104th of such Articles the following words, namely:—

'Every past, present and future Director who has been or is or shall become a Director of any other Company as the nominee of this Company may, in addition to any remuneration received by him under the preceding provisions of this Article, also retain for his own benefit any remuneration to which he has become or may hereafter become entitled as a Director of such other Company, whether his qualification for such Directorship shall or shall not be held by him in trust for this Company.'"

By order of the Board of Directors,
GEORGE DRAPER, Secretary.

Winchester House, Old Broad-street,
London, E.C., 6th February, 1901.

## THE ST. JAMES' AND PALL-MALL ELECTRIC LIGHT CO. (Limited).

NOTICE is Hereby Given that the SHARE TRANSFER BOOKS of this Company will be CLOSED from February 12th to February 25th, both days inclusive, preparatory to the payment of dividends for the half-year ending December 31st, 1900.

By order,
F. J. WALKER, General Manager and Secretary.

[illegible], Carnaby-street, Golden-square, W., February 1st, 1901.

## THE BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY COMPANY (Limited).

NOTICE is Hereby Given that the TRANSFER BOOKS and REGISTER of MEMBERS will be CLOSED from the 6th to the 2[illegible]th inst., both days inclusive, preparatory to payment of the Dividend on the Preference Shares of the Company for the half-year to the 31st December, 1900.

By order,
H. B. RENWICK, Secretary.

Moorgate-court, Moorgate-place,
London, E.C., 4th February, 1901.

## BUSINESS FOR DISPOSAL.

TO BE DISPOSED OF as a going concern, very remunerative ELECTRICAL CONTRACTING BUSINESS. Net profits, £[illegible]. Capital required about £[illegible]. Every investigation. Principals only.—Address A. 40, care of Charles Birchall, Ltd., Liverpool.

## WANTED and FOR SALE.

WANTED, LAMP TOPS, with Platinum, Scrap Platinum, &c.—EDEY & Co., 29, Ludgate-hill, London, E.C.

WANTED, NEW or SECONDHAND STEAM ENGINE and DYNAMO, either direct coupled or belt-driven engine, to develop 46 B.H.P. with steam-pressure of 100lbs. The dynamo, preferably compound-wound, to develop 110 volts, 190 amperes.—SAXON PORTLAND CEMENT Co., Ltd., Cambridge.

NEW TELEPHONE CABLE (about 3 miles) seven pair 1.18's, air space, lead covered and armoured. Offers invited. Write R. A. CHATTOCK, Esq., M.I.E.E., City Electrical Engineer, Town Hall, Bradford.

FOR SALE 100kw. E.C.C. ALTERNATOR, 2,000 volts, 420 revs., 50 periods, belt driving; good order, very low price. Apply Electricity Works, Woolwich.

ACCUMULATOR CHARGING.—C. H. CATHCART and CO., having plant specially adapted for this purpose, Charge Cells of all sizes promptly, thoroughly and cheaply. Terms on application. Accumulators on Hire for temporary lighting, experimental uses, &c. 3, Dorset-buildings, Salisbury-square, Fleet-street, E.C. (Telephone No. 200.)

# SECONDHAND ELECTRICAL MACHINERY.

Messrs. THOMPSON, SON & CO., of New York, have a LARGE QUANTITY of

***DYNAMOS, MOTORS, SWITCHES, ARC LAMPS, ENGINES, BOILERS, &c., &c.,***

in Stock, of Standard makes, for Immediate Delivery.

*COMPLETE EQUIPMENT FOR ELECTRIC LIGHTING PLANTS OR STREET RAILWAY SERVICE.*

Write for Catalogue and particulars to—

**W. H. MERRIMAN,** 39, Victoria St., LONDON, S.W.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,186. [No. 16. Vol. XLVI.] FRIDAY, FEBRUARY 8, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Mr. Mordey's Paper on "Capacity in Alternate Current Working" has evoked a most interesting letter from Dr. Maurice de Hoor, which we publish in our correspondence columns this week This letter constitutes an important contribution to the discussion which will be resumed at the Institution of Electrical Engineers next Thursday. Dr. De Hoor joins issue with Mr. Mordey in some of the main points of his Paper, and his views, supported as they are by figures derived from actual experience, should have considerable weight. Mr. Mordey and Dr. De Hoor will each, no doubt, have many supporters, and the proceedings at next week's Institution meeting promise to be of unusual interest, even if the ever-recurring question of priority raised by Prof. Ayrton is not further discussed.

The Electro-Chemical Co. of St. Helen's, Lancashire, is certainly an unfortunate company. Formed in 1895 to purchase and work the Richardson and Holland patents for the electrolytic production of alkalies and chlorine compounds, it made its first mistake by paying too high a price for the patent rights of an imperfect process. The process had, it is true, been at work upon an industrial scale for some months previously, at Snodland in Kent, and such high authorities as the late Prof. Hopkinson and Mr. James Swinburne had reported favourably upon it. Nevertheless the process was found to be unsatisfactory in operation when transferred to the larger works at St. Helens, and the history of the company has been one long series of disappointments for the original shareholders. A year ago the company was reconstructed and further capital raised in order to alter and extend the electrolytic plant in accordance with the plans of Dr. Laurie, the then general manager. The original process had been a non-diaphragm gravity process (see *The Electrician*, February 12, 1897), and Dr. Laurie's improvement seems to have consisted in the addition of a diaphragm to the original cell.

This improved process has, however, failed to realise the expectations based upon it, and a report from Dr. Laurie, dated December 19, 1900, and another from the directors of the company, dated January 4, 1901, have been circulated amongst the shareholders. Dr. Laurie considers the non-success of his improved process to be due to the unreliable quality of the carbon anodes supplied by the Acheson Graphite Co. of America; but the directors themselves are evidently less certain on this point, and doubt whether even with durable anodes the process can be worked so as to yield a satisfactory profit on the invested capital. A meeting of the shareholders of the company is to be called shortly in London in order to consider the future policy, and it would seem likely that this shareholders' meeting may decide that it will only be throwing money away to experiment further with either the old or the improved processes.

The disagreement between the London United Tramways Co. and the authorities of Kew Observatory has entered upon a new phase. At last, after weeks of paper warfare, matters have taken a practical turn, and, in a moment of luminous inspiration, it has occurred to someone that it would be a good plan to make trial runs of the electric cars, to see what would be their effect on the precious instruments at Kew. Accordingly, what might have been done in the first instance has been resorted to in the last. Cars have been run night after night in increasing numbers with the object of obtaining practical data upon which the Board of Trade will, we hope, be able to make up its mind what to decide in this vexatious matter.

As chairman of the committee of opposition to the proposed new electric tramways in the west end of London, Lord Kinnoull sends a letter to *The Times* of the 6th inst., in

which he states that "the introduction of tramways into well-inhabited districts almost inevitably brings about great depreciation in the value of residential and other property." This is quite the popular view of the matter, and it may seem justified to some extent by the history of horse tramways in this country. But we would respectfully point out to his lordship that with electric tramways the results are quite different: indeed, they are the very opposite. Wherever the cleanly and well-lighted trolley car has been introduced, either in this country or abroad, neighbouring property has actually *appreciated* in value. We commend this aspect of the question to Lord Kinnoull and to all other imperfectly-informed opponents of electric traction.

Mr. H. A. Humphrey contributes this week an interesting reply to the leading article in our last issue, in which we commented on his able Paper on the use of gas engines in central stations. We welcome the additional defence of gas engines implied in the terms of his letter, for we are as desirous as anyone that obstacles to the displacement of the steam engine by the far more efficient internal combustion engine should speedily be removed. It has never been our wish to champion steam as against gas plant, but candour has always compelled us to admit that, in spite of its many glaring elements of inferiority, the steam engine has a firm hold on the premier place. If Mr. Humphrey and other energetic gas engineers can do anything towards elevating the gas engine to that chief place, every electrical engineer will have reason to be grateful.

We are not so unacquainted, however, as Mr. Humphrey appears to think, with the use of gas engines in electricity works; the vicissitudes of this type of station, indeed, have been attentively watched by us since its inception. It was not without reason, therefore, that we expressed the view that the starting of large gas engines cannot be carried out so simply and expeditiously as is the case with a steam engine. A gas engine is essentially not a self-starting engine, whereas a steam engine is. The gas engine requires to be started by some auxiliary process, such as by using compressed air, or by secondary batteries motoring the dynamo, or by auxiliary explosion valves. Even compressed air is not always satisfactory, we have heard more than once of starting having been seriously delayed through a leak having arisen in the compressed air reservoir.

Referring to the other points raised in Mr. Humphrey's letter, we may notice that his reason for having ignored ordinary coal gas carries with it as a necessary consequence that the gas generator must be adjacent to the electricity works. Where gas transmission is adopted, the richest possible gas is clearly the only kind admissible. Were gas engines to be universally employed in electricity works, it would not be desirable everywhere to erect gas producers close to the works. Mr. Humphrey's figures do not convince us: we still believe that a 100,000 H.P. gas-driven station in a residential district would be an intolerable nuisance, especially if the gas producer were to be annexed to the station. If we may add one item to Mr. Humphrey's list of figures, we would remind our readers that producer gas contains a large percentage of carbon monoxide, and that that ingredient is a violent poison. Moreover, gas-engine exhaust, although less in *quantity* than steam-plant chimney-exhaust, has a peculiar *quality* that is as disagreeable as it is unmistakable.

The plating of articles wi h nickel by electro-deposition is now a very important minor industry, thanks to the extent to which such nickel-plated articles are used in the manufacture of cycles. The production of satisfactory deposits of nickel from solutions of the sulphate or chloride salts of nickel and ammonium is comparatively simple, if low current densities be used, and if the deposit be not permitted to grow to any appreciable thickness. Should it be desired to hasten the operation by using currents of greater intensity, or to obtain thick coatings of nickel, difficulties are met with, and the physical characteristics of the deposited metal change. The electro-deposited metal becomes foliate in structure, and for ordinary purposes the deposit becomes useless. Some years ago, Foerster stated that he had overcome the difficulty by using solutions of the sulphate at temperatures between 50°C. and 90°C., with a fairly high current density. Full details of his investigation were given in our issue of October 8, 1897. The January number of the *Elektrochemische Zeitschrift* states that the time required for electro-depositing coatings of metallic nickel has now been still further reduced, and that deposits 1mm. thick can be obtained in eight to nine hours as compared with 194 to 258 hours by the older methods of working. The deposit is homogeneous and malleable, and thick plates of the metal can be obtained by the improved method possessing all the characteristics of metal produced by metallurgical processes of manufacture.

It is considered that this reduction in the time required for obtaining electrolytic deposits of metallic nickel, will lead to a great increase in its use in electrotyping and type-casting works, as copper or type metal faced with nickel, will stand longer use than the unprotected metals. For ordinary nickel-plated goods, it is stated that two or three minutes in the bath, using the improved method, will suffice to give a coating of nickel of the requisite thickness. The article from which these notes are drawn would have been of much greater value if further details had been given concerning this improved method; but these are withheld, and one is only incidentally led to infer that the improvement relates to the composition of the plating bath. Possibly the process depends for its success upon the use of some double salt of nickel which has hitherto been overlooked by practical electro-chemists. Upon electrolysis, double salts yield a complex anion, and the deposition of metal at the cathode usually occurs, not as a primary electrolytic action, but as a secondary chemical action, due to the instability of this complex anion under the conditions obtaining in the cell. Metallic deposits obtained in this way generally exhibit the characteristics of the metals to a higher degree than the deposits obtained by direct electrolytic action.

In a recent issue (see *The Electrician*, November 2, 1900) we gave a detailed account of the industrial production of oxygen and hydrogen by electrolysis. Many forms of

electrolyser have been devised and patented for carrying out the electrolysis of water. The more successful of these utilise iron as electrode material, with caustic soda solution as electrolyte, and incomplete metallic diaphragms. In the issue of the *Elektrochemische Zeitschrift* for January, 1901, a new form of electrolyser devised and patented by SCHOOP is described, and it is stated that this form has been working upon a small industrial scale for some months in 1900 with satisfactory results. The electrolyser differs from those referred to above in the absence of diaphragms, and in the use of an acid electrolyte. Lead is used for constructing the cells, which are entirely closed, and for the electrodes. The formation of lead peroxide at the anode causes a back E.M.F. equal to between 2·5 and 3·0 volts. This defect is held to be more than counterbalanced by advantages which are unfortunately not enumerated. The yield of oxygen and hydrogen is stated to be 68 and 136 litres per electrical horse-power hour respectively. (The original article gives 136 and 68, but this is obviously a slip.) This yield may be compared with that of 108 litres of H at Brussels, 107 litres of H. at Rome, and with the theoretical figure of 204 litres per electrical horse-power hour. If these figures be correct the Schoop electrolyser possesses a higher energy efficiency than the Garuti type with metallic diaphragms. In order to remove traces of acid moisture carried over by the gases they are passed through milk of lime wash vessels before passing to the respective gas-holders. The purposes for which the oxygen and hydrogen gas obtained from water in this way may be used, were discussed in our issue of November 2nd last.

IT does not fall to the lot of all inventors to obtain such a complete grasp of a difficult problem as Prof. SLABY has done in the subject of selective systems of wireless telegraphy. His description of the system published in a recent issue is a delightful example of successfully applied reasoning. While methods based on simple syntony between the waves themselves are being perfected, it is interesting to note how other inventors are attacking the problem in another direction, basing their methods either on what may be termed the electric fire-alarm principle or on the Delaney multiplex telegraph. An example of the former is afforded by an article by Herr ANDERS BULL, in another column of this issue, and of the latter by the device of Messrs. COHEN and COLE referred to briefly in a note some time ago. Unfortunately, the greater number of such inventions do not survive the test of actual experiment; but occasionally they offer useful suggestions to others working at similar and kindred problems. The development of a type-printing Hertzian wave telegraphy may still be a dream of the future, but attempts at its realisation even now are not to be discouraged.

**Correspondence.**—Pressure on our space compels us to hold over a letter from M. Emile Guarini on his experiments in wireless telegraphy between Brussels and Malines.

**Cycle Engineers Institute.**—At an ordinary general meeting of this Institute at Birmingham yesterday, Mr. R. A. Marples read a Paper on "The Utilisation of Electric Power Transmission in Factories."

**Electric Traction on the Underground.**—We are authorised to state that the recommendation of the committee, including Sir William Preece and Mr. Thomas Parker, will be considered next week, at a meeting which has been arranged of the boards of directors of the two railway companies working the Inner Circle.

**The London School Board and Scientific Education.**—At its weekly meeting last Friday the London School Board unanimously decided to appeal against the judgment of Mr. Justice Wills and Mr. Justice Kennedy in the case of Regina *v.* Cockerton, in which it was decided that the Board could not apply the rates to the maintenance of science and art classes.

**The Pacific Cable.**—It was announced by *The Times* Melbourne correspondent on Wednesday that Mr. Joseph Chamberlain, M.P., had notified the New South Wales Government that Canada, in view of the concessions granted by some of the Australian States to the Eastern Extension Telegraph Company, is reconsidering her position as a contracting partner in the Pacific cable project.

**Royal Society.**—At yesterday's meeting it was resolved that a dutiful address of condolence and homage should be presented to His Majesty the King.—Among the Papers down for reading were: "The Boiling Point of Liquid Hydrogen, determined by Hydrogen and Helium Gas Thermometers," by Prof. Dewar, and "The Integration of the Equations of Propagation of Electric Waves," by Prof. Love.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | — |
| Pernambuco—Ceara | Nov. 29, 1900 | — |
| Marseilles—Barcelona | Jan. 7, 1901 | — |
| Shanghai—Amoy | Jan. 17, 1901 | — |
| Havre—Waterville | Jan. 19, 1901 | Feb. 2, 1901 |
| Malta—Tripoli | Jan. 24, 1901 | Feb. 5, 1901 |
| Singapore—Banjoewangie | Jan. 25, 1901 | Feb. 1, 1901 |

**Postponement of the International Telegraph Conference.**—All arrangements had been made for the holding in London, on May 15th and subsequent days, of the tenth International Telegraph Conference, under the presidency of Lord Londonderry. The meetings of the delegates appointed by the States subscribing to the St. Petersburg Convention were to have been held in the Examination Hall of the College of Physicians and Surgeons in London. In consequence of the national mourning it has now been decided to postpone the Conference until next year.

**Works Management.**—The first of the series of six lectures to the Institution of Junior Engineers on "Works Management" was delivered at the Westminster Palace Hotel last Tuesday evening by Mr. A. H. Barker. The appreciation of the arrangements made by the Institution for the delivery of these lectures was manifest from the very large number present. The chairman (Mr. Percival Marshall), in opening the proceedings, referred to the opportunities which those attending would have in the discussion at the close of each lecture for obtaining special information bearing on their own particular work. The lecturer's introductory remarks dealt with the general state of organisation in this country, with special application to engineering firms. The causes of our present position in the market, questions of experience, and selling power of products were then treated. The best methods for dissection of orders and of providing continuous work for operatives engaged attention. An analysis followed of the number of employés in different shops and of machines used, with prices of equipment. Curves were exhibited showing the relative cost in each case of machine tools, fitters' tools, &c. The questions of buildings, driving power, electrical *versus* mechanical driving were considered, and the lecture concluded with some figures relating to the determination of various particulars in connection with the size of steam engines and boilers. The next lecture takes place on Wednesday, the 20th inst.

**Plant for Copper-Coating Carbons.**—A new machine for plating carbons automatically and continuously, having a capacity of 120,000 carbons per day, was installed last autumn by the United States Carbon Co., of Cleveland, Ohio, in order to meet the constantly growing demand by this new company for copper-coated carbons, and it is, says the New York *Electrical World*, one of the most ingenious pieces of mechanism employed in the electrical industry. The principle of the machine, our contemporary continues, is simplicity itself. The carbons to be plated are deposited in large quantities in a hopper, from which they are taken by a revolving drum and automatically fed to 3,000 individual holders, carried on a continuous chain belt. The holders, in circuit with the electrical current, carry the carbons for a distance of 175ft., through 14 plating tanks, being taken from one tank to the next over large idler wheels. After passing through the plating tanks, the carbons pass through three tanks containing hot water, for boiling out the copper salts and fixing the colour of the copper coating. The endless belt carrying the carbons then returns over the head, through the drying chambers, and, after registering on the counter, the carbons are automatically discharged from the holders on to a conveyor, which carries them for a distance of 50ft. to the packing room, located in one of the large buildings recently added. Among the electrically operated labour-saving devices, such as acid pumps, syphons, &c., used in connection with the machine, is a small double trolley motor car, for lifting and moving any one of the large plating tanks when it is necessary to clean it. This car is notable for the extreme compactness and simplicity of its design, using but one 10 H.P. ironclad motor for propulsion forward or back, lifting and lowering the tanks and the various operations required.

**Fatal Fall of Telephone Wires in Liverpool.**—On Monday evening last a considerable fall of overhead telephone wires occurred in Liverpool, owing to the snowstorm. Many of these wires fell across the trolley wires of the tramways, causing great havoc and killing two persons and injuring a number of others. *The Times* gives an account, which, we have ascertained is substantially correct as to technical and other details, and from which we extract the following particulars:—The view of Mr. Bellamy, the general manager of the Liverpool Corporation Tramways, is that the half-melted snow, which had been falling more or less during Monday afternoon, stuck to the thin telephone wires, which became so heavily weighted that they fell in several parts of the city in the evening. In Pembroke-place a bunch of about 50 wires fell across the trolley wires charged with the very strong current employed for the tramways. The snow acted as a conductor, and as pedestrians came in contact with the wires, which could not be seen in the snow and darkness, they were subjected to shocks. In some instances the wires coiled round the people, and their agonised cries attracted large crowds. The sufferers were taken to the Royal Infirmary in the immediate neighbourhood. The current was turned off as soon as possible, but there was some delay because the telephonic communication with the generating stations had naturally broken down owing to the fall of the wires. Mr. Bellamy added that another bunch of 20 to 30 telephone wires fell about the same time over the trolley wires in Lodge-lane, Toxeth-park, but so far as he could learn nobody was hurt there." There was also a fall of telephone wires at the top of Islington (Liverpool), and several persons were entangled, but were liberated uninjured. Mr. Bellamy himself had a narrow escape.

**The Jungfrau Railway.**—In spite of rumours to the contrary, says *Engineering*, the work on the Jungfrau railway so far continues without avoidable interruptions. Operations were recommenced in October, after the tourist season was over, provisions and blasting materials having meanwhile been stored up near the Eiger glacier, to last the 80 or 90 men during the winter. On the occasion of the visit of the Institution of Electrical Engineers in August, 1899, the Rothstock station at 2·89km., 2,522metres (8,295ft.) above sea level, had just been opened. When tunnelling was recommenced in November, 1899, all spoil had to be taken back to the side gallery at the Rothstock. By the middle of May, 1900, the work had been pushed to 3·363km., a length of 473 metres (1,552ft.) having been added in six months and a-half, at the rate of almost 10ft. per day, reckoning 25 working days per month. No side gallery for the removal of the blasted rock can be cut before 3·630km. is reached; that means another 270 metres of tunnelling. As it would have been impossible to maintain the tourist service while the spoil cars were constantly coming down from the front to be sent up again, operations were suspended until late in the autumn, as work can be carried on during the winter months, in spite of the severity of the weather, whilst the tourist season is limited to a few months. To facilitate the transport of the blasted rock—the gradient is 25 per cent.—a wire-rope telpher service, driven by electric motors, has been established in the tunnel. 3,630km., where the side gallery is to be pierced, will be reached by the end of January, it is hoped. The tunnel will then be pushed up to the next projected station—Eigerwand—at 4·1km, 2,867·6 metres (9,400ft.) above sea-level; and, as there will be an outlet for the spoil at the new side gallery, operations will probably continue during next summer without interference with the tourist traffic. Eismeer Station is to follow at 9·8km. and at an altitude of 3,161 metres (10,370ft.) above sea-level This, our contemporary adds, will be the highest railway station in Europe.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), February 8th.**

PHYSICAL SOCIETY.

*5 p.m.* Annual General Meeting in the Rooms of the Chemical Society, Burlington House, when the President will deliver an address. An Ordinary Meeting will follow, at which Prof. R. W. Wood will read a Paper on "A Mica Echelon Grating."

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Extra Meeting at Storey's Gate, to take the adjourned discussion on Mr. H. A. Humphrey's Paper on "Power Gas and Large Gas Engines for Central Stations."

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel. Paper to be read: "Electric Power Supply in the Metropolis," by L. F. Awde.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. G. H. Bryan, F.R.S., on "History and Progress of Aerial Locomotion."

**SATURDAY, February 9th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*3 p.m.* Students' visit to the generating station and depôt of the Central London Railway Co., Shepherd's Bush.

**MONDAY, February 11th.**

INSTITUTION OF ELECTRICAL ENGINEERS.—NEWCASTLE-ON-TYNE SECTION.

Meeting at the Royal College of Science, Newcastle.

**TUESDAY, February 12th.**

INSTITUTION OF ELECTRICAL ENGINEERS.—MANCHESTER SECTION.

*7.30 p.m.* Meeting at Owen's College, Manchester. Paper to be read: "Direct-Current Generators," by Sydney H. Short.

**WEDNESDAY, February 13th.**

INSTITUTION OF CIVIL ENGINEERS.

*2.30 p.m.* Students' visit to inspect the engineering models at the Victoria and Albert Museum, South Kensington.

INSTITUTION OF ELECTRICAL ENGINEERS.

*7.30 p.m.* Students' meeting at 28, Victoria-street, S.W. Papers to be read: (1) "Electro-chemistry at the Paris Exhibition," by M. Solomon. (2) "Accumulators at the Paris Exhibition," by J. H. West.

INSTITUTION OF ELECTRICAL ENGINEERS.—GLASGOW SECTION.

*8 p.m.* Meeting at 207, Bath-street, Glasgow.

**THURSDAY, February 14th.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting to take the adjourned discussion on Mr. Mordey's Paper on "Capacity in Alternate-Current Working."

**FRIDAY, February 15th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting at Storey's Gate. Paper to be read: "Light Lathes and Screw Machines," by J. Ashford.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse: Subject, "Electric Waves," by the Right Rev. Monsignor Gerald Molloy.

**SATURDAY, February 16th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*11 a.m.* Students' visit to the Metropolitan Electric Supply Co.'s Generating Station at Willesden.

## OFFICIAL OBSTRUCTION OF ELECTRIC PROGRESS.

Under this title Prof. J. A. Fleming contributes an article to the current number of that clumsily entitled contemporary *The Nineteenth Century—and After.* His article consists of a deal of ancient history and a little that is more modern, and it is mainly directed to show that in reviewing the nationality of those who have helped to make the electric current the nimble servant of mankind, it is impossible not to be struck with the fact that British names do not preponderate :—

In the region of pure scientific research, in the development of electrical theory, Great Britain has unquestionably held her own with the world. In detailed improvements or adaptations we have not been backward, but if we except the inventions of Lord Kelvin in connection with submarine telegraphy, Mr. Swan in electric lighting, and the contribution which the late Prof. D. E. Hughes made to telephony by the invention of the microphone, it is difficult to name any first-rate new adaptation of electrical discovery for practically useful purposes in the last 30 years which has not come to us first from non-British sources. It cannot be said that the country which has produced a Watt, a Stephenson, and an Arkwright is deficient in mechanical inventiveness, but it is impossible to deny that the period of time since 1870 has not been marked by the evolution of distinctly novel electrical inventive ideas proceeding from British minds. We cannot therefore help asking whether there is any cause for this deficiency. Why should the transformation of electrical knowledge into useful arts go forward more rapidly in other countries than in Great Britain? Is it well that our national imports of electrical inventions should much exceed our exports, and if so why is this the case?

The author attempts to fasten the blame for this upon the British Government. His first and most important attack is upon the Government of 1870, in respect of the creation of the telegraph monopoly; but he also finds fault with the Elementary Education Act (Forster's) passed by that same Government, as well as with the municipalising policy of recent Governments, and with the policy of the Board of Trade. He thus surveys a wide area of ground. With regard to the telegraph monopoly he commences as follows :—

Now it is a curious coincidence that just at the dawn of this period of electrical activity—viz., in 1870—the Government of this country set themselves up in business as electricians, and proceeded to create a gigantic Government monopoly in one large department of electrical invention which has exercised a most undoubted control over the supply and demand for invention in a wide area of electrical work. Prior to 1870 the chief practical use which had been found for the electric current was in the electric telegraph. Public telegraphy was conducted by competing electric telegraph companies covering various areas of the country, just as the various railway companies do at present. Their development created a demand for electrical inventions in telegraphy, and the records of the Patent Office show how prolific were some inventors in supplying the need. The Government of that day thought it right in the public interest to buy up all these companies for a capital sum of £10,000,000, with the object of bringing the benefits of telegraphy within the reach of all. But in order to protect the capital thus invested from injury by competition, they passed Acts of Parliament in 1868 and 1869, giving the Post Office exclusive rights, with certain exceptions, to transmit messages and information by electricity when practised for profit. When the telephone made its appearance in 1877, and telephone exchanges began to be devised in 1879, the question arose whether a telephone was a telegraph within the meaning of the act. The Government telegraph officials feared that their monopoly was threatened; hence with the assistance of the Crown lawyers they proceeded to stake out a big claim, and to obtain an interpretation of the Telegraph Acts, passed to legalise the purchase of the old electric telegraph companies, which was equivalent to an authoritative statement that the Post Office possessed the sole right to transmit intelligence by electrical means in return for payment, not merely as the art was then known, but by all and every method which the wit of man could or might throughout everlasting ages devise. Two judges, not the very strongest who have ever sat upon the bench, gave judgment in this sense against the United Telephone Co. Unfortunately the case never went to appeal, far less to the House of Lords. The victorious Post Office said to the vanquished Telephone Company, "Don't let us fight any more. Give us 10 per cent. of your gross receipts, and we will give you a licence to work your invention."

The story of the relations of the Post Office and the telephone is a long one; some simple facts can only be mentioned here. The 10 per cent. royalty paid by the National Telephone Co. to the Post Office amounted in 1898 1899 to £123,061; in the past year probably to about £130,000. . . . The total royalty paid by the National Telephone Co. and its predecessors up to Sept. 30, 1900, has been £1,081,490. This has been a tax imposed by the Post Office on a new industry barely 20 years old. When the telephone first made its appearance the technical experts of the Post Office laughed at it as a toy. It was only when they were convinced of its utility by hard facts that they set in motion the legal machinery which enabled them to bring it within the grasp of the Telegraph Acts. Yet the claim of the Post Office to finger this million of sovereigns depends only on a single decision in a Court of First Instance, and has never been confirmed by the higher legal tribunals of the land.

Prof. Fleming errs in throwing the blame upon the judges. It is his opinion that they were "not the very strongest who have ever sat upon the bench," but there can be no two opinions about their having given the correct interpretation of the Telegraph Acts. The learned professor should blame the ingenious draughtsmen of those acts, not the innocent judges whose duty it was to interpret their letter. This consideration may perhaps assist Prof. Fleming to understand why the judgment never was appealed against. He appears to be very annoyed that the Post Office has been able to finger a million of sovereigns "on a single decision in a Court of First Instance," but he overlooks the fact that the business men at the back of the Telephone Company interests would not have failed to appeal even to the House of Lords had not the judicial pronouncement been so palpably in accord with the terms of the Acts. Prof. Fleming next asks the question: What has been the result? He answers it himself thus :—

The officials in the Government Telegraph Department were at once exalted into a position of paramount power over all electrical invention in land telegraphy. It is pure waste of time for an inventor to spend days and nights over a telegraphic invention, or invest capital in patenting it, unless he can get it tried, and if it succeeds, market his invention to a purchaser. He is not generally a philanthropist, but is spurred to work by the hope of reward. But in electric telegraphy he can try nothing and market nothing unless he first persuades or pleases the permanent officials of the State Telegraph Department. He has to overcome their inertia, opposition, or it may be ill will, before he can even get a trial of his telegraphic apparatus, and when at last he demonstrates an important advance, he is entirely at their mercy whether it shall be adopted or not, and, if so, what price he shall receive for it. The permanent official in any Government department is not, as a rule, eager to introduce improvements from outside. He loves his departmental routine, his habits of mind are slow, methodical, cautious, and he does not want radical reforms. If there is to be any invention at all, he generally likes it to proceed from himself, doubtless at the expense of the nation, so that he may keep before the public eye, and convince his chiefs that he is a clever and important person. A young man bursting with new ideas does not generally enter the Civil Service, he prefers the greater freedom—if more risk—of a career outside; hence we should hardly expect a State telegraph official to be a prolific and original inventor. He would probably have any trace of such disposition toned down on his way up the ladder of promotion. . . . . . . . The most effective method of afflicting any department of applied science with creeping paralysis is to constitute it a Government monopoly.

Lest the Post Office officials should retort that they are always on the look-out for novelties, the author enters into a long account of "one important case only, viz., that of wireless telegraphy," which disproves this claim in anticipation. We need not, however, follow him over this already much-trodden track. The real inner history of the early development of wireless telegraphy in this country remains yet to be written, and the pen that is to write it must not be held by an *ex parte* historian.

Some ancient history forms the chief part of the next section, in which the author re-states the facts of the early legislation in electric lighting and discusses its obstructive influence. Curiously enough, by the way, Prof. Fleming considers that "the principle of limited liability" in joint-stock companies leads to "waste of capital." Passing over these matters we arrive at the ultimate section, wherein the attitude of the Government towards education is adversely discussed, with the following conclusion :—

The late Prof. Huxley once declared that if a young Faraday could be purchased in the open market for the price of a first-class battleship the purchase would be a bargain. For all we know he may be had for nothing, but we must first make an environment suitable to foster inventive genius, and not permit it to be repressed by educational or legislative conditions.

## A TUNING SYSTEM FOR WIRELESS TELEGRAPHY.

BY ANDERS BULL.

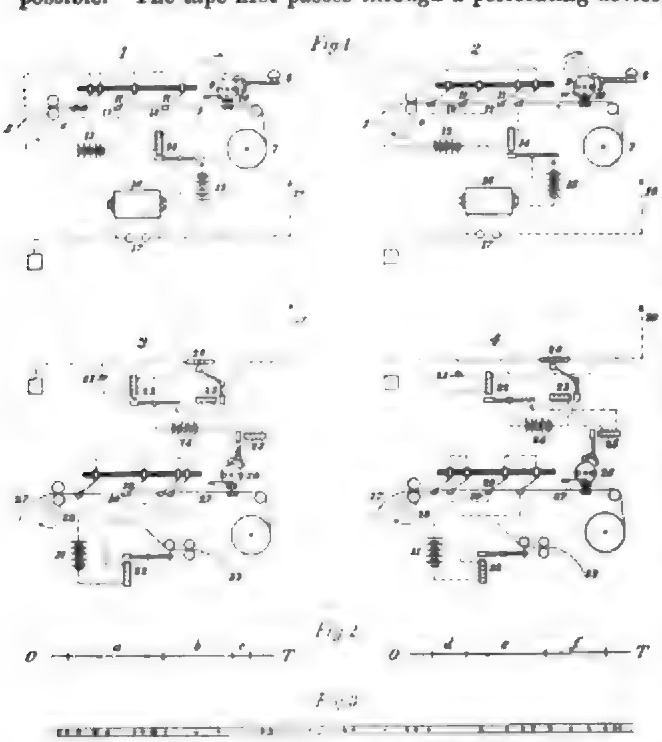
The tuning of wireless telegraphic apparatus is a question that has so often been discussed in the columns of this journal, that most readers probably are acquainted with its importance. This article will describe a system by which a solution of the problem can be arrived at. The system was invented by the writer of this article 1½ years ago, and details were given at the meeting of the Electrotechnischer Verein, Berlin, on December 18 last. By this system the possibility of messages being intercepted by stations for which they were not intended will be almost precluded, and independent signalling may be carried out between a considerable number

of stations lying within the sphere of influence of each other's waves, while several despatches can be transmitted simultaneously without their being affected the one by the other.

For this purpose the signals are conveyed from the transmitters to their corresponding receivers exclusively by the aid of series of impulses, each series consisting of a certain number of short wave impulses following each other at predetermined intervals of time. By suitable choice of these intervals the impulses can be arranged in series of different form. Now it is possible to tune each transmitting and receiving pair for its own special form of series in such a way that the transmitter only dispatches series of this special form, and the corresponding receiver only responds to series of the same form.

Fig. 1 in the diagram shows two transmitters, 1 and 2, with their two receivers, 3 and 4, arranged according to this principle. Suppose the left-hand one of these sets to be tuned for the series *a*, *b*, *c*, the one on the right for the series *d*, *e*, *f*, as shown in Fig. 2, where the time-intervals are represented by lengths on the axis OT, and the impulses by cross strokes.

The transmitter consists of a paper tape 5, which, by means of clockwork 6, is drawn from the reel 7 at as even a rate as possible. The tape first passes through a perforating device,



forming a hole in it by each depression of the key 8. The punching of the holes is performed so rapidly that the movement of the tape is not interfered with; a ratchet wheel 9 is released and makes half a revolution, by which one of the two projections 10 strikes against the punch attached to a spring. In a line with the punch, a number of contact brushes 11, supported by metal pieces 12, are arranged, adjustable for various distances apart, and they press lightly against the tape 5. The brushes 11 are electrically connected together, as well as their supporting pieces 12. While the tape is moving, every hole must pass the brushes, which are generally insulated from their supporting pieces 12 by the paper, and metallic contact will momentarily be effected between each brush and its support through the hole, causing the current from the battery 13 to excite the relay 14, the armature of which is attracted. Thereby connection is established between another battery 15 and the primary of an induction coil 16. Then a discharge takes place between the spark balls 17 connected in the usual manner with the earth and the mast wire 18, a wave impulse being caused to emanate from the latter.

The hole must pass all the brushes, and by passing each a new impulse is produced. As the tape is moving at an approximately constant speed, the intervals occurring between such impulses must, consequently, correspond with the distances between the brushes 11. At each depression of the key 8 a hole is formed in the tape, and, as a matter of course, a special series of impulses is sent out by the transmitter. By various adjustments of the brushes 11 the form of this series can be altered to any desired extent.

At the receiving station the waves impinge upon the mast wire 19, which is connected to the coherer 20. At each arriving impulse the resistance of the latter is reduced, and the current from the cell 21 excites the relay 22. This then closes by attracting its armature, a secondary circuit, containing the battery 24, a decohering device 23, and the electromagnet 25. The latter releases in like manner, as described above, a punching device 26, and a hole is formed in the tape 27. The hammer at the same time knocks upon the coherer, the resistance of which is again increased, and the relay 22 and magnet 25 release their armatures. The receiver is then ready to respond to another impulse, and, consequently, each arriving impulse is indicated by a hole in the tape 27.

In the receiver the same number of brushes as in the transmitter are arranged in a line with the punch. The points of contact between these and the metal pieces 30 are, however, not connected in parallel like those of the transmitter, but in series, so that a current from the battery 31 can only first flow through the writer 32, when all the brushes are simultaneously in contact with their supports—*i.e.*, when there is one hole under each brush. As the tape 27 at the receiver is unwound by means of clockwork 28, at an approximately constant speed, the distances between the holes made by the punch when impulses encounter the mast wire 19 will correspond to the intervals of time at which the impulses arrive. The greater these intervals are, the greater will be the spaces between the holes.

A series of a certain form will always, therefore, produce a group of holes at distances apart, corresponding to the intervals between the impulses. If, then, the brushes of a receiver are arranged at the same distances apart as the holes in such a group—*i.e.*, in such a manner that, at a certain position of the tape, each hole in the group is covered by a brush—a simultaneous contact of all the brushes can only be effected by series of a similar form as that transmitted. The current from the battery 31 will then, so long as the simultaneous contact lasts, flow through all the points of contact and the writer 32, the lever of which will be attracted, and a dot be printed on the tape 33.

Each corresponding set of apparatus can thus be adjusted for its own special form of series. If several transmitters are working simultaneously, all their impulses on each receiver within their sphere of influence will be indicated by holes in the tape 27, and the latter will assume an appearance somewhat similar to Fig. 3. A receiver will, however, only respond to those of the punched holes that have the same mutual spacing as its brushes. The filled-in holes in Fig. 3 may thus represent groups by which the left-hand receiver in Fig. 1 will be put into action.

It might appear as if groups of this kind could also be formed accidentally by holes produced by impulses intended for other receivers, but this may easily be prevented. For this purpose the various series must be formed in such a way that the time-intervals between any two impulses in them are all different. If, by making the intervals short, the space of time between the successive series of each transmitter is always sufficiently great in relation to the length of the series themselves, then in no instance can the groups of holes produced by one of the transmitters contribute more than one hole to the formation of one group of holes of another kind. In order, therefore, that any critical group of, say, four holes could be formed accidentally, the number of the simultaneously-worked transmitters would also have to be at least four. If, in consequence, their number is but three, accidents of the kind described are precluded.

For the purpose of making this plain I shall call the special series of four transmitters respectively: *a*, *b*, *c*; *d*, *e*, *f*; *g*, *h*, *i*;

and $k$, $l$, $m$. The series should then be chosen in such a manner that none of the following 24 time-intervals are alike.

$$\begin{array}{llll} a, b, c, & d, e, f, & g, h, i, & k, l, m, \\ a+b, b+c, & d+e, e+f, & g+h, h+i, & k+l, l+m, \\ a+b+c, & d+e+f, & g+h+i, & k+l+m. \end{array}$$

As each of the above series consists of four impulses (three intervals), any three of the four mentioned transmitters can be worked simultaneously without the possibility of an accident happening. Some series that, for instance, would satisfy requirements are: 9, 4, 15; 2, 6, 12; 11, 5, 17; and 8, 7, 14; where the intervals are expressed in suitable units of time. It will easily be seen, that, no matter how one places two of the corresponding groups of holes above each other, these will never have more than one hole in common.

According to what has already been stated, the number of the transmitters, worked simultaneously, should not exceed the number of time-intervals in the series employed. Only by providing the apparatus with more brushes, the number of transmitters could be increased. It might, however, appear in practice, that this number could confidently be greater than according to the above condition; in any case that would depend greatly on the careful and exact manufacture of the apparatus.

It must be noticed that a synchronism between the clockworks 6 and 28, by which the paper tapes in the transmitter and receiver are unwound, is not necessary, as long as the relation between the speed of the tape and the spacing of the brushes is alike in both apparatus. The more perfectly this is attained, the smaller can be the size of the holes in relation to a certain rate of the tape 27, and the less will be the chance of critical groups being formed when the number of the transmitters exceeds the number of the intervals in the series.

As shown above, for each depression of the key 8 of a transmitter, a dot will be printed on the tape 38 of the corresponding receiver. If, then, the Morse code be employed, two dots, closely following each other, might represent a dash. It would be better, however, in this case to furnish the apparatus with two independent systems of brushes—*i.e.*, to tune each corresponding set for two special forms of series, and use the one for dashes and the other for dots. The transmitter would then be provided with two keys, and the receiver with two writers, one of which would mark the dashes, the other the dots on one and the same tape 38.

The system is especially suitable for the type-printing apparatus of Hughes. As each letter requires in such apparatus only one short current impulse, it is only necessary to tune each corresponding set for one form of series. Each current impulse is transformed at the transmitting station into a series of wave impulses, which at the corresponding receiving station again is transformed in a single-current impulse. One great advantage that would be gained in using the Hughes apparatus is that the messages exchanged could be kept secret, for if the transmission of the signs, by means of series, would render an illegal interception of the despatches very difficult, such interception would be impossible when Hughes apparatus is employed.

Instead of, as in the above-described arrangement, allowing decohering to take place mechanically by a knock of the hammer, automatic coherers could be employed—for instance, those invented by Tommasina and by Neugschwender—as they would act with far greater precision and rapidity than others.

In my system it is immaterial where the various transmitters and receivers are placed, whether several apparatus are mounted at one and the same station, or whether each is by itself. The apparatus are entirely independent of each other. Any station is, therefore, capable of sending several different messages as well as of receiving some and sending others, at the same time.

My system can also be adapted in telegraphing by wire. In this case the relay 14 at the transmitting station might send current impulses from the battery 15 direct into the line, this being at the receiving station connected to the magnet 25. Especially by employing the Hughes apparatus, I consider my system practicable for wire telegraphy.

The apparatus can also be made in other and more practical forms, but as this article is only intended to explain the principle of the system this form has been chosen to illustrate it in a simple way. The apparatus can be made, for instance, by using an arrangement of a number of pendulums with a similar period of oscillation, so that the evenly-running devices necessary for the apparatus above described could be dispensed with. This, of course, would greatly simplify the management of the apparatus, as they would only require winding like clocks from time to time, and no further attendance would be wanted.

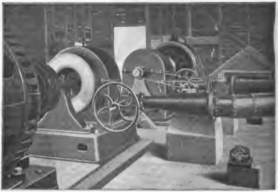
## A POWER TRANSMISSION PLANT IN SUMATRA.

The Redjang-Lebong gold mine of Sumatra has been fitted with an interesting water-driven three-phase power transmission plant by Messrs. Siemens and Halske, and we are enabled to reproduce below some picturesque photographs which they took while they were carrying out the work.

High-Pressure Mains leaving the Generating Station.

It had been observed for many years past that the native population of the Dutch Indies were in possession of a large amount of gold which they utilised in the manufacture of rough jewellery, and this, together with preliminary geological observations, led to the conclusion that gold might be present in large quantities. An accurate examination of the ground fully confirmed this supposition, but it was some years before European enterprise took the matter up energetically and sent out mining experts to prospect. When it had been

Generating Station in Course of Construction. Foundation of One of the Machines.

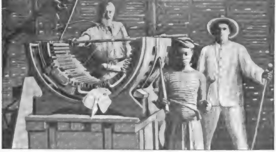


Generating Station, Completed.

demonstrated that gold was present in profitable quantities, a large number of companies were formed to acquire concessions to exploit the goldfields. One of these companies, which resolved to utilise all the improvements in modern machinery in their undertaking, was the Redjang-Lebong Mining Co., founded by the Batavian commercial house of Erdmann and Sielcken for the purpose of working the goldfields in the neighbourhood of Lebong Donok in the interior of Sumatra. Besides the rich quantities of ore, these gold fields had the further advantage that a large amount of water power was accessible within a distance of only 2 miles, so that by means of electric transmission this would furnish motive power for the entire works.

The work of a gold mine may be divided into two parts. The ore must first be extracted from within the mine and then the gold must be extracted from the ore. In the first of these, the ore can, of course, be obtained by ordinary manual labour with the assistance of hand drills and dynamite blasting, but naturally the output is much greater and the cost per ton of ore much less if the holes for blasting are made by special drills worked either by compressed air or electricity.

If the gold-bearing strata are near the surface so that it is not necessary to sink any shaft, the work can be carried out without any mechanical auxiliaries; but even then, as the distance to which the ore has to be carried gradually increases, the cost of labour and beasts of burden becomes so high that the introduction of machinery is nevertheless necessary. In this case the engineer has steam, compressed air and electrical energy to choose between. When coal cannot be supplied regularly, the employment of steam is impossible and electrical energy has to be resorted to, for even if compressed air is preferred, it is necessary to drive the air compressors with electric motors. After the ore has been obtained, mechanical contrivances are still more necessary for breaking and pulverising the ore; hand labour is quite insufficient for this, and machinery for the purpose has become a necessity in practically all goldfields. Crushing machinery is the first necessity, in which the ore is pulverised after it has been broken up into smaller pieces by heavy rough crushing stamps. In works where extensive operations are carried out the latter machines require at least 30 H.P. to 40 H.P., and each stamp for pulverising the ore delivered from the rough crushing stamps will need about 3 H.P. or 4 H.P. delivered from the shafts of the motors.



Winding the Stator of One of the Generators.

The further treatment of the ore after it has been crushed, to recover the pure gold, can be carried out in various ways. From among the processes which have been successfully carried out in practice we need only mention the amalgam process, in which the gold is separated with the aid of mercury, and the McArthur-Forrest process, in which the gold is recovered from a cyanide solution by electrical means. In both these cases the cyanide solution serves in the first instance to extract the gold from the finely-pulverised

ore so that afterwards the metal can be recovered in a pure condition by means of zinc filings or by the electric current. For all this work, in whatever manner it may be carried out, motive power is necessary, partly for the transportation of the various materials and partly to work the pumps, &c. Lastly, a workshop is required in order that all kinds of repairs can be carried out on the spot, and even parts of the machines removed. Besides what is used for power purposes a certain amount of electrical energy is also necessary for lighting.

A Shift of Fitters.

Part of the Plant on its Way to the Works.

Thus the power required for a gold mine even of small dimensions may be computed at several hundred H.P. at least. This estimate assumes further that only quite small machines are necessary for transportation of the ore. If the gold-bearing strata lie at a considerable depth and can only be reached by means of a shaft, of course a considerable power has to be added for working the cages and lifts. Then, again, in such cases a large quantity of water has to be pumped away. At the Redjang-Lebong mine, electrical energy is required for the following purposes:—

(*a*) Stamps, including the rough crushing stamps, and separators for separating the coarse from the fine material coming from the stamps themselves; 66 H.P.

(*b*) Extension of the stamping equipment, 37·5 H.P.

(*c*) Compressor to produce compressed air for working the drills, 37·5 H.P.

(*d*) Workshop, 10 H.P

(*e*) Pumps for the cyanide solution, 10 H.P.

(*f*) Lighting, 10 H.P.

Initially, Mr. G. A. Wright, the technical manager of the mine, has adopted compressed air drills, but tests are to be made with electrically-driven drills to see if the small energy consumption claimed for this pattern is borne out in practice.

The water power, which is at a distance of 2 miles from the mine, has a fall of 133 metres (436ft.). At first only about 10 cubic metres (2,200 gal.) of water per minute will be made use of, so that assuming an efficiency of 85 per cent., about 125 H.P. will be available. Pelton wheels were adopted in view of their simplicity and the advantages they offer in the case of a high fall. There is sufficient water for a considerable extension of the present installation.

The Pelton wheels are directly coupled to three-phase generators, this being the natural arrangement in view of the high speed of this class of water motor. A pressure of 2,200 volts has been chosen, and this is generated directly from the machines without the interposition of transformers. Each of the three generators is rated at 100kw. for an inductionless load. In erecting the station, a considerable difficulty was experienced owing to the absence of transport facilities,

Carrying a Shaft through the Forest.

the generating station being at a distance of 170km. (106 miles) from the coast. The nature of the country to be traversed was such that a light railway was out of the question, and all the parts of the machinery had to be carried in small, low two-wheel carts or else by hand. One of our illustrations gives a view of a couple of these carts, and another shows a gang of natives carrying a shaft through the forest. On account of these transport difficulties no single piece was allowed to weigh more than 600 kg. (12cwt.), and this necessitated quite special designs in the case of some of the larger motors and the dynamos. For instance, the stators of the larger machines, which, according to usual practice would be made in one casting for machines of this size, had to be made in four pieces, and the iron stampings had to be delivered separately and fitted into the casting on the spot. Thus the dynamos could not be wound at Messrs. Siemens and Halske's works, and this had to be done during erection. In order that the winding might be carried out in the easiest and quickest possible manner, mica troughs were employed for the insulation, and these were laid directly in the open slots of the cores.

Power Line through the Jungle.

A staff of three was sent out to erect the plant, the man in charge being assisted by a dynamo fitter and a second fitter for the erection of the overhead line, the latter member of the staff being considered as a reserve hand to take the place of one of the others in case of illness.

The smaller motors, and also the two 37·5 H.P. motors, did not occasion the same difficulties as the three dynamos. The 37·5 H.P. motors merely had their stators divided into two halves, and each part of the machine separately packed, and in the case of the switchboard also, by dividing it up suitably, it could be packed in cases within the maximum limit of weight without any modification in the standard design. It took some weeks to carry the dynamo shafts from the coast to the works. As already mentioned, this was done by coolies, in the manner shown in our illustration. The two wooden frames seen at each end were to guard against damage to the shaft when setting it down. Considerable difficulties were experienced on the way, and in one case the journey was stopped by an earthquake, followed by landslips. The buffalo carts employed for the other dynamo parts afforded a relatively convenient and advantageous means of transport, but even in this case trouble was occasioned by the tropical rains, which not only spoilt the roads, but also frequently caused damage to the contents of the cases. Some of the dynamo windings and instruments suffered in this way, either owing to their cases having been broken in transit, or to the heavier ones having been unpacked on arrival at the coast, their contents divided, and re-packed in smaller cases without proper provision for rendering them watertight. Fortunately the possibility of mishaps of this sort had been anticipated to a large extent, and plenty of spare parts, especially material for winding, &c., had been sent out. It took four months to erect the plant once it had arrived at the station, and in this work the German fitters were assisted by native labour.

The illustration opposite shows a section of the high-pressure transmission line through the jungle. The poles were chosen as high as possible, so that the line should not be damaged by the quickly-growing trees, and a thorough inspection of the line takes place at regular intervals of time. The entrance of the line into the station and the three horn-shaped lightning protectors is shown in the figure on page 575. As the walls of the building are only of thin boards, it was necessary to add a panel, as seen, to hold the insulators and the porcelain leading-in tubes.

The smaller motors and lighting are provided for on low-pressure circuits through transformers, but some of the larger motors are supplied directly at 2,000 volts. In order to be secure against accident, the switches, cut-outs, ammeters, and voltmeters are enclosed in cases which are carefully earthed. Rubber cable, with extra good insulation, is employed within the buildings, and fixed to the wall with iron fastenings which are earthed here and there. Up to the present no accident has occurred. A telephone enables communication to be held between the generating station and the mine. The telephone wire is placed beneath the high-pressure wires on the same posts. In order to guard against injury, should a high-pressure wire fall and come in contact with the telephone line, a telephone set, specially designed for such cases, is employed, in which the mouthpiece and receiver ear-pieces are connected to the instrument by rubber tubes, and are not in metallic connection with it.

The whole installation has been working for several months to the satisfaction of the owners of the mine, and Messrs. Siemens and Halske are to be congratulated on their success. It is to be regretted that British firms are not more frequently engaged on similar enterprises, for there now should be plenty of demand for electrical power transmission plant in our colonies and dependencies.

## THE COWPER-COLES ELECTROLYTIC PROCESS FOR THE MANUFACTURE OF PARABOLIC REFLECTORS.

We have referred on several occasions to Mr. Cowper-Coles process for manufacturing parabolic reflectors. We are now able to give some account of a plant (Fig. 1) that has been erected recently for the Search Light Syndicate (of America), Ltd., for the manufacture of parabolic mirrors and locomotive headlights. Four of these reflectors have recently been fitted to the United States cruiser "Albany." The process is entirely electrolytic, one of the chief features being that the surface produced requires no after polishing or trueing up. When once a true mould has been produced, any number of reflectors can be reproduced from it at a comparatively small cost. A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic or other reflecting surface. As the mould only

requires shaping and polishing on the convex side, it is comparatively cheap as compared to a glass reflector, which has to be ground on both sides. The glass moulds are prepared as follows: First of all a convex cast-iron mould is made to the approximate curve of the mirror. From this a concave mould is made of refractory material. Over this is laid a piece of flat glass about ¼in. thick, the whole being placed in a furnace and heated to such a temperature that the glass will adapt itself to the curvature of the mould without fusing. The roughly-shaped glass mould thus prepared, is then ground and polished on the convex side only. The mould is slowly revolved, the first breaking-down operation being done by means of emery wheels, the desired curvature being given to the mechanical feed by means of a template or gearing. The glass is finally polished with pads and rouge, which are caused to move over the surface in different directions. This process is an expensive and laborious one, two or three months being taken with the largest-sized reflectors.

white metal, and is sufficiently ductile to be rolled into thin sheets. Its specific gravity is 11·4, being about half that of platinum. The present price of palladium is about double that of platinum, but its density being only one-half, the same area can be covered at the same cost.

In carrying out the manufacture of reflectors by this process, it is essential that the glass mould should be perfectly clean and free from grease before the silver coating is applied. It has been found, however, that if the cleaning is solely effected by chemical means there is a great liability to the silver adhering too firmly to the glass, whereby the mould is in danger of being broken during the removal of the reflector. This difficulty has been overcome by cleansing the mould with a suitable paste or powder, such as peroxide of iron, and then washing the glass with a 50 per cent. solution of ammonia. It is necessary that this cleansing operation be repeated prior to the production of each mirror. After the convex side of the mould has been properly cleaned a thin

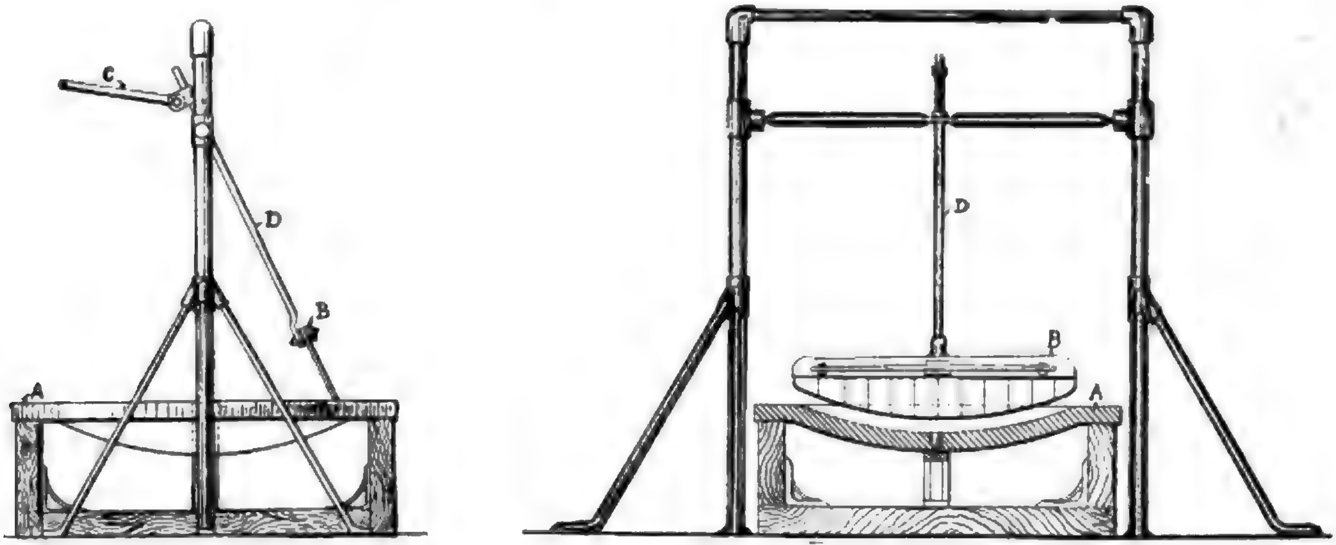
FIG. 1.—THE SEARCH LIGHT SYNDICATE'S PLANT FOR THE MANUFACTURE OF PARABOLIC MIRRORS BY THE COWPER-COLES PROCESS.

The next step in the process, after having obtained a suitable glass mould, is to clean it, and then coat the convex surface with metallic silver, which is thrown down chemically on the glass and polished so as to ensure the copper backing being adherent to the silver. The glass mould (marked A in Fig. 1) is then placed in a suitable ring and frame and immersed in an electrolyte of copper sulphate, the mould being revolved in a horizontal position at about 15 revs. per min. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and then gradually raising the temperature of the water to 120°F., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The concave surface of the reflector thus obtained is an exact reproduction of the surface of the mould. It has the same brilliant polish, and requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal to prevent it tarnishing. Palladium is found to answer this purpose; a bright coating can be deposited rapidly to any desired thickness. This metal resists to an extraordinary degree both tarnishing and the heat of the arc. It is a silver-coating of metallic silver is applied as follows, the process being that commonly employed for silvering reflectors for astronomical telescopes. Two solutions are prepared, the first of which contains the silver salt, the second the sugar preparation. Ammonia is added to a solution of nitrate of silver until the precipitate that is formed is dissolved, then re-precipitating with caustic soda, and again dissolving in ammonia; a solution of glucose is then added. Excellent results have been obtained with a silvering solution made up of equal parts of solutions of the following strengths: Silver nitrate 0·55 per cent., caustic potash 0·25 per cent. Mr. Cowper-Coles has found the weight of silver deposited from such a solution to be equal to about 0·000588grm. per square inch, the thickness being 0·0000034in. The surface of the mould to be coated is immediately dipped into the solution face downwards. In from 4min. to 5min. the silver begins to form on the glass mould, the solution changing from pink to dark brown and black; the film thickens quickly, and in from 30min. to 35min. a good coating of silver is deposited. Dr. Common has found a good deposit of silver to have a thickness of $\frac{1}{25000}$in. The silver is found to be thicker, clearer, and more uniform if the glass mould is dipped into a solution of protochloride of tin, and then washed

before being placed in the silvering bath; the action is supposed to be catalytic. The silver coating is thoroughly washed and then allowed to dry, and the silver which has been deposited is burnished bright with a piece of cotton wool and peroxide of iron, freshly precipitated by ammonia from a dilute solution of ferrous sulphate. The cost of silvering is found to vary from 2d. to 4d. per inch diameter.

The apparatus used for silvering can be seen in the right-hand corner of Fig. 1. A is the glass mould ready for silvering, mounted on a sucker formed by a disc of rubber or leather, backed with a metal plate, and attached to one end of a tube which communicates with an exhaust pump and vacuum gauge, B, and has its other end fixed to a screw rod C, D is a rotary wooden bar having metal journals attached to its ends. These journals are mounted on plummer blocks fixed on a wooden frame. A hole is bored through the centre of the bar at right angles to the longitudinal axis, into which is fixed an internally screw threaded metal bush. The screw rod C engages with this bush, and has a hand wheel attached to its free end. E is the washing tank containing the silvering solution. When required for use, the bar D is rotated by means of a hand wheel, until the sucker is turned up into a vertical position. The concave surface of the mould A is then placed on the sucker, and the air exhausted from between the mould and the sucker by means of the exhaust pump; the mould is thus securely attached to the apparatus. when a copper backing is being deposited, is of copper. The anode rests upon packing blocks and has vertical rods attached to it, the free ends of which are adjustably secured in metal brackets attached to the sides of the vat and one to the main frame. By means of adjusting these rods in the brackets, the distance between the anode and the mould or cathode may be regulated. The tank is fitted with an inlet at the bottom of the tank and an outlet at the top for the supply of the electrolyte; one terminal is connected to the mercury box, which is in electrical connection with the shaft H, the cross-arms D, the bolts F, and the mould forming the cathode, the positive terminal being connected to the anode by means of copper cable.

When first lowering the mould into the solution it is advisable to avoid throwing the work of carrying the whole electric current on the silver alone, so the shaft H is raised by means of pulley blocks to suspend the mould. The mould is then tilted and the shaft gradually lowered, bringing the edge of the mould in contact with the electrolyte, the circuit being thus established. A thin film of copper is deposited at the place of contact near the edge of the cathode. The shaft is then lowered until it rests on the bearing, and at the same time the mould is allowed to resume its horizontal position. The operation just described occupies a very brief interval of time, and the current for a few minutes is worked at a pressure of about 6 volts, which is ultimately reduced.



FRONT ELEVATION.

Figs. 2 and 3.—Apparatus for Deposition on Backing.

When the glass mould is in this position it is cleaned as previously mentioned. It is then, by means of rotating the bar D, turned down into the tank E, when its concave surface is submerged into the silvering solution and coated with silver by the process already described, and finally washed and polished.

The mould is now removed from the sucker, and placed so that its bevelled edge fits accurately into the corresponding inner edge of a bevelled metal ring which serves to support it in the copper-depositing tank, while the metal backing of the reflector is being deposited. The metal ring is suspended by means of metal bolts, F, from metal crossbars G. These crossbars are connected by means of the metal bolts to a metal frame, which is hinged to a vertical shaft, H, by means of a pin or pivot. This shaft passes through a box, and is carried on the main frame by means of a bearing, having balls, which support the shaft by a collar, and allow it to rotate freely. A pulley, I, is provided, through which the shaft and the mould may be rotated freely by a belt or cord. Attached to the metal ring by means of small bolts are an annular baffle-plate and an annular stopping-off ring. The distance of the baffle-plate below the stopping-off ring is regulated by packing pieces. The object of the baffle-plate is to prevent the formation of "trees" or "nodules" at the edge of the mirror, and the stopping-off ring or plate is to determine the exact size of the mirror. Situated also in the tank is the anode, which, It is very important that the silver be flashed over with copper immediately on immersion in the copper sulphate solution. At this stage the baffle plate and stopping-off ring are not applied, and the mould simply rests on the metal ring. The shaft is then rotated, and the operation of depositing the base metal continued until a sufficiently thick coating has been obtained to act as a good conductor to the electric current. The copper solution generally used is of the following composition: Copper sulphate, 14 per cent., sulphuric acid 3 per cent., water 83 per cent. When sufficient copper has been deposited to act as a good conductor, the metal ring, with the mould in it is lifted out of the bath, and the stopping-off ring and baffle-plate applied, the one to determine the size of the reflector and the other to prevent the formation of "trees" and "nodules" at the edge of the reflector. The stopping-off ring also ensures a clean even edge. After a sufficient thickness of metal has been deposited on the mould to form a suitable backing, the mould with the deposit upon it is removed from the tank, and the reflector backing separated by heating. The concave surface of the backing is now chemically cleaned, preferably with potassium cyanide or hydrate, and the backing (see Figs. 2 and 3) placed in an earthenware pan adapted to fit it, where a reflecting and protecting surface of platinum or palladium is deposited upon it. This apparatus cannot be seen in Fig. 1 as it is hidden

by the partition buttress. The tank A is supported on a wooden frame, its height being regulated by means of packing pieces. An anode is suspended from the main frame, and consists of carbon plates fixed in a holder B by means of lead strips. The carbon plates are arranged to form an approximate curve to the mirror. The height of the anode can be adjusted by means of a vertical movement of the rod D which is attached to the holder B. One end of a connecting rod, C, Fig. 3, is pivotted to the rod D, and the other end is pivotted to a revolving disc. The disc is provided with a radial slot in which the pivot carrying the connecting rod is adjustable, so that by shortening or lengthening the distance between the pivot and the centre of the disc, the throw of the connecting rod can be regulated. The electric terminals are attached to the backing which forms the cathode, and to the frame carrying the anode holder B.

If the reflector is to have a surface of platinum, the tank is filled to a sufficient depth with a solution of platinum, composed of a freshly-precipitated solution of the double chloride of platinum and ammonium, dissolved in a boiling concentrated solution of neutral citrate of sodium. If the reflecting surface is to be composed of palladium, a solution of palladium ammonium chloride is used. During this last process the anode is caused to swing backwards and forwards through the electrolyte by means of the revolving disc, in order to obtain an even deposit over the whole surface of the reflector, to keep the electrolyte agitated, and to prevent the deposition upon the reflecting surface of any foreign matter; 70 to 80 grains of palladium per superficial foot is found to afford a good protective coating. The silver-faced reflector previous to being placed in the palladium solution is thoroughly washed with a hot, weak solution of caustic soda. The back of the reflector is usually varnished before placing in the bath, to prevent local action setting up between the copper and silver and the palladium solution. When sufficient palladium has been deposited on the reflector, it is removed from the bath and dipped in boiling water, and is then ready to be mounted in a suitable clamping ring. This ring is provided with a knife-edge which holds the reflector against a ring of asbestos, placed in a groove. The knife-edge retains the reflector in position after it has been carefully centred, whilst resting on the asbestos ring.

Reflectors made by the process which has been described above have been subjected to a number of tests, and have been found to stand excessive heat without tarnishing. Salt water has been thrown on the reflectors when they have been too hot to touch, the result being that the water was driven off as steam, the salt being left behind as a white deposit, which was easily removed with a wet cloth. A reflector tested at Portsmouth had a number of rifle bullets passed through it, when the parallelism of the rays was found to be but little affected. On the other hand, the first shot fired at a glass reflector splintered it to pieces. Some 8ft. mirrors, made by the process for coast defence, were placed in a projector case, in which was worked a 175-ampere lamp, for six hours, during which time the temperature at the top of the reflector was found to be 740°F. On removal the palladium-faced mirror was found to be quite bright with the exception of a few small stains which were easily removed with a chamois leather.

For the above account of this ingenious process, as well as the illustrations which accompany it, we are indebted to Mr. Sherard Cowper-Coles.

## A NEW AUTOMATIC CUT-OUT.

BY H. MÜLLER.

In order to protect electrical circuits and apparatus against injury from too strong a current, safety fuses were formerly exclusively employed which, consisting of an easily fusible metal, melt if a short-circuit occurs in the circuit. In installations, however, in which overloads of short duration often occur, as, for example, is the case in tramway installations when there is a simultaneous starting of a number of tramcars, the safety fuses are inconvenient, because the insertion of a new safety fuse always involves trouble and some loss of time. Automatic cut-outs have, therefore, been constructed which are to be regarded in reality as a combination of an ordinary lever switch with an electromagnet. As soon as the current, in consequence of short-circuit or from any other cause, becomes too great, the electromagnet becomes strong enough to switch out the lever, which is held firmly by a spring in the switched-in position.

All apparatus which have hitherto been constructed for the purpose have in common a shortcoming which renders their application inappropriate. If the apparatus has started working, and the current has been interrupted, it is possible that on again switching in, the cause of the current being too strong will continue. If now the handle used for switching in the apparatus is held tight in the hand in the switched-in position, the automatic interruption cannot occur, and the injurious influences of an excessively strong current are not prevented. In order to be safeguarded in this respect it has hitherto been necessary to add a special hand switch besides the automatic cut-out, which hand switch, after the operation of the automatic cut-out in the event of a short-circuit, is first opened, and is switched in again only after the

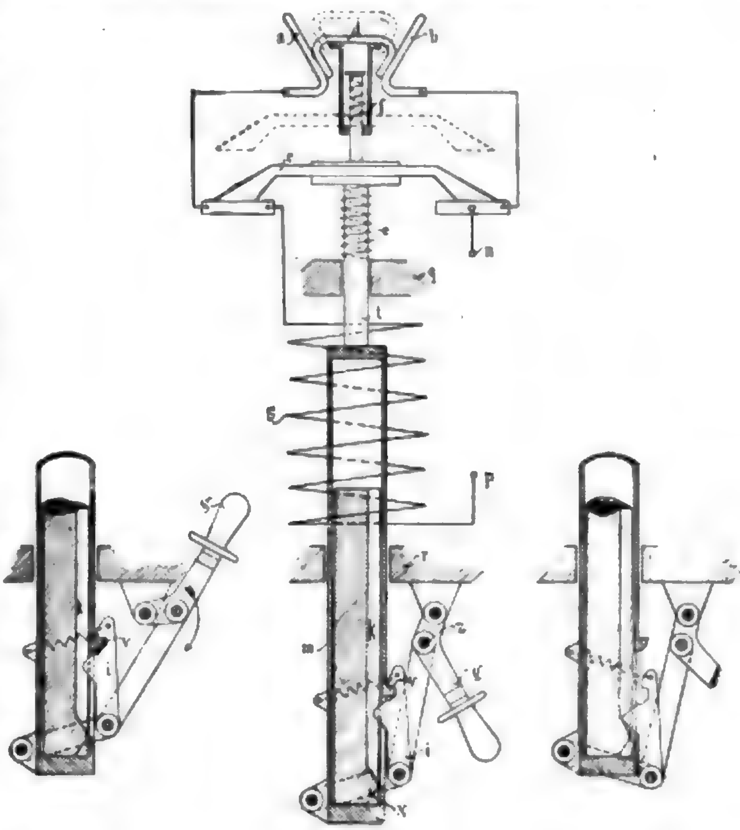


FIG. 1. FIG. 2. FIG. 3.

automatic cutout has been already closed. If an apparatus were desired which would avoid the defect above-mentioned, it would have been necessary to make the construction so that the mechanism for switching out, acted upon by the electro-magnet, would be rendered independent of the hand lever.

This problem has been solved in a newly-introduced design by the firm of Schuckert. The construction is shown in diagram in Figs. 1 to 3, and its external appearance in Fig 4. The closing of the circuit is effected by means of a main contact piece, *c*, and an auxiliary contact piece, *d*, in shunt with the former. The piece *c* is composed of thin springs, which, when pressed down, rub on the support, and thereby give a good contact. The same effect is obtained at *d* by the contact parts being made elastic. The two parts *c* and *d* are not rigidly connected with each other, but come into or out of contact one after another on switching in and switching out respectively. The part *d* is carried on a loose cap, which encloses the cylindrical upper prolongation *t* of the contact piece *c*. A tube, *m*, is attached to the lower end of *t*. The tube *m*, together with the support *t*, is kept

in its vertical position at the points *q* and *r*. A link connected with a detent, *i*, is set in motion by a handle, *g*. The detent takes hold of a projecting piece, *r*, of the tube *m*. Fig. 1 shows the lowerpart of the apparatus in the switched-out position, in which case the contacts *c* and *d* take the position indicated by the dotted line in Fig. 2. The cap which carries the piece *d* rests in this position on the head of *t*. If the hand lever *g* be pressed downwards, the tube *m* together with the piece *t* is moved downwards also by the detent *i*. The piece *d* first comes into contact with *a* and *b*, and is pressed tightly against them by the spring *f*. When *d* moves farther, the contact piece *c* comes also into contact. When the lever *g* has come into the position represented in Fig. 2, the apparatus is completely switched in. Should the current rise above a certain value, the iron core *k* in the tube *m* is drawn upward by the coil S, whereupon the nose *x* strikes against the projection of the detent *i*, and makes the latter lose its hold. Thus the tube *m* is freed, and *t* can be acted on by the spring *e*, which drives it upwards. When the upward movement takes place the principal contact *c* first comes out of connection, and only afterwards the switching out is effected by means of the contact in the shunt.

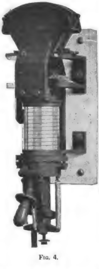


Fig. 4.

The significance of this contact lies, firstly, in the fact that the production of an arc can only occur at this easily renewable part. The arc which is being formed is, however, at once extinguished by the blowing operation of the magnetic field created between the two iron plates visible in Fig. 4, which are placed before and behind the pieces *a*, *b*, and *d*, and represent the poles of an electro-magnet which is excited by the coil S. The pole-plates serve at the same time as supports for a box made of fireproof insulating material, which encloses the parts *a*, *b*, and *d* at the sides and underneath like a chimney. In Fig. 3 the lowerpart of the apparatus is represented in the position which it takes after the automatic switching-out. To switch the apparatus in again the lever *g* is brought again into the position shown in Fig. 1, whereupon the detent is again thrown into gear, and the switching-in follows in the manner before described. If the cause of the excessive strength of current still continues on switching-in, the iron core is again driven upwards under the increased influence of the coil, detaches the detent, and the operation above described of switching-out is repeated, while the hand lever *g* remains in the switched-in position. Even when holding the hand lever firmly, the above-mentioned defects of apparatus of older design cannot occur, and thus the application of a special hand switch along with the automatic cut-out becomes superfluous.

By means of the screw visible at the lower end in Fig. 4, the stationary position of the iron core *k* can be altered, and the apparatus adjusted for various currents.

## BOOKS RECEIVED.

Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.

"The Automotor and Horseless Vehicle Pocket Book for 1901." (London: F. King & Co.) 1s. 6d.

"Mesures Electriques." By Eric Gerard. 2nd edition. (Paris: Gauthier-Villars.)

## THE PRESENT STATUS OF THE ELECTROLYTIC REFINING INDUSTRY IN THE UNITED STATES.*

BY TITUS ULKE.

The wonderful development of electrolytic refining—that is, the art of purifying metals or alloys by removing the objectionable impurities and contained precious metals from the alloys or crude metals to be refined and simultaneously electro-depositing commercially pure metals—in the United States can best be appreciated by comparing the condition of this industry in previous years with its status to-day. Let us consider, in order, the electrolytic refining of bullion or alloys of copper, silver, and of gold, which are to my knowledge the only metals or alloys electrolytically refined on a commercial scale in our country.

*Copper.*—The art of electrolytic copper refining, invented in 1865, by James Elkington, was first practically applied in the United States in 1879. At this time small electrolytic separating works were operated at Phœnixville, Pa., with two of Weston's nickel-plating dynamos, but the Balbach establishment of Newark, N.J., was the forerunner on a large scale of this branch of metallurgy. The progress of electric refining, from its introduction, 20 years ago, until to-day, has certainly been phenomenal. Since 1880, when by far the greater part of our copper, in the condition of sulphide or matte, was shipped abroad to be refined, there has been a steady increase in the quantity of crude copper or matte refined here, and a decrease of the amount shipped for refining to Europe. Our refiners now smelt and refine practically all of our domestic matte and crude copper, and, in addition, treat electrolytically a considerable quantity from other countries, among these being Mexico, Australia, Tasmania, and Japan. Our copper exports, which are very considerable both in tonnage and in value, now consist of refined copper, instead of the much less valuable ore, matte or bullion as formerly, and we no longer, therefore, pay a tribute to foreign refiners.

A glance at the statistics of production of electrolytic copper during a few recent years will show the rapidity of the increase. In 1889, according to the census, the United States produced nearly 80,000 short tons of fine copper, of which less than 25,000 tons were obtained electrolytically. Only five years later, the production of electrolytic copper in the United States alone had risen to over 57,000 tons, or nearly one-third of the world's copper output at that time, and it steadily increased until in 1900 it reached the enormous total of 211,000 tons, or about 422,000,000lb. This is eight times what it was 10 years ago, and equal to half of the entire copper production of the world.

The estimated daily output of the 11 copper refineries in this country is 579 tons. From the copper treated are obtained gold and silver slimes containing over 53,000oz. of silver per diem, or over 19,400,000oz. per annum, besides nearly 174,000oz. of gold. It thus appears that more than one-third of our total silver output is now derived from copper ores. It is also interesting to note that the cost of refining copper to-day is but half of what it was 10 years ago, and that contracts have been recently closed for refining copper anodes for as low as $8 per ton. We will now consider some of the conditions which have made such a cheapening of the cost possible, and outline the present practice of electrolytic refining.

As is generally known, the object of electrolytic copper refining is two-fold: First, the saving of the gold and silver always found in crude copper; and, secondly, the separation and removal of the bulk of the impurities, such as antimony and arsenic, from the fine copper, so that the latter will possess a high electrical conductivity, and will be suitable for drawing into wire or pure enough for the various uses for which copper is required in the arts.

There are at the present time only two systems of refining in commercial use—the multiple and the series system. The series or Hayden system is in use at only two refineries, one at Baltimore and the other at Brooklyn, and is only advantageously employed where the crude copper to be refined is of uniform high grade and can be rolled out into smooth long sheets about ¼in. thick. In the usual or multiple system the anode sheets are cast into plates and not rolled, and they are usually between 1in. and 2¼in. thick. As the series system requires a rolling mill, which will consume about one-third of the power of the plant, and a special refining of the crude blister copper to adapt it to rolling, it is not in general use in the United States.

The composition of typical anodes of refined blister copper is as follows: 99·250 per cent. copper, 0·338 per cent. silver, 0·001 per cent. gold, 0·300 per cent. oxygen, 0·054 per cent. antimony, 0·033 per cent. arsenic, 0·009 per cent. lead, 0·008 per cent. selenium and tellurium, 0·002 per cent. bismuth, 0·002 per cent. nickel and a trace of iron. After being electrolytically refined and melted into wire-bars and other shapes for rolling and conductivity purposes, the commercially pure electro-deposited copper obtained from such anodes has approximately the following composition: 99·925 per cent. copper, 0·001 per cent. silver, 0·070 per cent. oxygen, 0·002 per cent. antimony, 0·001 per cent. arsenic and 0·001 per cent. lead.

The chief characteristic of modern copper refining in the United States is the introduction and adoption of efficient labour-saving

---

* From the *Electrical Review* of New York.

*Electrolytic Copper Refineries in the United States (operated in 1900).*

| Name of company and location of works. | Kind of material chiefly treated. | Daily output of electrolytic copper in tons (2,000lb.). | Number and capacity of generators. Kw. = kilowatts. | No. of tanks in refinery. | Arrangement of electrodes. | Daily output of gold and silver from slimes. |
|---|---|---|---|---|---|---|
| Raritan Copper Works (Lewisohn Bros.), Perth Amboy, N.J. | United Verde, Utah, B. & M. and Mt. Lyell copper. | 160 (capac. 160) | 3 Westinghouse @ 600kw. | 1,600 | Multiple. | 8,800oz. Ag. 170oz. Au. |
| Anaconda Mining Co., Anaconda, Mont. | Anaconda anodes | 100 (capac. 135 | 6 W'hse @ 270kw. 2 W'hse @ 300kw. 1 W'hse @ 220kw. | 1,430 | Multiple. | 8,000oz. Ag. 35oz. Au. |
| Baltimore Smelting and Rolling Co., Baltimore, Md. | Anaconda anodes | 80 (capac. 100) | 8 Edison @ 80kw. 3 W'hse @ 60kw. | [illegible] | L. p. series. S. p. multi. | 6,400oz. Ag. 28oz. Au. |
| Boston & Montana Cons. Copper & Silver Mining Co., Great Falls, Mont. | Boston and Montana anodes | 60 | 2 Westinghouse @ 600kw. | 600 | Multiple. | 3,960oz. Ag. 9oz. Au. |
| Nichols Chemical Co., Laurel Hill, N.Y. | Copper anodes from Spanish and Canadian pyrites cinders, and Mountain Copper Co. | 60 | 4 General Electric @ 200kw. | 400 | Series. | 1,000oz. Ag. 24oz. Au. |
| Guggenheim Smelting Co., Perth Amboy, N.Y. | Mexican and Colorado copper anodes | 50 | 3 General Electric @ 180kw. | 390 | Multiple. | 20,000oz. Ag. 175oz. Au. |
| Balbach Smelting and Refining Co., Newark, N.J. | Orford anodes and miscellaneous | 30 | 8 Excelsior @ 75kw. | 432 | Multiple. | 2,500oz. Ag. 13oz. Au. |
| Bridgeport Copper Co., Bridgeport, Ct. | Parrot anodes | 30 | 3 General Electric @ 200kw. | [illegible] | Multiple. | 1,800oz. Ag. 6oz. Au. |
| Irvington Smelting and Refining Co., Irvington, N.J. | Miscellaneous | 9 | 2 Hochhausen @ 80kw. | 90 | Multiple. | 720oz. Ag. 2oz. Au. |
| Chicago Copper Refining Co., Blue Island, Ill. | Copper from by-products and miscellaneous pig copper | 5 | 2 Edison @ 64 kw. | 200 | Multiple. | 100oz. Ag. 2·5oz. Au. |
| Buffalo Copper Works, Buffalo, N.Y. | Argentiferous copper from near Lake Superior, Mich. | 5 | 1 General Electric @ 200kw. | 100 | Multiple. | 100oz. Ag. 2oz. Au. |

Estimated total daily production of electrolytic copper 579 tons, or about 211,000 tons annually.
Estimated total gold and silver obtained in refining copper annually: 19,483,700oz. silver; 175,923oz. gold.

*Electrolytic Nickel Refinery (probably not now in operation).*

| Name of company and location of works. | Material treated. | Estimated daily output of electrolytic nickel. |
|---|---|---|
| Balbach Smelting and Refining Co., Newark, N.J. | Orford crude nickel anodes. | 6,000lbs. |

*Electrolytic Silver Refineries in the United States (operated in 1900).*

| No. | Name of company and location of works. | Material treated. | Estimated daily output. |
|---|---|---|---|
| 1. | Guggenheim Smelting Co., Perth Amboy, N.J. | Doré bullion. | 100,000oz. Troy. |
| 2. | Pennsylvania Lead Co., Pittsburgh, Pa. | Doré bullion. | 35,000oz. Troy. |
| 3. | Globe Smelting and Refining Co., Denver, Colo. | Doré bullion. | 25,000oz. Troy. |

*Electrolytic Gold Refinery (in process of erection).*

| | | |
|---|---|---|
| U. S. Mint, Philadelphia, Pa. | The material refined is gold bullion. | Estimated daily output 1,000oz. Troy. |

devices, both to and from the melting furnaces and the electrolytic tanks. Thus the largest and probably the best equipped electrolytic refinery in the world—*i.e.*, the Raritan works of the Lewisohn Bros., at Perth Amboy, N.J., is provided with a simple and very effective casting arrangement, in which the molten copper is tapped from the melting furnaces into moulds attached to an endless conveyor running in front of the furnace but sunk below the floor level and covered by removable iron plates, so as not to interfere with the approaches to the furnace in any way.

In the tank room a full tank load of electrodes is handled at one time by means of a rack-frame and travelling crane, and charged into one of the 1,600 tanks in the refinery referred to, or discharged therefrom, as desired. This means a great saving in the labour item alone, besides facilitating very rapid work. Walker's casting machine is also gaining much favour and is being introduced into several large refineries.

In conclusion I may add that considerable quantities of copper matte and bullion are now shipped from many parts of the world to the United States to be treated, chiefly because refining costs less here than in Europe, due to the large capacities, excellent equipment and progressive management of our leading electrolytic refineries.

*Silver.*—The first electrolytic silver refinery in the United States was erected in 1886 by the Pennsylvania Lead Co., near Pittsburgh, Pa., and, in its rebuilt state, is probably still in operation. It has a daily capacity for parting from 30,000oz. to 40,000oz. of doré bullion. A similar refinery was built a few years later by the St. Louis Smelting and Refining Co., but is now closed down, like the balance of this company's St. Louis works. In 1895 the Guggenheim electrolytic silver refinery at Perth Amboy, N.J., was erected, and later rebuilt and enlarged, so that it is now probably the most extensive in the world. The Globe Smelting and Refining Co.'s electrolytic silver refinery, near Denver, Colo., was not started until the spring of 1898.

In the electrolytic parting of silver and gold it is not necessary to obtain the deposited metal in sheet form, as silver in crystals is readily melted into bars. Owing to the great value of the metals treated, the chief aim is to secure a rapid output. As high a current density is, therefore, employed as is possible without unduly heating the electrolyte or carrying over impurities from the anode. Short circuits produced by the bridging over of silver crystals from cathode to anode when high-current densities are used can be avoided by scraping off the silver crystals. These fundamental principles were first recognised and commercially applied by the late Dr. Bernard Moebius, who, in 1884 and in 1895 respectively, patented the only two forms of apparatus now in commercial use.

The old Moebius process, in use at Pittsburgh, Pa., and Perth Amboy, N.J., and in which a fixed cathode is employed, is distinguished from the Moebius continuous-band process, now used at the Globe smelter, of Denver, Colo., and characterised by a moving silver cathode band. It will be impracticable to describe either of these processes here, but it may be pointed out that the Moebius continuous-band process was abandoned at Perth Amboy chiefly because of the difficulty of removing the deposited silver from the silver belts. A few years ago, however, Mr. Gustave Nebel, formerly an assistant to Dr. Moebius, discovered that oil will prevent the close adherence of the electrolytically deposited silver crystals to the belt, which fact has been successfully applied by Mr. Nebel to the band process as employed in the new Globe refinery. Another important improvement made in the last-mentioned plant was the replacement of the platinum electric contact points, formerly employed, by the both cheaper and better conducting contact points of silver, and the recognition of the necessity of removing the silver belts from the electrolyte when not in use to avoid their gradual solution.

In conclusion, I may add that the cost of parting doré silver by the Moebius electrolytic process, with careful management, should not exceed 20 to 30 cents per 100oz.

*Gold.*—Regarding the electrolytic refining of gold bullion, experiments were made at the Philadelphia Mint, during the past year, with the Wohlwill process, in use since 1880, or thereabouts, at the Norddeutsche Affinerie, at Hamburg, leading to the adoption of this process by the United States Government.

The Wohlwill method of producing chemically pure gold by electrolysis, and slightly modified by Dr. D. K. Tuttle and Mr. H. J. Schlaeker, will be installed at the new Philadelphia Mint. Thus far about 2,000lb. of gold bullion have been electrolytically refined at the old mint in Philadelphia, and beside the pure gold, platinum and other metals of the platinum group were recovered as by-products. The chief feature of the Emil Wohlwill process is the addition of hydrochloric acid or sodium chloride to an electrolyte of gold chloride, so as to prevent, or at least diminish, the evolution of chlorine at the anode and the consequent impoverishment of the gold contents of the solution electrolysed. In this respect there is an essential departure in the behaviour of gold from that of copper and silver under like conditions.

Wohlwill has demonstrated that it is practical and profitable to continuously purify impure gold and gold alloys by employing comparatively weak solutions of gold chloride and electric currents of

a density as high as 100 amperes per square foot and even higher, through the combined influence of higher temperature and added hydrochloric acid. The electrolyte used is a solution containing about 25 to 30 grammes of gold per litre, and maintained at a temperature of about 60°C. to 70°C., with about 20 to 50 cubic centimetres, according to the current density, of fuming hydro-chloric acid with a specific gravity of 1·19, or, instead, 21 grammes or more of sodium chloride or common salt per litre. When sodium chloride is employed, the amount of the compound added should in every case be limited to 100 grammes per litre of electrolyte, as otherwise the silver chloride present would be dissolved in the alkaline chloride and be deposited at the cathode with the gold, thus defeating the object in view. Therefore the amount of sodium chloride in the solution is restricted to that which will suffice to bind the chlorine evolved at the cathode.

As Dr. Wohlwill states, when the temperature of the electrolyte and the quantity of hydrochloric acid (or salt) therein are in proper accord with the density of the electric current, the anode gold, platinum, palladium and the bulk of the foreign constituents of the anode will pass into the electrolyte under the influence of the electric current. The major portion of the iridium and other metals of the platinum group remain undissolved, and with these the silver is separated as solid silver chloride. Similarly, a portion of the lead is separated in the form of lead chloride as soon as the electrolyte becomes saturated therewith, or nearly so, while the bismuth is separated in the form of an oxychloride should the amount of hydrochloric acid present be insufficient to keep it dissolved. The above-described insoluble mud, which separates and readily drops off the anode in small quantities at a time, also contains a very small amount of anode scrap and gold, forming about 10 per cent. of the weight of the anode in an extremely fine state of division. The presence of this gold is due to the fact that a portion of the anode gold is at once converted into protochloride instead of normal chloride, and the protochloride immediately after formation is decomposed into normal chloride and finely-divided gold.

While, as described, a portion of the anode constituents pass over into the solution and another portion subsides in the form of an insoluble deposit, pure gold is exclusively deposited at the cathode, even from solutions of constantly increasing impurity and with currents of a density of 100 amperes per square foot. The gold extracted from the electrolyte at the cathode is therefore constantly replaced, chiefly by gold dissolved at the anode, and in part by equivalent quantities of other metals, but as the quantity of gold deposited at the cathode corresponds in part with the quantity of silver, lead and bismuth converted into solid chlorides, there is a gradual impoverishment of the electrolyte in gold, which is replaced by the addition of a sufficient quantity of gold chloride.

The simultaneous accumulation of foreign constituents in the electrolyte does not affect the purity of the gold deposited, even if there is an excess of such impurities, so long as the proper amount of gold is present in the electrolyte. In fact, the presence of these foreign constituents is even advantageous to the deposition of pure gold at the cathode, because the compactness of the deposit, which is very bulky from pure solutions, especially when currents of high density are employed, increases with an increase in the impurities in the electrolyte without affecting the purity of the deposited gold.

The above-described method of extracting gold permits of the recovery (from large quantities of anode materials) of the comparatively small percentage of platinum contained therein, which after the precipitation of the gold may be directly recovered in the form of ammonio-platinic-chloride.

Owing to the high value of the anode material and of the solution, as well as of the product of electrolysis, it is advisable to refine within the shortest possible time and in the smallest possible space. Accordingly currents of the highest possible density and comparatively thin anodes are employed. With an anode 4mm. thick and an initial current density of 40 amperes per square foot, the anode will be so far consumed in 24 hours that the remainder, about one tenth of the original weight, is preferably re-melted and used in making fresh anodes. The cathodes are made of thin rolled pure gold electrolytically obtained, and may be of the same length as the anodes but considerably narrower, because they rapidly increase in size in all directions under the action of the electric current, the deposit being a coherent one, even with current of a comparatively high initial density. This fact enables the refiner to place the electrodes in close proximity to each other, say 3cm. apart without danger of short-circuiting or endangering the purity of the cathode deposit. At the beginning of the electrolytic operation, when the electrolyte is yet free from impurities and the deposited gold is not very dense, the electrodes must be placed further apart or the cathodes more frequently changed.

The apparatus for refining gold bullion consists of a tank or vessel made of porcelain, stoneware, or other suitable material, upon which is arranged a frame of wood, carrying the two conducting strips or bars of copper or brass, to which the cross bars, say nine in number, are alternately connected by means of binding posts. A number of such tanks, the electrodes of which are in multiple circuit, are electrically connected in series, and the end tanks with the negative and positive poles of a dynamo. As it is necessary to maintain the electrolyte at a uniform level, notwithstanding its loss by evaporation due to heating, a reservoir containing fresh electrolyte is arranged above the electrolytic tanks, and provided with a normally closed filling aperture. Two pipes, *a* and *b*, lead from this reservoir, pipe *a* having its outlet slightly below the surface of the electrolyte in the tank, while *b* is a siphon-pipe that extends near to the bottom of the reservoir, and supplies liquid to the tank the moment the level sinks below the outlet of pipe *a*, and allows air to enter the same, while the flow of liquid from the reservoir is stopped the moment the level of the electrolyte has risen to seal the outlet of the pipe.

The water used in washing the gold deposits and the residues and mud, which are periodically removed from the tanks, can be placed in the reservoir and thus returned to the electrolyte without previously concentrating the same, as this is effected by the evaporation of the hot electrolyte during the electrolytic operation. If the anode material contains a comparatively great quantity of silver, the anode surface will be coated therewith in the form of non-conducting silver chloride that does not readily drop off, thereby reducing the active area of the anode and giving rise to the evolutions of gaseous chlorine, so that the anode will be insufficiently attacked, and the gold in solution will be precipitated. In electrolysing alloys of this kind the interruption of the operation by the deposition of silver chloride at the anode is readily avoided by removal of the chloride mechanically, which operation is performed periodically, the frequency depending upon the percentage of silver in the alloy and the density of the electric current. This also applies in case bismuth is present in the alloy. If the latter also contains a considerable amount of lead, the acid solution becomes rapidly saturated with lead chloride, and as soon as this is the case, both electrodes, as well as the internal surfaces of the tanks and the surface of the electrolyte, become coated with crystals of lead chloride. It is advisable, in order to avoid this condition, to add a quantity of free concentrated sulphuric acid to the electrolyte, say, equal to the quantity of free hydrochloric acid present. The lead then forms an almost insoluble deposit of lead sulphate on the anode, which sulphate gradually drops off or is mechanically removed.

The present status of the electrolytic refining industry in the United States and its great economic importance can perhaps best be appreciated by a study of the carefully compiled tables given on page 583.

## ELECTRICITY WORKS ACCOUNTS.

### Southampton Municipal Electric Supply Works.

It is gratifying to find that the position of the Southampton undertaking is steadily improving. During the year ended at March 31 last additional lamp connections raised the total to the equivalent of 35,000 8 c.p. lamps, or 77 per cent. above the preceding year. The year's output shows the still greater advance of nearly 99 per cent.

To some extent this progress is, no doubt, due to the starting of the tramways at the beginning of last year, but the influence of the traction load was, therefore, only over three months of the year.

The management charges show a very considerable reduction, and to a most satisfactory value. Owing solely to the excessive fuel charge of 1·19d. per unit, the generating, works, and total costs are above the average in municipal supply stations of similar magnitude. The other items of generating costs are satisfactory, especially the item of wages at the station.

Notwithstanding a considerable reduction in the average total revenue—a relatively greater reduction than that in the costs—the undertaking exhibited, for the first time, a surplus for the year.

### Whitehaven Municipal Electric Supply Works.

Although the results of the working at Whitehaven during 1899-1900 were less brilliant than those of the preceding year, the general position of the undertaking was quite satisfactory, even considering the favourable load factor of 13·2 per cent. which characterised the load. The generating costs were all low, notwithstanding the natural and material increase in the fuel charge. Unfortunately, the distributing costs were largely increased, and to an abnormal value, thus raising the works and total costs to figures perhaps slightly above the average. That the concern is on a good footing is, however, evidenced by the financial results which accrued with the moderate total revenue from all sources of 4·2d. per unit.

| | SOUTHAMPTON. | | WHITEHAVEN. | |
|---|---|---|---|---|
| *Undertaking Worked by* | Southampton Corporation. | | Whitehaven Corporation | |
| *Date of Commencement of Supply* | 1891. | | Sept., 1893. | |
| *System of Supply* | 3-wire with batteries. | | 3-wire continuous-current. | |
| *Chief Engineer* | F. H. Chaplin. | | Ernest W. Dunton. | |
| **YEAR ENDED** | MAR. 31, **1899.** | MAR. 31, **1900.** | MAR. 31, **1899.** | MAR. 31, **1900.** |
| **QUANTITIES—** | | | | |
| Units generated | 331,458 | 702,678 | 226,748 | 258,208 |
| " SOLD (TOTAL) | 265,081 | 526,564 | 206,364 | 218,894 |
| " sold to consumers | 263,465 | 434,546[i] | 119,863[a] | 126,437[a] |
| " sold for public lighting, &c. | 1,616 | 92,008 | 86,501 | 92,457 |
| " used on works | 44,059 | 43,896 | 6,600 | 6,460 |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 10·6 | 21·6 | 31·5 | 33·4 |
| Maximum supply demanded | 330 kilowatts | 580 kilowatts | 180 kilowatts | 190 kilowatts |
| Number of public lamps | 21 | 58 arc, 116 (32 c.p.) glow | 438 total (arc and inc.) | 9 arc, 457 glow |
| Number of consumers | 240 | 500 | 141 | 190 |
| Connections to mains in 8-c.p. lamps | 19,775 | 35,000 | 8,257 | 22,000 |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | [illegible] | 24,400 | 6,560 | 6,560 |
| CAPACITY OF PLANT IN KILOWATTS | 800 | 780 | 210 | 210 |

| CAPITAL— | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| AUTHORISED (TOTAL) | £56,064 | £70·1 | £56,064 | £71·9 | £28,926 | £138 | £28,926 | £138 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 56,064 | 70·1 | 56,064 | 71·9 | 28,926 | [illegible] | 28,926 | 138 |
| RECEIVED (TOTAL) | 56,064 | 70·1 | 56,064 | 71·9 | 19,068 | 90·8 | [illegible] | [illegible] |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 56,064 | 70·1 | 56,064 | 71·9 | 19,068 | 90·8 | 28,926 | 138 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | 9,858 | 46·9 | nil | — |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | 9,858 | 46·9 | nil | — |
| REPAID (TOTAL) | — | — | — | — | 1,413 | 6·73 | 1,413 | 6·73 |
| RESERVE OR SINKING FUND | 10,990 | 13·7 | 13,161 | 16·9 | 1,474 | 7·02 | 2,291 | 10·9 |
| DEPRECIATION FUND | — | — | — | — | — | — | — | — |
| EXPENDED (TOTAL) | 67,503[a] | 84·4 | 90,529[a] | 116 | 20,276 | 96·6 | 23,885 | 114 |
| Lands and buildings | — | — | — | — | 1,785 | 8·51 | 1,921 | 9·14 |
| Plant | — | — | — | — | 7,279 | 34·7 | 10,590 | 50·4 |
| Mains | — | — | — | — | 9,497 | 45·2 | 9,599 | 45·7 |
| Miscellaneous | — | — | — | — | 1,714 | 8·16 | 1,774 | 8·44 |
| BALANCE OF CAPITAL ACCOUNT | - 11,439[b] | - 14·3 | - 34,465[b] | - 44·2 | - 1,208[b] | - 5·76 | 5,041 | 24·0 |

| REVENUE— | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
|---|---|---|---|---|---|---|---|---|
| TOTAL | £5,999 | 5·434d. | £10,542 | 4·809d. | £3,387 | 3·940d. | £3,851 | 4·225d. |
| Revenue from supply | 5,845 | 5·295d. | 9,403[g] | 4·286d. | 1,853 | 2·154d. | 2,201 | 2·413d. |
| " meters, &c. | 108 | 0·098d. | 168 | 0·077d. | 50 | 0·058d. | 56 | 0·061d. |
| " public lighting | 20 | 0·018d. | 922 | 0·421d. | 1,442 | 1·677d. | 1,541 | 1·690d. |
| " sale of lamps, &c. | — | — | — | — | 14 | 0·016d. | 26 | 0·029d. |
| " miscellaneous sources | 26 | 0·024d. | 49 | 0·022d. | 29 | 0·034d. | 28 | 0·031d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £3,105 | 2·812d. | £5,930 | 2·704d. | £1,763 | 2·050d. | £2,326 | 2·550d. |
| WORKS COSTS | 2,194 | 1·988d. | 4,897 | 2·233d. | [illegible] | 1·672d. | 1,832 | 2·010d. |
| *Generation of electricity* | *2,061* | *[illegible]* | *[illegible]* | *[illegible]* | *971* | *1·128d.* | *1,085* | *[illegible]* |
| Fuel (including cartage, &c.) | 1,293 | 1·171d. | 3,271 | 1·492d. | 409 | 0·476d. | 537 | 0·589d. |
| Oil, waste, water, stores | 139 | 0·126d. | 263 | 0·120d. | 78 | 0·091d. | 67 | 0·073d. |
| Wages at station | 477 | 0·432d. | 613 | 0·280d. | 336[c] | 0·391d. | 350 | 0·384d. |
| Repairs and maintenance at station | 152 | 0·138d. | 434 | 0·198d. | 148 | 0·172d. | 131 | 0·144d. |
| *Distribution of electricity* | *130* | *0·118d.* | *149* | *0·068d.* | *81* | *[illegible]* | *360* | *0·395d.* |
| Wages, &c. | 88 | 0·080d. | 69 | 0·032d. | 56 | 0·065d. | 356 | 0·391d. |
| Repairs, renewals of mains, &c. | 42 | 0·038d. | 80 | 0·036d. | 25 | 0·029d. | 4 | 0·004d. |
| *Public lighting* | *[illegible]* | *[illegible]* | *166* | *0·076d.* | *386* | *[illegible]* | *387* | *0·424d.* |
| Attendance | 3 | 0·003d. | 166 | 0·076d. | 177 | 0·206d. | 140 | 0·153d. |
| Renewals | | | | | 209 | 0·243d. | 246 | 0·270d. |
| MANAGEMENT AND PROPERTY CHARGES | 911 | 0·825d. | 1,033 | 0·471d. | 325 | 0·378d. | 494 | 0·542d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *127* | *0·115d.* | *[illegible]* | *0·057d.* | *142* | *0·165d.* | *122* | *0·134d.* |
| *Management* | *784* | *0·710d.* | *908* | *0·414d.* | *183* | *0·213d.* | *372* | *0·408d.* |
| Salaries | 516 | 0·467d. | 637 | 0·290d. | 127 | 0·148d. | 282 | 0·309d. |
| Stationery, &c. | 61 | 0·055d. | 47 | 0·021d. | 5 | 0·006d. | 22 | 0·024d. |
| Establishment charges | 91 | 0·082d. | 74 | 0·034d. | 17 | 0·020d. | 35 | 0·038d. |
| Law charges, &c. | 116[c] | 0·105d. | 150 | 0·068d. | 34[d] | 0·040d. | 33[d] | 0·036d. |

| FINANCIAL RESULTS— | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
|---|---|---|---|---|---|---|---|---|
| WORKING PROFIT FOR YEAR | £2,894 | 5·88% | £4,591[h] | 5·81% | £1,625 | 8·34% | £1,525 | 6·91% |
| Sum carried to Depreciation Fund | — | — | — | — | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 2,080 | 4·23% | 2,055 | 2·60% | 801 | 4·11% | 807 | 3·65% |
| Net interest on loans (incl. Debenture charges) | 1,454 | 2·96% | 2,391 | 3·03% | 543 | 2·79% | 528 | 2·39% |
| BALANCE FROM LAST ACCOUNT | — | — | — | — | 316 | 1·62% | 597 | 2·70% |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | — | — | 145[i] | 0·184% | 597 | 3·07 | 790 | 3·58% |
| *Deficit* | [illegible][d] | 1·30% | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | — | — | — | — |

| | Southampton 1899 | Southampton 1900 | Whitehaven 1899 | Whitehaven 1900 |
|---|---|---|---|---|
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 51·8% | 56·2% | 52·1% | 60·4% |
| Expenditure per kilowatt capacity | £3. 17s. 7d. | £7. 12s. 0d. | £8. 8s. 0d. | £11. 1s. 6d. |
| REVENUE PER KILOWATT CAPACITY | £7. 10s. 0d. | £3. 10s. 5d. | £16. 2s. 5d. | £18. 6s. 7d. |
| Expenditure per 8-c.p. lamp capacity | 2s. 5¾d. | 4s. 10½d. | 5s. 4½d. | 7s. 1d. |
| REVENUE PER 8-C.P. LAMP CAPACITY | 4s. 9½d. | 8s. 7¼d. | 10s. 4d. | 11s. 9d. |
| REVENUE PER 8-C.P. LAMP CONNECTED | 6s. 0¾d. | 6s. 0¾d. | 8s. 2½d. | 3s. 6d. |
| Price charged for lighting, per unit | 6d. to 4½d. | 6d. | 5d. | 5d.[f] |
| Price charged for power, per unit | 3d. | 3d. | 3d. | 2d. |
| Price charged for public lighting | £20 per arc per annum | £20 per lamp per ann.[f] | | 4d. per unit. |

SOUTHAMPTON.—REMARKS.—a Includes £21,100 paid on purchase of Southampton Electric Light and Power Co.'s undertaking. b Over-expended. c Includes £[illegible] compounded stamp duty, £78 insurance, and £[illegible] auditing. d Carried to suspense account, which stands at £1,[illegible]. e By maximum demand system [illegible] per unit for first [illegible] hour[illegible] per annum and [illegible] after. f Inclusive of incandescent lamps. g Inclusive of £[illegible] received for traction supply. h After deducting £[illegible] wages and repairs in respect of tramcars (electrical equipment). i For the year. [illegible] Including [illegible] units to tramways.

WHITEHAVEN.—REMARKS.—a Including supply for harbour lighting by contract; the units sold by contract in 1898-9 were [illegible] and in 1899-1900 [illegible]. b Over expended. c Includes £[illegible] bonus to engineer. d Insurance. [illegible] These glow lamps are the equivalent of [illegible] 16-c.p. lamps. f Or (alternatively) 2d. per unit plus £[illegible] per kilowatt of demand per annum.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*Il Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | | HALF-YEAR | | QUARTER | |
|---|---|---|---|---|---|---|
| United Kingdom | 26s. 0d. | ... | 13s. 6d. | ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | ... | 16s. 0d. | ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## THE ELECTROLYTIC REFINING OF METALS.

To judge by published accounts one might suppose that most metals are refined by electrolysis. The insider knows better. Only a few of those metals which are of industrial importance can be remuneratively treated by electrolytic methods. But those few yield rich profits to their exploiters, and it is a matter for regret that the profits should have gone abroad. In this country there is a single industry of the kind which is even mildly flourishing, namely, the refining of copper. How mildly may be judged from the fact, well authenticated, that a noted user of copper, whose name is a household word in the metal trades, solemnly and recently expressed his opinion that pure electrolytic copper was not a material to be encouraged, and that he liked the impure product on which he had been reared. One would have thought that impurities, if shown to be necessary, might better have been added in regulated amount!

Notwithstanding that electrolytic methods of metal refining are growing cautiously, slowly and with a ratio of progress almost indistinguishable from stagnation in the United Kingdom, they are proceeding apace elsewhere. In the United States of America at the present time nearly half the total world's supply of copper is refined electrolytically. Those fat profits arising from the recovery of the precious metals from crude copper which used to delight the European smelter when his American friend was ingenuous enough to ship his matte here, have disappeared, but they have not ceased to be; they are pouched some degrees farther west. Those who are anxious to hear the truth of the matter cannot do better than read the article by Mr. TITUS ULKE, transcribed into our pages this week. There is no philosophising in this Paper; it is a sober prosaic record of fact, and a study of its main heads may be commended to the enquirer. Pride of place is properly given to the refining of copper. At the present moment 211,000 tons of copper per year are electrolytically refined in the United States; from this 19,400,000oz. of silver and 174,000oz. of gold are won. Twenty years ago almost all this precious metal was ignored, and the copper of that era containing its proportion is fulfilling useful but

unexciting ends as fireboxes, steam pipes, brewers' vats, and kettles, unconscious of its stored wealth. The processes of copper refining have long since passed the stage of trial; a factory runs as smoothly and on lines as well known as those of a cotton mill. So much crude metal of a certain grade is supplied, so much current is administered and as a result so much refined metal is turned out. The cost of power is inconsiderable; 1,000 H.P., which is a bagatelle in electrolytic processes, will produce 15,000 tons of copper per year. It is interesting to note that the so-called "series" system, which consists in making intermediate electrodes unconnected with the main leads, anode and cathode on alternate faces, is recognised now as of limited scope and utility. It began from a mistake and has found its own level. There is a continuous improvement of the crude copper which should encourage the dry smelter. He, poor man! may be profitably occupied no in refining copper as he once vainly believed, but in preparing raw material for the use of the electrolytic refiner; the donkey work shall be his.

But although copper is properly dealt with at the beginning and at some length in Mr. ULKE's Paper, he has not failed to refer to other large refining industries. Silver is treated in great quantity and with complete success by the Moebius process. As far as we know nothing of the kind is attempted here. It can hardly be doubted that London, the home of the precious metal trade, contains many works occupied in separating silver from baser or more precious metals; if this be granted, is it not lamentable that the cumbrous and old-fashioned boilings with nitric or sulphuric acid should be continued when an elegant, exact and economical process, proved in its working on a substantial scale, is ready to hand? Gold is equally easily treated, but here must be given a word of warning. Gold electrically refined is not particularly pure. Reliable analyses have shown that it may contain as much as 0·05 per cent. of impurity, which is a serious matter in gold, not so much for the loss of value, though this is appreciable, but because of the modification of the properties of the metal. So it may be that our electrolytic refiners have still something to learn here. Most melancholy is the news that nickel refining has been stopped; it is scarcely credible, considering the substantial natural advantages of an electrolytic process for nickel and the good progress which had been made in its realisation. It will be observed, if we may return to our opening sentences, that the success of electrolytic refining is as restricted as it is conspicuous. No one cognisant of metallurgy, in the present state of our knowledge, would expect to refine lead, zinc or iron electrolytically. Antimony is in the debatable land; industrially it is, in any case, insignificant. Tin has a better chance. When the number of commercial metals is counted and the importance of these metals is appraised, we see clearly enough, first, that of the number a considerable fraction has already come within the dominion of the electrochemist; secondly, that he has yet a world to conquer. Many who have been impressed by the variety of new processes for insignificant improvements in the refining of metals almost unknown, who have seen these fail, and have conceived a distrust of the whole affair, may be restored to technical sanity by an examination of the Paper which has served us as a text. If there be any metal refiner who does us the honour of reading our comments, he may be induced to remove the reproach that we English people are the slowest of industrial communities to adopt and adapt the teachings of sound science. Until the reformer comes we must sit at the feet of transatlantic Gamaliels.

## OBITUARY.

### ELISHA GRAY.

We greatly regret to announce the sudden death of Dr. Elisha Gray, at the age of 66 years. His death took place on the 21st ult., at Newtonville, Mass., U.S., and removes from the ranks of the electrical profession an inventor and scientist of exceptional ability. We learn the following particulars of his death from an American contemporary: He had been in Boston for some time past, pursuing his work in marine signalling and telephony with Mr. A. J. Mundy, and was visiting at Newtonville. On the day before his death he complained of a chill, and consulted a doctor. He dropped dead on Monday, Jan. 21st, his complaint being stated as neuralgia of the heart.

Elisha Gray was born at Barnesville, Ohio, U.S.A., on August 2, 1835. In his early life he was a carpenter's apprentice, and learned boat-building and blacksmithing, and during this time he studied physical science. At the age of 21 he commenced to study at Oberlin College, where he devoted five years to working at physics. His first invention, at the age of about 30, was his automatic self-adjusting telegraph relay, which was soon followed by a telegraphic switch and annunciator for hotels, a private telegraph line printer, and a telegraphic repeater. Since that time he has taken out nearly 50 patents, mostly dealing with telegraphic and telephonic apparatus. The principal of these include his printing telegraph system, his harmonic telegraph, the telephone, and the telautograph. In conjunction with Mr. E. M. Barton he organised the firm of Gray and Barton, out of which sprang the Western Electric Co. February 14, 1876, was an important day in the life of Prof. Gray, for on that day he filed a patent caveat at Washington for an invention "For Transmitting Vocal Sounds Telegraphically." Almost simultaneously Prof. Graham Bell made his invention of the telephone, and it seems probable that the controversy which has been started as to the priority of this invention will be both fierce and prolonged. It has been alleged that one of the patent examiners named Wilbur betrayed the secret of Gray's patent specification both to Prof. Bell and to his attorneys for a money consideration. On this controversy Prof. Gray himself is reported to have made the following statement: "In the matter of the telephone, I should first place the man at the head of the list who discovered first the principle and method of operation. It lies between Bell and myself. I first described it in my caveat. Bell first made it a few days after the filing of my description. I then gave it to him, because he first made it, but now I have evidence which convinces me *beyond a doubt* that I showed him how. The public does not know this as I do, and I, therefore, do not expect a verdict in my favour."

Prof. Gray, in addition to having been elected a member of the Faculty of Oberlin College, was, in 1878, honoured at the Paris Exhibition with the Legion of Honour. In 1893 he was chairman of the World's Congress of Electricians at Chicago. As an author he is chiefly known by his popular work on electricity, but he also contributed papers on telephonic and other subjects to scientific societies.

**Utilisation of Furnace Gas in Germany.**—Vice-Consul-General Hanauer, of Frankfort, states that on October 30 last 25 representatives of the largest iron works in France and Belgium visited the Hörde Mining and Rolling Mills Association, at Hörde, near Dortmund, Prussia, to inspect the electrical central station for utilising the gas coming from the mouths of furnaces. This plant, when fully completed, will represent about 6,400 H.P. At present, three twin motors of the Oechelhaüser type are run by furnace gas to generate electric current for supplying power and light for the Hermann rolling mills. A fourth motor of 600 H.P., and four others of 1,000 H.P. each are now in process of construction to serve like purposes.

## THE AUSTRALIAN COMMONWEALTH CELEBRATIONS.

(BY OUR SPECIAL CORRESPONDENT.)

The inauguration with the New Century of the new nation in the Southern seas was heralded by a gorgeous display, in which electricity naturally took a prominent part. The illumination of the streets, parks, gardens and public buildings of Sydney during the New Year week attracted large crowds and formed a distinct feature in the celebrations. It was carried out by means of some 18,000 incandescent lamps of 8 c.p. each and 135 arcs. These were distributed as follows: The beds of the Botanic Gardens were picked out by means of 6,000 coloured lamps, which gave a very striking effect. The gardens could thus be thrown open to the public both day and night. The Domain, which has usually to depend on a few flickering gas lamps, was ablaze with 85 arcs arranged in crowns of five each on tall masts round the central grass square in which the Continental entertainments were held. Hyde Park was similarly illuminated with 12 crowns of four arcs each. Queen Victoria's statue, at the head of Macquarie-street, was canopied by 2,000 incandescents festooned from a central pole to the pavements. Thence a long perspective of 22 transoms, with 72 red-white-and-blue lamps, carried one down Macquarie-street, past Parliament House and the Botanic Gardens to Government House gate, the arch over which carried 400 lamps. On the other side of the street the Treasury offices were picked out with 500 lamps, and the Public Works buildings with 1,000, of which 400 were in a large crown which surmounted the dome. The Customs House, on Circular Quay, was very effectively decorated with 1,000 lamps, giving an especially good effect when viewed from the boats in the harbour or from North Shore. The Post Office, which is always to the fore on such occasions was ablaze with 1,000 lamps, in various devices, and Martin Place was decorated with 14 transoms of 74 lamps each.

The Post Office lighting was carried out without difficulty from their permanent lighting plant, consisting of two Willans-Siemens sets, and one Morris-Oerlikon set, capable of giving in all 1,800 amperes at 110 volts. Of this, 500 amperes is the usual maximum load, and 1,000 amperes were thus easily provided for the decorations by reducing the interior lighting a little. The remainder of the public lighting was carried out from four temporary stations containing some 500kw. of plant, which, during the week's festivities, was taxed to its utmost. These stations were put down by the Public Works Department, under the direction of Mr. Thomas Raw, and are marvels of rapid and ingenious work. Within a month of the celebrations the sites of each were bare ground. The largest is in the Botanic Gardens. Five of the railway locomotive boilers were dismounted from their frames and installed here. The main generating unit is one of the Willans-Siemens 2,000-ampere units sent out a few years back to the unfortunate Cockle Creek works. In addition a Marshall 14in. by 20in. single cylinder horizontal engine belted to a 350-ampere 110-volt Mather and Platt dynamo and two 16in. by 36in. Lancashire horizontal engines belted to a 6½in. countershaft from which a variety of small machines were driven, which, though they constituted quite a museum of antiquities, did their work well. These included five 25-light Brush series arc machines for the Domain and Hyde Park lights, the remainder being on the 110-volt incandescent circuits in the Botanic Gardens and Macquarie-street. Within four weeks of its completion this spot had been used as a potting bed, and in that time heavy concrete foundations 8ft. deep had been put in and the plant erected —the large set alone weighing 28 tons. The steam pipes are screwed together at the joints and the exhaust pipes are of galvanised iron, and yet there is not a leak visible at 100lb. pressure. Exhaust heaters and Worthington feed pumps are employed.

The lower part of Macquarie-street and the public buildings are supplied from a small station containing a direct coupled Westinghouse set giving 200 amperes and a Raworth Universal engine belted to a Mather and Platt dynamo to keep them running through the storm. The expense, of course, has been heavy, as most of the work was carried out by working three shifts in order to get it into the alloted time, but the result formed the most striking feature of the great celebrations.

Private illuminations also should not be forgotten, many good devices being picked out in incandescent lamps. In the harbour the festooning from masthead to masthead of the R.M.S. "Rowe" and "Grosser Kurfurst" was particularly striking.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 553.*)

Consider the case of a cylinder of iron placed parallel to the lines of flux in a uniform magnetic field due, say, to a solenoid traversed by a current. If we suppose the iron suddenly introduced into the uniform field, the flux begins to penetrate into it through its surface and, so to speak, soaks more or less slowly into the mass. Very elegant demonstrations of this fact were given by experiments shown by Dr. J. Hopkinson and Prof. E. Wilson, for the first time, in this room some years ago.† It was then shown experimentally that the application of a magnetising force to a cylinder of iron resulted in the slow propagation of the magnetic flux into the iron from the surface inwards, and it was pointed out that the time required to establish the practically steady or uniform state of flux in the iron varied as the square of the diameter of the cylinder. Hence it follows that if the cylinder of iron, or any other conductor, is placed in a rapidly alternating magnetic field, the magnetic flux never quite penetrates to the centre of the mass of metal if its diameter exceeds a certain value. The alternation of magnetic force results in the flux, so to speak, being recalled before it has time to establish itself throughout the whole mass of the metal. A precisely similar effect takes place, as every electrician knows, when an alternating electromotive force is applied to establish an alternating current in a cylindrical conductor. Under these circumstances the current never penetrates beyond a certain depth into the metal, and this *skin effect*, as it is sometimes called, causes the resistance of a conductor to periodic currents to be greater than its resistance to continuous or unvarying currents. Lord Rayleigh, some years ago, gave two formulæ calculating the effective resistance ($R^1$) and the effective inductance ($L^1$) per unit of length of a circular section wire when traversed by an alternating current of known frequency.‡ Lord Kelvin has also provided us with a formulæ from which the resistance of copper wires of known diameter for alternating currents of stated frequency can be calculated.§ The figures in Table II. show the relative resistance of copper wires of various diameters under periodic alternating electromotive force having a frequency of 100.

**Table II.**—*Table of Resistance of High Conductivity round Copper Conductors.*

| Stranded cable. | Sectional area in sq. in. | Resistance in ohms per 1,000yds. to— Continuous currents. | Alternating currents of frequency 100 per sec. |
|---|---|---|---|
| 7/18 | 0·0126 | 1·974 | 1·974 |
| 7/16 | 0·0225 | 1·108 | 1·108 |
| 7/14 | 0·0351 | 0·712 | 0·712 |
| 19/18 | 0·0351 | 0·712 | 0·712 |
| 19/16 | 0·0624 | 0·401 | 0·401 |
| 19/14 | 0·0973 | 0·257 | 0·257 |
| 19/12 | 0·1645 | 0·153 | 0·155 |
| 19/10 | 0·2500 | 0·100 | 0·1034 |
| 37/16 | 0·1227 | 0·204 | 0·2041 |
| 37/14 | 0·1913 | 0·131 | 0·1334 |
| 37/12 | 0·3235 | 0·077 | 0·081 |
| 37/10 | 0·4905 | 0·051 | 0·057 |
| 61/14 | 0·3185 | 0·078 | 0·082 |
| 61/12 | 0·5385 | 0·046 | 0·052 |
| 61/10 | 0·8167 | 0·0305 | 0·0391 |
| 91/13 | 0·6354 | 0·0385 | 0·0458 |
| 91/12 | 0·8111 | 0·0305 | 0·0391 |
| 91/11 | 1·0000 | 0·0250 | 0·0350 |

* Cantor lecture delivered before the Society of Arts, November 26, 1900.

† *Journal* of the Institution of Electrical Engineers, Vol. XXIV., 1895, p. 86.

‡ Lord Rayleigh on "The Self-Induction and Resistance of Straight Conductors," *Phil. Mag.*, May, 1886, p. 382; also J. A. Fleming, "The Alternate Current Transformer," Vol. I., p. 294.

§ Presidential address to the Institution of Electrical Engineers, Vol. XVIII., 1889, "Electricity, Æther, and Ponderable Matter"; also "Mathematical and Physical Papers," Vol. III., p. 492, *et seq.* See also A. Gray, "Absolute Measurements in Electricity and Magnetism," Vol. II., Part I., p. 331.

When we are dealing with alternating currents of very high frequency, such as those which constitute electrical oscillations, Lord Rayleigh's formula for the effective resistance takes a very simple form in the case of round, straight, or nearly straight conductors. If R is the true ohmic resistance of the conductor under continuous currents, and $R^1$ is the effective resistance for alternating currents of frequency $n$, then—

$$R^1 = \sqrt{\pi n l \mu R} = R\sqrt{\pi n \mu k S}$$

where $l$ is the length of the conductor and $\mu$ the permeability of the material of which it is made; $k$ the conductivity and S the sectional area; hence the effective resistance varies as the square root of the frequency.

Take the case of a copper conductor 1 sq. cm. in section conveying oscillations having a frequency of a million. Then $\mu = 1$ and $n = 10^6$ and $R^1/R = 1{,}772\sqrt{\left(\frac{l}{R}\right)}$; but $R/l = 1{,}600$ C.G.S. units. Hence the resistance to electric oscillations of this frequency is 44 times that for continuous currents. Also, Lord Rayleigh showed that for very rapid oscillations the effective inductance ($L^1$) of a conductor can be expressed in the form $L^1 = A + \frac{R^1}{2\pi n}$ where $R^1$ is the effective resistance for the same frequency, and A is a quantity which depends on the geometrical form of the circuit, but not on its resistance. Hence it is clear that the inductance decreases as the frequency increases. This concentration of an alternating current at the surface of a conductor, or so-called *skin effect* is very marked in the case of the magnetic metals even for quite low frequencies. In the case of an infinite flate plate of thickness $2h$, traversed by an alternating current of frequency $n$, in a direction parallel to the plane of the plate, Prof. J. J. Thomson has shown that the current amplitude decreases from the surface inwards in geometrical progression as the distance from the surface increases in arithmetic progression. Also, if $x$ be the distance of any point from the surface, the rate at which the maximum values of the alternating current at successive points, taken inwards from the surface, decay is determined by a decay factor $= 2\pi\sqrt{\frac{\mu n}{\rho}}$ where $\mu$ is the magnetic permeability, $\rho$ the electric resistivity, and $n$ is the frequency. If we consider a plate of iron for which $\rho = 10^4$, $\mu$ = say 1,000 and adopt a frequency of $100 = n$, then the decay factor is nearly 20. Hence at a depth of 0·5 mm. from the surface the maximum value of the current during its period will be only $1/\epsilon$ = 0·368 of its value at the surface, and for other depths as follows:—

| Distance in millimetres of point from surface of plate. | Maximum value of the alternating current at that point expressed as percentage of the maximum value at the surface. |
|---|---|
| At surface | 100·0 |
| 0·5 below | 36·8 |
| 1·0 „ | 13·5 |
| 2·0 „ | 1·8 |
| 3·0 „ | 0·25 |

The corresponding percentage values for copper would be about 13 times greater. Hence, in the case of iron when employing alternating currents of a frequency of 100, the current practically penetrates only about 2 mm. into the surface. In the case of copper the practical penetration would be about 26mm.

If, however, instead of employing alternating currents of a frequency of 100 we are dealing with electrical oscillations having a frequency expressed in millions, then the "skin" or used portion of the metallic circuit may be less than $\frac{1}{10}$th of a millimetre in thickness. Accordingly, the specific resistance of the material of which the discharge circuit is made becomes of little consequence; the whole effects are determined by the frequency and inductance, which latter in turn depends upon the geometric form of the circuit. Professor J. J. Thomson has calculated (see "Recent Researches in Electricity and Magnetism," p. 281), that for electrical oscillations having a frequency of 1,000,000 the thickness of the conducting skin for soft iron is about [illegible]th of a millimetre, and for copper about [illegible]th of a millimetre. In these cases there is a concentration of the current at the surface, and the outer layers of the metal are for a short time carrying more current than would suffice to melt them if it were maintained continuously. It should be noticed that the actions whereby the alternating current is kept more or less to the surface of the conductor not only make its resistance per unit of length greater than it would be for continuous currents, because, so to speak, less of the metal is made use of, but it decreases also the inductance of the wire.

There are several ways in which we can regard the property of a circuit we call the inductance, but one of them is as follows:—We may think of the current in a wire as split up into a number of current elements or current filaments; variation in the strength of any of these elementary currents create opposing or assisting electromotive forces of induction in the circuits of the other current elements. Hence the more compacted together these elements, the more they are able to act and re-act upon one another, and the greater the self-induction or inductance of the whole circuit. On the other hand, the farther apart these current elements are separated, the less is the total inductance (see Fig. 8). When the current in a wire keeps to the surface or skin the current elements are as far apart as can be, and hence the inductance of the whole circuit is much less than when the current is distributed uniformly over the cross-section. Another way of looking at the matter is as follows: The inductance is an effect in virtue of which the current takes time to establish itself or become constant. The less, therefore, the distance that the magnetic flux, which from one point of view constitutes the current, penetrates into the metal the sooner will the practically steady state be established.

Whichever view we take, theory and experiment alike indicate that a rapidly alternating or periodic current only makes use of the surface skin or outer layer of the conductor, and that a rapidly alternating magnetic force only in the same manner produces magnetisation or magnetic flux in the surface layer of a magnetisable substance. Accordingly, if we give the conductor such a section that the central portions of the metal are as near as possible to the surface—say by giving it the form of a flat strip, this reduces the inductance compared with another conductor of equal cross-section. The inductance varies with the shape of the cross-section just as does the torsional rigidity. For equal sectional areas the flat strip has less inductance and less rigidity to torsion than a round wire. When we are considering not merely steadily periodic currents, but electrical oscillations damping out or dying away, a further modification of theory is necessary. It has been shown by Dr. Barton

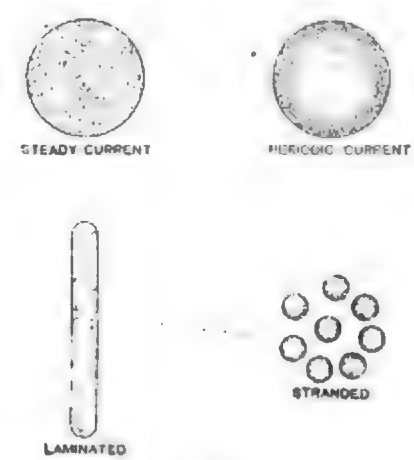


FIG. 8.

that if we consider the case of electrical oscillations taking place in a wire, the current strength at any instant being represented by a function of the form $\epsilon^{-kt}\cos pt$ where $p = 2\pi n$, and $n$ is the frequency and $k$ the damping factor; the effective resistance is slightly greater than that which would be given by Lord Rayleigh's formula on the assumption that the alternations of current were steadily periodic and of the same frequency.* Dr. Barton and Prof. Morton have also investigated the effect of this change on the criterion of discharge of the Leyden jar. They find that the increased skin effect has a tendency to promote the oscillatory state. The simple theory given at the beginning of this lecture indicates that when the resistance R of the discharge circuit $= \sqrt{4L}/\sqrt{C}$, the discharge will just pass from the oscillatory to the unidirectional form. As a matter of fact, corresponding to that value of the resistance of the discharge circuit, the discharge would really be oscillatory.†

It appears, therefore, that we have to consider three different kinds of electrical resistance. There is the resistance (R) which a conductor presents to continuous or unvarying electric currents, which some years ago I ventured to call the *ohmic resistance*, a phrase now very generally adopted, because it is the resistance determined in accordance with Ohm's law. In the next place we have the resistance due to steadily periodic alternating currents, which when the conductor takes the form of a circular section wire, can be calculated by the formulæ of Lord Rayleigh and Lord Kelvin. In this case the resistance for the same conductor is always greater than that

* See Dr. E. H. Barton, *Proc. Phys. Soc.*, Vol. XVI., p. 409, June, 1899, "On the Equivalent Resistance and Inductance of a Wire of Oscillatory Discharge."

† See Dr. E. H. Barton and Prof. W. B. Morton, *Proc. Phys. Soc.*, London, Vol. XVI., p. 465, December, 1899.

corresponding to the uniform or unvarying current, and it increases with the frequency. This second type of resistance (R′) might be called the *alternating resistance*. Then, thirdly, when we are dealing with electrical oscillations which decay away, the effective resistance of the conductor is still further increased by an amount which depends upon the frequency and damping factor. This may, perhaps, be called the *oscillatory resistance* (R″). The explanation of this fact is probably that when damped oscillations exist in any circuit electric radiation in the form of electric waves is being given off. This is a source of dissipation of energy, and as a non-reversible process may be looked upon as equivalent to an *addition* to the real resistance of the circuit over and above that calculated by the Rayleigh formula. The following Table III., taken from Dr. Barton's Paper, shows the relation between the alternating resistance and the oscillatory resistance for various damping factors :—

**Table III.**

| Damping factor ($k$) | Ratio of R″/R′, or of oscillatory to alternating resistance. |
|---|---|
| 0 | 1 |
| $k = 1/4\pi = 0{\cdot}0798$ | 1·044 |
| „ $= 3/10\pi = 0{\cdot}0955$ | 1·054 |
| „ $= 1/2\pi = 0{\cdot}1595$ | 1·097 |
| „ $= 1/\pi = 0{\cdot}319$ | 1·228 |
| „ $= 1$ | 2·197 |
| „ $= 2$ | 4·602 |
| „ $= 3$ | 7·85 |

Table III. shows that when the damping factor $k = 1$ the ratio of the electrical resistance to damped oscillatory currents to that for sustained alternating currents of the same frequency is 2·197.*

In the experimental study of electric oscillations, we have many opportunities of noticing the great effect which inductance in the transmitting circuit has in presenting an obstacle to the flow of very high frequency currents, thus throttling them out. With the Leyden jar apparatus, already described, it is easy to show this phenomenon. We place the closed secondary circuit near the primary and then set up oscillations in this last circuit, thus creating secondary oscillations in the secondary circuit, and we employ the current so generated to illuminate a small incandescent lamp in the secondary circuit. In this latter circuit is then introduced a coil of insulated wire, the turns of which can be spread out on a cylinder of card and squeezed up together. The resistance of this last wire is small and not sufficient to have much effect upon the magnitude of the electric oscillations, and, hence, when the coils are spread out as far as possible, the mere introduction of the wire into the secondary circuit has no apparent effect upon the brilliancy of the lamp. If, however, we squeeze the turns of the coil together the glow lamp is at once extinguished. This is clearly because the approximation of the turns of the coil causes its inductance to be increased, and hence the inductance of the whole secondary circuit is increased to such a point that it reduces the mean amplitude of the current oscillations to a value below that sufficient to heat the lamp filament to incandescence. It is obvious that this increase of inductance is due to the interaction of the currents in the neighbouring turns of the spiral upon each other ; the current in each turn of wire creates an opposing electromotive force in neighbouring turns, and so builds up an obstacle against itself. Hence, when it is desired to choke or throttle electric oscillations, the circuit should be coiled into a coil of many turns. It is remarkable, however, how little coiling of a wire creates great obstruction to the transmission of electrical oscillations along it.

In the next place, with the aid of the same apparatus we can make some observations on another interesting matter—viz., the magnetisation of iron by these extra high-frequency currents. In the apparatus just employed we find that the introduction of a core of iron or bundle of iron wires into the coiled wire introduced into the secondary circuit has little or no effect in increasing the effective inductance of the latter, and if the coils on the auxiliary circuit are placed so far apart that the little glow lamp is just visibly incandescent, it is easily seen that the introduction of the iron core does not produce so much effect in extinguishing the light as the movement of the coils of wire a little nearer together. We can arrange many experiments of the same kind which seem at first sight to show that the inductance of a coil in the case of these electrical oscillations is not sensibly affected by the presence of iron round or within it. At the first glance these experiments seem to indicate the conclusion that the extra high-frequency currents of electric oscillations are unable to magnetise iron. From what has already been explained it will be clear, however, that the rapidly reversed magnetising forces due to electric oscillations can in any case only create magnetisation in the iron to a very small depth, and that the thickness of this magnetised skin must be reduced with increasing frequency. It has been shown that the conclusion that iron and other ferro-magnetic materials are not magnetised at all by electric oscillations is incorrect. The question has been much debated whether the inductance of an iron wire for these high-frequency currents is or is not greater than that of a copper wire of the same frequency and dimensions. Hertz came to the conclusion that it was not greater, and stated in one of his Papers that the magnetic susceptibility of the iron played no part in the case of very rapidly reversed magnetising force.* It has been shown, however, by Prof. J. Trowbridge (*Phil. Mag.*, December, 1891, "Damping of Electric Oscillations on Iron Wires") that electric oscillations on iron wires are more quickly damped out than in the case of copper wires, hence there must be an energy absorption due to the magnetisation of the iron. An excellent investigation by Mr. C. E. St. John (see *Phil. Mag.*, November, 1894) has confirmed the above results. By creating electric waves along wires in a manner to be described in the last lecture Mr. St. John has shown that the inductance of iron wires is greater than that of similar sized copper wires when made into circuits of the same form, and conveying electric oscillations of a frequency of about 56 millions by 3·4 per cent. to 4·3 per cent., and he has confirmed the result that in the case of iron wire there is a more rapid damping out of the oscillations. The experiments show that the permeability of the iron even at this frequency is still as high as 385. Additional evidence that the magnetic qualities of iron are, however, still exhibited, even when the magnetising forces are reversed some millions per second, is given by an experiment due to Prof. J. J. Thomson. Employing the Leyden jar apparatus already described, if we make the wire connecting the outside coatings of the two sets of jars into two coils, and if we place in one of these coils a glass bulb exhausted to the point of maximum conductivity, then, as already shown, secondary oscillations are set up in this rarefied gas and make themselves evident by creating a brilliant luminous ring discharged in the gas. If in the other coil we introduce any conducting substance which is capable of absorbing energy, either by permitting tertiary electrical oscillations to be set up in it or by becoming magnetised, then the damping of the electrical oscillations due to this cause will be shown by the rarefied air in the bulb being no longer luminous.

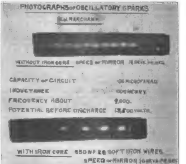


FIG. 9.—Photographs of Oscillatory Sparks from Coils with and without Iron Cores. (Dr. Marchant.)

It is possible to arrange the experiment so that the introduction of a cylinder of copper, or bundle of copper wire, into the second coil of the primary circuit does not much affect the luminous discharge in the gas, but the introduction of a similar-sized cylinder of iron or equal bundle of iron wire immediately destroys it. This, Prof. Thomson shows, must be a consequence of the energy absorption involved in magnetising the iron, so that, although its electrical conductivity is much less than copper, yet, owing to the fact that its permeability is much higher than unity, its damping effect on the electrical oscillations is on the whole greater.† Accordingly we are led to the conclusion that even at these high frequencies the iron is magnetised by the action of electrical oscillations and possesses a permeability which is probably as high as 300 or 400.

---

* In the case of simple periodic currents all the quantities are proportional to $\epsilon^{ipt}$ where $\epsilon$ is the base of the Napierian logarithm $i = \sqrt{-1}$, and $p = 2\pi n$; when $n$ is the frequency and $t$ is time. For the special characteristic of a simple periodic quantity $y$ of frequency $n$ is that $d^2y/dt^2 = -p^2y$ where $p = 2\pi n$. The function $y = \epsilon^{ipt}$ fulfils this condition ; also $y = \sin pt$ and $y = \cos pt$ are other functions which likewise obey the same law. In the case of damped oscillations all the functions vary as $\epsilon^{(i-k)pt}$ where $k$ is the damping factor.

* *Ann. der Physik und Chemie*, Vol. XXXIV., 1888, p. 558.

† See "Researches in Electricity and Magnetism," p. 323. Also, see J. J. Thomson, *Phil. Mag.*, November, 1891, p. 460.

Direct photographic proof of the magnetisability of iron by oscillatory discharges has been obtained by Dr. E. W. Marchant, and the two photographs of oscillatory sparks here shown* illustrate this fact well. (See Fig. 9.) The first photograph is that of the spark taken when a condenser of 0·06 microfarad was discharged through a coil having an inductance of about 5 millihenrys, the potential of the discharge being 13,500 volts. The coil contained in this case no iron core. The second photograph shows the spark when a core of 550 fine iron wires No. 28 was inserted into the paper tube on which the wire was wound. These photographs show that the effect of the iron is to increase the time period or slow down the oscillations, and also owing to the increase in the permeability of the iron as the discharge dies away, we see that the interval between successive oscillations increases; in other words, the oscillations are no longer isochronous.

We need not, however, demand photographic proof that electrical oscillations can magnetise iron; the old and well-known experiments of magnetising sewing-needles by Leyden jar discharges is sufficient proof. It was the anomalies which presented themselves in the polarity of the resulting magnetism which led Joseph Henry to suspect that the Leyden jar discharge was oscillatory in nature.† We thus discover that electrical oscillations possess all the characteristics of ordinary alternating currents. They can be transformed by step-up and step-down transformers, and they can produce magnetisation in iron, but they exhibit an enormous sensibility as it were to inductance in the circuits through which they pass, and the shielding effects with metallic screens, which are hardly noticeable when dealing with low-frequency alternations, become immensely enhanced when we deal with electrical oscillations.

# CORRESPONDENCE.

## CAPACITY IN ALTERNATE-CURRENT WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issues of January 18th and 25th you published a paper on "Capacity in Alternate-Current Working," by Mr. W. M. Mordey. In connection with this I would like to make some remarks regarding the theoretical as well as the practical data and conclusions drawn by Mr. Mordey in his Paper.

Before all I have to remark, that our views regarding dielectric hysteresis are by no means as vague as they were about 10 years ago, and the well-known contributions of Messrs. Arnò, Ayrton, Boltzmann, Bouty, Carpenter, Dunstan, Exner, Fleming and Dewar, Hutin and Leblanc, Klemenčič, Smale, Steinmetz, Swinburne, Smith and Rosa, Tallquist, H. F. Weber, and, finally, my own modest researches and essays have furnished valuable data for enlightening our ideas upon dielectric polarisation and hysteresis.

As consulting engineer to Messrs. Ganz & Co. I have occupied myself during the last 10 years with researches regarding the properties of dielectrics. Already at my first lecture at the Budapest University of Technical Sciences I pointed out that, starting from the prevailing views regarding dielectric polarisation, Ewing's theory of the magnetisation can be transplanted and applied for the explanation of electrostatic hysteresis phenomena. I also pointed out that the supposition that the electrostatic induction would be a linear function of the E.M.F.—*i.e.*, that the specific inductive capacity would be independent of the E.M.F. cannot be sustained on account of theoretical reasons for those bodies in which the existence of electrostatic hysteresis can undoubtedly be proven.

I enclose an abstract of a Paper which I presented last June to the Royal Hungarian Academy of Science on "Contributions to the Physics of Dielectric Bodies."

From these figures, the tables and curves—which are, as it were, in international language—it can be seen that in the cited case the dielectric constant varied with the E.M.F., and that it is possible to produce dielectrics showing clearly these phenomena and in connection therewith the phenomena of electrostatic hysteresis.

Perhaps I shall also publish the researches which I have made during the last few years in this matter in English, and therefore I will recapitulate shortly the results obtained by others and myself regarding this subject.

1. The dielectric constant of all those bodies, in which the existence of an electrostatic hysteresis can be proven, varies with the polarising E.M.F.

2. At small E.M.F.s, for instance, from zero to 80 volts cm., this variation can—on account of other disturbing influences of other phenomena—as a rule be examined only with great difficulty. However, there are types of dielectric bodies—*e.g.*, layers of plant fibre dielectrics, at which the experimental proof can be brought without difficulty at E.M.F.s between 80—100,000 volts/cm.

3. Measurements executed with alternating E.M.F.s alone cannot give a clear picture regarding the variation of the dielectric capacity with the E.M.F., and can be used only in combination with the results of static methods. The much-mentioned experimental fact that in a given dielectric the "capacity current" rises proportionally with the effective impressed E.M.F. is not a proof for the constancy of the dielectric capacity. I can mention cases in which the dielectric capacity varies, and yet the capacity current, calculated by means of the various values of dielectric capacity and the known curve of the E.M.F., and agreeing within large limits with the measured values, is proportional to the E.M.F.

4. The separation of the electrostatic and viscous hysteresis work (the value of the latter is very low in the materials used for cables) by measuring the capacity currents at different periods can easily be effected.

5. The electrostatic hysteresis work increases *at low* E.M.F.s nearly proportionally with the second power of the E.M.F.—at higher E.M.F.s with the 1·7—1·6 power of the E.M.F.

Referring to the experimental data and the practical conclusions published by Mr. Mordey, I beg to remark as follows: The power factor of 0·124, which Mr. Mordey has found for the examined cable is an extraordinary high one, and can be explained only either by a mistake having occurred (which, however, with such an experienced observer as Mr. Mordey cannot very well be supposed) or by the cable having been made of a material of extremely high specific hysteresis.

It would be regrettable for alternate-current practice, if we had only cables of such high specific hysteresis work at our disposition; in fact, fortunately, the cables which are generally used have—as I am able to prove from the experimental results obtained by others and myself—a considerably lower power-factor and hysteresis loss per unit of volume. So, for instance, I gather from my records of tests, for a high-tension concentric cable of ordinary pattern, and 100 + 100 mm.² section, which is at this time working in the network of the Budapest central station, the following data for 50 ~ and sinusoidal E.M.F.s.

| Impressed E.M.F. | Cap. current. | Watts hyst. work. | Mfd. cap. | Cos $\phi$ |
|---|---|---|---|---|
| 2,070 | 0·289 | 12·33 | 0·44 | 0·0206 |
| 3,000 | 0·418 | 24·0 | 0·44 | 0·0187 |

for kilometre of length of this cable.

A network of 200 kilometres of such cables would therefore require a hysteresis work of 4,800 watts. Suppose the maximal load of such a cable network to be 8,000kw. and the load diagrams to be of the well-known shape, then we find, that compared with the magnetic hysteresis work of the transformers and the copper losses in such a plant, the electrostatic hysteresis loss is *exceedingly small*. Take into consideration that the average commercial efficiency of such a modern alternate current plant—all losses taken into account—hardly surpasses 60 per cent. (this is already a very high figure), and suppose, further, for a central station serving mainly for lighting purposes, and working with a maximum load of 8,000kw., an average load of 500kw., then the resulting losses would be about 380kw., and the electrostatic hysteresis loss would be only about 1·45 per cent. of the total loss.

Calculating on the well-known experimental data of similar cables for 5,000-6,000 volts, or calculating according to the above data, it will be found for a 100 + 100mm.² cable working as in the above example, under a $\frac{dV}{dn}$ = 8,400 volts cm., or 28 electro-

* Taken from a letter by Dr. Marchant to *Nature*, August 30, 1900.

† See "The Alternate-Current Transformer" (Fleming), Vol. I., p. 223.

static units, and taking in account the greater volume of the dielectric:—

| Impressed E.M.F. | Cap. current. | Watts hyst. work. | Mfd. cap. | Cos φ. |
|---|---|---|---|---|
| 6,000 | 0·6 | 55 | 0·32 | 0·015 |

and for a cable, working under the same conditions, but of 50 + 50mm.² section:—

| | | | | |
|---|---|---|---|---|
| 6,000 | 0·47 | 46 | 0·25 | 0·0165 |

for 1 kilometre length.

Considering the case of a 10,000-volt cable we find by calculation and experiment for cables of the above pattern, working under the same conditions the following data:—

| Impressed E.M.F. | Cap. current. | Watts hyst. work. | Mfd. cap. | Cos φ. |
|---|---|---|---|---|
| 10,000 | 0·7 | 110 | 0·23 | 0·048 |

for the kilometre of length.

Regarding the question of a 20,000-volt cable, thisquestion can at present be treated only from the academic standpoint, as practical experience is very meagre; it will be found, however, by calculation:—

| Impressed E.M.F. | Cap. current. | Watts hyst. work. | Mfd. cap. | Cos φ. |
|---|---|---|---|---|
| 20,000 | 0·96 | 176 | 0·157 | 0·0092 |

for 1 kilometre length of such a cable working under a $\frac{dV}{dn}$ *twice as great* as in the above example; for a cable working under the same $\frac{dV}{dn}$ as the 10,000-volt cable, the hysteresis loss per kilometre would be yet lower than 176 watts for 1 kilometre.

It can be seen that the total cost of production of a kilowatt-hour—taking into consideration the items of amortisation and the payment of interest on the invested capital—for a large plant, can be influenced only very little by the electrostatic hysteresis loss, while for small plants 10,000-20,000-volt cables doubtlessly never will be used.

I would, however, like to call attention to the fact that the power-factor of the well-known Swinburne condensers is only about 0·01, and that the power factor of the condensers constructed by myself and Mr. Bláthy for the Vienna and Rome central stations working under a $\frac{dV}{dn}$ of 50,000 volts cm. and 42 ~ was about 0·015.

It is therefore clear that the power factor of cables working with considerably smaller strains cannot be much higher.

Regarding the chokers proposed by Mr. Mordey, I beg to remark that the motors and the not-fully-loaded transformers of a modern alternating-current plant are the *natural chokers*; I would like to call them, in the sense of Mr. Mordey, even *supernatural*, as in consequence of their action the current always *lags behind* in modern central stations working for light and power; and the average power factor hardly surpasses 0·8, so that the electricians would rather be inclined to *increase* than to *decrease* the capacity. Even supposing that in consequence of the action of the capacity the current would be leading by 45deg., I could not derive any technical difficulties from this circumstance. With regard to the efficiency and armature reaction of generators I would decidedly prefer a current 45deg. in advance to one 45deg. lagging behind.

The only technical difficulties in the use of great capacities are those arising from resonance phenomena, and those arising from the switching in or out of great cables, and the burning out of fuses; and these can—as experience has shown—easily be made harmless by the use of suitable and relatively cheap safety devices.

I considered it advantageous to give the above data for the information of the younger readers of *The Electrician*.—Yours, &c.,

Dr. M. de Hoor.

Budapest, Feb. 4.

## GAS POWER FOR CENTRAL STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: One breathes the air of frank and open criticism in your leading article on "Gas Power for Central Stations," and on the two points on which you do me the honour of disagreeing with me I trust you will allow me to make the following remarks:—

You say I ignore altogether "existing town gasworks which supply a hydrocarbon gas of very high calorific value—the very *extractum carnis*, as it were, of the fuel." That, Sir, is precisely the reason *why* I ignore the ordinary town gasworks, for the cream of the coal is far too valuable a product to consume in gas engines, even if it could be bought at 1s. 6d. per 1,000 cubic ft. or generated on the premises at half this cost. Mond gas is already *delivered* to the Northwich Electric Supply Co. (Ltd.) at 2d. per 1,000 cubic ft. (equivalent to lighting gas at 8d.), which leaves a very good profit for the firm supplying the gas.

Later on you state, as your first objection to large central gas-power stations, that "the large gas producers necessitated by works of this magnitude, and the enormous volumes of injurious and unpleasant gases exhausted by the engines, would constitute a nuisance of far more serious gravity than is now the case with steam plant." My answer will, I think, convince you that the very opposite view is correct. First, as to the size of the plant. At Winnington we have a plant capable of supplying 25,000 H.P. of gas engines. It occupies ground measuring about 56yds. square. Could you get the necessary steam boilers and appliances for an equivalent steam power into the same space?

Then as to the volume and nature of the gases emitted. In either case fuel is burnt with air and steam, and the products are of exactly the same nature. There is nothing more injurious in the exhaust from a gas engine than in the flue gases from a steam boiler; both contain nitrogen, oxygen, carbonic acid and steam. If a difference exists it is in favour of the exhaust gases, for some of the sulphur of the coal is taken out in the process of the gas manufacture, while, on the other hand, *all* of it goes into the atmosphere from the boiler chimney. Also, there is no possibility of making black smoke with the gas-plant and gas engines, but where is the steam central station that does not commit this nuisance?

Let us see what are the relative quantities of gases emitted in the two cases, and for this purpose the following approximate figures are sufficiently near to serve the purpose:—

| *Steam power Plant.* | |
|---|---|
| Average weight of fuel per B.H.P. hour | 3lb. |
| Weight of gaseous products leaving boiler chimney | 60lb. |
| Weight of carbonic acid leaving boiler chimney | 8lb. |
| Volume of products leaving boiler chimney | 750 cubic ft. |
| *Gas-power Plant.* | |
| Average weight of fuel per B.H.P. hour (total) | 1¼lb. |
| Weight of gaseous products leaving gas engines | 15lb. |
| Weight of carbonic acid leaving gas engines | 2·2lb. |
| Volume of products leaving gas engines | 175 cubic ft. |

These figures show clearly that the steam plant is much the worse sinner in polluting the atmosphere.

I can fancy that you have the impression, which perhaps is a natural one, that the Mond plant is a kind of chemical works spreading noxious vapours around. If so a visit to the plant would entirely disabuse your mind on this point. Visitors who come to lunch with us eat vegetables grown on the ground adjoining the works, and can see grapes, orchids, delicate ferns and foliage plants growing within a few yards of the works boundary.

Finally, the starting of large gas engines is now a matter of great simplicity. Compressed air is used for the purpose in the ordinary cylinder, and its action is quick and certain. On the average it requires 2½ minutes to start our 400 H.P. gas dynamo and to parallel it with the others, but we can do it in less time if necessary. Our arrangements in this respect may be a little primitive, as we do not stop frequently. One of our smaller sets (100kw.) has generated 200,000 units *since it was last started* and is still running as I write.—Yours, &c.,

Cheshire, Feb. 4. Herbert A. Humphrey.

## MR. CAMPBELL'S PHASE-TURNING DEVICE AND MR. MORDEY'S EXPERIMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In issue of Jan. 25th you published a reply from Mr. Campbell to my remarks on his Paper before the Physical Society, in which he proposes some revised methods. The revised method shown in Fig. 3, p. 517, of obtaining X from

the observed values of the resultants P and Q is free from the objections which I raised to his former method, and it is also more general, for it can be employed without finding maxima and minima by means of phase-turning devices. It is only necessary to find the resultant P of X and any known auxiliary voltage V of the same frequency, and the resultant Q of X and V reversed, from which X may be obtained as shown in Fig. 8. When X is small compared with V the accuracy will be increased by having X and V approximately in phase, but I fear that even under favourable conditions the experimental errors in P, Q, and V, will cause such serious errors in the calculated value of X as to render the method of small practical importance. And unless X is very small, it will generally be found easier and more accurate to measure it directly by means of an electrostatic voltmeter, as they are now obtainable sufficiently sensitive to measure one volt to within half per cent.

In his revised method of measuring power lag, Mr. Campbell says that "the power lag $\phi$ between $X_1$ and $X_2$ can be obtained by the formula" $\cos\phi = \cos\theta_1 \cos\theta_2 + \sin\theta_1 \sin\theta_2 \cos(\psi_2 - \psi_1)$. Is there not an error in this formula, or are the latitudes $\theta_1$ and $\theta_2$ to be measured from the pole and not from the equator, as usual? The sentence just under the formula seems to indicate that the latitudes are measured in the ordinary way; but by putting $\theta_1 = \theta_2 = 0$ in the equation, I obtain $\cos\phi = 1$, a contradiction with the latter part of the sentence.

Assuming that $\theta_1$ and $\theta_2$ are measured from the equatorial plane, and that $\phi$ = angle $X_1OX_2$, then the equation should read $\cos\phi = \sin\theta_1 \sin\theta_2 + \cos\theta_1 \cos\theta_2 \cos(\psi_2 - \psi_1)$. In this case, however, I should be obliged if Mr. Campbell will give a general proof that $\cos\phi$ = the power factor between $X_1$ and $X_2$ *irrespective of the wave-forms of $X_1$, $X_2$ and of the phase-turning device.* I am of the opinion that this is not the case, as the following example illustrates. Let $X_1$ and $X_2$ be sine waveforms and have time-phase difference = power-phase difference $= \eta$, let the phase-turning device gives a symmetrical wave such as those given in Mr. Russell's Paper, Fig. 3 (*The Electrician*, Vol. XLIV., p. 72), and let $\cos\theta$ be the power factor of this latter wave with the sine waves $X_1$ and $X_2$. Then, by Mr. Campbell's method $\theta_1 = \theta_2 = \theta$, and $(\psi_2 - \psi_1)$ is evidently $\eta$. $\therefore \cos\phi = \sin^2\theta + \cos^2\theta \cos\eta = 1 + \cos^2\theta(\cos\eta - 1)$. Therefore if $\cos\phi$ = power factor between $X_1$ and $X_2$, it depends on $\cos\theta$, that is, on the wave-form of the phase-turning device, which is absurd.

In two other places in your recent issue Mr. Campbell proposes to use a transformer (*a*) to obtain a fictitious alternating non-inductive load, (*b*) in a method for the measurement of power in an alternating-current circuit. In both cases he assumes that the waves of P.D. between the terminals of the primary and of the secondary are *practically similar curves and in phase*; but is this sufficiently accurately the case with ordinary transformers? In 1897 I made some experiments on this subject with a view to utilising a transformer in connection with my oscillographs, and I found that the secondary P.D. lags behind the primary P.D. by from 170deg. to 178deg. for sine waves with different transformers and circuit conditions. This phase difference would only introduce errors of less than about $1\frac{1}{2}$ per cent. when the current and voltage are in the same phase for the fictitious load (*a*), but in the method for the measurement of power (*b*) serious errors will be introduced when the power factor of the circuit, to which the supply of power is being measured, is low.

Suppose, for example, that it is required to measure the power wasted in dielectric hysteresis of a cable, which has, I am informed, a true power-factor of probably *less than 0·028* for an india-rubber cable, and that the transformer used produces a lag of 175deg. (I assume that all the waves are sine curves.) When V and X add to give P then V leads 5deg. on U, and therefore the same amount on C, and X actually leads $\cos^{-1} 0{\cdot}028 = 88^\circ\ 24'$ on C; so that $\phi$ by Mr. Campbell's method $= 88^\circ\ 24'$, and $\cos\phi = 0{\cdot}115$, *or is over 400 per cent. too large.* Again, if Mr. Campbell had observed a power factor of 0·124 (as found, for example, by Mr. Mordey) with the above transformer, then [since $\cos^{-1} 0{\cdot}124 = 82^\circ\ 53'$], the true power factor would only be $\cos(82^\circ\ 53' + 5^\circ) = 0{\cdot}037$, *or under one-third of the observed value.* And if the true power factor of a cable were of the order 0·01 the error would be as high as 1,000 per cent. with a lag of 175deg. in the step-down transformer. It is, therefore, evident that this method of employing a step-down-transformer should not be used for the measurement of power supplied to circuits having low power factors.—Yours, &c., W. DUDDELL.

## TRAMWAY BILLS IN PARLIAMENT.

On Friday last the standing orders examiners of the House of Commons (Mr. Campion and Mr. Jeune) sat together (an unusual course) to investigate the standing order proofs of the following tramway bills:—

City of Birmingham.
West Cumberland Electric.
Bradford Corporation (including Tramways).
South Lancashire.
Bexley.
London County Council (Tramways and Street Widenings).
Scarborough Electric.
Chester Corporation.
Tyneside.
Wigan Corporation.

Mr. CAMPION said in cases in which it was proposed to electrically equip existing tramways there was ground for supposing that a disturbance of the streets would be necessary, and a question had arisen whether this fact would not bring the bills within Standing Order No. 10, which provided for the notice which should be given in respect to proposed new tramways, &c. The parliamentary agents, he believed, contended that Standing Order No. 10 did not apply in the case of an existing tramway upon which it was proposed to adopt electricity as a means of traction. He (Mr. Campion) and Mr. Jeune would take the Birmingham Bill as a test case, and if the agents could convince them that the order did not apply, well and good, but if not, that disposed of the bills.

Mr. JOHN KENNEDY, parliamentary agent for the City of Birmingham Tramways Bill, said no doubt whatever existed in the minds of the parliamentary agents on the point. They were of opinion that Standing Order No. 10 did not apply. In his case the tramways extended over so wide an area that the additional expense to the promoters, if it were held that the order did apply, would be some £3,000, £4,000, or even £5,000. It would mean posting notices in the streets, the preparation of a number of plans, and other things, which he contended was quite unnecessary in the case of existing tramways.

Mr. PRITT (Messrs. Sherwood & Co., parliamentary agents) followed, at the request of the examiners, and expressed the same view.

Mr. CAMPION said the examiners were satisfied on the matter. When the clause of the standing order was drafted electric traction was not contemplated, and that was the way the difficulty had arisen. If anything further ought to be done for the protection of the public or the frontagers it should be done by the amendment of the standing order. The effect of their decision was that the standing order did not apply, and that the bills might be considered.

## THE FENCING OF SWITCHBOARDS.

On Thursday last week at the Greenwich (London) police court, before Mr. Kennedy, summonses against the Blackheath and Greenwich District Electric Lighting Co. (Ltd.), at the instance of Mr. J. Owner, H.M. Inspector of Factories, were heard, alleging that at the company's works at River-terrace, East Greenwich, a death from electric shock was caused in October last in consequence of the company's neglect to securely fence certain machinery on the premises.

Mr. WONTNER, for the defence, said it was idle to ask for a conviction against the company as Robinson, the man who met his death, was actually engaged in the work of fixing a protective handrail, which was the precaution required by the Factory Acts.

Mr. J. A. CONSTABLE, resident engineer to the company, said the switches were placed in a gallery 14ft. from the ground, and were approached by a stone staircase. After the fatal accident which occurred in March last to a shift engineer the handles of the switches were raised to a height of 5ft. 9in. from the ground and indiarubber mats were placed on the floor of the gallery. Inquiries were also made as to the new form of switchboard, and Sir Frederick Bramwell's firm were consulted on this matter. In the meantime it was decided to place a handrail in front of the switchboard as an additional precaution and while engaged on this work the present fatality occurred. They had told a man off to see that no one went near the switches, but in this man's temporary absence and being apparently anxious to get on with the work the deceased did so with the result that while removing a bolt he placed his hand on a live wire and received a fatal shock. As to the non-registry of the accident he did enter it in his own book and informed the Board of Trade of the accident on the day it occurred. The men who worked the switches were required to wear gloves, and were not allowed to use both hands.

The hearing was adjourned was adjourned for a week.

The hearing of the case was resumed yesterday (Thursday).

Mr. WONTNER said the parents of the deceased man Robinson had a suit pending for compensation, they claiming £500 damages, and he thought that fact should take the question of compensation out of the

magistrate's mind, and that he should not impose a fine, if any, increased for the purpose of compensation.

Mr. KENNEDY, the magistrate, said his view was that if the case were considered one of gross negligence the fine should be proportionately increased.

Mr. WONTNER proceeded to argue that the two first summonses were for the same offence, and that there had been what practically amounted to contributory negligence on the part of deceased.

Mr. KENNEDY said he had come to the conclusion that these works were not in such a position or of such construction as to be equally safe to every person employed within the meaning of the act, especially so to an outside workman not skilled in electrical matters. In assessing the fine, however, he should take into consideration that there were a great many safeguards. On the summons under sec. 5 of the act there would be a fine of £10, under sec. 82, £20, and for not entering the accident on the register, which he thought was an oversight, 20s. The costs would be £10. 10s. on the first summons, and 2s. on each of the others.

## LEGAL INTELLIGENCE.

### FitzGerald v. Dublin United Tramways Co.

In the High Court, Dublin, Mr. Justice Gibson, on Monday, Tuesday, and Wednesday, heard an action brought by a Dublin wine merchant, against the defendant company for injuries alleged to have been caused from the non-sanding of the company's tramway track, whereby plaintiff, while driving, was seriously injured from the fall of his horse. Damages were laid at £6,000. Defendants denied that the accident was caused by their negligence or that they were liable for the maintenance of the streets in the manner suggested by plaintiff.

After a very lengthy hearing, the following points were left to the jury to decide:—

(1) (a) Was the part of the pavement for which the company was responsible at the time of the accident slippery and unfit for traffic?—*Answer*: Yes.

(b) Was it at the time of the accident in its then state a danger and annoyance to the ordinary traffic?—*Answer*: Yes.

(c) Was it in its then state a nuisance?—*Answer*: Yes.

(2) Did the plaintiff's horse fall upon the said part of the pavement?—*Answer*: Yes.

(3) If the first and second questions are answered "Yes" was it by reason of the condition of the said part of the pavement that the plaintiff was injured?—*Answer*: Yes.

(4) If the above questions are answered "Yes," was the misfortune caused (a) by the fabric of the pavement being improperly constructed?—*Answer*: No.

(b) Or improperly maintained?—*Answer*: No.

(c) Or by reason of the omission of reasonable precautions, such as sanding, to prevent the pavement from becoming slippery?—*Answer*: Yes.

(5) Were the defendants negligent (a) in the construction or maintenance of the pavement?—*Answer*: No.

(b) Or in the omission of sanding?—*Answer*: Yes.

(6) To what damages, if any, is the plaintiff entitled?—*Answer*: £1,000.

His LORDSHIP entered a verdict for plaintiff, but on the application of counsel for defendant company granted a stay of execution.

### Electro Chemical Co. (1900), Ltd.

Mr. STEWART SMITH, on Friday last, in the matter of the Electro-Chemical Co. (1900), Price v. the Company, moved for the appointment of Mr. Robert Shaw as receiver at the instance of debenture holders. Counsel said the company was incorporated on Feb. 14 last year with a capital of £200,000 in £1 shares, to acquire certain carbon and chemical alkali works for the purpose of working a new electrolytic process. £40,000 had been subscribed on debentures, and these debentures were a charge on all the assets of the company, except the foreign and colonial patents. On Feb. 17 there was executed a debenture trust deed, and the plaintiff was holder of 300 debentures, a condition of which was that the principal should become due in the event of a winding up resolution being passed. On Jan. 25, 1901, a special resolution was passed to wind up, and a meeting summoned to confirm that resolution would be held in a few days.

Mr. TOPHAM, for the company, did not oppose the application.

His LORDSHIP said the security seemed to be in jeopardy. On counsel giving security in the usual way he would appoint Mr. Shaw.

### Armanni v. Corradi.

At Clerkenwell (London) County Court on Wednesday, before Judge Edge, K.C., Luigi Armanni, an electrical engineer, sought to recover £17. 10s. for work done and materials supplied in connection with an electric lighting installation on defendant's premises in the Buckingham Palace-road. From the evidence it appeared that the price originally stipulated for the work was £8, plaintiff agreeing, in consideration of his name being advertised on defendant's premises during the execution of the work, to make no charge for certain fittings. Defendant subsequently withdrew his consent to the advertising, and therefore plaintiff claimed £5 for the fittings and £4. 10s. for extra work.

Judge EDGE held that plaintiff had established his case and gave judgment for the full amount, with costs.

### Marr v. St. Helens Cable Co. (Ltd.).

At the Manchester Assizes on Monday Mr. Langdon mentioned that this action, which was for wrongful dismissal, had been settled. The parties having come to terms judgment was given for the plaintiff.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

An outside manager and engineer is required for a large power distribution system in the North of England supplying three-phase high-tension current. See advertisement.

There is a vacancy for a shift engineer at the Dundee Corporation lighting and traction station. Applications to the city electrical engineer, Mr. W. H. Tittensor, Dudhope Crescent-road, Dundee. See advertisement.

Charge electricians and switchboard attendants are required for extra high-tension power station and sub-stations operating electric tramways. See advertisement.

A traffic assistant is required by the East Ham District Council for their electric tramways department. Applications to Chairman of Electric Lighting and Tramways committee, Public Offices, East Ham, E. by noon 14th inst.

Devonport Corporation require a chief assistant engineer to the borough electrical engineer. Applications by Feb. 17.

Mr. Ernest Cross, of Aberdeen, has been appointed borough electrical engineer at Rotherham at a salary of £200 per annum. The following were invited to the meeting at which the appointment was made: Messrs. D. Adams (Preston), E. Cross (Aberdeen), E. R. Hill (Bromley), T. C. Parsons (Halifax), A. H. Roe (Bury St. Edmunds), R. J. J. Swan and F. L. Todd (London), and F. H. Whysall (Rotherham).

The Lancaster Town Council last week appointed Mr. W. A. Tester electric tramways engineer at a salary of £300 per annum.

Mr. F. S. Ransome, late assistant manager at the Brush Company's works at Loughborough, has been appointed general manager to the Clayton Engineering and Electrical Construction Co. (Ltd.).

Worcester City Council on Monday appointed Mr. E. E. Hoadley, who has acted as temporary engineer of the electricity works during the absence of Mr. C. J. Sutherland, chief assistant engineer at a salary of £250 per annum.

Mr. Alexander Murdoch has been appointed assistant engineer at the Fulham (London) Borough electricity supply works.

**Alfreton.**—Messrs. Gibbings and Baker have been appointed consulting engineers in connection with the Council's application for a provisional electric lighting order.

**Association of Municipal Corporations.**—At a meeting of the Council of this Association last week, Sir Albert K. Rollit, M.P., was nominated president, and Sir. J. T. Woodhouse, M.P., vice-president, for the ensuing year.

**Barrow-in-Furness.**—The electric lighting mains are to be extended to Vickerstown at an estimated cost of £620, provided that Messrs. Vickers, Son and Maxim guarantee the total aggregate consumption shall produce not less than £1,000 per annum irrespective of street lighting. The General Purposes committee recommended that the date at which the Corporation reserve the right to purchase the tramway undertaking be extended from 1919 to 1926, and this has been agreed to by the Council. It was, however, stated that if the British Electric Traction Co., who have acquired a controlling interest in the local tramway company, would submit fresh proposals the committee would consider them.

**Belfast.**—During the past year there was an increase in the number of units sold of 32·4 per cent., and in the rental of 13·6 per cent. There was also a satisfactory increase in the current supplied for power.

**Birkenhead.**—The New Ferry electric tramway route was opened for traffic on Monday. The line is completed from New Ferry terminus to the Session's Court, and a 10min. service is given.

**British Columbia Electric Railway Co.**—The directors estimate that, roughly, the company has incurred a loss of about $6,200 through the recent snowstorm. Since Jan. 8 there has been no recurrence of the storms.

**Colchester.**—In the report of the borough electrical engineer (Mr. A. R. Sillar), presented to the Council on Wednesday, it is claimed that although no public lights are connected, the Colchester electricity station holds the second position in the United Kingdom for progress during the past 12 months. The only place showing a better average than Colchester was Wimbledon, and Wimbledon had almost entirely lighted the streets during the last year. Several consumers had complained of the high charge for lighting, which, Mr. Sillar suggests, might be reduced. It was decided to take this suggestion into consideration.

**Croydon.**—An inquiry was held here yesterday (Thursday) into the application of the Corporation to borrow £30,000 for electric lighting extensions. There was no opposition.

At a meeting of the Corporation last week the town clerk reported that the Local Government Board had decided not to entertain future applications for borrowing capital for "free" wiring, and consequently the Lighting committee were unable to give effect to the free wiring scheme adopted by the Council on Nov. 26.

The Lighting committee recommend that Mr. T. H. Minshall, the borough electrical engineer, in lieu of his usual summer vacation, should be granted six weeks' leave of absence in the early spring to enable him, at his own expense, to visit America. The recommendation has been adopted by the Council.

**Darwen.**—The proposed loan for extensions of the electricity undertaking has been increased from £13,000 to £15,000.

**Dudley.**—The Local Government Board has refused to sanction the Council's application to borrow money for wiring consumers' premises on the easy payment system. A deputation has been appointed to consult with the Board on the subject.

**Dundee.**—The new electric tramway route from High-street to Clepington-road, was officially inspected on behalf of the Board of Trade on Wednesday. The Perth-road extension and the permanent way of the Blackness-road route were also inspected.

**East Middlesex Electricity Scheme.**—An interesting report has been prepared by Mr. W. C. C. Hawtayne (and endorsed by Mr. Robert Hammond), and submitted to the District Councils of Edmonton, Enfield, Southgate, Tottenham, and Wood Green, upon the proposed joint electricity undertaking embraced in the East Middlesex Electricity Bill, 1901. Last week we reported that the joint scheme had received the approval of meetings of ratepayers of several of these districts, and now awaits the result of polls to be taken. This week further consideration (as reported below) has been given to the subject by ratepayers meetings at Edmonton and Enfield Highway. The total capital expenditure involved in the scheme has been put by Mr. Hammond at £345,000, made up as follows:—

| | |
|---|---|
| Generating station buildings, shaft, &c., coal and ash conveying plant, &c., and purchase of site | £38,000 |
| Generating plant | 84,740 |
| Mains, high tension feeders, low tension distributors, transformers, and sub-stations | 109,260 |
| Public street lighting | 25,000 |
| House services and meters | 40,000 |
| Free wiring | 25,000 |
| Legal, expert, and engineering fees and contingencies | 23,000 |
| Total | £345,000 |

The plant capacity is given as 4,000kw., including a reserve of 1,000kw. Allowing 600kw. for loss in distribution, this leaves the total plant capacity at 2,400kw., to be utilised as follows: Public lighting (500 arcs maximum load, or equivalent), 310kw.; private demand, 1,590kw.; and power along canal and generally throughout district, 500kw. The revenue from 3,524,400 units generated is forecast as under:—

| | |
|---|---|
| Public lighting (842,400 units at 2d.) | £7,020 |
| Private lighting (1,590kw.), say, equal 53,000 lamps all burning at one time (106,000 connected)—1,590kw. for 400 hours at 7d. = 636,000 units at 7d. | 18,550 |
| 1,590kw. for 600 hours at 2d. = 954,000 units at 2d. | 7,950 |
| Electric power (700kw. installed, with a maximum load of 500kw.)—500kw. with 25 per cent. load factor = 1,092,000 units at 2d. | 9,110 |
| Free wiring—10 per cent. on £25,000 | 2,500 |
| Meter rentals—4,250 at 6s. | 1,275 |
| Total | £46,405 |

The upkeep expenditure involved in producing 3,524,400 units, it is estimated, should not exceed 1·5d. per unit, including management expenses and ample allowance for maintenance and repairs on buildings, plant, and mains, &c. This would equal £22,027. Interest and redemption (at 5¼ per cent. on £345,000) would reach £18,112, leaving a margin of £6,266.

The Edmonton site selected for the generating station is approved, being described as excellently situated for an undertaking of this nature, with close proximity to rail and canal. No provision is made for supplying current for electric traction, but it is pointed out that, if terms can be made with the authorities controlling the tramways, light railways, &c., in the district, large additional plant can be provided, and the profits of the undertaking should be increased therefrom. A three-phase system is recommended. The bill before Parliament provides a total of £400,000 as the cost of the undertaking, and the margin between this sum and the £345,000, specified in the above report, is considered a sufficient allowance for extensions. The bill provides that only interest on capital expenditure shall be paid for the first three years, the repayment of the principal being left over till the lapse of that period.

At a meeting of ratepayers of Enfield Highway on Monday a resolution approving the joint electricity bill of the Tottenham, Southgate, Wood Green, Enfield, and Edmonton Councils was carried unanimously. Mr. W. C. C. Hawtayne was present, and replied briefly to the remarks recently made by Mr. George Offor on behalf of the North Metropolitan Power Distribution Co., who are opposing the scheme of the joint local authorities.

A meeting of ratepayers was held at the Edmonton Town Hall on Tuesday, at which Mr. George Offor made a lengthy speech to show that the ratepayers affected by the East Middlesex Electricity Bill would find it much to their interest to entrust the question of electricity supply in the hands of the company with which he is associated rather than to place it under the control of the local authorities. Mr. Offor pointed out that there were two companies interested in the area affected by the bill, and one of these had obtained an Act of Parliament to generate electricity in bulk at large stations at Ponder's End and Hertford, the other was the Electrical Power Distribution Co., with which he was associated, which had made offers to the District Councils to supply current for public lighting at 2d. and to private consumers at 3½d. per unit. In the proposals put forward by his company, provision was made for the local authorities, after 12 years, if they so desired, to purchase the undertaking and goodwill at a value to be fixed by independent valuers. He urged that work of this kind should be in the hands of practical men prepared to speculate with their own money, and not in the hands of municipal councils. Every member of the directorate of his company was an electrical expert, and they held transfers of the electric lighting provisional orders from the Hertford Corporation and the Barnet District Council. The figures that had been put forward showing a surplus profit on 75 municipal undertakings of £71,480 was, he complained, misleading. In these cases there was no allowance for depreciation, and a moderate sum to deduct in this respect was 2½ per cent. on the capital invested. On the question of the reduction of rates he asserted that in the case of only about five local authorities throughout the kingdom had there ever been a reduction of rates through the success of electricity supply. In the bill of the local authorities in East Middlesex it was proposed to omit sec. 21 of the Electric Lighting Acts, which bound them to supply electric current to everybody. Further, the bill only made provision for public lighting by 500 arc lamps, which would light only about 14 miles of streets, yet in one of the five districts included in the bill there was 45 miles of public roads. A motion hostile to the proposed bill of the District Councils was put to the meeting, and, the show of hands being about equal, no decision was come to.

**Eastbourne.**—Councillor Maude, at Tuesday's Corporation meeting, stated that the charges for fuel for the electricity undertaking for 1898 and 1899, when owned by the Eastbourne Company, had been £1,716 and £2,065, whereas in 1900, under Corporation control, it had reached £3,218. Salaries and wages for the same periods (1898, 1899, and 1900) had been £1,205, £1,689, and £1,550 respectively.

**Electric Traction in South-East London.**—The Greenwich Borough Council object to the proposals of the South Eastern and Metropolitan Tramways Co. to substitute electric for horse traction on their line from Greenwich through Lewisham to Catford on the Schuckert surface contact system, and have placed their objections before the Board of Trade.

**Electrical Standardising, Testing and Training Institution.**—The Board of Control of this institution have awarded Joseph Goodman, of Wellingborough Grammar School, a Maxwell entrance scholarship, value 50 guineas, tenable for two years, and Francis Norman Wilson, of Felsted School, a special prize of 10 guineas.

**Electrical Trades' Union.**—We have received a copy of a set of proposed rules which the Electrical Trades' Union executive council desire shall come into force as soon as possible to regulate the working of wiremen, cable jointers and assistants employed in the London district who are members of this union. The proposed rules are as under. Employers' objections and comments are requested not later than March 31:—

1. That 53 hours constitute a week's work, but when members are working on jobs where the hours are less, the money shall be made up to equal the 53-hour week.

2. That nine and a-half hours constitute a day's work for five days in the week, and five and a-half hours on Saturday, finishing work on that day at 1 p.m. Overtime on Saturdays, from 1 p.m. till 4 p.m., to be paid for at the rate of time and a-half, after 4 p.m. double time. Overtime worked during the first five days in the week to be paid for at the rate of not less than time and a-quarter for the first two hours, time and a-half for the next two hours, and after that double time. Each day to stand by itself; night shifts to be paid for at the rate of not less than time and a-half.

3. That the rate of pay for wiremen and cable jointers shall be not less than 9½d. per hour, chargemen not less than 10½d. per hour. Apprentices, assistants and jointers' mates shall be not less than 17 years of age when entering the Society, and shall serve three years at the trade as apprentice, assistant or jointer's mate, and one year as probationary member. The rate of pay during the probationary period to be not less than 7½d. per hour. No one shall be allowed to join as assistant, apprentice, or jointer's mate who is above the age of 21 years.

4. Members working over 1 and less than 12 miles from shop to be allowed travelling time and expenses. Country expenses to be not less than 10s. 6d. per week. Travelling time and expenses to be paid for the journey from London to job, and from job to London.

5. All members working on boats, under floors, in roofs, on accumulators, oil vessels, waterside premises, and other dirty jobs, must receive not less than 6d. per day dirty money.

6. District holidays to be Easter Monday, Whit Monday, August Bank Holiday, Christmas Day and Boxing Day. That no holiday shall entail more than two days' loss of time. The rate of pay for Bank Holidays shall be not less than time and a half, Christmas Day and Sundays not less than double time.

7. That no member in the London district be allowed to work more than one night in succession, namely, that after working all night our members must cease work at the usual time of leaving work the next day.

8. One hour's notice to be given on either side. Weekly wage employés to give and receive one week's notice. Members running casing to receive one hour's grinding money.

9. That on all jobs requiring four or more men not more than one assistant or apprentice to four men shall be employed.

10. That no member be allowed to work overtime, unless absolutely necessary, when members in the district are unemployed.

11. That on all jobs a lock-up for tools and materials be provided, and on building jobs, and where circumstances require, a mess-room shall be provided.

**Erdington.**—The Tramways committee have appointed Mr. Green, of Messrs. Pritchard, Green & Co., Birmingham, consulting engineer to advise generally on the proposed application for powers to construct tramways.

**Exeter.**—In the report presented by the Electric Lighting committee on Wednesday, it is stated that the machinery at the generating station had run very well throughout the past year, but that since the new year two breakdowns had occurred. A considerable number of new lamp and motor connections had been made. The total lamp connections now exceed 21,000.

**Hackney (London).**—The Electric Lighting committee have submitted a statement of the estimated capital expenditure of their electricity supply and refuse destructor scheme, which is now put at £262,740—about £20,000 more than that originally estimated—and the Council are recommended to borrow this additional amount. The committee also recommend that the charge for electric current for private lighting be fixed at 4d. per unit and 2d. for power.

**Hampstead (London).**—The Borough Council has, on the recommendation of the Lighting committee, resolved that all electric mains that may in future be sanctioned by the Council shall, until further orders, be laid on the "solid" system.

**Heating of Tramcars.**—The Christiania *Journal* contains some comments *apropos* of the heating of tramcars in Christiania and Stockholm. In both cities the weather is intensely cold in winter. The cars are all precisely similar to those employed in London and many of our provincial towns, with sliding doors at each end. They generally carry no conductor, the fare being dropped into a slot by the side of the driver. The Christiania Tramway Co., whose cars are horse-driven, and the new electric tramway both appear satisfied with the new method adopted for heating their cars, as it is said a pleasant warmth is diffused without any trace of hygienic unpleasantness. The apparatus consists of long perforated boxes, one under each length of seats, one or both sets of apparatus being in operation as required. The boxes, which are shot in from the platform at either end of the car, are filled with red-hot coal briquettes specially prepared, so that no smoke or smell is emitted. A channel of iron sheeting runs underneath the seats, perforated on the outer side to allow the fumes or smoke to escape into the open air. On fresh air passing through a ventilator placed under the coal-box at the bottom of the car the hot combustible gases pass through this channel of iron sheeting throughout its entire length, diffusing a steady heat into the car through a set of perforated iron plates between the legs of the seats. It is found that the speed of the car causes sufficient draught, so that the briquettes are completely consumed. The temperature of 60°C. is obtained even with an outside temperature of from 12°C. to 14°C. of frost. On a second tramway in Christiania a different system of heating is adopted. The air rising from the briquettes is emitted into the space between the double windows, where it is absorbed by felt mats. This keeps the great plate-glass windows free from ice, but little heat goes into the car. On both lines of tramways the seats are covered with cushions in winter, but not in summer.

Last winter experiments were made in the electrical warming of the electric tramcars of Christiania, American apparatus being used in the experiment. Three boxes of this apparatus were placed under each row of seats, current being taken from the wire working through the contact rod of the car. These experiments are said to have given excellent results as regards regular heating and speed, but proved too expensive for general adoption. At Stockholm the tramcars are heated by the coal briquette system, which is said, in this case also, to have proved satisfactory.

**Hereford.**—The Council have obtained sanction to a further loan of £5,000 for electric lighting extensions. The total receipts of the electricity department for the year amounted to £1,608. 7s. 9d., and the working expenses to £695. 15s.; interest absorbed £577. 10s. 11d, and there was a balance of £335 left to meet sinking fund instalment.

**Leeds.**—The salary of the assistant electrical engineer of the tramway department (Mr. Harold G. Jekin) has been increased from £250 to £300 per annum.

**Leicester.**—The Council have unanimously resolved to purchase the undertaking of the local tramway company and to introduce electric traction. The total cost is estimated at over £500,000.

The total output of current by the municipal electricity works for the half-year ended Dec. 31 was 670,613 units.

**Llanrwst.**—Mr. O. I. Jones, J.P., and Mr. Marriott, J.P., have purchased the undertaking of the Llanrwst Electricity Supply Co. (Ltd.).

**London County Council.**—At Tuesday's meeting it was agreed to loan £830 to St. Pancras for the electric lighting of public buildings, £17,229 to Hampstead for electric lighting, £24,145 to Fulham for dust destructor and street lighting.

Mr. Parker moved, Mr. Baker seconded, and the Council approved a motion that the General Purposes committee should consider the best means of bringing before the new borough councils the necessity of making subways in all the leading thoroughfares in the metropolis to contain telephone and telegraph wires, gas and water pipes, &c., and, if necessary, to summon a conference on the subject.

The motion of Mr. Baker, which was set out in our last issue (p. 557), on the subject of the construction of a double of electric conduit tramway in Rosebery-avenue was withdrawn.

The motion of Mr. Westacott, set out on p. 557 of our last issue, was agreed to without discussion.

**London Fires.**—In the annual report of the chief officer of the Metropolitan Fire Brigade, presented to the London County Council on Tuesday, it appears that during the year 1900 seven fires (one serious) occurred in the metropolitan district owing to the short-circuiting of electric wires.

**Merthyr.**—The Board of Trade have issued their award in the arbitration on the claim of the District Council against the British Electric Traction Co. for £1,600 in regard to the levels of the lines between Merthyr, Dowlais, and Cefn. The award is adverse to the Council, except upon the question of costs.

**Middlesbrough.**—The Electric Lighting committee on Wednesday discussed estimates submitted by the consulting engineer (Mr. Robert Hammond) for the extension of the electricity undertaking. The cost of the proposed extensions was estimated at about £21,000, including £1,000 for boiler-house plant, £5,200 for engine-house plant, £9,000 for mains, and £2,000 for railway sidings and building works. Mr. Hammond stated they had almost reached the limit of the present plant, as they could only supply 10,000 lights, and they had already applications for 9,252. It was decided that details of the extensions, which practically mean the provision of duplicate plant, should be set forth in the minutes, and it was also agreed that the charge for electric supply for power purposes should be 2½d. per unit.

**Motherwell.**—The electricity works were formally inaugurated on Friday last.

**Municipal Telephony.**—The Sunderland Chamber of Commerce invited Mr. A. W. Heaviside to a meeting last week to give information on the subject of telephones. It will be remembered that the Sunderland Council have under consideration the establishment of a municipal exchange. Mr. Heaviside, asked as to the facilities the Government were prepared to offer, said if the Council decided not to proceed with their municipal service the Government was prepared to proceed at once to open out a competitive system with the National Company on reasonable terms, but that the Government could not entertain competition with the municipality. The matter will be further considered as soon as the decision of the Council is known.

**National Electrical Contractors' Association.**—A meeting was held at Anderton's Hotel, Fleet Street, London, on Friday last, for the purpose of forming a National Electrical Contractors' Association, Representatives from the leading provincial towns, including Birmingham, Glasgow, Leeds, Manchester, Newcastle-on-Tyne, Sheffield, West Hartlepool, &c., were present, and a provisional committee was appointed to draw up a preliminary set of rules. A meeting will be convened at a later date to inaugurate the Association, which will embrace all local associations in Great Britain and Ireland. Further information can be obtained from the convener, Mr. Thomas Guthrie, C.A., 46, Queen Victoria-street, London, E.C.

**Nelson.**—The Corporation have appointed Messrs. Gibbings and Baker consulting engineers for drawing up plans, &c., for a new combined lighting and traction station.

**Poplar (London).**—The Borough Council has now appointed all its officials, the appointment of Mr. Alex. Blackman as borough electrical engineer at £400 per annum having been confirmed.

**Portsmouth.**—The Electric Lighting committee recommend the Corporation to borrow £24,478 for electric lighting extensions. Of this sum £10,895 has already been expended in making 400 house connections during the year, and other work sanctioned by the Council; £4,322 is required for new feeders to distant parts of the

town and for supplying the new naval barracks should the Admiralty require it. The remaining £16,717 is required for a new boiler house and coal bunkers, but for the present only £11,042 of the sum is to be spent.

**Private Bill Legislation.**—Notwithstanding the opposition of the Council, the Scarborough Tramways Co. have decided to persevere in their attempt to get parliamentary powers to construct electric tramways in the town.

By the casting vote of the chairman the Liverpool Parliamentary committee have decided to withdraw their opposition to the Manchester and Liverpool Electric Express Railway Bill.

**Rangoon.**—Messrs. Kilburn & Co., the Indian agents of Messrs. Crompton & Co., have submitted proposals for the erection of electricity supply works and for the construction of electric tramways. The matter is being considered by the new Municipal committee.

**Reddish.**—Col. von Donop has held an inquiry into the application of the Council for sanction to borrow £13,500 for the construction of tramways from the Stockport boundary to Mid-Reddish, and from thence to Manchester. The tramway, which will be worked electrically, will be leased to the Manchester and Stockport Corporations, who will provide the necessary rolling stock, supply electric current, &c.

**St. Helens.**—The Board of Trade have sanctioned the borrowing of £2,540 for the construction of tramways along Corporation and Parr-streets, and £248 to meet the cost of the 1900 provisional tramways order. The borough electrical engineer (Mr. J. S. Highfield) has been instructed to report as to the cost of constructing a double track from Cropper's Hill to the Toll Bar.

**Salford.**—The Corporation on Wednesday confirmed the appointment of Mr. C. D. Taite, of Southport, as borough electrical engineer at a salary of £700 per annum.

**Scottish Electrical Contractors' Association.**—At a meeting of the general committee of this Association last week it was decided that the first business meeting should be held about the end of February.

**Stirling.**—The Board of Trade have ratified the proposal of the Council to purchase so much of the undertaking of the local tramways company as lies within the burgh.

**Sutton Coldfield.**—The Council have applied for sanction to borrow £5,000 for "easy" wiring premises in the district.

**Sudbury.**—The Council have approved the estimates for the erection of electricity supply works. The initial capital outlay is put at £16,300.

**Swindon.**—A meeting of the Swindon Traders' Association was held last week to consider the Corporation's proposal to seek Parliamentary powers to establish a system of electric lighting and traction for the borough. Ald. Skurray, chairman of the committee which has charge of the matter, explained that the Corporation were practically unanimous that the scheme should go through. They had consulted Mr. E. Price, of Portsmouth, who held that the scheme which the Corporation had prepared would undoubtedly prove remunerative. Acting upon the advice of their consulting engineers, a site had already been secured for a generating station, and tenders for the buildings and equipment of the station would shortly be considered. The meeting, with only two dissentients, approved the scheme.

**Telephones and the Snowstorm in London.**—The National Telephone Co. has notified subscribers that the snowstorm on the 4th inst. has caused a partial dislocation of the London telephone service, and asks the forbearance of their subscribers.

**Theft of Telephone Wire.**—At the Marlborough-street (London) police court, on Wednesday, Robert Conolly was brought up on remand before Mr. Plowden, charged with stealing 23 lengths of telephone wire from the National Telephone Co. Particulars of this case appeared in our issue of Jan. 25. The prisoner was committed for trial.

**Tramway Capital.**—A Parliamentary return just issued gives the capital invested in tramways, the gross receipts, working expenses, &c., of tramways in the United Kingdom. It shows that the total capital paid up in England and Wales for tramways on June 30 last was about £16,000,000, compared with £14,000,000 in the previous year; while for the United Kingdom the total is £20,500,000, compared with £18,000,000 in June, 1899. In England and Wales the length of line open for traffic in June was 933 miles, and in the United Kingdom 1,177 miles. There were 526 locomotive engines employed in England and Wales, compared with 557 in 1898. The number of passengers carried in England and Wales was 817,000,000, compared with 700,000,000 in the previous year. The net receipts were £1,030,552, compared with £898,662 in 1899 and £623,338 in 1894. The total number of horses employed in the United Kingdom was 37,481, compared with 44,171 in 1899, when the number was the highest on record.

**West Bromwich.**—The town hall and municipal offices are to be wired for the electric light.

**Wigan.**—The new electric tramway to Martland Mill Bridge has been inspected and approved by the Board of Trade, and the line is open for traffic. There was no opening ceremony owing to the death of the Queen. During the first week 15,748 persons travelled on the cars.

**Workhouse Lighting.**—The Local Government Board have asked the Kensington (London) Guardians to re-consider their proposal to establish an independent generating plant for the electric lighting of the workhouse and infirmary, and to also consider the question of obtaining supply from a company.

The Mile End (London) Guardians, having considered the question of the electric lighting of the workhouse, have decided to incur no further outlay on the plant at present in use until the Borough Council has provided a public supply.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Electric Haulage for Mining.*—The Ffaldau Collieries Co., Ltd., *Cardiff*, require plans, specifications and estimates of cost for providing secondary haulage by electricity from their working faces to the end of their rope haulage, the latter being operated by steam engines near the shaft. As electric haulage has not yet been successfully applied in South Wales guarantees must be given that the plant will be efficient, absolutely safe from danger of explosion in a gaseous atmosphere, and considerably cheaper than haulage by compressed air. The company's collieries are at Pontycymmer, near Bridgend, An advertisement gives a few further details, and all additional information can be obtained from the Company.

*Extension of Time—Launceston (Tasmania)* Corporation invite tenders for the supply of 500 electric meters. Tenders by 12 noon of *April 22* (*not April 8* as previously announced). See *The Electrician* for Jan. 25.

The Council of the Metropolitan Borough of *Bermondsey* invite tenders for the construction, supply, and erection of a main switchboard and instruments and a battery of accumulators and accessories. Specifications, &c., may be obtained at the Town Hall, and specifications may also be inspected, but not obtained, at the offices of the consulting engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W. An advertisement gives additional particulars. Tenders must be forwarded to the town clerk, Mr. Frederick Ryall, Town Hall, Spa-road, Bermondsey, London, S.E., by noon of 30th inst.

*Taunton* Corporation invite tenders for the construction, supply and erection of two 100kw. tramway generators, one engine and tramway switchboard and connections. Specifications, &c., can be seen, but not obtained, at the offices of the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, London, S.W. Some further particulars will be found in an advertisement, and tenders must be sent to Mr. G. H. Kite, town clerk, Municipal Buildings, Taunton, by 2 p.m., Feb. 25.

The trustees of the *Clyde Navigation* invite tenders for a 3-ton electric wharf crane. An advertisement contains further particulars, and specifications, &c., may be obtained from the mechanical engineer (Mr. Geo. H. Baxter), or of the general manager and secretary (Mr. T. R. Mackenzie), 16, Robertson-street, Glasgow. Tenders to Mr. Mackenzie by noon of March 11.

*Long Eaton* District Council require tenders for the following work in connection with their electricity station: (*a*) Producers, gas engines, dynamos, and switchboard, and (*b*) feeder and distribution cables and conversion of street lamps. An advertisement gives further particulars, and tenders must be in to the Council Offices by noon of Feb. 18.

*Brighton* Corporation invite tenders for the supply, delivery, and erection of continuous-current arc lamps and accessories for street lighting. An advertisement gives further particulars, and tenders must be sent to the town clerk, Mr. F. J. Tillstone, Town Hall, Brighton, before 10 a.m., Feb. 25.

*Brighton* Corporation aslo require tenders for supply, delivery, drawing-in and jointing complete of feeder, distributing, test and telephone cables. Tenders to town clerk by 4 p.m., Feb. 14.

*Brighton* Corporation also invite tenders for the supply and erection of overhead trolley construction and equipment of tramway routes. Tenders to town clerk by 4 p.m. Feb. 14.

*Aberdeen* Tramways committee require tenders for the electrical equipment for their Bathing Station tramway route and the supply and laying of lead-covered, paper or fibre insulated cables. Tenders to city electrical engineer by noon Feb. 13.

*Wallasey* District Council require tenders for extension of engine-house, Lancashire boiler, condensing apparatus, water-cooling tower, overhead travelling crane, engines and dynamos, cables, economisers, and transformers. Tenders to Mr. H. W. Cook, Public Offices, Egremont, by 21st inst.

*Wallasey* District Council also invite tenders for the erection and completion of car sheds, stores, workshops, and dwellings at their tramway depot, Liscard. Tenders to Mr. Cook, by 21st inst.

*Wallasey* District Council also invite tenders for steel rails, fish plates, tie-bars, and sole plates. Tenders to clerk, Public Offices, Egremont, Cheshire, by noon Feb. 19.

*London County Council* invite tenders for the supply of two blocks of water-tube boilers required for their Camberwell tramways depôt. Tenders, to clerk by 10 a.m. Feb. 19.

*London County Council* Asylums committee require tenders for electric lighting sundries for Claybury and Heath asylums. Tenders by Feb. 13.

*Wimbledon* Urban District Council invite tenders for steam and exhaust pipes, &c., and moving two boilers, feed-pumps, feedwater heater and storage tank; independent surface condensing plant; and the supply and erection of two water-tube boilers. Tenders to clerk by noon Feb. 18.

The managers of the *Poplar and Stepney* Sick Asylum District invite tenders for sundry work in connection with the installation of the electric light at the Sick Asylum. Tenders to Mr. Foskett, at the Asylum, Bromley, by 10 a.m. Feb. 12.

Borough of *Southwark* (London) require tenders for the supply and erection of a 400kw. high-speed engine and dynamo and accessories, two water-tube boilers, with mechanical stokers, &c. Tenders to town clerk, Town Hall, Walworth-road, S.E., by noon Feb. 13.

*Beckenham* District Council require tenders for boilers, steam alternator, and combined engine-dynamo and motor, pipe work, battery, and switchboard. Tenders to Council Offices, Beckenham, by Feb. 25.

*Glasgow* Corporation invite tenders for the supply of 100 car equipments and spare parts. Tenders to town clerk by 5 p.m. Feb. 22.

*Glasgow* Corporation also invite tenders for steel straight track rails, curved rails, fish-plates, and steel tie-bars. Tenders by 5 p.m. Feb. 22.

*Kirkcaldy* Corporation require tenders for dry-back marine boilers, with mountings, &c., but alternative tenders for water-tube boilers will be considered. Tenders to town clerk by 10 a.m. Feb. 15.

*Stirling* Town Council require tenders for engines and dynamos (two sets, each of about 350 H.P.) and Lancashire boilers. Tenders by Feb. 15.

*Wakefield* Corporation invite tenders for independent surface-condensing plant at their electricity works. Tenders to town clerk by 12th inst.

*Bristol* Electrical committee invite tenders for coal conveyors and elevators, coal discharging plant, including hoist, automatic weigher, tower and bridge over roadway. Tenders by noon Feb. 21.

*Bournemouth* Corporation require three dynamos and two steam-driven surface condensers, &c., also 42 electric tramcars. Tenders by noon March 2.

*Luton* Town Council require tenders for wiring the council chamber, town hall, free library, corn exchange and baths. Tenders by 4 p.m. March 4.

*Islington* (London) Borough Council invite tenders for electrical stores, &c. Tenders by 21st inst.

*Croydon* Corporation require tenders for two dry-back boilers. Tenders by 16th inst.

*Nelson* Corporation invite tenders for the supply of a storage battery. Tenders by 11th inst.

Tenders are invited by the General Telephone Co., *Stockholm*, for the supply of the following telephone cable, all c. i. f. Stockholm—13,000m. to 15,000m., 250 pair; 1,000m. (armoured), 250 pair; 4,000m. 100 pair. Some particulars may be inspected at the Commercial Department of the Foreign Office, Downing-street, London, S.W., between 11 a.m. and 5 p.m.

*Amsterdam* Municipal Council invite tenders for the supply of electricity generating plant. Further particulars can be obtained from the Direction of the City electrical works, 213, Achterb urgwal, Amsterdam, and tenders must be in by noon of April 1.

## TENDERS RECEIVED AND ACCEPTED.

Worthing Corporation have received the following tenders for the supply of a main switchboard :—

| | | | |
|---|---|---|---|
| Jno. Fowler & Co. (*accepted*) | £1,015 | Brush Co. | £1,076 |
| Crompton & Co. | 1,730 | Cowans Limited | 1,050 |
| Nalder Bros. and Thompson | 1,450 | Williamson and Joseph | 1,040 |
| Heaton and Smith | 1,434 | J. E. Spagnoletti & Co. | 1,038 |
| Siemens Bros. & Co. | 1,293 | Lea and Warren | 1,035 |
| General Electric Co. | 1,285 | R. W. Blackwell & Co. | 1,032 |
| Cox-Walkers | 1,205 | W. J. Fryer & Co. | 806 |
| Mechan & Sons | 1,200 | | |

Messrs. Mather and Platt have received orders for the supply of water-softening plants from the Metropolitan Electric Supply Co. (to deal with 240,000 gallons per day of 24 hours); from the Hayling Water Co. (to deal with 120,000 gallons per day); and from Messrs. J. B. Kent & Son (to deal with 14,400 gallons per day) for their new works at Hemel Hempstead.

Colchester Corporation have accepted the tender of the Electrical Power Storage Co. for an additional E.P.S. battery, at £822. 15s., and that of Messrs. Davey, Paxman & Co. for piping, valves, &c., for the surface condensing plant, at £295.

Aberdeen Corporation have accepted the tender of the Electrical Power Storage Co. for the supply of a storage battery of 1,100 ampere-hours' capacity at £6,032, including maintenance for five years.

Eccles Corporation have accepted the tender of Messrs. Browett, Lindley & Co. (Ltd.), for the supply of a 40kw. steam alternator at £732.

The Committee of the Visitors of the Lancashire County Asylum have acccepted the tender of Messrs. Robert Dawson & Co. for wiring the Winwick Asylum.

The tender of Mr. H. Millar has been accepted by the Ilford District Council for the electric lighting of the town hall and public offices at £101, and schedule prices.

Eastbourne Corporation have accepted the tender of Messrs. J. C. Johnson & Son, Leicester, for erecting new electricity supply station buildings at £9,100—about £1,000 below the estimated cost.

Wrexham Town Council have accepted the tender of Messrs. Jones and Cathrall for wiring the Guildhall at £100. 15s.

## BUSINESS NOTICES.

We are informed that Mr. J. C. Ward has ceased, by mutual consent, to represent Messrs. Meirowsky & Co., makers of mica and megomit insulation materials, Cologne, Germany; and that Messrs. George Schultz & Co., 90, Cannon-street, London, E.C., have been appointed representatives for the United Kingdom.

Mr. T. H. Roberts Wray notifies us that he has resigned his position as general manager to the Renewable Electric Lamp Co. in order to enter into partnership with Mr. Alfred Baxter, late London representative of the British Electric Works Co. (Ltd.). The new firm will trade as Baxter and Wray, electrical engineers and suppliers of electrical machinery, at 5, Macclesfield-street, Shaftesbury-avenue, London, W.C., and have been appointed sole agents for London for "Taunton" plant and London agents for the B.I.W. house-wire system.

Messrs. A. Maund and W. D. Seed (trading as Maund and Seed), electrical and mechanical engineers, 120, Lord-street, Southport, have dissolved partnership. Debts by Mr. A. Maund, who continues.

The offices of the Smithfield Markets Electric Supply Co. (Ltd.) will be removed from 53 to 57, Charterhouse-street, London, E.C., on and after 28th inst.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Alfred Lloyd, electrical engineer, Llandudno, has executed a deed of arrangement. Liabilities, £416 11s. 6d.; assets, £225 16s. The trade creditors include

| | | | |
|---|---|---|---|
| Edwards and Armstrong | £40 | O. Braulik | £16 |
| Baxendale & Co. | 34 | Kenyon and Moulding | 15 |
| F. J. Borland | 30 | Isidor Frankenburg (Ltd.) | 12 |
| A. Vandam & Co. | 20 | E. P. S. Co. | 11 |

In the Burnley Bankruptcy Court last week the adjourned examination took place of Robert Foster, of Nelson, and Walter Baker, of Burnley, trading at Burnley as Robert Foster & Co., electrical engineers, and at Nelson as the Nelson Electrical Engineering Co. The O.R. said that a cash account had now been filed, and so far as it went was satisfactory. The examination was again adjourned.

In the bankruptcy of Tom Flather, electrical engineer, 406, Meanwood-road (late of Park Electrical Works, Speedwell-street), Leeds, the first meeting of creditors will take place on 13th inst. at 22, Park-row, and the public examination on 26th inst. at the County Court, Leeds.

Claims against L. Francis, electrical engineer, 13, Corporation-street, Southwold, Suffolk, must be in by 16th inst. to Mr. H. P. Gould, 8, King-street, Norwich.

A first dividend of 3s. 6d. is payable at 24, Railway-approach, London Bridge, on 15th inst., in the failure of A. W. Hirst (trading as Hirst & Co.), electrical engineer, St. Michael's-road, West Croydon.

Claims against Recording Telegraphs (Ltd.) must be sent by 22nd inst. to the liquidator, Mr. G. H. Chantrey, 57, Moorgate-street, London, E.C.

A first and final dividend is about to be declared in the liquidation of the Phæton Electrical Co. (Ltd.). Claims by Feb. 20 to the liquidator, Mr. W. J. Ogden, 6A, Austin Friars, London, E.C.

**Sales by Auction.**—An advertisement elsewhere gives preliminary notice of a sale by auction by Messrs. Wheatley Kirk, Price & Co. at an early date (unless previously disposed of) of a quantity of modern high-class plant, machinery, stock, and stores.

As announced in an advertisement, Messrs. Percy Huddleston & Co., in conjunction with Messrs. Norman and Bowen, will sell by auction on the premises, 65, South Audley-street, London, W., on Feb. 12 and 13 (the fixtures and fittings on Feb. 20), at one o'clock prompt, the valuable stock and plant of an electrical engineer and lamp manufacturer. Catalogues may be obtained from Messrs. Percy Huddleston & Co., 72, Finsbury-pavement, E.C., or of Messrs. Norman and Bowen, 62A, Aldersgate-street, E.C., London, and on the premises.

Messrs. Horne & Co. will sell by auction, on the premises, Wood-lane, Shepherd's Bush, London, W., on Tuesday, Feb. 26, and following days, at 12 noon precisely each day, the whole of the remainder of the machinery and plant recently used in the construction of the Central London Railway. An advertisement elsewhere gives particulars of a portion of the plant and accessories which will be disposed of, and catalogues, when ready, will be obtainable from Messrs. Horne & Co., 8, Delahay-street, Westminster, S.W., and 85, Gresham-street, E.C., London. A large quantity of electrical plant, cable, &c., is included in this sale.

**Plant for Sale.**—The Great Eastern Railway Co. give notice that in consequence of the substitution of hydraulic machinery at Parkeston Quay for steam and the installation of new electric lighting plant they are prepared to receive tenders for the purchase of the whole or any part of the existing steam and hand-power cranes, &c., and also for the existing electric light installations at the quay. An advertisement gives some further particulars, and tenders should be addressed to Mr. W. H. Peppercorne, secretary, Liverpool-street Station, London, E.C., by 10 a.m. of March 4.

Aberdeen Electric Lighting committee invite offers for two direct-coupled continuous-current Willans-Elwell-Parker sets which they have for disposal. Some information is given in an advertisement, and further particulars can be obtained on application to the city electrical engineer (Mr. J. Alex. Bell), Cotton street, Aberdeen. Tenders by noon of March 1.

Blackburn Corporation invite tenders for the purchase of two Willans-Siemens, 45kw. continuous-current, direct-coupled steam dynamos (110 to 150 volts and 120lb. steam pressure), one spare armature, crank shaft, &c. The plant may be seen by appointment with the borough electrical engineer (Mr. A. S. Giles), and tenders are to be sent to the town clerk, Town Hall, by 22nd inst.

Messrs. Wake and Carr, 123, Victoria-road, Darlington, have for sale four sets of vertical marine-type triple-expansion engines. An advertisement gives additional information, and further particulars can be obtained from Messrs. Wake and Carr, Darlington, or Mr. Thos. W. Ward, Sheffield.

An advertisement also contains some particulars of eight large locomotive boilers which are for sale. Applications to Messrs. Wake and Carr, Darlington, or to Mr. Thos. W. Ward, Sheffield.

The Brighton Lighting committee have for sale two continuous-current motor-driven alternators. Offers to manager, electricity works, North-road, Brighton, by 23rd inst.

**Sheets and Stampings.**—Messrs. George Schultz & Co., 90, Cannon-street, London, E.C., sole selling agents for the products of Messrs. W. Gilbertson & Co., of Pontardawe, forward a circular illustrating plain and slotted dynamo armature stampings, discs, rings and segments of the "Iso" brand. For this brand of sheets, &c, a guarantee is given of a hysteresis test not to exceed an ultimate limit of 0·50 watts loss per pound at 4,000 B, and a periodicity of 100; and, where required, an ultimate limit of 0·45 watts loss per pound, will, subject to special conditions, be undertaken. An extensive stamping plant for the production of these goods has been put down at the Pontardawe works.

**Agencies.**—Messrs. Geipel and Lange have been appointed sole sale agents for Europe of the products of the factories of the Okonite Co., of New York and London.

Messrs. Ludw. Loewe and Co. have taken over the agency in this country for the Bullard Machine Tool Co.'s manufactures.

**D.P. Batteries.**—A new price list of D.P. storage batteries and battery accessories is just issued, and contains illustrations and particulars of all the latest types of D.P. cells. A lengthy list of testimonials from users, with instructions for erecting and starting, &c., is also given. Owing to the introduction of labour-saving machinery at the company's works at Bakewell and Charlton, prices have been further reduced. Standard sizes of these cells can usually be supplied at short notice.

**Westinghouse Plant.**—Circular No. 1,038, issued by the British Westinghouse Co., deals with the subject of tramway motors.

**"General" Electrical Progress.**—Circular, No. 31, issued by the General Electrical Co., deals with electric hand-drilling machines. These machines consist of a small electric motor of the ironclad type, the drills being coupled direct to the shaft by means of an adjustable chuck. The smaller sizes can be worked from an ordinary 16 c.p. lamp connection, and for ease of working can be suspended from above by pulleys and counterweights.

**Condensers and Cooling Apparatus.**—A list of cooling specialities fitted with Paul's patent triple and duplex liner tubes, as applied to condensing plant, is issued by the British Power, Traction and Lighting Co. (Ltd.), York. The company claim for their makes of condensing apparatus several advantages over other types of this plant, notably that less space is required, that lighter weight of metal is necessary, and a smaller bulk of circulating water per pound of steam condensed.

**Ejector Condensers for Electricity Works.**—Messrs. Körting Bros., 53, Victoria-street, Westminster, London, have issued catalogue C1., which deals with ejector condensers for electricity works, and gives some notes on spray cooling. An illustration on page 21 shows the spray-cooling plant erected for the electricity works at Cheltenham. Tables of dimensions, &c., of this apparatus are also given.

**"Modern Opera Houses and Theatres."**—Some two years ago we noticed the original issue of "Modern Opera Houses and Theatres," by Mr. Edwin O. Sachs. Mr. B. T. Batsford, 94, High Holborn, London, W.C., informs us that he has arranged for a re-issue of this monumental work, prefaced by a note dealing with the latest developments and improvements in theatre architecture, &c., both at home and abroad.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Jan. 30 to Feb. 5, with the ports of destination:—

*Africa*—Alexandria, £160; Cape Town, £2,126 (including £1,269 telegraph material); Chinde, £31; Durban, £991 (including £607 telegraph material); East London, £65; Port Elizabeth, £359. *Argentine*—Buenos Ayres, £903; Rosario, £119 (telegraph material). *Australasia*—Adelaide, £1,350; Brisbane, £40; Fremantle, £18; Hobart, £30; Melbourne, £1,428 (including £494 telegraph material); Sydney, £1,934 (including £247 telegraph material). *Brazil*—Rio Janeiro, £18. *British Guiana*—Demerara, £520. *Ceylon*—Colombo, £220. *Chili*—Boca, £1,167 (including £189 telegraph material); Santiago, £67. *China*—Shanghai, £139. *Denmark*—Copenhagen, £38. *Germany*—Hamburg, £400 (telegraph material). *Greece*—Syra, £24,000 (telegraph cable). *Holland*—Amsterdam, £110. *India*—Bombay, £459; Calcutta, £706; Madras, £48. *Japan*—Yokohama, £592 (including £517 telegraph material). *Straits Settlements*—Singapore £35. *Uruguay*—Monte Video, £100 (telegraph material). Total £38,234 against £314,495 in the corresponding week last year (Jan. 31 to Feb. 6).

## COMPANIES' MEETINGS AND REPORTS.

### City and South London Railway Co.

The thirty-third ordinary general meeting of this Company was held on Tuesday under the presidency of Mr. CHARLES GREY MOTT.

The SECRETARY (Mr. W. F. Knight) having read the notice calling the meeting, the report of the Directors was taken as read.

The CHAIRMAN then said: Since we last met, a great sorrow has come over this nation in the death of our beloved Queen. History, I believe, has never recorded a reign of any sovereign who was so wise, so noble, and so beloved as our dear departed Queen. She was honoured and beloved, and her loss is felt not only in this country, not only throughout the British Empire, but throughout the whole of the civilised world. We here to-day may add our small meed of mourning to that great tide which has rolled during the last fortnight from every corner of the inhabited world. The enormous progress that has been made, both theoretical and practical, during the past reign has been quite unexampled. We had the power of the steam engine applied first to industrial enterprise, and then upon our railways and other means of locomotion. It has almost revolutionised this country in its day. Then there came on another power—not less important, and one in which we are especially interested—that of electricity. Electricity may be said to be the handmaid of steam, because it has enabled the power of the steam engine to be transmitted and used at distances and under circumstances which were quite impossible for the steam engine before electricity was brought in as its servant. Many of you will remember that at the commencement of this reign electricity was the mere plaything of the lecture-room. Then we were startled by its wonderful adaption to the communication of ideas and the annihilation of time in the shape of the electric telegraph. Then it developed again as an illuminant, and there has been wonderful progress, which is still going on in that direction. Last, and not least, we are now having it applied to traction forces. In regard to that as applied to railways, we have the satisfaction of feeling that here we have been the pioneers; and the adaptation of this power is destined to revolutionise to a great extent the travelling facilities of the whole world. Since we showed, 10 years ago, its capacity on this railway, the development has been something marvellous—not in this country only, but in its application all over the world as regards traction; and we may look forward to enormous improvements and an enormous development of the system which we

ourselves had much to do in first inaugurating here. Well, you will tell me that although we can look back with satisfaction to its introduction, we have not yet solved the problem of giving to its shareholders an adequate dividend. That is true at present, but I have no doubt whatever that the time is rapidly coming when we shall be able to do away with that reproach, and to give to the shareholders of this Company something like an adequate return for the money they have expended; and if we do that we shall do what has not always been done for those who stand in the van of progress. We shall not only have had the satisfaction of having done the moral good, but we shall also have the satisfaction of having made our enterprise profitable to those who have taken the head and front in the battle. There is one proud satisfaction that we can look back upon—that the present King, in the very kind and gracious way that has always characterised him, opened this line to the public something more than 10 years ago, and I trust that that is only the beginning of the great work which His Majesty will be able to do now with his greatly increased powers, and that we shall all rejoice that we have so good a sovereign to follow upon our unexampled Queen. To return to our own affairs, I daresay that some of you are disposed to say, "Well, you paid us a dividend of 2½ per cent. when we were only a little line 3 miles long, but now you have extended it and are extending it, you are reducing our dividend." That is true in one sense, but you will remember that our little isolated line before was worked up by great care and economy to the dividend we got; but, as I explained to you on more than one occasion, we felt that we were very fast getting to the position that our dividend would not increase beyond a certain very limited point, and further, that we were in great danger of even losing that by the competition to which we were subjected—the unfair competition I have characterised it on more than one occasion—of the London County Council and their tramways running at fares that we could not compete with. They were carrying, and they are carrying to-day, passengers at ½d. fares. We know from our own experience that the only safety of this line was in extending it, and that it was not safe to sit still; and therefore we advised you nearly 10 years since to go in for an extension, first, to Clapham, and subsequently, seven years ago, to get powers to go to Islington. We hope to finish six months hence the extension, for which we obtained power seven years ago, to the Angel, and then, I think, you will see the whole thing as we have been designing it from the beginning—a complete undertaking. But for some time past we have been afraid of what might be the result of the intermediate stage of these extensions in the past half-year and the one we are in now, and I am thankful to think that we have been able to go through and around that corner, if I may say so, which we have dreaded, with a diminution of only ¼ per cent. in the dividend. As soon as we get the Islington extension opened, I think we may look forward to a steadily growing and improving condition of things, and you will see that in the end our policy of extensions, carefully designed and slowly carried out, will result in a satisfactory state of things in the future and a development which will produce a result which I think will satisfy everyone. As regards the City and Brixton Railway Co., with which we have made some arrangements in order to utilise that portion of our line which is now standing idle, the condition of the money market has been such that it was not thought prudent to attempt to raise the capital—at least they could not raise the money for it: and some negotiations are now going on which may lead to a change altogether as regards that line, and we may be able to sell to the company, apart from ourselves, the piece of line now lying idle, and upon which we are, of course, losing heavily. It is an expensive piece of line to the City still lying absolutely unused, and if we had been earning in the past six months our proper return on that piece of line, you would have had from it a revenue probably equal to nearly 1 per cent. dividend. We have lost that because it is lying idle; we are paying a dividend on its cost and are getting nothing from it. I hope, however, that it will not be long before that line is utilised. There is a proposal also before Parliament for an independent company to make a line at the end of our station at Islington to King's Cross and to Euston. It seems that it will be a very valuable line to the public, and it is likely to produce a very large traffic upon itself, and also to bring a very heavy traffic from there down to our City stations here. We therefore thought that it would be very advisable for us to try and make some arrangements to work that line. That would save them the necessity for a generating station, and we should be able to work it at very much less cost than they could. These arrangements are not yet finally completed, although we are approaching what we think may be a fair settlement. The construction of the Baker-street and Waterloo Railway is going on rapidly, and I have no doubt that when that line is finished up to the Elephant and Castle we shall get a very large accession of traffic from it. They have just purchased the asylum for the blind for their generating station. Their line will connect us with the very heart and centre of the busy West End traffic of London, and this cannot fail to bring a very large accession of traffic to us. The City station of the Great Northern and City Railway is exactly opposite this station, and they are going on fast. The proposed Euston line will also, I think, be a most valuable feeder, because it will give us access—if the bill is passed—to King's Cross, St. Pancras, and Euston stations, and it will also connect us with the Hampstead and Charing Cross line, so that the Hampstead passengers coming down on all that line to Euston will be able to change there and come straight into the City by our line in a few minutes. The same remark applies to the three great termini of the other railways. Altogether our line, when all these works are carried out, will become one of the most important and valuable railway links that can exist in a great city like this. We have been obliged to provide at great cost our central part in the City, which has been very expensive, but it will be one of the most valuable adjuncts of the line in the future development of its traffic. It may be interesting to you to know that if you take the actual cost of the line we are working now, deducting the value of the piece that is not being used but including the cost of the line up to Moorgate-street, we have earned more than 3 per cent. Of course, you are not getting the 3 per cent. because there are prior charges at a higher rate in the shape of debenture and preference stocks; but looking at the concern altogether, the railway has earned rather over 3 per cent. per annum on the total capital apart from the extension to Islington and the piece of line that is not being used at the present moment. We have got to provide for the future, and we have certain additional payments to make next year as regards the final completion of the contractors' certificates and other things in connection with the Islington line, and we want additional rolling stock—additional carriages and engines—and improvements at the generating station. It is, therefore, necessary for us to apply to Parliament for certain additional powers, but they will only be used for purposes that are absolutely necessary, and on which we shall get a return. The only constructive work in the bill is a subway from the Islington station to come out into the main road opposite the Agricultural Hall, and we believe that this will bring us a considerable amount of traffic. At first we thought of extending the line up to that point, but on further consideration we found that, there being a considerable curve at the corner, it would be a costly piece of line to construct, and we thought that we should derive as much advantage by making a subway for persons to walk through from point to point. We believe that this subway will enable us to tap the very extensive traffic at the Agricultural Hall, and we believe that the subway will give us traffic which will far more than compensate us for the cost of this work, towards which we hope to get some assistance from the Agricultural Hall people. As regards the capital account, we have received in the half year by the issue of shares £86,625, but there has been a very small issue of debenture stock, and therefore there has been a very small amount of premium obtained. The total receipts on capital account for the six months were £87,048, but we have spent £97,645 on works and rolling stock, and we have paid interest out of capital to the amount of £5,519; and then there appears the discount on the issue of the 10,000 shares I have mentioned—a discount of £48,000. These figures mean an expenditure or debit on capital account this half year of £151,780, which is £64,730 more than we have received in the same period. Of course, you will realise that a great deal of that is nominal. In regard to the revenue account we have carried 1,575,900 more passengers: but, of course, we have opened the extension, and the increase in the receipts has been £17,125. In season tickets the increase in number is 188, and the increase apparently in amount is £1,392, but that is far more than it would ordinarily have been on account of a change that has been made in the mode of bringing the season tickets into account. From parcels we have had an increase of £82, and from rents of £657, but there is a decrease of £32 in sundry receipts—this leaves a net increase of £19,234. On the other side—the expenses—the maintenance charges show an increase of £262, locomotive and generating power of £2,901, carriage repairs of £348, traffic expenses of £6,202, general charges of £403, passenger duty of £53, law charges of £7, and rates and taxes of £136, making a total increase of £10,312. The traffic expenses are somewhat increased on account of the cost of issuing tickets, but I may say that this change from the uniform fare that we had before the issue of tickets has been advantageous. We started originally with the uniform fare of 2d., but we had to alter it because of the competition, and we reduced many of the fares at certain places to 1d. We did not, however, issue tickets—we had pay gates. The result was that our average receipts were considerably below the average at the 2d. By the issue of tickets the result in the past half-year is that our average fare is as nearly as possible 2¼d., which is a very satisfactory result. The locomotive power and some of the other charges have been increased this half-year owing to the high price of coal and of almost all the materials we have used. The advance in the price of coal accounts for practically the whole of the diminution of our dividend; but for this we should have paid the same dividend as last year. Having explained other items, he said: We are left with £1,068 to the bad or the difference between 1½ per cent. and 1¾ per cent., which is the decrease of the dividend. We have run 141,697 more miles, and the number of trains run has increased. The number run the whole distance was 3,956. We are running the trains a longer distance, but our traffic has increased more than proportionately. We carried in each train in the corresponding half of last year 44·8 passengers, but in the past half-year the average carried in each train was 62·13. The receipts per train rose from 7s. to 11s. 7d., and the receipts per train mile—which is a much clearer test—were 2s. 3·28d. as against 2s. 5·24d. This is very satisfactory. The receipt per passenger has increased from 1·91d. to 2·23d., and the working expenses, which for the December half of 1899 were 58 per cent., were reduced last half-year to 56·22 per cent. Considering the increased price of coal and materials, I think that this is an extremely satisfactory feature. It is almost the lowest rate—I believe it is the lowest rate—at which we have ever worked, and as the traffic develops and the extent of line is increased, this percentage will go down considerably. In order to compare our rate of working expenses with those of the ordinary steam railways, the cost of the working of the lifts must be deducted, and this being done the working expenses of this company are 48·80 per cent.—a very low rate, as you know, but I believe that we shall be able to reduce it considerably. The expenses per train mile have increased from 1s. 3·84d. to 1s. 4·44d. The locomotive charges have actually decreased from 5·85d. in the December half of 1899 to only 5·50d. last half-year. The traffic expenses have increased from 6d. to 7½d. per train mile, but we shall see those decreased before long. I do not think there is anything further that I can say, and I will now move—

*"That the report and statement of accounts for the half year ended December 31, 1900, be received and adopted."*

Mr. CHARLES SEYMOUR GRENFELL seconded the motion.

A discussion followed, in which Major Perry, Mr. Jarvis, Mr. Searle, Mr. Salter, and other shareholders took part.

The CHAIRMAN, in reply, said that the question of the diameter of the tunnels was a very interesting one. They started with a very small

diameter. They subsequently found that they wanted a larger one, not for the carriages, but in connection with the other things that were carried through the tunnels. They therefore made a larger tunnel on the Stockwell extension, but it was suggested afterwards that it would be desirable to make them still larger—11ft. 6in. That was the size of the Central London tunnel, and they had themselves adopted this diameter through the City, but they afterwards came to the conclusion that the increased size was not of any particular advantage. They had some new rolling stock on order, and they were always endeavouring to improve it, but they did not see that there would be any advantage—on the contrary it would be a disadvantage—to have stock similar to that of the Central London. He would rather have shorter, but much more frequent trains. In the busy parts of the day they now ran trains every 2½ minutes, but it was their intention to run them still more frequently before they had done. They hoped to receive assistance from the Agricultural Hall people in making the subway to that point from Islington. It would be a quarter of a mile long, and was estimated to cost £40,000 at the outside. They believed that by its construction they would be able to "tap" a great deal of traffic, but they were only asking for powers to build it if it should be thought advisable to do so. They had received no complaint as to vibration on their line. He believed that this was a matter which was greatly exaggerated in the case of the Central London; if there was vibration there, it was owing to the heavy rolling stock. The subject of lifts caused much anxiety—not as regarded the question of safety, but as regarded convenience; and experiments had been going on for some time with the object of arriving at a more satisfactory mode of working the lifts.

The motion was adopted and the dividends having been declared, a special general meeting was held, at which the Company's bill in Parliament was approved.

The meeting then separated.

## Great Northern and City Railway Co. (Ltd.).

The fifth half-yearly meeting of this company was held on Friday last, Sir Charles Scotter, J.P., presiding.

The SECRETARY (Mr. H. Barrow Doo) read the notice convening the meeting, and

The CHAIRMAN said: I do not think it necessary to deal with the accounts, as these are duly certified by an eminent accountant. These accounts accurately set forth the position of the company's finances, and shall defer my comments upon them until we become what I may term a working company. Within the last few days my colleagues and myself have visited the railway and the works in connection therewith, and we were exceedingly pleased not only with the progress made, but especially with the admirable and substantial manner in which all the works are being carried out by the contractors, Messrs. Pearson & Son. The tunnels are all ventilated by electric fans, and are lighted up from end to end by electricity. Two-and-a-half miles of tunnel have been completed, and at the rate of progress which is going on over a quarter of a mile of tunnel will be completed each month. The construction of these underground works was complicated, difficult and expensive: but, through the invention of the shield by the late Mr. Greathead, the work was of a most interesting character. The shields in use upon their railway were really an improvement upon Mr. Greathead's, and had been specially designed. There has been no accident of any description with this dangerous work. He (the Chairman) was connected with another electrical railway (the Waterloo and City) and the tunnels there compared with those of the Great Northern and City were exceedingly small. Of course the large tunnels had added considerably to the cost of their undertaking. The excavations and the iron lining of the tunnels would be about double the diameter of the Waterloo and City Railway tunnels: but the advantages to be derived from these large tunnels are just now being appreciated: and doubtless one of the wisest acts in connection with their railway had been the making of these large tunnels, which would admit of the largest rolling stock that is built in the country, and would enable carriages with side doors to be opened when in the tunnel. That could not be done on any tunnel of any of the electric railways now in operation. With their large tunnel they would be able to adopt any form of electric power that is at present known, and, if they thought proper, what was known as the multiple unit system. References had recently been made in the press to the transformation which will shortly take place on the Metropolitan and District Railways. Up to the present time they had always assumed that the best form of electric traction was to be found in America, where the advance in the uses of electricity was considerably greater than in this country: but the time had arrived when America was to be eclipsed by the invention of an Austrian engineer. A new system of electrical working, he was told by those best able to judge—in fact, the highest authority in this country on electric traction—was going to revolutionise electric traction in this country; but the system could not, he feared, be applied to small tunnels. The enormous advantage they would derive by having the large tunnel was that they could adopt any system for traction on their railway. He was told that the cost of the new system was 40 to 45 per cent. less than the cost of any existing known system in use in this country. That was, if true, a marvellous fact. The working expenses would also, he understood, be enormously reduced. He had doubted in his own mind whether they were justified in going on so long before selecting the electrical system upon which they would work their railway, but it had turned out that they had exercised a very wise discretion in delaying until the last moment, so as to be able to adopt and secure the best system that could possibly be used. By adopting the new system the use of heavy locomotives will be avoided. They knew that many of the difficulties of the Central London Railway were caused by the heavy locomotives. By adopting the new system he had mentioned, and by having the advantage of the large tunnels, they would avoid those difficulties. The wear and tear to the permanent way was, of course, enormously increased by heavy locomotives, and that expenditure would be saved. They would have, also, largely increased fresh air space. At present the carriages on the tube railways fill up practically the whole of the tunnel space, whereas on their line there would be a great space round the carriages and a free current of air, and less resistance also to the train, so that less power would be required in the larger tunnels. Another point he might dwell upon was the length of the platforms. The platforms on the underground railways are necessarily very short, but the platforms on their railway were 420ft. long, and they would be able to take a train and accommodate it at the platform sufficient to carry 600 to 700 people. On the Waterloo and City Railway they had more passengers than they could carry between the hours of 8:30 and 9 and 10:30 and 11 a.m., and that is also the experience of the directors of the Central London Railway. That condition of things prevails not only in the mornings, but also at night between 4 and 6 o'clock. Each of these railways could carry three times the number of people if the trains and platforms could accommodate them. They had provided for all this on the Great Northern and City line by these large tunnels and platforms, and they would be able to carry in one train at those times of the day and evening double the number of passengers. Another novelty in the construction of their tunnel was the substitution of brickwork in cement for the lower half of the tunnels. The tunnels are made and lined with iron. After the line is complete and the tunnel is projected forward, the lower half of the iron shields are taken out and brindle bricks in cement substituted. You may ask what good this is likely to effect? Well, they knew what a vital question vibration had become, and what claims were being made in connection with it. A committee had actually been appointed by the Board of Trade upon this very question of vibration. He believed that the construction of the tunnel in the manner he had described would not, perhaps, absolutely do away with vibration, but reduce it to a minimum. The new form of traction doing away with the locomotives, and the new form of tunnel construction would, he believed, leave them absolutely free from complaint with regard to vibration.

The report and accounts were then approved.

The retiring directors were then re-elected, and a vote of thanks to the chairman and directors terminated the proceedings.

## Anglo-American Telegraph Co. (Ltd.).

The ordinary general meeting of this company was held on Friday last, under the presidency of Mr. FRANCIS A. BEVAN.

The SECRETARY (Mr. T. H. Wells) having read the notice convening the meeting,

The CHAIRMAN said: In conformity with the new Act of Parliament I now read the auditors' report appended to the report and accounts of the directors and general balance-sheet, which you will doubtless take as read. Before proceeding to the usual business I am sure I shall be expressing the feelings of all present, as well as of the many absent shareholders (amounting to some 7,000), if I, in your name, express the sense we feel of the deep loss that has been sustained by the death of our beloved Queen Victoria, and at the same time to express to His Majesty King Edward VII. our loyal devotion to his person.

I may now proceed with our ordinary business, but before doing so I cannot help recalling a fact which may be considered part of the history of the Anglo-American Company, or rather of the Atlantic Telegraph Company, of which we are successors, and which connects this Atlantic enterprise and its initial success with her late Majesty. It is an incident that connects Queen Victoria with the 1858 cable of the Atlantic Telegraph Company, for the first message that was sent by that cable (*i.e.*, the first message that was sent by any ocean telegraph company) was the message sent by Her Majesty to the President of the United States, and the reply from the President to our Queen. The chairman then read the messages in which Queen Victoria "congratulated the President of the United States upon the successful completion of the Atlantic cable," and in reply President Buchanan referred to "the skill, enterprise, and indomitable energy which had secured a successful issue to the labours of those engaged in this great enterprise." Mr. Buchanan's message concluded: "May the Atlantic telegraph, under the blessing of heaven, prove to be a bond of perpetual peace and friendship between the two kindred nations, and an influence destined by Divine providence to diffuse religion, civilisation, liberty, and law throughout the world! In this view will not all nations of Christendom spontaneously unite in the declaration that it shall be for ever neutral, and that its communications shall be held sacred in passing to their destination even in the midst of hostilities?" This was the position of affairs in 1858, and since that date the relations between the two nations have several times been severely strained, but have stopped short of the breaking point. The loss which our great nation has sustained in the death of Queen Victoria proves that ourselves and the United States are more closely united than ever before, according to her wishes and those of President Buchanan.

We must now pass to the business more immediately before us. We are not looking at so favourable a balance-sheet as we looked at last year, and I think you will be aware of the causes. The directors have always held out to you that when the German cable was in working order it must take from us a certain amount of traffic, and so it has proved. The German cable to the Azores commenced working on September 1. Before that time we had lost a small portion of the traffic—that portion which had been sent by Germany over the Commercial Cable. This falling off in the Continental traffic has reduced our receipts for the half-year by rather more than £16,000 compared with the previous half-year. Another cause of loss has been the fact that our cable steamer "Minia" has not been so fully employed by other companies as was the case in the previous half-year. Altogether the receipts from this source are less by £15,300, and the working expenses

have increased by £2,961. The earnings of the "Minia," however, are less by £20,760, so that the whole or the greater part of the diminishment in our revenue arises not from the traffic receipts but from the smaller earnings of the "Minia." That is a matter over which we have no control. These reductions in earnings, and the fact that we have had to spend a good deal more on the "Minia" for repairs, &c., leaves us with £38,920 less available for dividend than we had last year. The dividend for the half-year will, therefore, be at the rate of 32s. 6d. per cent. against 43s. 6d. last year. The renewal fund is increased this year by £28,035, and this is accounted for by the fact that we have as usual placed from revenue £24,000 to that account, have received in interest £23,767, and there has been a profit on sale of securities of £3,320, making a total increase of £51,089. Out of this sum we have spent on our new Cuckmere Havre cable £23,054, which leaves a balance of £28,035 to be added to the renewal fund for the year.

As to our present and future prospects, I do not like to prophesy, but we have begun the year very well. We had estimated that we might lose from the German traffic about £200 a day, but during January this has only reached £70 a day, less than in the corresponding month last year, which seems to show that we are making up from other sources the loss that we cannot help sustaining from the opening of the German cable. We are gaining considerably by the boom in American stock exchange traffics, but how long this may last we cannot say. I cannot but bear testimony to the extreme diligence and efficiency of our staff and to the great energy displayed by our general manager, Mr. Carson, for looking out where he could improve the service or save expense in any legitimate way. I should not be discharging my duty if I did not express the sense of the debt we owe to Mr. Carson. Looking at all the difficulties we have to overcome, I think the shareholders, although the deferred holders may think they come off rather poorly, are to be congratulated on the results, and I hope that the year which we have begun so well will result in their all securing a dividend. I now move that the report and accounts to Dec. 31, 1900, be adopted, and that the dividends recommended by the board of directors be declared.

Sir GERALD FITZGERALD, K.C.M.G. (deputy chairman), seconded.

In reply to questions the CHAIRMAN said: A great deal of their expenditure had been in the repair of cables, which was a matter over which they had no power. Such expenses could not be foreseen. As to the traffic with Germany, the Anglo-American Company received much the larger share of the traffic coming from America to Germany, while they received almost nothing of the traffic from Germany to America.

The resolution was then carried unanimously.

Mr. Herbert S. Leon and Sir Gerald FitzGerald, K.C.M.G., were re-elected directors of the company, and Mr. John Gane and Mr. Ernest Cooper (the latter to replace Mr. Joshua Dean, who retires) were appointed auditors to the company.

A vote of thanks, proposed by Mr. JOHN NEWTON, was afterwards unanimously agreed to, and the proceedings terminated.

## Amazon Telegraph Co. (Ltd.).

The sixth ordinary general meeting of this company was held on Wednesday, under the presidency of Mr. W. S. ANDREWS.

The SECRETARY (Mr. R. M. Cunningham), having read the notice calling the meeting, the report of the directors was taken as read.

The CHAIRMAN then said: There is very little for me to say about the existing state of things. The report is brought down to June 30, 1900. There has been a good deal of delay owing to postal difficulties and the difficulty of getting the returns from our stations in some of the remote parts of the Amazon territory. The outcome, I am sorry to say, is not very satisfactory. We all, of course, regret this, but there is no help for it under the circumstances. The total receipts from message earnings and subsidy amount to £14,427. This, of course, is owing to the interruptions that have taken place. There is a slight increase in the receipts over those of the previous year, because the interruptions were not quite so frequent, and therefore more subsidy was earned. The figures, however, are not material in face of the expenses. The general working expenses are rather more than covered by the earnings, but a deficit is occasioned by expenses on maintenance account, by debenture interest, and by sinking fund. The question of the maintenance of the lines, as you know, has been a very great difficulty which has faced us quite unexpectedly from the first, and it is only now that we are really beginning, within limits, to see our way. The deficit caused by these extraordinary expenses amounts to some £35,000. The only point—the crucial point—with respect to the future of this concern is, What chance is there of improvement? Well, we think that the prospects of improvement are considerable. The faults in the cable are becoming less frequent, and the repairs are executed with much more rapidity. Then the removal to safer bottoms for the cable, the alterations in the course of the cable line, and the selection of more sheltered routes, originating through the more intimate knowledge of the river, are all beginning to tell, and are all gradually diminishing our difficulties. For instance, the traffic from last June to the end of last January—seven months—amounted to £8,600, or some £2,000 more than for the whole 12 months of 1899-1900, and this reacts again on the subsidies which are paid in consideration of the working of the lines. Then the new landline, which is to bridge over the most difficult portion of the cable route, is approaching completion. We are reminded on all hands that if we can keep the lines going—the subterranean and the terrestrial—there are subsidies amounting to some £27,000 per annum in addition to message receipts. These subsidies of £27,000 per annum depend on the working of the cable, and now, fortunately, of the landline, which comes in to duplicate the cable if broken. There is, consequently, more hope than we have ever had before of earning these very large subsidies; and if we can earn them and keep the cables going, there is no doubt that the revenue is there, there being plenty of traffic. Even in the limited periods we have had for working the traffic has run up at once, and I cannot help thinking—though I do not like to prophesy—that if we can maintain the lines the traffic would run up to £1,000 a week, and therefore the amount of revenue we should earn would be very large. The result of a survey of the position by ourselves and by large shareholders and debenture holders is the proposition we have to submit to you at the extraordinary meeting—that is, with respect to the issue of debentures, and I think we shall be able to show you that that is a step which, in the interests of the shareholders as well as of the debenture-holders, ought to be taken as speedily as possible, and there is every prospect of its resulting favourably for the concern.

Mr. BAILEY asked what the exact position of the landlines was.

Mr. GOODSALL replied that half the work was finished and the other half would be completed by the end of March.

The SECRETARY: Or thereabouts. The poles are up the whole way, and all the materials are on the spot. Whether it is all erected we cannot say, but, as the chairman has said, the work is approaching completion, and will now very soon be finished.

The motion was adopted unanimously, and resolutions were afterwards passed re-electing the retiring directors, Mr. Goodsall and Mr. George Keith, and electing Messrs. Welton, Jones & Co. auditors.

At an extraordinary general meeting held subsequently a resolution authorising the issue of debentures to an amount not exceeding £150,000, bearing interest not exceeding 6 per cent. per annum, ranking in all respects in priority to the existing issue of £200,000 was proposed.

The CHAIRMAN: As you may imagine, gentlemen, this matter has occupied the attention of the board over a considerable period. We felt that there was only one way of getting the concern properly upon its legs, and that was to provide a sufficiency of means to enable the landline to be completed, to enable any new cable required for repairs to be purchased, and for obtaining a ship, besides the settlement of the immediate liabilities of the company. On the part of the debenture-holders—or some of them, at all events—a strong disposition was evinced to aid a measure of that sort, because I suppose they felt that the property they have at present in the concern would be best protected and its prospects improved by the provision of means that would succeed in establishing the lines and effect this duplicate communication. We think that the way is pretty clear. We have made more than one effort for the establishment of arrangements which would result in the economical settlement of the question without being unduly burdensome on the company, and, in fact, we have had arrangements of all sorts proposed; but we are, of course, unable to fix beforehand the terms that may be ultimately come to. We are therefore asking you for power to issue these bonds on the best terms we can obtain. We have sought in several quarters to obtain those best terms, and it looks to me as if we should succeed on the most satisfactory conditions. Although we are asking for this amount of money, we do not want the whole of it immediately.

The motion was carried unanimously.

A vote of thanks to the chairman was then carried and the proceedings terminated.

## Crompton & Co. (Ltd.).

An extraordinary general meeting of this company was held on Wednesday to consider a resolution to increase the capital. Mr. J. TROTTER occupied the chair.

The SECRETARY (Mr. E. Reeves) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, when we met together last autumn I was asked by a shareholder whether we had before us any increase of capital, and I said at that time that we did not contemplate anything of the sort. Neither have we had in our minds any desire unduly to increase the works at Chelmsford, and the business of this company; but practically some such proposal as is now put before you has been forced on us. We have always of late years gone on conservative lines, desiring rather to be under-equipped for possible business than over-equipped, because we have had always present in our minds the danger of a slack time for electrical engineering coming and finding ourselves with a large number of men and large works and large capital sunk in this works on which it might be difficult to earn satisfactory dividends. But the course of electrical engineering has changed very rapidly lately, and we find that the effect of the last development at the works, which it was intended should equip us for the volume of business that was then in hand, has had this further effect, that, by being able to turn out our machines more rapidly, the number of orders placed with us has very largely increased. The consequence is that, at the present time, we find ourselves quite unable, although we are working night and day with an increased staff, to cope with the business that is offered to us. Everyone in this room must have noticed the additional attention which has of late been given to the production of electrical appliances. The result is that we see before us, and within our grasp, an amount of business which it is perfectly impossible for us to carry through with our existing equipment. We therefore think that the right thing, in the interest of the shareholders, is to provide beforehand for what we see in front of us. Large factories are being established in this country for the purpose of producing electrical machinery and if we are to compete with our rivals we must expend money on equipment as they are doing; otherwise we must take a second place. After considering the matter very carefully we have come to the conclusion that it is desirable to further enlarge the works at Chelmsford and to provide what is involved by that—an increase in the working capital. The electrical appliances now in use have become very large indeed and so they take a long time to produce. We have now orders on our books the delivery of which is for July, 1902. Having these huge machines a long time in our shops involves a very large amount of money for work in progress. We have always fought, and successfully fought,

against producing a stock. Obviously, if we had a stock and could deliver from it promptly, we could replace it more or less at our leisure; but we have held the view, and I think rightly, that with the constant changes which are taking place in electrical machinery, it is not desirable to hold a large stock which at any time might become obsolete. Practically we have no stock at all. All we make is to order, and our only difficulty is that we cannot deliver promptly enough. Therefore, I think that the business is in a sound condition from that point of view. We shall probably not require at once all the capital foreshadowed in the resolution, but, while asking for power to increase the capital, we have thought it best to bring it up to the round figure of £300,000. Before putting the resolution, I shall be happy to answer any questions that shareholders may like to ask.

Mr. BALDWIN inquired what would be the issue price?

The CHAIRMAN: The actual price is not finally settled, but the principle guiding us is to issue the shares at a fairly low price, rather than at high one in order to get a big premium.

Mr. J. BRODIE asked whether the new shares were to be offered to the present shareholders.

The CHAIRMAN: We do not think of offering them exclusively to the existing shareholders. This company has made several issues of capital, in each case to existing shareholders, and the result is that our shareholders' list is not so large as it is desirable that it should be in order to secure a good market for the shares. We think that the effect of making the new issue to outsiders will be to enlarge the market and increase the value of the shares. However, the present shareholders will have consideration. The chairman then moved: That the capital of the company be increased to £300,000 by the issue of 46,000 new shares of £3 each, to rank in all respects *pari passu* with the existing shares of the company.

The resolution was caried unanimously.

## St. James' and Pall Mall Electric Lighting Co. (Ltd.).

The report of the directors of this company for the year ending Dec. 31, 1900, states that the supply of current has been fully maintained from the Carnaby-street and Mason's-yard stations. There has been an addition of 21,597 to the number of 8 c.p. lamps connected, and notwithstanding the high price of coal, the cost per unit has not increased. The large extensions of Carnaby-street station are being completed, and will be ready in good time to deal with the expected demand of next winter's season. The works of the Central Electric Supply Co. at Grove-road are being pushed on, and the directors are assured that all anticipated requirements from the winter of 1902-3 onwards will be duly provided for thereby.

3½ per cent. debenture stock, amounting to £150,000, was issued in June last at 96 per cent., and the whole amount taken up. The discount and expenses of this issue have been carried to the debit of capital reserve fund.

In the net revenue account for 1899 credit was taken for £1,582. 5s. 9d. interest charged on advances made to the Central Electric Supply Co. The auditor of the Board of Trade having expressed an opinion that this amount should not at present be credited to revenue, the directors recommend that this and like sums chargeable in subsequent years should for the present be placed to a special interest suspense account.

The net earnings of the company for the year 1900 were £37,646. 4s. 1d. An interim dividend was paid in August for the half-year ended June 30, at the rate of 7 per cent. on the preference shares and 10 per cent. on the ordinary shares, absorbing £13,500. The balance brought from 1899 was £1,737. 18s. 11d. (less £1,582. 5s. 9d. carried to interest suspense account), leaving now to be dealt with £24,301. 17s. 3d. The directors recommend a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year (absorbing £3,500), and a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making a total distribution of 14½ per cent. for the year. This will require £19.000, and leave to be carried forward £1,801. 17s. 3d.

## Kensington and Knightsbridge Electric Lighting Co. (Ltd.).

The directors' report for the year to Dec. 31, 1900, is issued, and states that during the year the number of houses and shops connected with the system has increased from 2,110 to 2,324, and the equivalent number of 8 c.p. lamps from 183,462 to 199.098.

£7,594. 10s. 9d. has been transferred to renewal account, making the total £37,974. 10s. 4d. After providing this amount, and paying dividends on the 6 per cent. first preference shares to June 30, on the 5 per cent. second preference shares to Sept. 30, and an interim dividend at the rate of 12 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to credit of net revenue is £11,006. 12s. £1,425 of this has been appropriated to the payment of first preference dividend to the end of the year, and £593. 15s. is set aside for second preference dividend accrued to the same date, leaving £8,987. 17s., out of which it is proposed to pay a further dividend on the ordinary shares of 6 per cent. for the past half-year, making 12 per cent. for the year. This leaves £4,712. 17s. to be carried forward.

The issue of new ordinary capital has been fully subscribed by the shareholders, and the directors will, at the forthcoming meeting, invite the shareholders to concur in the issue of shares to the staff.

The new generating station constructed in conjunction with the Notting Hill Electric Lighting Co., was sufficiently advanced at Dec. 31 last to enable the company to obtain material assistance from it towards the end of the year, and will, it is anticipated, be fully available for regular supply early in the spring. The capital for this undertaking has been obtained by the issue of 4 per cent. debenture stock, guaranteed by the two companies.

A transformer station has been equipped, and is now in full working order on a site obtained from Her Majesty's Commissioners for the Exhibition of 1851, at the back of the Royal Albert Hall; this will render the accumulator station in Queen's-terrace-mews unnecessary, and it will shortly be discontinued.

£1,656. 10s. received as premiums on the issue of second preference shares has been appropriated to the reduction of the purchase of the Kensington Court Company account, and £818. 11s. 11d. received from Mr. Lane-Fox, in payment of the amount agreed by the directors to be taken in settlement of the company's claim for costs, has been transferred to the credit of the mains account.

## Dublin United Tramways Co. (1896), Ltd.

The report of the directors for the half-year ended Dec. 31 states that the net profit of the Dublin United Tramways (Old) Co. amounted to £45,154. 7s. 5d., and, after taking into account the balance from the previous half-year (£713. 15s. 6d.) and paying interest on mortgage bonds, loans, &c. (together amounting to £12.635. 17s.), there was a balance of £33,232. 5s. 11d. Of this sum dividends already declared have absorbed £21,000, interest on loans £12,000, and the balance (£232. 5s. 11d.) has been carried forward. The net profit on the Dublin Southern District Co.'s lines was £8.568. 6s., and, after taking into account the balance from the previous half-year, and paying wayleave rents (£606. 16s. 9d.) and dividends already declared (£8,000), there was a balance of £61 9s. 3d. The directors have declared a dividend for the half-year ended Dec. 31 at the rate of 6 per cent. per annum on the preference shares, and at the rate of 6 per cent. per annum (tax free) on the whole of the ordinary shares, £84,500 of which now, for the first time, rank for dividend. These dividends absorb £35,100, leaving £1,243. 17s. to be carried forward. The new tramway from Capel-street, through Britain-street and Summer-hill, was opened for traffic on Oct. 1, and the new tramway from Ringsend to Sandymount on July 4. There is still a break on the Ringsend line at Victoria Bridge, the rebuilding of which should be completed within a month, when the cars will be run through. The horse cars which ran from Haddington-road to connect with the Sandymount line were replaced by electric cars on Jan. 14, 1901, and the whole of the Dublin Tramways system is now worked exclusively by electric power. The full advantages of working from the Ringsend central station were not available during any part of the half-year, as it was not until Jan. 1 of this year that it was possible to save the cost of operating Ball's Bridge as a separate station.

## Waterloo and City Railway Co.

The 14th half-yearly general meeting of this company was held yesterday (Thursday). Sir WYNDHAM S. PORTAL, Bart., the chairman of the company, presided.

Mr. GODFREY KNIGHT (the secretary) read the notice calling the meeting.

The CHAIRMAN (who was warmly received) first referred to the sad loss the country had sustained in the death of our beloved Queen Victoria. He then said: Gentlemen, I presume you will, as usual, take the report as read. Before going through the accounts with you I should like to mention what, perhaps, is the most interesting point to you—namely, that the receipts of the line have considerably increased, and that the working expenses are less than the 55 per cent. limited by the working agreement. The accounts show that to the end of last December £594,791 has been spent on capital account out of a total authorised capital of over £700,000, and during the past half-year the expenditure has been £5,718; £3,502 has been spent on construction of way and stations, and £2,216 for electrical equipment. Our estimate of further expenditure on capital is £19,000, and we hope this will cover any additional outlay that may be required. To meet this we have over £116,000 available borrowing powers. The gross receipts derived from passengers, after deducting duty, have been £15,303, or over £2,000 more than for the same period of 1899. The working expenses were £8,321 against £7,342, chiefly accounted for by the increased price of fuel and other materials. The deficiency on this occasion made good by the South Western Company under the working agreement of March, 1894, is £1,732, against £2,518 a year ago. We have, altogether, £15,488 on the credit side of this account, and after providing for £259 general charges (which is a decrease of £132), we carry £8,638 to credit of net revenue. The profit and loss account shows that we have a balance of £8,176. 19s. 9d. available for dividend. A dividend of 3 per cent. on the ordinary stock will absorb £8,100, and we have, therefore, £76. 19s. 9d. to carry forward. The number of passengers (excluding season ticket holders) carried during the half-year was 2.038,400, and season ticket holders on Dec. 31 numbered 983. Both these figures are increases. In the daily passengers there is an increase of 268,569 over the corresponding period of 1899, and this we consider very satisfactory. There are one or two schemes before Parliament which may affect your railway by tunnelling under it, and these will be carefully watched so that all necessary protection may be obtained. He concluded by moving the adoption of the report and accounts.

In reply to a shareholder the chairman said the Waterloo and City Railway Co. had no projects before Parliament or otherwise for extension at present.

The motion was then carried unanimously.

A resolution approving the payment of a dividend at the rate of 3 per cent. per annum on the ordinary stock (less income tax) was approved.

The retiring directors, Lieut.-Col. the Hon. H. W. Campbell, Mr. Adolphus F. Govett, and Mr. Frederic J. Macaulay, were re-elected directors of the company, on the motion of the chairman, seconded by Sir Chas. Scotter, and the retiring auditor having been re-appointed a cordial vote of thanks to the chairman, the directors, secretary and staff of the company was unanimously carried, and the chairman having briefly replied, the proceedings terminated.

## Central London Railway Company.

The directors' report for the half-year ended Dec. 31, states that the amount expended on capital account during the half-year was £158,415. 17s. 8d. The railway was opened for public traffic on July 30 last, and the revenue derived from that date to Dec. 31 amounted to £119,889. 18s. The working expenses, which were seriously increased by the abnormally high prices of fuel and materials which prevailed during the same period, amounted to £70,433. 19s. 7d. (58¾ per cent. of the receipts) leaving as net profit for the five months £49,455. 18s. 5d. The total net revenue amounts to £49,576. 6s. 4d., and, after providing for debenture interest, there is an available balance of £39,152. 8s. 4d. The directors recommend that a dividend be paid on the share capital for the six months at the rate of 2½ per cent. per annum. To this dividend the various classes of shares will be entitled to the following rates of distribution: Undivided ordinary shares 2½ per cent. per annum, preferred half shares 4 per cent., and deferred half shares 1 per cent. The balance (£3,527. 8s. 4d.) will be carried forward. The number of passengers carried on the line from the date when it was opened for public traffic to Dec. 31, 1900, was 14,916,922.

A bill has been deposited in Parliament to authorise the construction of a loop extension from the Bank station, and an additional station in Liverpool-street, also for a small loop at the Shepherd's Bush terminus. These extensions will enable the company to provide for the carriage of a much larger number of passengers by a more frequent service of trains running in a continuous circuit.

---

**BLACKPOOL AND FLEETWOOD TRAMROAD CO.**—The report of the directors for the half-year to Dec. 31 last shows that, including the sum brought forward the balance of profit after providing debenture interest is £10,686. 18s. 1d., and a dividend at the rate of 9 per cent. per annum (absorbing £6,750) is recommended, £1,000 is placed to depreciation reserve, and £1,100 is written off preliminary expenses, leaving £1,836. 18s. 1d. to be carried forward. The number of passengers carried during the half-year was 1,171,525. The receipts from all sources amounted to £21,130. 3s. 7d.

**CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)**—The report of the directors for the year to Dec. 31 states that the progress of the company continues to be satisfactory. During the year the equivalent of 2,863 8 c.p. lamps was added to the company's mains, making the total 30,986 The number of units supplied was 367,435, an increase of 59,043 or 19 per cent. In spite of the large increase in the price of coal the company has been able to more than maintain its income without increasing the price of electricity. After paying all charges, placing £250 to extinction of preliminary expenses, £448. 14s. 10d. to extinction of suspense account, and £750 to depreciation, there is a balance of £4,278. 10s. 11d., which, added to £210. 15s. 2d. from last year, makes £4,489. 6s. 1d. An interim dividend of £1,413. 16s. 2d. and interest on temporary overdraft and loan (£193. 18s. 9d.) have already been paid, leaving a net balance of £2,881. 11s. 2d., out of which the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,843. 2s. 5d., leaving to carry forward £38. 8s. 9d.

**NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (Ltd.)**—At the annual general meeting of this company on Tuesday, Mr. J. W. Milburn presided, and referred in feeling terms to the death of Queen Victoria. The chairman gave an interesting review of the progress of British industry during the late Queen's long reign. Referring especially to the development of the electrical industry, Mr. Milburn said that until recently the application of electricity to industrial uses had met with anything but encouragement from successive British Governments, who seemed to possess a special function for retarding English industry. This had been especially noticeable with regard to shipping and mining, and to the industries associated with military operations. If we had not had the gift as a nation of muddling through and coming out all right, and had instead taken the direction which some of the great Government departments seemed to have preferred, it was probable that we should not now be in existence as a nation. There was one other point to which he wished to allude, and that was the restriction of output practised by members of labour unions. The mistaken notion seemed to prevail that the amount of work could be increased by spinning it out as long as possible. On the important point of standardisation Mr. Milburn said they heard a lot about locomotive orders going to America, but it must be remembered that in England every different railway engineer had, perhaps, a different type of locomotive and fads and fancies of his own, whereas in America railway engineers held conferences with a view to assimilating ideas and agreeing upon common standards, and, in this way, engines and other machinery could be put in hand in the shops even though not immediately required, and when a sudden demand came upon the works the standardised parts of the machines could be put together and the demand supplied. He recommended that similar conferences should be held in this country in order that they might see how they could better adapt themselves to successful competition with other nations. He was hopeful that our new King would follow the example of the German Emperor, who stood by and applauded whenever German engineers turned out something exceptionally excellent—sometimes when its only recommendation was its size. But commercial men valued this applause. Coming to the business of the meeting, the chairman pointed out that the supply of electric current provided by the company had given satisfaction to their consumers. They had added the equivalent of 4,800 10c.p. lamps to their system, bringing up the total to 46,678. 1,211,649 units of current had been supplied, against 1,008,622 units in 1899. In September last the company commenced to supply continuous current mostly for power purposes, and already motors equal to about 400 H.P. had been connected to the company's mains, and fresh applications were being received. During the year 10,399 yd. of main and branch piping had been laid, and 19,648 yd. of main and branch cable. The abnormally high cost of coal had involved large additional expenditure, but the gross earnings amounted to £9,339. 12s. 3d., and after paying interest on debentures and loans, the directors recommended the usual dividend of 5 per cent. for the half-year (less tax), which, with the interim dividend, made 8½ per cent. for the year. Owing to the recent reduction in the price of coal, and the increased gross revenue of the company, the directors hope to be able to place a further substantial amount to reserve and depreciation. In the present balance-sheet £311. 17s. 7d. is put to this account. They had, during the year, spent no less than £18,000 in the completion of their first power station. They had spent £17,000 more for coal. Nevertheless, the increase in the company's business had been considerable, and it would have been greater still had they been able to move forward with their new power station.

**NORTH METROPOLITAN TRAMWAYS CO.**—At the half-yearly meeting on Friday, the chairman (Mr. George Richardson) said that they had received a letter from the London County Council, inviting them to name a price for the surrender of their lease, but the directors had replied that they were not prepared to do so. They had no intention of giving away the company's rights to all those parts of the system which remained with them, because they held the key of the position to the northern portion of London, and the country beyond, for 23 years, and those lines would join on to the light railways which the Middlesex County Council had approved.

**SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)**—The report of the directors for the year ended Dec. 31 states that the accounts show a gross profit of £4,452. 9s. 3d., after allowing £500 for directors' fees. The gross revenue amounted to £15,187. 16s. 10d., against £12,083. 6s. for the preceding 15 months. Of the gross profit debenture interest and other charges absorb £2,567. 5s. 6d., and £1,000 has been placed to depreciation. The balance carried forward, after writing off deficit at end of 1899, is £675. 1s. 1d. The business of the company continues to make satisfactory progress, 57 new installations having been obtained during the year. The equivalent number of 8 c.p. lamps installed at Dec. 31 was 23,239, an increase of 6,279. A new boiler, engine and dynamo, representing an additional 300 H.P., have been installed within the last few weeks to meet the increasing demand for electric current for lighting. This expenditure has been provided for by the issue on Jan. 1 of a further £3,800 second debentures, making the total issue £8,000. It is not proposed to raise further capital at present. The plant and machinery have worked satisfactorily, and have been maintained out of revenue.

---

## CITY NOTES.

**MEMORANDA.**—Bank rate 4½ per cent. (Feb. 7). Price of silver 27⅜d. per oz. (Feb. 7). Consols (2¾ per cent.) 96⅛—96⅜ for money, 96$\frac{11}{16}$—96$\frac{13}{16}$ for account; 2½ per cent. 96½—97½ (Feb. 7). Consols Pay Day March 1. Stocks and Shares Continuation Days, Feb. 12 and 26; Ticket Days, Feb. 13 and 27; Pay Days, Feb. 14 and 28; Mining Share Carry-over Days, Feb. 11 and 25.

**BOURNEMOUTH AND POOLE ELECTRICITY CO. (LTD.)**—The transfer books and register of members are closed from 6th to 15th inst. inclusive, preparatory to payment of dividend on the preference shares for the half-year to Dec. 31.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1900-1 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Jan. 26 | 553 | + 16 | 34 | 23,745 | + 3,265 |
| *Birmingham Tramways. | Feb. 2 | 3,708 | − 170 | 4 | 15,783 | − 173 |
| *Blackburn Corporation.. | „ 2 | 340 | + 81 | ... | 1,664 | − 221 |
| Blackpool Corporation... | Jan. 31 | 159 | + 19 | 44 | 29,046 | + 7,685 |
| Blackpool and Fleetwood | Feb. 2 | 142 | − 25 | 5 | 674 | − 66 |
| Bolton Corporation ...... | „ 3 | 1,242 | ... | 44 | 69,495 | ... |
| Bradford Corporation... | „ 3 | 656 | + 306 | 44 | 26,248 | + 9,276 |
| Brisbane Trams ......... | Dec. 19 | 2,070 | + 213 | 24 | 45,605 | + 8,237 |
| *Bristol Trams & Carriage | Feb. 1 | 3,612 | +1,136 | 5 | 18,285 | + 4,919 |
| *Buenos Ayres & Belgrano | Jan. 6 | 3,324 | + 670 | 1 | 3,324 | + 670 |
| Central London Railway | Feb. 2 | 7,112 | ... | 5 | 30,578 | ... |
| City & South London Ry. | „ 3 | 1,956 | + 836 | 5 | 9,978 | + 4,388 |
| Cork Elec. Trams......... | ... | ... | ... | ... | ... | ... |
| Dover Corporation ...... | „ 2 | 139 | − 10 | 44 | 9,557 | + 602 |
| Dublin & Lucan Rly. .. | „ 2 | 64 | + 16 | 5 | 333 | + 72 |
| Dublin United ............ | „ 1 | 3,109 | + 248 | 5 | 6,275 | + 1,754 |
| Dublin Southern Dist.... | „ 1 | 613 | + 43 | 5 | 3,840 | |
| *Dundee Corporation ... | Jan. 30 | 445 | + 89 | ... | ... | ... |
| *Glasgow Corporation ... | Feb. 2 | 7,958 | − 189 | 5 | 45,972 | + 2,054 |
| Hull Corporation.......... | „ 2 | 1,454 | + 823 | 31 | 44,460 | +24,128 |
| *Liverpool Corporation... | Jan. 26 | 8,143 | +1,545 | 4 | 32,151 | + 5,626 |
| Liverpool Overhead Rly. | Feb. 3 | 1,404 | − 123 | 5 | 7,398 | − 155 |
| *Sheffield Tramways ...... | „ 3 | 2,500 | + 721 | 5 | 13,348 | + 4,228 |

* Partly electrical.

**EASTERN TELEGRAPH CO. (LTD.)**—Notice is given that an extraordinary general meeting of this company will be held at Winchester House, Old Broad-street, London, E.C., on 13th inst., at 2:30 p.m., to confirm as a special resolution the resolution passed at the meeting of the company on Jan. 28.

**ISLE OF MAN TRAMWAYS CO.**—The receiver for the debenture holders (Mr. W. H. Walker) has filed his accounts for the period between July 25 and Dec. 31. The gross receipts were £29,820. Of this working expenses and debenture interest absorbed £23,861, leaving £5,958 available for creditors and shareholders.

**MEXICAN GAS AND ELECTRIC LIGHT CO. (LTD.)**—An order has been made to restore the name of this company, which had been struck off the register of joint stock companies.

**NEW COMPANY.**—We learn that at Leigh, which will form the centre of the operations of the South Lancashire Electric Traction and Power Co.'s extensive system, and at which town the company's generating station will be erected, there has been formed a new company for the manufacture of electric cables and wires, under the style of the Anchor Cable Co. (Ltd.), with a capital of £50,000. The directors include Councillor George Shaw (Mayor of Leigh), and Messrs. R. A. and W. E. Rumney and Wm. Henderson, all of Leigh, Lancs. The South Lancashire Company is, it is stated, to take over the several Acts for the construction of tramways and light railways in the district, and will possess a system of an aggregate length of 107 miles of track.

**PEARSON FIRE ALARM SYSTEM (LTD.)**—Mr. James Hill Hartridge and Col. F. B. Vaughan have joined the board of this company.

**ST. JAMES' AND PALL MALL ELECTRIC LIGHTING CO. (LTD.)**—The share transfer books of this company will be closed from Feb. 6 to Feb. 20 inclusive, preparatory to the payment of dividends for the half-year to Dec. 31.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange Committee have appointed the 13th inst. as a special settling day in the further issue of 13,769 ordinary £10 (£5 paid) shares (Nos. 85,001 to 98,769) of the *Metropolitan Electric Supply Co. (Ltd.)*, and the same has been ordered to be quoted in the official list. The committee has also been asked to allow 20,000 6 per cent. cumulative preference £5 shares (Nos. 1 to 20,000) of the *Electric Light and Traction Co. of Australia (Ltd.)* to be quoted in the official list.

**TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)**—The directors of this company propose to pay a dividend of 10 per cent. (£1. 4s. per share), together with a bonus of 2½ per cent. (6s. per share), in addition to the 5 per cent. already paid, making 17½ per cent. for the year 1900.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Prices, Jan. 30. | | Price Wednesday, Feb. 6. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Feb. 6. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅞ | 1 | ⅞ | 1 | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (fully pd. and con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12¾ | 13¾ | 12¾ | 13¾ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 100 | 103 | 100 | 103 | 4 7 5 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7 | 8 | 3 15 0 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9¼ | 8¾ | 9¼ | 3 18 8 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¼ | 6¾ | 6¼ | 6¾ | ... | ... | 6½ | ... |
| 30,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9¾ | 10¼ | 9¾ | 10¼ | 4 3 1 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 3 18 3 | " " | 5¾ | 5¾ |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6¾ | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,679 | 10 | 8/0 | City of London Electric Lighting Ord. | 8½ | 9½ | 7½ | 8½ | 4 14 2 | February and August | 8 | .. |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 18 9 | June and December | 125½ | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (60% pd.) (red.) | 61 | 63 | 61 | 63 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | ... | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,300 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10¾ | 11¾ | 10¾ | 11¾ | 4 11 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Preference | 6½ | 7 | 6½ | 7 | 4 5 7 | January and July | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 55,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 6 7 | April and October | 12½ | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £450,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 10 8 | ... | 97½ | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 14½ | 15½ | 15 | 16 | 4 7 6 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6¾ | 6½ | 6¾ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ⅞ | 1⅛ | ⅞ | 1⅛ | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 6% | River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb. | 70 | 80 | 70 | 80 | 8 0 0 | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 180 | 4 8 11 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 7 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9¾ | 8¾ | 9¾ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 19/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 2⅞ | 2⅞ |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12½ | 13½ | 12 | 13 | 5 0 0 | March and September | 12¾ | 11⅞ |
| 29,618 | 5 | ... | Do. Do. | 12 | 13 | 11½ | 12½ | ... | ... | ... | .. |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 3 7 7 | February and August | ... | ... |
| 35,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 10½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 15,600 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 64,000 | 10 | 6/0 | British Elec. Trac. Ord. | 13 | 14 | 13½ | 14½ | 5 17 3 | ... | 13⅝ | 13⅛ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12 | 13 | 12 | 13 | 4 11 6 | February and August | 12½ | 12⅛ |
| £250,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | [illegible] | 120 | 123 | 4 1 4 | ... | 122 | 121½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | 5⅛ | 5 |
| 27,500 | 5 | ... | Do. "B" | 4¼ | 4¾ | 4¼ | 4¾ | ... | ... | 4¼ | .. |
| £330,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | .. | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) | 95 | 98 | 95 | 98 | 5 1 0 | ... | ... | ... |
| 206,297 | 10 | 3/0 | Central London Ordinary | 7½ | 9 | 6½ | 8½ | 3 6 7 | June and December | ... | ... |
| £956,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 60 | 64 | 60 | 64 | 2 10 11 | February and August | 60½ | ... |
| 37,500 | 10 | 1/3 | Do. Ordinary (Nos. 33,501 to 71,000) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | 4¾ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 138 | 143 | 138 | 143 | 3 9 11 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | " " | .. | ... |
| £314,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 115 | 120 | 115 | 120 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Tramways (1896) Ltd., Ordinary | 15 | 16 | 13½ | 14½ | ... | ... | ... | ... |
| 51,987 | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 21½ | 22½ | 21½ | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,500 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8¼ | 8¾ | 8¼ | 8¾ | 4 14 2 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13¼ | 13¾ | 13¼ | 13¾ | 3 14 1 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 103 | 104 | 103 | 104 | 3 16 10 | January and July | ... | ... |
| $350,000 | $1,000 | 5% | London Street R'y. (Ont.) 1st Mort. 5% Debs. (red.) | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| £325,744 | Stock | 2/6 | Lond. Utd. Trams 4% 1st Mt. Db. Stk. Prv. Certs. (£60 pd.) | 62 | 64 | 62 | 64 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 103 | 105 | 103 | 105 | 4 7 5 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 80,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 6,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | " " | ... | ... |
| 11,364 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | 12½ | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | [illegible] | Do. 4½ per Cent. Debenture Stock | 103 | 105 | 103 | 105 | 4 5 9 | ... | ... | ... |
| £944,000 | Stock | 6% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | [illegible] | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Jan. 30. | | Price Wednesday, Feb. 6. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Feb. 6. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | January and July | ... | ... |
| 35,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 6% | Do. 6 per Cent. Debentures | 75 | 85 | 65 | 75 | ... | ... | ... | ... |
| £837,720 | Stock | 15/0 | Anglo-American | 51 | 54 | 53 | 56 | 5 13 2 | Feb., May, Aug., Nov. | 54 | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 94 | 99 | 98 | 100 | 6 2 6 | " " | 101 | 97¾ |
| £3,088,640 | Stock | 27/0 | Do. Deferred | 8½ | 8¾ | 8¾ | 9¼ | 14 11 8 | " " | 9⅛ | 8½ |
| 13,333,300 | $100 | 8¼ | Commercial Cable Capital Stock | 170 | 180 | 175 | 185 | 4 8 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,711,030 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 16 11 | " " | 103 | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 8 | 9 | 6 2 3 | February and August | 8 | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | " " | 16½ | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 | 10½ | 10 | 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10½ | 10 5/16 |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 25/0 | Eastern Ordinary [to 1,200] (red.) | 138 | 141 | 140 | 145 | 4 16 11 | Jan., Apr., July, Oct. | 141½ | 138½ |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 95 | 98 | 95 | 98 | 3 11 5 | " " | ... | ... |
| £1,452,368 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 110 | 113 | 110 | 113 | 3 11 5 | May and November | 111 | 111 |
| 250,000 | 10 | 2/6 | Eastern Extension | 14 | 14½ | 14 | 14½ | 4 16 7 | Jan., Apr., July, Oct. | 14 5/16 | 14½ |
| 50,000 | 10 | ... | Do.(Nos.250,001to300,000)£5pd.Is'd at £3pm,allpd | 11½ | 12½ | 13½ | 14½ | ... | ... | 14½ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock .. xd | 112 | 117 | 110 | 115 | 3 9 7 | February and August | 112 | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 .. xd | 101 | 104 | 99 | 102 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 100% | 103% | 100% | 103% | 3 18 3 | May and November | 101 | ... |
| 189,327 | 10 | 1/3 | Globe Telegraph and Trust xd | 10½ | 10¾ | 10 | 10½ | 5 0 0 | Jan., Apr., July, Oct. | 10½ | 10 1/16 |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference xd | 15 | 15½ | 15 | 16½ | 3 17 6 | " " | 15 7/16 | 15 |
| 160,000 | 10 | 5/0 | Great Northern of Copenhagen | 32 | 34 | 31 | 34 | 3 13 6 | January and July | 32½ | ... |
| £83,000 | 100 | 4½% | Halifax&Bermuda Cable 4½%1stMort.Deb (withnNos. | 99 | 103 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [1 to 1,200] (red. | 47 | 51 | 47 | 51 | 4 11 0 | May and November | 48½ | 47½ |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 | 107 | 104 | 107 | 5 12 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 103 | 99 | 103 | 3 15 5 | June and December | 99½ | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7 | 8 | 7 | 8 | 5 0 0 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 121 | 125 | 124 | 129 | 4 14 0 | " " | 125 | ... |
| 16,609 | 10/0 | ... | West African Telegraph | 2½ | 3½ | 2½ | 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 102 | 99 | 102 | 4 19 6 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ¼ | ¾ | ¼ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | ¾ | ¾ |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | 6 1/16 | 6½ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 6% | * Do. 6 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 307,930 | 10 | 3/0 | Western Telegraph (late Brazil'n S'bm'rine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14½ | 14 1/16 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £343,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 6/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 324,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 3/6 | 4/1 | 3/1 | 4/6 | 6 13 4 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ¼ | ½ | ¼ | ½ | 5 0 0 | November | ... | ... |
| 66,493 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 3/0 | National | 4¼ | 4¾ | 4 | 4½ | 7 1 2 | February and August | 4 5/16 | 4 1/16 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 | 14 | 12 | 14 | 4 5 9 | " " | 12 | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | " " | ... | ... |
| 250,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | " " | 5 | 4½ |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 94 | 97 | 94 | 97 | 3 12 2 | June and December | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 | 100 | 97 | 100 | 4 0 2 | ... | 99½ | ... |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5½ | 4½ | 5½ | 6 13 4 | July | ... | ... |
| 16,639 | 5 | 3/6 | Do. 5% Cumulative Pref. (Nos. 1 to 16,639) | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | ... |
| 73,361 | 5 | 1/3½ | Do. do. (Nos. 16,640 to 90,000) | 4½ | 5½ | 4½ | 5½ | ... | ... | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 2d. | Alliance Electrical Co. 5% Cum. Pref. | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 135,000 | 1 | 1½d. | Aron Electricity Meter 6% Cum. Pref. | 11/16 | 13/16 | 11/16 | 13/16 | 7 8 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 95 | 97 | 95 | 97 | 4 7 8 | ... | ... | ... |
| 73,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ | 11½ | 10½ | 11½ | 8 13 11 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 4¾ | 4½ | 4¾ | 6 6 4 | ... | ... | ... |
| 90,060 | 2 | 1/2½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 6 8 4 | September | 1½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 3 per Cent. Pref. Non-Cum. | 2 | 2½ | 2 | 2½ | 5 6 8 | " | 2 1/16 | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 106 | 111 | 105 | 110 | 4 3 7 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 5 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 13 | 14 | 13 | 14 | 6 7 2 | " " | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 5¾ | 4 8 11 | " " | 5½ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 11 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½ First Mort. Deb. (red.) xd | 97 | 100 | 97 | 100 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 84,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 84,000) xd | 3½ | 4 | 3½ | 3¾ | 6 0 0 | January and July | 3½ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 | 102 | 99 | 102 | 4 15 0 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2½ | 8 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 89 | 92 | 89 | 92 | 4 8 11 | June and December | ... | ... |
| £100,000 | Stock | 2/4½ | Do. 5% 2nd Deb. Stamping Prov. Certs (all pd) | 98 | 100 | 98 | 100 | ... | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 8 10 0 | Half-yearly | 4½ | 4½ |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 102 | 104 | 102 | 105 | 4 5 11 | ... | 103 | 103½ |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) xd | 1½ | 2½ | 1½ | 2½ | 5 13 2 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | ... | Gilfre Electro Chemical and Power Co. Ord | ½ | | ½ | | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 13½ | 14½ | 13½ | 14½ | 5 3 5 | February and August | 14½ | 14½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ | 21½ | 20½ | 21½ | 4 13 0 | " " | 21½ | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 8 | March and September | 101 | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | 38 | 43 | 39 | 43 | 4 3 3 | March and July | 41½ | 41¼ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 10 | 11 | 5 15 2 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 6 1 9 | April and October | 10½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 3 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

**SPECIALITIES.**

**WIRES** and **CABLES** up to one square inch section of copper insulated with Vulcanised Indiarubber.

**HIGH INSULATION VULCANISED INDIARUBBER.**

**LOW INSULATION VULCANISED INDIA-RUBBER** combined with great Mechanical Strength, Durability, and suitable for Highest Working Pressures. The most Economical and Reliable Cable for Central Station Work.

Telegrams: CONNOLLYS BLACKLEY.

**CONNOLLY BROTHERS, Ld.,**
Insulated Wire and Cable Makers,
**Blackley, MANCHESTER**

Tele. No. 2361.

**LEAD COVERED CABLES.**

**CONCENTRIC CABLES** of all Descriptions.

**BOARD OF TRADE CABLES.**

*AGENCIES and STOCKS in LONDON, BIRMINGHAM, and GLASGOW.*

***SOLE MANUFACTURERS of "BLACKLEY" TAPE.***
THE BEST TAPE FOR OUTSIDE COVERING IN THE MARKET

# THAMES

**DYNAMOS**
**MOTORS**
**ELEC. DRILLS**

**The THAMES IRONWORKS, SHIPBUILDING & ENGINEERING CO., Ltd.,**

THAMES ELECTRICAL ENGINEERING WORKS,

**BLACKWALL, LONDON.**

# SPECIAL NOTICE

"The Electrician"
**ELECTRICAL TRADES DIRECTORY**
AND HANDBOOK for 1901 is
**NOW READY**

And contains all the ADDITIONS and CORRECTIONS to NAMES and ADDRESSES which are made in the important month of JANUARY, 1901.

33 of the changes in Names and Addresses for Directory purposes are effected in January.

PRICES.—[illegible] 18/3; Colonies, 14/-; Abroad, 14/6; United States, 15/-.

**Offices: 1, 2 & 3, Salisbury Court, Fleet Street, London, England.**

# DAVEY, PAXMAN & CO., LD. COLCHESTER,

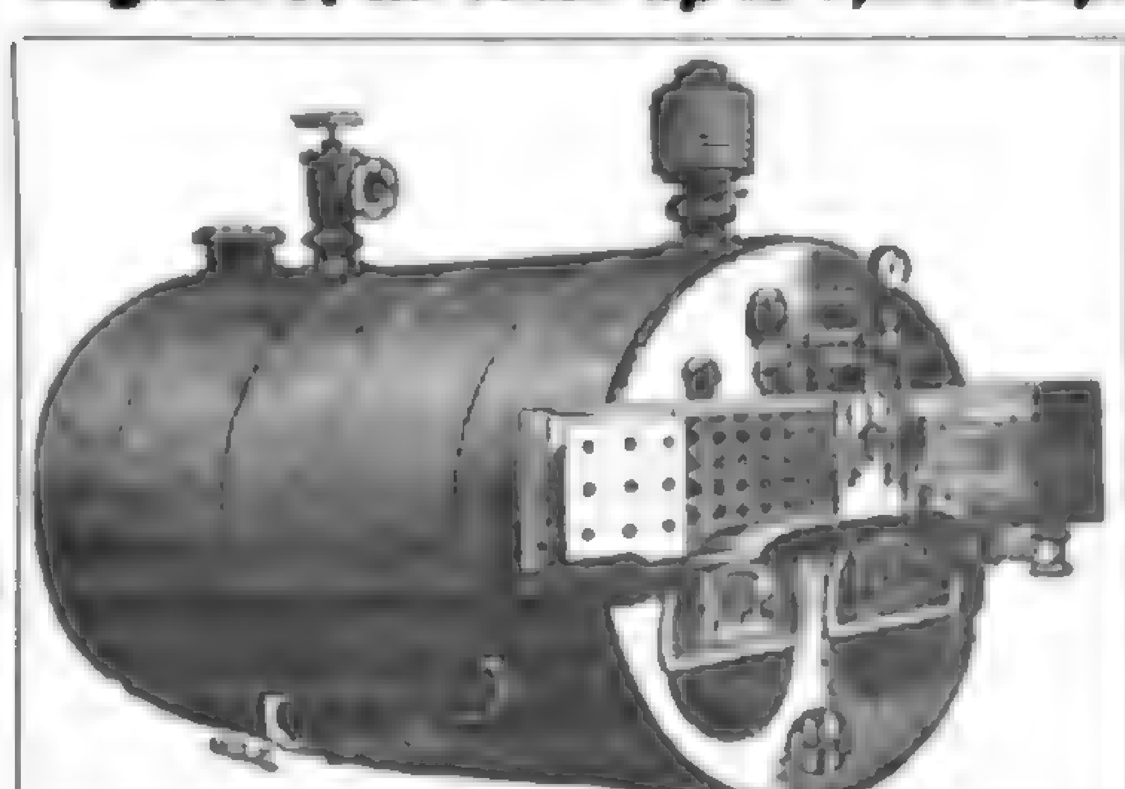
**Engineers and Boilermakers.**

**Speciality:** STEADY RUNNING ENGINES FOR ELECTRIC LIGHT INSTALLATIONS.

MAKERS OF

Portable and Semi-Portable Engines
Semi-Fixed Engines and Boilers.
Horizontal Engines.
Vertical Engines and Boilers.
Tandem Engines, Simple and Compound.
Triple-Expansion Engines.
Corliss and Trip Gear Engines.
Horizontal Winding Engines.
Air Compressors.
Compound Portable & Semi-Portable Engines
Vertical Hoisting Engines and Boilers.
Compound Semi-Fixed Engines and Boilers
Compound Horizontal Fixed Engines.

**Engines of all Sizes up to 1,500 h.p.**



Paxman's Patent "Economic" Steam Boiler.

The "ECONOMIC" Boiler is one of the best steam generators before the public not only for efficiency, but for Economy and Durability. This Boiler contains particularly good features and high qualities, and is BEING ADOPTED VERY LARGELY FOR CENTRAL ELECTRIC LIGHTING STATIONS, MILLS, and FACTORIES, &c., WITH GREAT SUCCESS.

Cornish, Lancashire, "Essex," Vertical, Locomotive, "Economic," Safety, Water-Tube, Marine, and other Boilers.

D. P. & CO. ARE MAKERS OF HIGH-CLASS STEAM BOILERS OF EVERY DESCRIPTION.

*ALL RIVET HOLES DRILLED.*

*Telegraph Address:* "PAXMAN, COLCHESTER." BOILERS MADE UP TO 200lb WORKING PRESSURE.

Catalogue and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ld., Engineers, COLCHESTER.**

London Office: 78, QUEEN VICTORIA STREET, E.C.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,187. [No. 17. Vol. XLVI.] FRIDAY, FEBRUARY 15, 1901. PRICE SIXPENCE (by post, 6½d.) *Abroad, 8d., or 16 cents, or 80c., or 75pf.*

CONTENTS OF THE CURRENT NUMBER.

## NOTES

The interest which all classes are now taking in electric traction was well shown by the numbers who availed themselves of the London County Council's invitation to inspect the model conduit systems at Camberwell, yesterday afternoon. The object of the gathering was presumably to impress the various Metropolitan Borough Councils of the superiority and elegance of the slotted-conduit system, for the London County Council can only run its tramways with the concurrence of the several local authorities on the routes. Two conduits were on view, one was the Westinghouse track recently exhibited at the Agricultural Hall, and this was in actual running order "with car complete." The other was a model of the conduit as arranged by the Council's engineers, and provisionally adopted by them subject to the approval of the Board of Trade.

The non-technical visitor who saw the car running so smoothly over the Westinghouse track would assume that similar or possibly better results could be obtained from the model conduit, whereas, of course, it does not at all follow that the action of an entirely different conduit system is to be equally successful; in fact, from what we were able to see, we are compelled to say that the London County Council conduit can hardly, as it stands, be considered an advance on recent practice. We propose, however, to return to this matter in our next issue, when we shall be able to trace out in detail the points of difference between the two conduits, and their technical consequences.

Mr. H. A. Humphrey, in a letter this week, asks us to explain why we believe that "where gas transmission is adopted the richest possible gas is clearly the only kind admissible." Our reason is that it is more economical to transmit gas that is wholly good fuel than it is to transmit gas that is largely composed of inert and useless gases. Is not that obvious? Producer-gas consists largely of nitrogen, and, to some extent, of other inert gases; and though it can be produced very cheaply, yet it does not pay to pipe-line it over long distances because of the much greater capital outlay on larger pipes and gas-holders, and because of the extra cost of forcing large volumes of useless gas through the mains. A richer gas, even though costing more to manufacture, is better for long-distance transmission. We do not, of course, mean that the gas must be as refined and costly as ordinary lighting gas: that is quite unnecessary for power gas. Cheap yet rich power gas is not beyond the resources of gas engineering, and its general introduction would do far more to encourage the spread of gas power than the improvement of diluted producer-gas plant.

Slowly, but we hope surely, the long-desired amendment in the obnoxious Board of Trade Regulation B6 is being proceeded with. We have already announced that the Board of Trade had advertised that "application had been made" to have this regulation amended to a form which would no longer impede the remodelling of 100-volt networks, and that a date had been fixed for hearing objections. The Board of Trade now announces that it will hold an enquiry in the matter on March 1st (11 a.m. at the Westminster Town Hall). The full text of the announcement appears in our advertisement columns this week. It is hardly open to question that the result of the enquiry will be favourable to electric lighting undertakings, and that one of the many legislative impediments to the progress of electrical industries will soon be removed.

The Board of Trade is making another interesting move in electric supply matters, the result of which we cannot but think will be for the ultimate benefit of electrical engineering. We learn that the Board is of opinion that the maximum price of 8d. per Board of Trade unit, which it has fixed hitherto under the authority of the Electric Lighting Act of 1888 and the Electric Lighting Clauses Act of 1899, is too high, in view of the progress made in electrical engineering since that date. It proposes, therefore, that in future provisional orders 6d.

shall be the maximum charge to be quoted. There may be, of course, some few places still far removed from railway communication where electrical energy at 8d. per unit might prove the cheapest artificial illuminant obtainable; but in such cases the Board of Trade would be empowered to increase the maximum rate if it thought such increase were justifiable.

There has been considerable agitation in the newspapers of late in connection with the reduction of the staff at the engineering college at Cooper's Hill. No less than seven professors and other teachers have been dismissed by the India Office, the reasons given being that the college has been a "financial failure from the first," and that modern requirements necessitated not only retrenchment but a reorganisation of the curriculum. On Tuesday last an influential deputation of scientific men was received by the Secretary of State for India (Lord George Hamilton) for the purpose of presenting a memorial signed by nearly 400 signatories, protesting against this action. The deputation was headed by Lord Kelvin, and included, among others, Lord Rayleigh, Lord Lister, Sir F. Bramwell, Sir H. Roscoe, Sir N. Lockyer, and Prof. J. Perry. After the memorial had been presented, and several speeches had been made, the Secretary of State made a lengthy and telling reply, in which he closely criticised the position of the deputation, and declined to adopt its recommendations.

It is greatly to be regretted that a deputation of so many leading men of science should have been treated so cavalierly. Even if the reasons for the reduction of staff were unassailable, it would have been far more satisfactory to the public mind if an open inquiry had been instituted at which these invincible reasons could have been publicly ventilated. But it is by no means certain that these reasons are beyond criticism. Indeed, one member of the Board of Visitors is a signatory to the memorial and stated that he had no idea such drastic reforms were to be introduced. On other grounds, also, the reforms appear to us to be ill-advised. We fear, however, that some of the speeches by the minor lights of the deputation must have told against the acceptance of the memorial, if they did not make the Secretary of State utterly impatient on account of their irrelevance. Prof. H. E. Armstrong rambled on the subject of indigo planting and the study of chemistry by engineers, and Dr. Johnstone Stoney advanced the singular view that the appointment of a professor or scientific teacher was not subject to the ordinary law of contracts, but was a specially sacred thing that should never be annulled. To this last view Lord George Hamilton made sarcastic reference in his reply, observing that it would "virtually make officials irremovable, no matter what the terms of the agreement or the needs of the public service might be." We think also that the deputation did its own cause an injury by the attempt to convey the impression that science will suffer by the abolition of certain departments at Cooper's Hill. Science is not so sensitive; it would not appreciably suffer if Cooper's Hill College were abolished altogether. Besides, that college does not exist as a happy hunting ground for professors, but is supported out of Indian taxes for the purpose of supplying engineers for the Indian Government.

The crucial question, therefore, is whether the proposed changes will enable the college to turn out better engineers. What, then, are these changes? They involve the abolition of the chairs of physics, chemistry, hydraulic engineering, and mechanism, the assistant professorship of engineering, the lectureship in accounts, the demonstratorships in the mechanical laboratory and in physics, and the instructorship in electrical engineering. The selection is amazing! What sort of engineering college training can it be that can dispense with a teacher for any one of these subjects? And considering that the supply of telegraph engineers has been one of the chief features of the college, how are we to regard patiently the abolition of the professorship of physics and the instructorship in electrical engineering? This is economy false to the core—so palpably absurd, indeed, that we doubt if economy is the real reason for these startling changes. Lord George Hamilton stated that in the revised curriculum "electricity would be thoroughly taught," as Sir William Preece had advised them that "a demonstrator was capable of giving all the necessary instruction." We entirely dissent from this view; with the rapid increase in the engineering applications of electricity, not less but *far more* instruction in electrical and allied subjects becomes increasingly necessary in any engineering college.

**Personal.**—We learn with regret that, owing to ill-health, Prof. Tait is resigning the chair of Natural Philosophy at Edinburgh University. Prof. Tait, who is approaching his 70th year, has occupied this chair since 1860.

**Obituary.**—We regret to record the death of Col. G. M. Hutton, C.B., chairman of Ruston, Proctor & Co. (Ltd.), who expired suddenly on the evening of the 11th inst. Col. Hutton was a director of the company since its formation.

**Mr. Tesla's Latest.**—Mr. Tesla has authorised the New York *Sun* to state that the plans for the machinery to transmit wireless signals across the Atlantic Ocean has been completed, that a site has been selected for the plant, and that the work of installation is to be commenced at once!

**Royal Society.**—Among the Papers down for reading yesterday there was only one on an electrical subject:—"On the Application of the Kinetic Theory of Gases to the Electric, Magnetic, and Optical Properties of Diatomic Gases," by Mr. G. W. Walker—to be read "in title only."

**Electro-Harmonic Society.**—Mr. W. E. Lane, A.M.I.E.E., having been elected honorary secretary (pro tem.) to this society, in succession to the late Mr. C. E. Grove, it is requested that subscriptions, applications for membership, and other communications be addressed to Mr. Lane, at 14, Durley-road, Stamford Hill, London, N.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Cayenne—Pinheiro | Nov. 26, 1900 |
| Pernambuco—Ceara | Nov. 29, 1900 |
| Marseilles—Barcelona | Jan. 7, 1901 |
| Shanghai—Amoy | Jan. 17, 1901 |
| Fao—Bushire | Feb. 6, 1901 |
| Havre—Waterville | Feb. 13, 1901 |

**Huddersfield Corporation Electric Tramways.**—The overhead trolley lines of the Huddersfield Corporation were opened on Monday last. At present some 15 miles of standard gauge lines have been converted from steam to electric traction, but there will eventually be 25 miles of double track worked by this means. A separate power station has been erected in a central position, and the lines so far equipped constitute four routes.

**Local Sections of the Institution of Electrical Engineers.**—At a meeting of the Glasgow section on Wednesday a Paper was read by Mr. M. B. Field on "A Method of Compensating Voltmeters for the Voltage Drop in Long Feeders." The announcement of this came to hand too late for insertion in our "Societies' Meetings" column last week. For a similar reason, a wrong announcement was made as to the Manchester meeting on Tuesday. Instead of Prof. Short's Paper, a Paper by Dr. J. T. Nicholson "On the Training of Electrical Engineers" was read.

**Long-Distance Wireless Telegraphy.**—In the course of an address to the Liverpool Chamber of Commerce, on Tuesday, Prof. J. A. Fleming mentioned that the latest achievement of the Marconi Company in long-distance wireless telegraphy was the sending of messages between the Lizard and St. Katherine's Point, Isle of Wight, a distance of 200 miles. Employing Mr. Marconi's latest improved apparatus, two messages in both directions could be sent, and two or more independent messages could be received at once at each place. Prof. Fleming's lecture was on "The Marconi System of Wireless Telegraphy as applied to Lightships and Lighthouses," and it was an endeavour to stimulate Chambers of Commerce and similar bodies to impress upon the Government the necessity of wireless telegraphic communication with lighthouses and lightships around the coast.

**Manchester Corporation and Electric Wiring.**—Mr. C. H. Wordingham, the electrical engineer to the Manchester Corporation, has sent us a copy of the revised list of fittings "approved" in accordance with the system of registration he instituted in December, 1898. It is interesting to see the great number of contractors who have submitted samples of their fittings for this test, and to note the large range of sizes covered. Besides affording a guide to the actual fittings which have been approved by Mr. Wordingham, the list may also be taken to indicate the various sizes of switches which the majority of makers have chosen as their standard. For instance, in the case of single-pole switches, although there are a few listed from 0·35 ampere up to 2 amperes, the greatest number of patterns seem to be of the 2·5, 3, and 5-ampere sizes whether for 100 volts or 200 volts, whereas for ceiling roses, 1 ampere seems to be the most popular rating. Assuming that Mr. Wordingham's system has not resulted in increasing the average cost of good house wiring, it may be considered to have proved itself successful, for the consumer has quite sufficient choice of fittings in the list issued.

**The Proposed 150-miles-an hour Railway.**—During the last few weeks a great deal of attention has been devoted to the proposed extra high speed electric railway, concerning which Herr Rathenau, the manager of the Allgemeine Elektricitäts Gesellschaft, recently laid plans before the German Emperor. So much has been made of the matter in the lay Press that it might be thought to have reached a further point of development than is really the case. No actual experimental line has yet been constructed, but it is proposed to build, as a trial, a military line intended for a speed of from 200km. to 250km. (125 miles to 150 miles) per hour from Berlin to Zossen. For this line two trains will be built, one by the Allgemeine Elektricitäts Gesellschaft and the other by Messrs. Siemens and Halske, each intended to carry some 50 passengers. For the purposes of this line the two companies above mentioned, together with some of the leading industrial banks, have formed a company (Studiengesellschaft für Elektrische Schnellbanen), which, we understand, is making active preparations for the realisation of the project. We hope to be in a position to give our readers further particulars when the matter is in a more advanced stage.

**Tests on Electric Fans.**—The following is a report on some tests made on two of Messrs. John Gibbs & Son's electric fans by Dr. Hele-Shaw and Mr. Alfred Hay at Liverpool University College:—

We have carried out a careful series of tests with two of Messrs. John Gibbs & Son's electric fans, one of which was a 24in. fan, while the other, driven by a watertight completely-enclosed motor, was a 15in. fan. The 24in. fan (No. 205) when supplied at a potential difference of 100 volts was found to take a current of 3·05 amperes and to run at a speed of 655 revs. per min., delivering 5,100 cubic ft. of air per minute. The temperature rise after 3½ hours' run was found to amount to only 23°F. The same fan when fitted with a conical discharge pipe tapered from 24in. to 12in., was found to take 3·2 amperes at a potential difference of 105 volts, discharging 1,360 cubic ft. per minute. The pressure in the discharge pipe was found to exceed that of the atmosphere by an amount corresponding to a column of water ¼in. high.

The smaller fan, No. 247, was 15in. in diameter and was driven by a totally enclosed and completely waterproof electric motor. When supplied at a potential difference of 110 volts, the fan was found to run at a speed of 695 revs. per min., taking a current of 1 ampere and giving a discharge of 1,160 cubic ft. per minute. The temperature rise after 3 hours' run was found to be 50°F., which is well within the limits of safety. The running of the 15in. fan was remarkably smooth and silent.

We consider the above results to be highly satisfactory. The mechanical construction of the fans is substantial, and the workmanship good.

**Resolution of Condolence of the Institution of Electrical Engineers.**—At a special meeting of Council of the Institution of Electrical Engineers, held on February 7th, the following resolution was carried unanimously:—

That the Council of the Institution of Electrical Engineers, in special meeting assembled, hereby records its deep sense of the irreparable loss which the British Empire has sustained through the lamentable death of Her Majesty Queen Victoria, and its sorrow, in which each member shares, that one who spent her life for the good of her people, and to whom her subjects were affectionately devoted, has been removed from the scene of her unremitting labours and that a reign marked by unparalleled social, scientific, and industrial progress has thus been brought to a close.

The Council humbly begs permission to express to His Majesty King Edward, and to the members of the Royal Family, its most sincere condolence and sympathy, and, further, to lay before His Majesty the assurance of its unswerving loyalty and devotion, and its earnest wishes that he may, with Her Majesty Queen Alexandra, long be spared to reign in happiness and peace over a loving and united people.

It therefore directs that a sealed copy of this resolution, with copies of resolutions of condolence passed by local sections of the Institution, be forwarded to the Home Secretary for transmission to His Majesty.

Copies of resolutions have been received from the local sections of the Institution in Calcutta, Cape Town, Dublin, Glasgow, and Manchester, and the whole are to be forwarded to the Home Secretary on receipt of resolutions expected from other sections.

**Opening of the Lowestoft Electricity Supply Works.**—On Tuesday last the official opening of the electricity supply works of the Lowestoft Corporation took place. These works, designed by Mr. W. C. C. Hawtayne, are on the three-wire system with 460 volts between the outers. The generating plant consists of Babcock and Wilcox boilers, Musgrave and Browett-Lindley engines, and B.T.H. and Lancashire Dynamo Company's dynamos. The boilers are four in number, with a total evaporative capacity of 22,000lb. of steam per hour. There are two Musgrave engines driving B.T.H. dynamos, and one Browett Lindley engine coupled to a dynamo manufactured by the Lancashire Dynamo and Motor Co., the aggregate capacity of the generating plant being 475kw. The battery in the station consists of two sets of 135 Chloride cells of 400 ampere-hours capacity, these being charged with the assistance of a booster combined in one set with a balancing transformer. This machine is of B.T.H. manufacture, and is rated at 18kw. Duplicate feed pumps are provided, one steam and one electrically driven, and there are also injectors. The feed water passes through a Green economiser. The boilers have natural draught and are fired by hand. The mains are of Callender's bitumen laid in bitumen stoneware ducts on the solid system. The price fixed for current is 7d. and 8d. on the "Wright" system for lighting and 7d. and 1½d. for power, gas costing 2s. 5d. in the district. A considerable amount of public lighting has been carried out, there being 60 enclosed arc lamps and 120 incandescent lamps. The Council are seeking powers for a system of free wiring. Mr. G. A. Bruce is the resident engineer.

**The London County Council's Electrical Engineer.**—It is with the greatest pleasure that we announce the appointment of Mr. J. H. Rider, borough electrical engineer to the Plymouth Corporation, to the position of electrical engineer to the London County Council. The Council has been wise in its selection, for it has secured the services of an engineer well able to look after its interests, and to serve them in all respects in a highly satisfactory manner, and we tender our congratulations alike to the Council and to Mr. Rider. Born at Bristol in 1864, Mr. Rider first studied electricity at the Bristol Trade and Mining Schools, and in 1883 was apprenticed to Messrs. Paterson and Cooper. The contracts he superintended for this firm were chiefly in England and Norway. In 1887, he went to Messrs. Blakey, Emmott & Co., but it was in

1898 that he first obtained experience of municipal working, being appointed borough electrical engineer to the Bolton Corporation. After carrying out this electric lighting undertaking from his own plans and designs, and reporting on a general traction scheme for the same body, Mr. Rider, in 1896, took up a similar post with the Plymouth Corporation. Here, as consulting and resident engineer for electric lighting and traction, he has installed a first-rate combined system. The Municipal Electrical Association owes its existence to Mr. Rider, for it was in 1896, at a meeting held in London to consider the then new Board of Trade regulations, that he suggested the formation of such an Association. The Institution of Electrical Engineers and the Institution of Mechanical Engineers both claim him as a member, and he is also an associate member of the Institution of Civil Engineers. We wish Mr. Rider every success in his new position.

**Telephone and Telegraph Connections between Scandinavia and the Continent.**—The important system of direct telephone and telegraph connections between Norway, Sweden, Denmark, and Germany, which has been in course of construction for some years, has just been completed. The work on the direct telegraph system commenced in November, 1898, when the laying of the cable began between Trelleborg, the southernmost point of Sweden, and a spot near Sassnitz, in the island of Rugen, on the Pomeranian coast, which has now been finished. The cable is 112km. in length, with four wires, and it has now been directly connected with Stockholm, via Malmö, on the Sound, by a new 3mm. copper wire Through these new cables, direct communications have thus been established between Stockholm-Berlin, Stockholm-Hamburg, Gothenburg-Hamburg, Malmö-Berlin, Malmö-Stettin, and Malmö-Emden. The telephone connections between Denmark, Sweden, and Norway have also been established by the laying of a cable, 20km. long, across the Sound from Vidbek, on the Danish, to a point near Landskrona, on the Swedish coast. Moreover, through double cables of 4·5mm. thickness each between Christiania-Gothenburg-Malmö-Copenhagen and Malmo-Stockholm, the central and south of Sweden has been placed in direct telephone connection with the two neighbouring States. The Swedish and Danish capitals will shortly be in direct telephonic connection with the north of Sweden and Lapland, whose iron mines are proving a veritable Golconda. A line of 4·5mm. copper wire is now being laid to the north. This line will in time be continued along the new Trans-Scandinavian railway, now under construction, to its terminus, Ofoten Fjord, on the North Atlantic shore. In the above-mentioned cables, having a total length of about 2,000km., there have been used about 400 tons of bare copper wire, and the cost has been kept within the estimated grants. To Sweden it is a matter of interest and importance that whereas copper wire had formerly to be bought abroad, all the quantity used in this case has been manufactured at home, much other material being also of Swedish make.

**Visit of the Institution of Electrical Engineers to Berlin.**—Preliminary arrangements for the Institution visit to Berlin, on the initial invitation of the Allgemeine Elektricitäts Gesellschaft and Messrs. Siemens and Halske, are now being made by the German Reception Committee, of which Mr. Gisbert Kapp is the secretary, and the Council of the Institution will shortly send out a circular in order to ascertain the number of members of all classes likely to take part in the visit. It is proposed that the whole party, starting on Saturday, June 22nd, should break the journey at Hanover for one night, visiting installations at that place, and should arrive in Berlin on Monday, June 24th. In Berlin it is understood that visits will be made to the works (among others) of the Allgemeine Elektricitäts Gesellschaft and of Messrs. Siemens and Halske, as well as to installations of special interest. An evening entertainment will probably be given by the two firms above mentioned. A ladies' committee will be formed in Germany to arrange for the entertainment of ladies accompanying members. The visit to the city of Berlin will terminate on Thursday, June 27th. Members of the Institution are, however, invited to take part in the meetings and visits of the Verband Deutscher Elektrotechniker in Dresden from Thursday, June 27th, to Sunday, June 30th. Should, therefore, a sufficient number of members signify their intention of joining each group, special arrangement will be made with a tourist agency to supply to those who wish for them tickets and hotel coupons at a special rate for the following parties:—*A*. London—Hanover—Berlin—London. *B*. London—Hanover—Berlin—Dresden—London. *C*. London—Hanover—Berlin—Dresden—Nuremberg—Frankfurt—Cologne—London. The last-named group (*C*) has been arranged to enable members to see the works of Messrs. Schukert & Co., at Nuremberg, and of Messrs. Lahmeyer & Co., at Frankfurt, to which it is hoped visits may be arranged. Those extending their visit in this way could arrive in London probably about July 5th or 6th. It is anticipated that the cost of the visit, if the reduced rates are available (including railway fares and hotel expenses, but exclusive of wines and extras), need not exceed—for group *A*, £12 first class and £10 second class; for group *B*, £16 first class and £13 second class; and for group *C*, £22 first class and £18 second class. These figures are based on the preliminary estimates of a tourist agency, to which estimates a certain amount has been added for contingencies.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), February 15th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting at Storey's Gate. Paper to be read: "Light Lathes and Screw Machines," by J. Ashford.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse. Subject: "Electric Waves," by the Right Rev. Monsignor Gerald Molloy.

**SATURDAY, February 16th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*11 a.m.* Students' visit to the Metropolitan Electric Supply Co.'s generating station at Willesden.

**WEDNESDAY, February 20th.**

ROYAL MICROSCOPICAL SOCIETY.

*7.30 p.m.* Ordinary Meeting at 20, Hanover-square, W.

ROYAL METEOROLOGICAL SOCIETY.

*7.30 p.m.* Ordinary Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W.

SOCIETY OF ARTS.

*8 p.m.* Ordinary Meeting. Paper to be read: "Some Features of Railway Travelling - Past and Present," by F. McDermott.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel, when Mr. A. H. Barker will deliver Lecture II. on "Works Management."

**THURSDAY, February 21st.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Extra Meeting at the Institution of Civil Engineers. Paper to be read: "The Electrical Power Bill of 1900: Before and After," by W. L. Madgen.

INSTITUTION OF ELECTRICAL ENGINEERS.—DUBLIN SECTION.

Meeting at the Royal Dublin Society.

**FRIDAY, February 22nd.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "How Air subjected to X-Rays loses its Discharging Properties and How it Discharges Electricity," by Prof. E. Villari; (2) "On the Propagation of Cusped Waves and their Relation to the Primary and Secondary Focal Lines," by Prof. R. W. Wood; (3) "On Cyanine Prisms and a New Method of Exhibiting Anomalous Dispersion," by Prof. R. W. Wood.

ELECTRO-HARMONIC SOCIETY.

*8 p.m.* Concert (Ladies' Night) at the St. James's Hall Restaurant (Banqueting Hall), Regent-street, W.

ROYAL INSTITUTION.

*9 p.m.* Evening discourse by Sir W. Roberts-Austen, F.R.S., on "Metals as Fuels."

**SATURDAY, February 23rd.**

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to the City of London Electric Lighting Co.'s works at Bankside, S.E.

INSTITUTION OF JUNIOR ENGINEERS.

*2.30 p.m.* Visit to the Willesden Station of the Metropolitan Electric Supply Co.

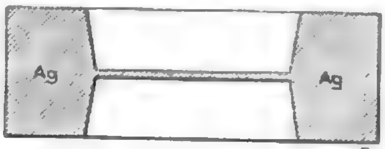
ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture I. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Anti-Coherers.*—Neugschwender's moist gaps between metals deposited on glass, though sensitive and efficient as anti-coherers, are not sufficiently durable for practical use. Much better in this respect are the dry slits scratched in a silver film deposited on glass and covered by a thin layer of celluloid, the so-called Schäfer plates. E. Marx has examined the conditions which govern the sensitiveness of these plates. He finds that the celluloid film does not penetrate into the interior of the gap, being unable to overcome the capillary repulsion. The chief effect of the celluloid is to prevent the dissipation of the minute particles of silver which partly fill up the gap, and whose motion under the influence of electric waves is probably one of the causes of the temporary increase of resistance. That it does not fully account for it is shown by the fact that signals can be obtained with an anti-coherer of the form shown in the diagram, in which the slit is much widened, and only a



narrow bridge 0·1mm. wide left. These anti-coherers are just as sensitive as Branly's coherers, but require no tapping, and are much freer from accidental disturbances.

[E. Marx, *Phys. Zeitschr.*, January 26, 1901.]

*The Electric Analogue of the Zeeman Effect.*—That an electric field has some influence upon the emission of light is an article of faith among our most advanced physicists which has up to the present remained unconfirmed by actual observations. The latter have only extended over the region of transparent bi-refracting bodies. The examination did not cover the most interesting occurrences which theory predicts in the vicinity of sharp absorption lines. Among the effects to be observed in this domain, the electric analogue of the inverse Zeeman effect is the most anxiously awaited. W. Voigt states this effect as follows: A body with fine and sufficiently separated absorption lines shows for ordinary light traversing it parallel to the electric lines of force (without double refraction), a displacement of these lines without separation; while for light traversing it normally to the lines of force (with double refraction) it shows a displacement with accompanying separation. In the second case one of the components of the separated line assumes the same position as the displaced line in the first case. The most general theory gives no indication with regard to the second component. But a very plausible special formulation implies that the second component has three times the displacement of the first. All the displacements are proportional to the square of the effective field intensity. The probability of the author's theory is increased by the fact that Lorentz's elementary theory of the Zeeman effect, by an obvious extension to electro-optics, leads to exactly the same result as that attained by the author through an application of Kirchhoff's law to the inverse Zeeman effect. The author overhauls the whole theory, and arrives at an estimate of the magnitude of the phenomenon looked for. Even in the case of the greatest known electric double refraction with very small $(n_0^2 - 1)$, with a potential gradient of 300 volts per centimetre, which is not easy to produce in a vapour, the effect to be observed would not exceed the 20,000th part of the distance between the two D lines. It is no wonder that such a minute effect has hitherto escaped detection.

[W. Voigt, *Ann. der Physik*, No. 1, 1901.]

*Wireless Arc-Telephony.*—Independently of Duddell's recent improvements in the "speaking arc" (see *The Electrician*, Vol. XLVI., Nos. 8 and 9, December, 1900), H. T. Simon has made a number of advances in the construction of his arc "radiophone," which promises to place wireless telephony with the aid of light, upon a basis of practical success. He has confirmed the supposition, advanced by Brown, that the intensity of the sound is in direct proportion to the intensity of the current upon which the microphone currents are superimposed. This is no doubt due to the fact that the Joulean heat is directly proportional to the square of the current strength, and that the sounds emanating from the flame are produced by variations of its temperature. The author uses a Schuckert projection lamp with differential gear, and a current of 16 amperes to 20 amperes. To increase the distinctness of transfer, the change of resistance of the microphone must be small. As a receiver, the author uses by preference a selenium cell, placed in the focus of a search-light mirror. Experiments were successful with distances of 20yd., but the author expects that Bell's radiophone limit of 250yd. will soon be very considerably exceeded.

[H. T. Simon, *Phys. Zeitschr.*, January 26, 1901.]

*Conductivity of Positive Light.*—The occurrence of internal E.M.F.s in a gas traversed by a current makes it, generally speaking, impossible to calculate its conductivity according to the usual methods, except in the case of the unstratified positive light column of considerable length. For in that portion of the discharge the transverse conductivity and the gradient are constant for relatively large distances, from which we may conclude that the gas is in a uniform condition, and possesses no internal E.M.F.s. In calculating the conductivity it should be borne in mind that it varies with the current density. A strong current means a high degree of ionisation, and an increase of ionisation, which means an increase of conductivity, may go on until all the molecules are ionised. J. Stark calculates the conductivity $\lambda$ from the formula

$$\lambda \times 10^3 = \frac{j}{a - bj}$$

where $j$ is the current density, and $a$ and $b$ constants of which $a$ is much larger than $b$. This formula implies that for great densities $\lambda$ increases more rapidly than $j$.

[J. Stark, *Ann. der Physik*, No. 1, 1901].

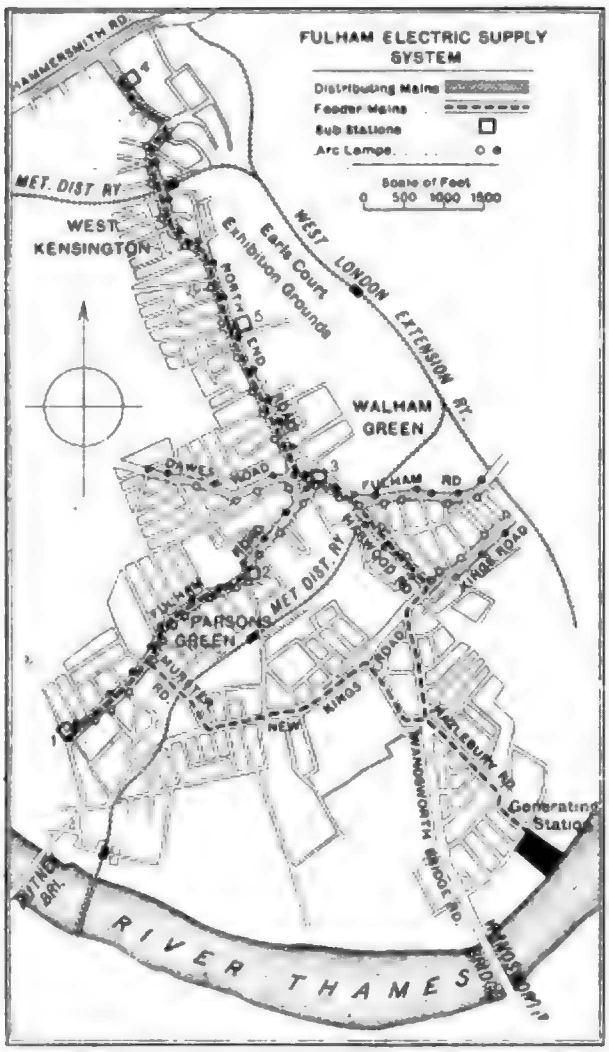
*An Improvement in the Bolometer.*—A remarkable improvement may be brought about in the sensitiveness of the bolometer by placing it in a vacuum. F. Kurlbaum found that half the heat lost by a black bolometer is radiated away, while the other half is lost by convection, and the conduction is negligible. Hence, by placing it in a vacuum, the rise of temperature due to absorption of heat is doubled, and hence also the efficiency is doubled. That is not the only advantage, for the air currents produced by the heated bolometer, which produce the well-known disturbances of the galvanometer needle, are also done away with. When the bolometer is not black, but polished platinum, the advantage is 10 times greater, for in that case the loss by radiation is only about $\frac{1}{20}$th of the loss by convection. The vacuum bolometer is, therefore, peculiarly fitted for the measurement of Röntgen ray intensities, since polished platinum is used for that purpose. Taken together with the throttling of the disturbances, the sensitiveness of the bolometer would be increased 40 or 50 times.

[F. Kurlbaum, *Phys. Zeitschr.*, January 26, 1901.]

**Water-Tube Boilers.**—A course of five lectures on water-tube boilers will be given at University College, Gower-street, on Friday evenings during March by Mr. Leslie Robertson. Application for admission to the lectures must be made to Prof. T. Hudson Beare at the college, and the fee for the course is 10s. 6d. To a limited number of engineer apprentices, pupils, and workmen a fee of 2s. 6d. only will be charged. The first lecture, on March 1st, will commence at 8 p.m.

# THE FULHAM MUNICIPAL ELECTRIC SUPPLY WORKS.

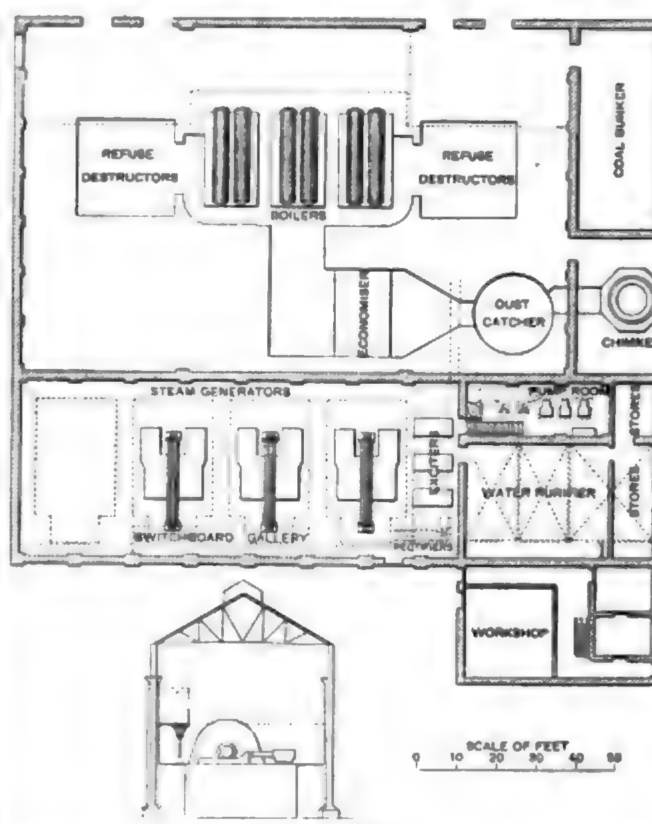
"Residental Flats from £80 to £300 a year, fitted with Electric Light, lifts, hot water, and the Most Modern arrangements and sanitary appliances. Situate in South-West London, within easy distance of the City and West End. Excellent rail and omnibus service," &c., &c. These familiar words recur to one on visiting the district which the combined refuse destructor and electricity supply works of the Fulham Borough Council are to furnish with electrical energy. The neighbourhood is covered with flats of all sorts and kinds, from the highly aristocratic ones, in close proximity to Hurlingham, down to the modest two-floor terrace house, the occupants of whose lower floor vie with the more pretentious "mansions" of "West Kensington" in seeking occupants for their suites of rooms up in the sky. The Borough covers a fairly large area, lying to the south-west of the district supplied by the Brompton and Kensington (formerly called the House-to-House) Electricity Supply Co., and extending as far as the River Thames. On the north-west of Fulham is Hammersmith, and Chelsea just touches one portion on the eastern boundary.



Map showing Position of Mains.

In spite of the large number of flats, the groups of larger ones, which constitute the "mansions" wired for electric light and replete with all the outward signs of modern civilisation that could be desired by the most exacting house agents' circular, are yet not so close together as the electric light engineer could wish; for, many as they are, they have nevertheless to be parcelled out over an area of nearly 8 sq. miles. Moreover, the same applies to those faithful and useful long-hour consumers the large public houses, which are numerous, but of necessity at greater distances apart than, for instance, in a provincial town of the same population as Fulham (nearly 120,000). Again, the "easy distance of the City and West End" has the effect of reducing the number of large shops and business houses to a minimum. Thus it is that the number of lamps per yard of main is small; and since the area cannot be said to have any definite centre of lamp density, it is seen that there were several reasons in favour of alternating-current distribution as against a supply by continuous and uni-directional currents. Alternating current has been adopted therefore, and in order to be in a position to deal with a motor load in an efficient manner, a two-phase system has been chosen.

Before entering into the technical details of the system, however, a few historical notes may be of interest. For many years the question of electricity supply has been discussed by the Fulham Vestry, and the differences of opinion on the subject have even given rise to considerable friction and heated debates during the initiation and progress of the scheme. No very definite step was taken, however, to provide a supply of



Plan of Works.

electricity until May, 1895, when a committee was appointed on the motion of Mr. W. R. Sayer, a veteran member of the Vestry, to consider the desirability of obtaining electric lighting powers with the idea of erecting electricity works in conjunction with a refuse destructor. Mr. Tom Green, the leader of the Moderate party, was elected chairman of the committee, and devoted much time and attention to the duties of his position, which he held with conspicuous success till the vicissitudes of party warfare and the birth of the new Fulham Borough Council necessitated the appointment of a new chairman in the autumn of 1900. Mr. Timothy Davies was then elected to this important position, which he still holds.

In the autumn of 1895 the committee resolved to obtain expert advice on the whole subject, and Mr. F. H. Medhurst was appointed to report on the matter generally. The recommendations contained in his report were, briefly, that a

combined scheme consisting of a refuse destructor, electric lighting works, and a disinfector would be a commercial success, and that an initial installation should be put down on the high-pressure alternating system to supply some 15,000 8 c.p. lamps. The Vestry, therefore, obtained a provisional order in the summer of 1897, and soon afterwards a deputation visited various towns with the object of satisfying the Vestry as to the desirability of the proposed combined scheme.

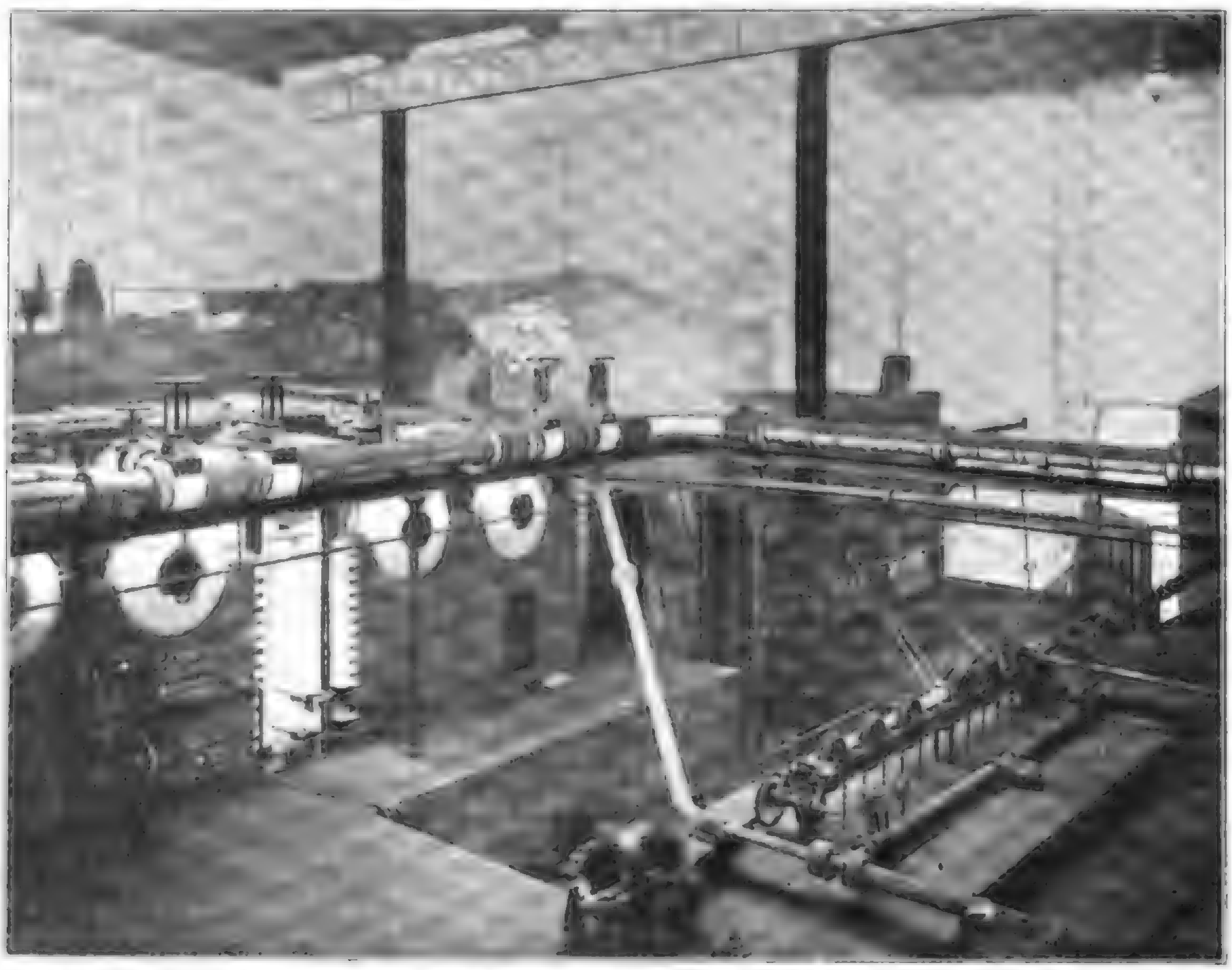
The result of these investigations was that in April, 1898, Mr. Medhurst was instructed to prepare the necessary detailed plans and specifications for a combined scheme to be erected on an excellent riverside site which the Vestry had, with commendable foresight, acquired a year or so previously.

In view of the growing demand throughout the country for electric light and power it was considered desirable to increase the capacity of the station beyond that originally proposed, and it will now, exclusive of spare plant, supply a total of 30,000 8 c.p. lamps.

that the consulting engineer's recommendation was set aside and the present contractors chosen. However, all has proceeded happily with the carrying out of the contracts, and the works are to be formally opened and will commence supply on Thursday next.

Site.—The generating station is situated on a site in the Townmead-road (see map), having an area of about 4 acres and a frontage to the Thames of 870ft., protected by a massive quay-wall. The present works cover but a small portion of the site, and there is, therefore, ample space for the extensions which will no doubt be necessary at no distant date.

Buildings.—The general arrangement of the buildings is illustrated in the plan opposite. Externally the buildings are of red brick with relieving bands of white Suffolk brick. The boiler and engine rooms stand parallel to each other and at right angles to the river, the offices standing between the end of the engine room and the river wall. The offices, therefore, face the river, and comprise the following apartments on the first floor:—Chief engineer's office, assistant engineer's office,



General View of One Side of Boiler and Destructor House, showing the Backs of Four Boilers, Group of Three Destructor Cells, Tipping Platform, and Economiser.

The capital outlay amounts to over £100,000, and the contracts entered into are as follows:—

| | |
|---|---|
| Buildings, comprising destructor house, engine-room, offices, and transformer chambers, also a small building for public disinfecting purposes (F. G. Minter, Westminster) ............ | £22,970 |
| Refuse destructor, steam-raising plant, inclined roadway, and chimney shaft (Horsfall Destructor Co.) ............ | 16 760 |
| Generating plant, including steam-pipes, condensing plant, mains, &c., and apparatus for the above-mentioned disinfector building (General Electric Co.) ............ | 46,000 |

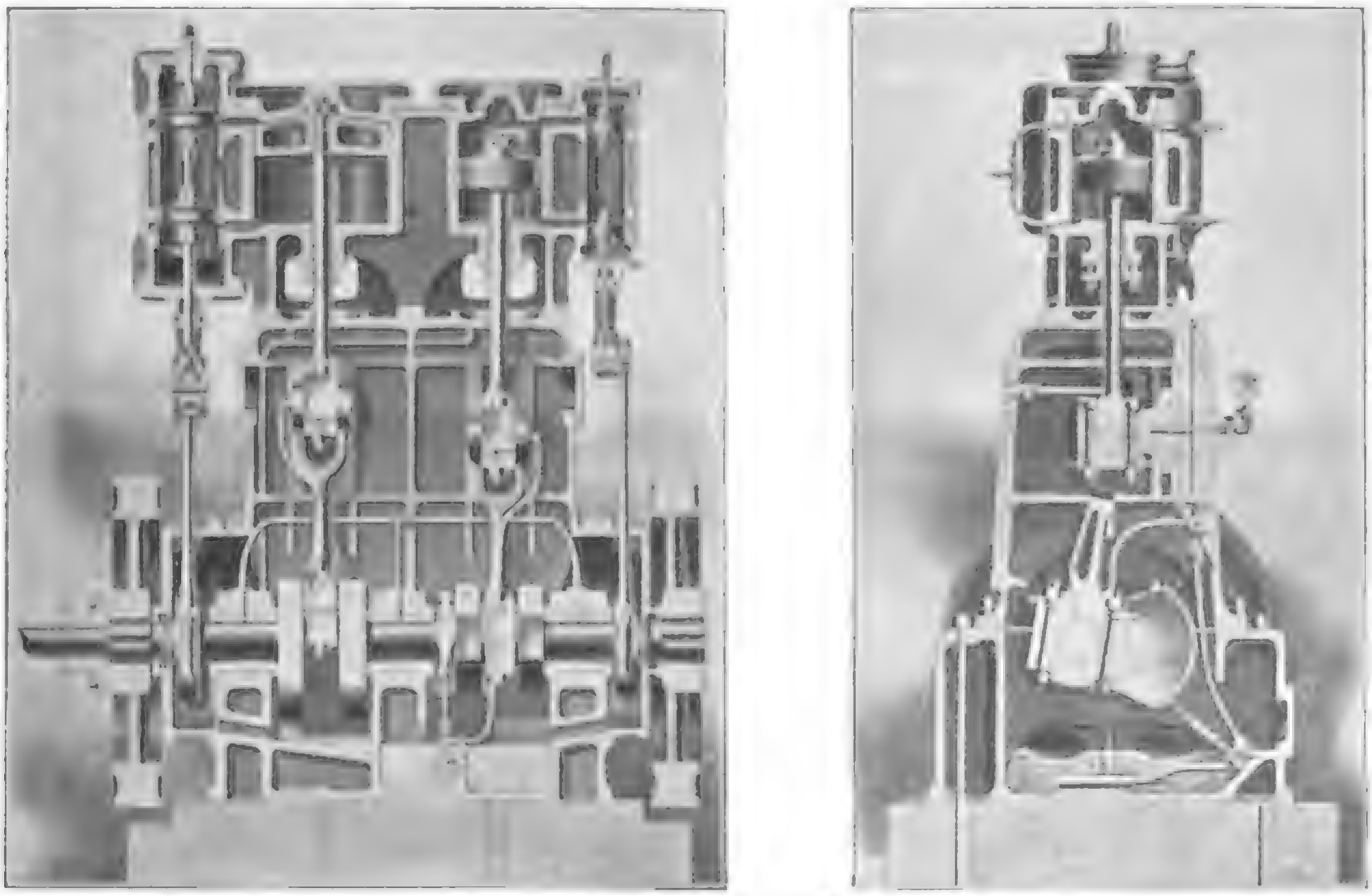
Additional contracts for the supply of coal-handling plant, and meters, well-sinking, extra foundations, and engineering expenses increase the total to £108,000.

We need not allude here at length to the disputes which took place before the final award of the contracts. The proceedings of the Vestry with regard to the electric supply scheme have been reported fully in our columns from time to time. It will be remembered that at first another firm's tender for the generating plant was recommended for acceptance, and it was only after repeated discussions and communications

chief clerk's office, general office, attendants' room, a lavatory and bath room. There is also a testing room on the first floor of this block, and on its ground floor there are stores, a meter testing room, workshops for light work and repairs, the water-softening and filtering room with the well-pump driving gear. Beneath this block of offices is also the pump room, both these latter rooms being reached from the engine room. Access to the offices is from outside. A corridor leads directly from the offices to the switchboard gallery, and a window in the assistant engineer's office affords a complete view of the engine room.

Destructor House and Steam-Raising Plant.—The destructor and boiler-house is a lofty building 35ft. high to the springing of the roof, 137ft. in length, and 87ft. wide. It contains 12 destructor cells with room for an additional four cells. The present cells are arranged in two groups of six each on either side of six Babcock and Wilcox boilers, and are capable of destroying efficiently 120 tons of refuse in 24 hours. Over

the boiler-firing floor, and extending from end to end of the building, is the tipping floor, to which the carts are brought for the purpose of discharging their loads on to the tops of the group of cells, where the refuse is fed into the furnaces. The tipping-floor is arranged to allow of the storage of a considerable quantity of refuse so that the working of the plant may be continued without interruption. Access to the tipping floor is obtained by means of an inclined roadway having a gradient of about 1 in 14, at the foot of which there is a weighbridge and house where an account will be kept of the weight of refuse brought in.

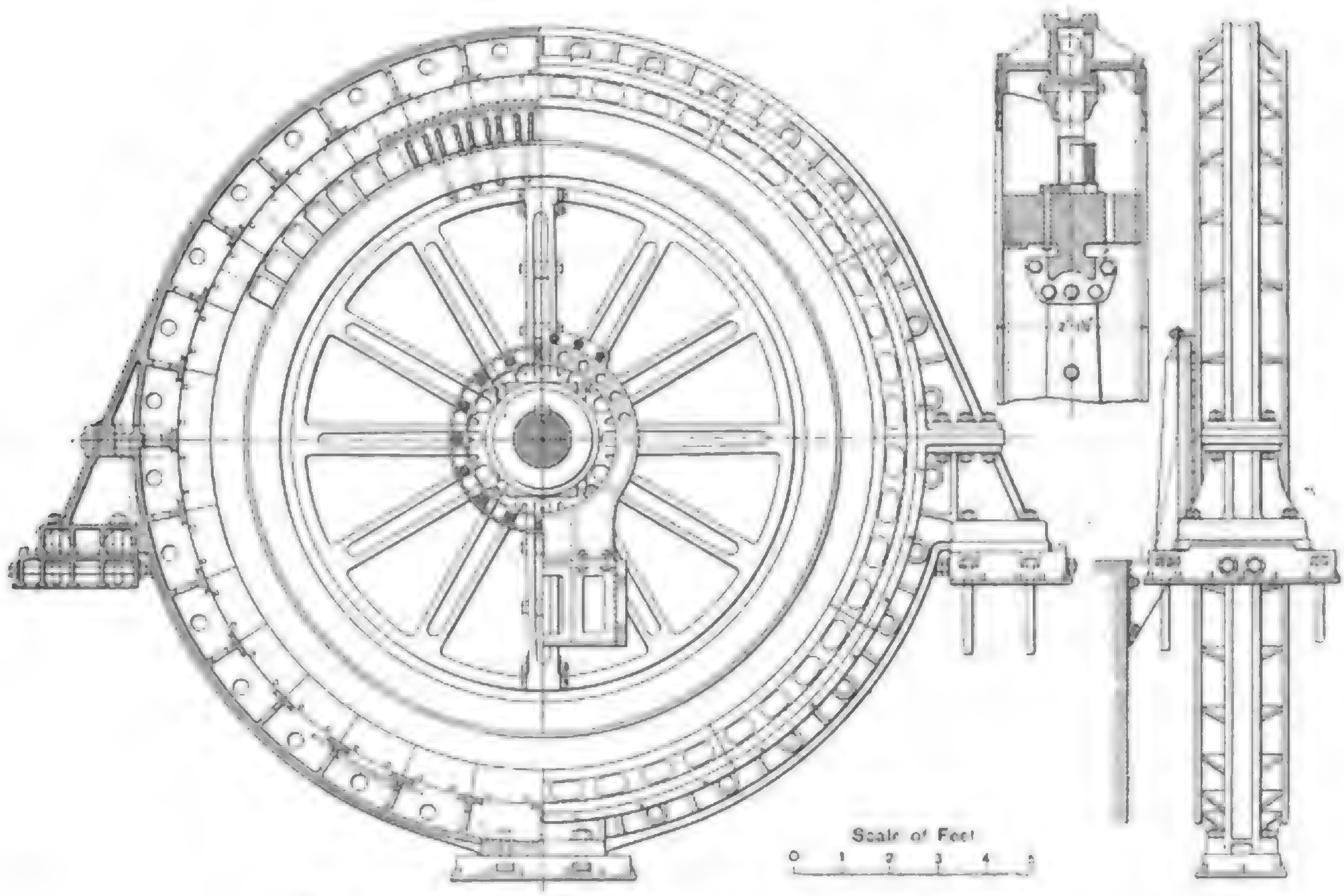


SECTION OF HIGH-SPEED MUSGRAVE ENGINE.

FRONT OF THE BOILERS, SHOWING ONE DESTRUCTOR CELL IN THE FOREGROUND.

The destructor furnaces are of the standard Horsfall type, each having a grate area of 30 sq. ft. The boilers are of the Babcock and Wilcox water-tube pattern, each having a heating surface of 1,284 sq. ft., and provided with Vicars mechanical stokers, which are electrically-driven. An opening behind the bridge of each boiler leads the destructor gases in, the flue to this opening being provided with a suitable damper so that the boiler may be heated at will from the destructor or be fed with coal. Provision has also been made for firing the boilers by hand in the event of interruption in the working of the mechanical stokers, and forced draught induced by steam jets has been applied to each boiler. Each boiler is made up of seven sections of tubes, each section being composed of eight tubes in height. The tubes are 4in. in diameter by 18ft. long, and are connected at the ends to the well-known continuous staggered headers, the tubes being fastened in them by being expanded. Each header is provided with hand-holes placed opposite the end of each tube to permit of cleaning, and removal and renewal of tubes. The sections of tubes are connected at each end to a steam and water drum 48in. diameter and 23ft. long, and at one end with a mud drum for collecting deposit. The boilers are constructed for a daily working pressure of 160lb. per square inch.

The refuse is fed into the destructor furnaces through charging openings on the tops of the blocks of cells, as mentioned above, the refuse itself closing the openings when the operation of charging is complete, and thus obviating the necessity for doors on the tops of the furnaces. Each furnace is provided with a sloping firebrick hearth on which the refuse rests before being drawn forward from below on to the grate bars. The grate bars have fine spaces between them and are made all in one length, so that there is no obstruction to the clinkering tools in traversing the length of the bars. The furnace crown is composed of special fire-resisting blocks, specially mixed and burned, capable of standing not only high temperatures, but rapid changes of temperature. At the sides of the furnaces, and extending about 8in. above the grate bars, are cast-iron side boxes through which the whole of the air for combustion is passed. These boxes serve the double purpose of heating the air for combustion, and at the same time protecting the sides of the furnaces from the undermining action which takes place with brick sides, and is caused by the clinker adhering to the brick. Each of these side boxes is provided with a valve, controlled from the front of the furnaces, and openings for the delivery of the mixed air and steam, forming the blast, into the ashpit

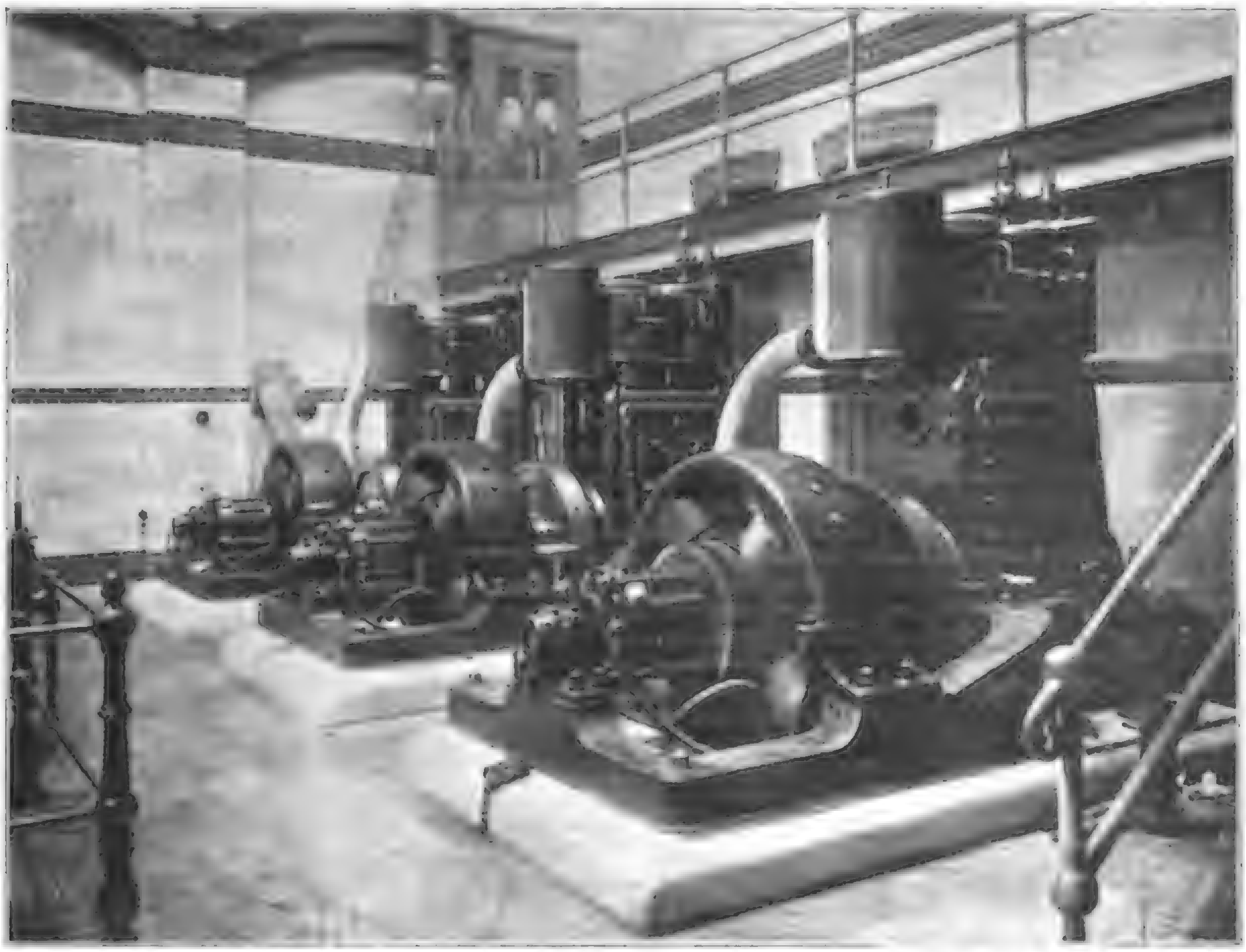


300KW. 2-PHASE OERLIKON ALTERNATOR MADE BY THE GENERAL ELECTRIC CO.

GENERAL VIEW OF ENGINE ROOM SEEN FROM GALLERY ABOVE EXCITERS.

underneath the grate bars. The air for the blast is drawn from above the charging decks of the furnaces, through large hoods, by means of powerful steam blasts, and thus ventilation of the upper part of the destructor house is assisted, and any smells arising from the refuse on the decks are partially drawn off and passed into the furnaces. The steam trumpets by which the blast is promoted are of the Horsfall Company's special construction, with flat steam jet apparatus. The blasts force the air into longitudinal air passages extending under the furnaces and communicating by means of the valves above described with the side air boxes of the furnaces. There is a single outlet for the products of combustion from each furnace, placed in the crown of the arch at the front of the furnaces in such a manner as to draw off the escaping gases over the hottest part of the fire, thus cremating them before they leave the furnaces. The unburnt gases which have been given off by the refuse drying at the back of the furnace are thus subjected to a temperature of from 1,800°F. to 2,000°F. before passing away to the flues. up to a certain point, but it is, of course, not anticipated that they will suffice at large loads. There will thus be considerable consumption of coal in the boiler furnaces and a coal-handling plant is being put down. The coal will be brought to the station by water, and will be raised from the lighters alongside the quay by a steam crane fitted with a Hone's patent grab. It will then be dropped into an Ingrey weighing machine, which automatically weighs, records and discharges the loads and adds up the successive quantities passing through the machine. After being discharged from the shoot of the weighing machine the coal is conveyed to the top of the bunker by an electrically-driven elevator (supplied by Messrs. Barry, Henry & Co.), whence it is deposited in different parts of the bunker through shoots.

The clinker is drawn from the furnaces into iron skips carried on an overhead railway by which it is conveyed to the wharf alongside the river. Two Green economisers, each having a heating surface of 1,920 sq. ft. are erected between the boilers, and there is a dust-catcher near the chimney.



EXCITER SETS. (The Door at the end of the Gallery leads to the Boiler and Destructor House.)

The exhaust openings from the furnaces lead into flues, which in turn open into a main flue running the whole length of both blocks of cells and the battery of boilers between them, the flue being on ground level under the blocks of cells, but below ground level under the boilers. The furnaces are provided with massive steel buck stays and tie bolts, and with cast-iron cleaning and clinker doors, the latter being lined with firebrick. The clinker doors are of the balanced type, and are so arranged as to open the whole width of the furnaces at once. Branch flues with dampers are provided from the main flue to lead the gases into the furnaces of the boilers, and also by-pass flues, by means of which the hot gases can be led past the boilers to the chimney. The dampers in the hottest parts of these latter are swivel dampers of a special design, being kept cool by means of water circulation.

The destructor gases alone will be able to furnish sufficient steam to maintain the boiler pressure at 160lb. per square inch

A by-pass is provided to carry the gases to the dust-catcher directly, when it is not desired to employ them for heating the boilers. The dust-catcher is a large circular brick chamber lined with firebrick, with a domed roof of the same materials. It is partly seen on the extreme right of our larger illustration of the destructor house. The structure is strengthened by massive iron rings and buck-stays, and is so constructed as to cause the gases to swirl round rapidly within it in such a way as to throw off the dust which they carry along with them by centrifugal force. Cleaning doors are provided for the removal of the dust at any time without stopping the furnaces.

The chimney, which was also built by the Horsfall Destructor Co., has a height of 100ft., and an internal diameter of 8ft. It is octagonal is form, and is lined throughout with firebrick.

It is estimated that the amount of refuse passed through the destructor per annum will be approximately 40,000 tons,

and its calorific value is placed at one-twentieth that of good steam coal. The Borough Council therefore expects to save the cost of 2,000 tons of coal per annum.

Pipework and Water Supply.—The system of steam pipes consists of a 9in. diameter ring main, with a branch to each steam alternator, and an auxiliary ring main of $3\frac{1}{2}$in. diameter, which supplies the three exciter engines and feed pumps. The steam pipes are of lapwelded steel with mild steel flanges and are supported on roller bearers. Provision has been made for expansion by the adoption of copper bends, and the range is drained by means of six separators of Holden and Brooke's manufacture, which are connected to steam traps discharging to the feed-water tank, the traps being fitted with three-way cocks and by-passes to allow of inspection. The main exhaust pipe is of cast-iron, 24in. in diameter.

The exhaust steam from the exciter engines is taken by cast-iron pipes 6in. in diameter to a Royle's feed-water heater situated in the pump-room, to which the exhaust from the feed pumps is also led, the heater being arranged with a by-pass to allow the engines to exhaust directly to the atmosphere when this is desired.

River water is used for condensing purposes, but it was not considered suitable for boiler feed. An artesian well was, therefore, sunk to a depth of 500ft. (the work being carried out under a separate contract by Messrs. A. C. Potter & Co.). At this depth it reaches the chalk. This well supplies all water required for the boilers, but there are the town mains in addition as a stand-by. The well-bore is uniform throughout with a diameter of $9\frac{1}{2}$in., and is lined with steel tubes to a depth of some 300ft.

The pump barrel is $7\frac{1}{2}$in. diameter, and is placed at a depth of 165ft. from the surface with 30ft. of suction pipe, the still water level being 104ft. from the surface.

The pump is driven through spur gearing by an E.C.C. 14 B.H.P. motor. The water, whether taken from the well or town mains, will be softened by the apparatus described below, and led to an underground reservoir in connection with the latter, having a capacity of 35,000 gallons. Thence it flows by gravity to the feed tank in the pump-room. There is also a direct connection between the town mains and feed tank to meet emergencies. Two vertical Weir pumps are installed for boiler feed purposes, each pump being capable of delivering 4,000 gallons an hour. A duplicate system of feed pipes has been arranged, the water passing in one case through the feed water heater, and then the two economisers in parallel or through the economisers alone, and in the other case direct to the boilers. The feed pipes are of wrought-iron, $3\frac{1}{2}$in. diameter, with heavy cast flanges and copper bends to the boilers.

Water-Softening Process.—The water-softening plant above referred to treats the water by Clark's process carried out on the "Atkins" system, named after the inventor, Mr. W. G. Atkins, whereby a certain quantity of caustic lime is added to the water, mixed with it, run into large tanks, where the chalk is precipitated, and finally filtered. The plant is capable of dealing with 8,000 to 10,000 gallons of water per hour. The guarantee requires that any intelligent workman can operate the plant, and that water with 15 or less degrees of hardness must be softened so that the hardness is reduced to less than one-half grain of carbonate of lime per gallon if required. The plant, whose arrangement is illustrated on p. 618, consists of the following parts:—

1. A lime slaking, straining and storing machine.
2. A cylinder in which lime water is formed.
3. A "mixer," being a shallow trough fitted with baffle plates.
4. A cistern in which the actual softening takes place.
5. A filter.

The method of working is as follows: The lime is delivered directly into a hopper, which forms part of the lime-slaking machine. The machine is set in motion, and in a few hours sufficient lime to last three weeks is automatically reduced to the form of cream of lime, and stored in a mill under the hopper. This mill is fitted with stirring arms and a self-cleaning strainer; about once a day the cream of lime is stirred, and a certain quantity pumped into the lime water cylinder. A jet of water is admitted at the bottom of this cylinder, and passes out at the top as a saturated solution of lime water. It is then conducted to the mixer, where it is joined by the hard water. There are two specially constructed regulating valves by which any desired quantity of hard water and the correct proportion of lime water can be adjusted, and both supplies can be turned on or off without interfering with the other. Whilst flowing through the mixer, the lime water and hard water mix automatically in a few seconds, and the water is delivered into the softening cistern, which is always full, and where water is always flowing through. It is during this period that the actual softening takes place, which may be described thus:—Chalk is dissolved in water by carbonic acid gas, forming bicarbonate of lime. When quick-lime is added the gas releases the chalk, which, together with the lime, is precipitated. The chalk being no longer in solution, the water is now soft, but excessively turbid owing to the deposit. This is removed by filtration.

The filter consists of a series of hollow discs covered with cotton filter cloth. The discs are secured to a hollow centre tube, and the tube and discs mounted in a cistern. The water is admitted to the cistern, filters through the cloth, leaving the deposit on the outside, passes inside the hollow discs to the centre tube, and is delivered outside the cistern. When cleaning is necessary, usually once a day, the discs and tube are revolved by means of gearing provided for this purpose, jets of water play on the discs, and the deposit which has been arrested is washed off in a few minutes, passes down a waste pipe, and filtering can be resumed. The advantages claimed by this system of filtering are that the filtering medium is cheap, it is arranged vertically, and takes up little room, and is readily cleaned by mechanical means.

Engine-Room Plant.—The engine room is 110ft. long, 42ft. wide, and 30ft. in height to the springing of the roof. The walls are entirely faced with white glazed bricks, relieved by bands and string courses of salt glazed bricks. The floor is paved with mosaic work, with hand-laid borders. A special feature of the room is the absence of all pipe work, this being arranged under the floor level. A gallery runs round two sides of the room, and carries the main switchboards and a switchboard attendant's office. Space is left at one end of the room for an extension engine and dynamo. Two entrances to the destructor house are provided from the engine room, one from the gallery and one from the floor, and these will be carefully protected by double doors and glazed screens, with the object of keeping out dust.

The steam alternators are three in number, each set consisting of a two-phase generator of the flywheel type coupled directly to a horizontal compound condensing engine. The engines are of the slow speed Corliss type made by Messrs. J. Musgrave & Sons, and each is designed for 450 B.H.P. when supplied with steam at a pressure of 130lb. per square inch at the engine stop valve and a vacuum of 24in. of mercury in the exhaust pipe, the governor being specified to control the speed within 3 per cent. from no load to full load, and to be adjustable whilst running to vary the speed 5 per cent. about the mean speed.

The H.P. and L.P. cylinders are of 17in. and 33in. diameter respectively, with a stroke of 3ft. 6in., and the engines run at 93·7 revs. per min. The cylinders are all fitted with Messrs. Musgrave's usual Corliss valves and valve gear, the steam valves of the H.P. cylinder being controlled direct from the governor, while the valves of the L.P. cylinders are arranged to be regulated by hand. All the Corliss valves are double ported.

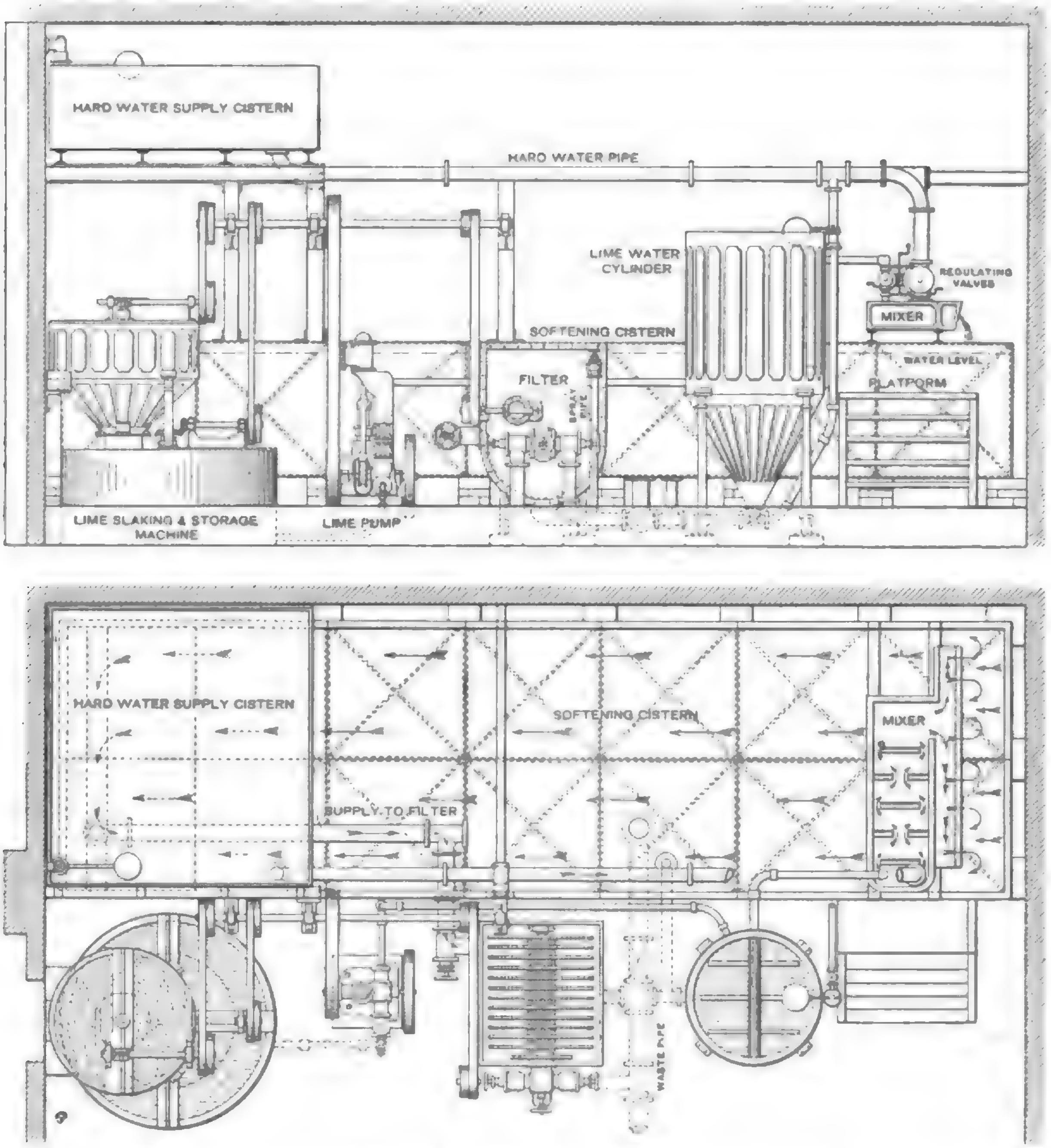
The three two-phase generators are of the well-known Oerlikon design, but were constructed by the General Electric Co. at their Manchester works. Each generator is capable of giving a normal output of 300kw., each of the two sets of coils being capable of giving 150kw. at all E.M.F.s from 2,800 to 3,000 volts at the terminals of the machines. The machines will also run continuously for two hours overloaded at 330kw. The speed, as already stated, is 93·7 revs. per min. and the frequency 50 ~ per sec.

The energy stored in the flywheel when running at its normal speed is 1,800,000 foot pounds. The field-magnet poles, with their windings, are fixed on the periphery of the flywheel. The poles are laminated, rivetted together, and fixed to the flywheel rim by means of steel wedges, the latter being securely fastened to the flywheel by strong bolts passing through its rim. There are 64 laminated poles on each flywheel, wound with round copper wire, the exciting current being brought to them through two slip rings. The diameter over the poles is about 14ft. The necessary current for exciting the field coils is obtained from the continuous-current dynamos driven by high-speed engines.

On the inner circumference of the stationary armature are spaced 256 slots, which carry the copper windings. These windings are arranged to form two circuits, one for each phase. The windings of the one circuit have straight ends, whilst those for the other circuit have bent ends, as is the usual practice. The insulation between the coils and the iron frame is efficiently effected by mica tubes, the coils being fastened securely in the slots by means of strong fibre wedges. In our figure giving a general view of the engine room, the upper sections only of the shields covering the end of the windings are in place. The two series of windings are quite independent, and their four ends are brought out to terminals from which the current is carried to the switchboard.

There are three continuous-current dynamos, which were also made by the General Electric Co., for exciting and light and power supply in and about the works. Each is capable of giving an output of 600 amperes at 100 to 110 volts at a speed of 460 revs. per min., and each is directly coupled (on one bedplate) to a high-speed enclosed type compound engine of Messrs. Musgrave's make.

These engines are almost, if not quite, the first fast-speed engines of this pattern supplied by Messrs. Musgrave for dynamo driving. The cylinders are 9in. and 14in. diameter respectively, 8in. stroke, run at 450 revs. per min. and work non-condensing. As seen in our sectional view, the engine is of the enclosed side-by-side type, and is provided with large oil-



General Arrangement of Water-Softening Plant. Plan and Elevation.

tight doors. The cylinders are mounted on the top of the standard, and are fitted with piston valves as seen, the high pressure valve being controlled by a throttle governor on the Pickering principle. The high and low-pressure cylinders are made in one casting, with the receiver cast on in the form of a belt. Separate liners are forced into the cylinder barrels and valve chambers. Separate eccentrics are used for working the valves so that each valve can be adjusted by its own eccentric. The piston rods are forged with the sockets, and no screw or cotter is needed for securing them.

The crank shaft and cranks are of Siemens steel forged in one piece, the cranks being placed at right angles and balanced, and the crank shaft pedestals are cast with the foundation-plate and fitted with bell metal steps lined with white anti-friction metal. A system of forced lubrication is employed, and all the working parts are lubricated by this system without moving joints. The engine is fitted with all the usual drain tap pipes, relief valves, sight feed lubricator, water catcher, and stop valve. As on the larger engines, the cylinders are covered with planished steel casings.

The dynamos, either of which are large enough to supply the exciting current necessary for all three alternators, are shunt-wound, having four poles with cast-steel yokes, whilst the armatures are of the slotted type with former-wound coils placed in the slots. The commutator is built up of hard-drawn copper, and is fitted with carbon brushes, and the machine is built to conform with the usual specification as to temperature and fixed position of brushes.

Arc-Lighting Plant.—There are two arc-lighting circuits, shown ○ and ● on the map, with 43 or 44 lights on each circuit. These are supplied by three Ferranti rectifiers of the standard 50-light pattern, which are placed in one corner of the engine room under the stairway. There is space for a fourth, although at present one of the three is a stand-by. The switchboard in connection with these is of the usual type constructed by Messrs. Ferranti for this purpose, and it is fixed on the wall beside the rectifiers. It is arranged for three circuits any one of which can be fed from any one of the rectifiers.

Crane.—A 15-ton overhead crane traverses the engine-room from end to end.

Condensing Plant.—The three steam alternators are fitted with Körting ejector condensers placed partly above the engine room floor level and partly in the pipe trench. A branch is run from each condenser to the main exhaust pipe, in which is fixed a Blake and Knowles automatic exhaust valve to enable the steam to reach the atmosphere in case of any failure of the condensing plant. Each condenser is required to give a vacuum of 24in. of mercury when dealing with 10,000lb. of steam per hour. The condensers are supplied with water from a large tank, placed on the roof of the pump room, and kept filled by three motor-driven centrifugal pumps of 18 B.H.P. each, running at 1,200 revs. per min., the motors being of the General Electric Co.'s make. These pumps are placed in the pump room, and are each capable of delivering 33,000 gallons of water per hour with a total lift of 48ft. at low tide.

The supply pipe to the condensers is 14in. diameter, and is carried on brackets fixed to the wall of the destructor-house with 9in. diameter branches to each condenser. The water returns to the river through cast-iron pipes discharging over a concrete apron on the foreshore. The condensing water is drawn from a closed sump made of piles on the foreshore, but as water could not be obtained from this sump at all states of the tide, a line of 24in. cast-iron pipes was run out into the river for a distance of 170ft. These pipes have spherical joints to allow of some slight play and terminate in a cast-iron sump which is always submerged.

In order to clean this second sump and its line of pipes of the river mud which is expected to collect in it, arrangements have been made for discharging the contents of the overhead tank already referred to into the pipes, when required. It is anticipated that the powerful flush that will thus be obtained will have the desired effect.

Main Switchboards.—The high-pressure switchboard for controlling the 3,000-volt two-phase currents is of Messrs. Ferranti's standard pattern, and is placed in the gallery 10ft. above the engine room, as seen in one of our illustrations. It consists of 16 panels, providing for the six circuits of the three two-phase alternators, two rectifier circuits, and the testing circuit, and there is one spare panel. The controlling gear for the alternators is fixed below board on the regulating table, the alternators are regulated by open type rheostats in series with the field. The present exciter board is only a temporary one, and the General Electric Co. is replacing it with one of its newest design. Regulation of the exciter fields will take place at this board, from which also the light and power circuits of the works are to be controlled. In connection with the high-pressure board, a Ferranti plug testing box has been fitted, from which leads are run to the instrument room. Plugs can be inserted in the box and connected to any panel on the high-pressure board for making insulation tests. There are three Ferranti wattmeter panels, one for each alternator. Two wattmeters are fixed on each, with cut-outs, transformers and fuses, there being one recording wattmeter in each phase. Kelvin instruments are employed on the switchboards.

THE FERRANTI RECTIFIERS.

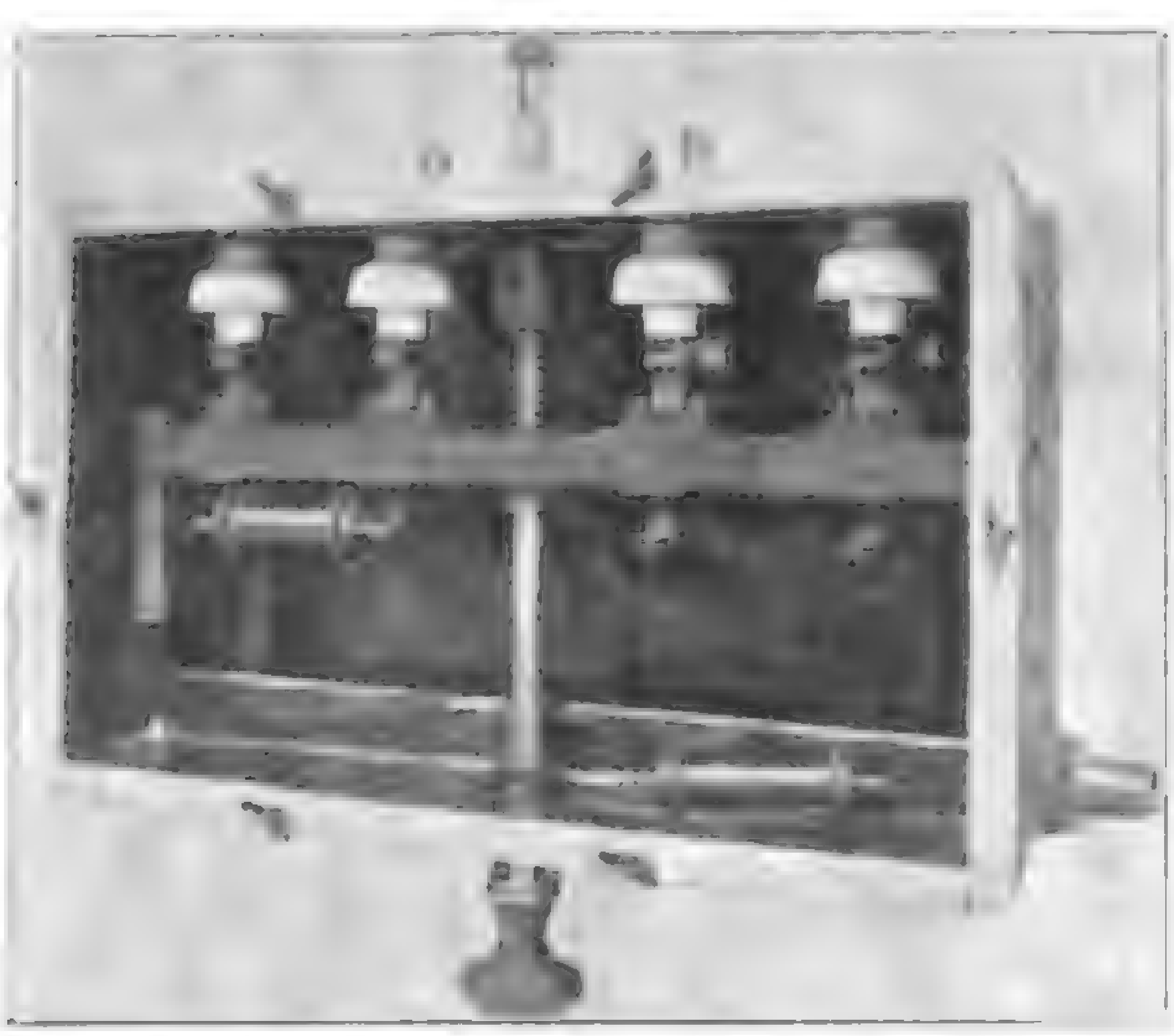
One terminal of each phase is permanently earthed to the earth bar of the switchboard in the usual manner, and of course the switch and fuse connections are all on one pole only. The synchronising contact is made in connection with one phase only of each alternator, the handles of the two switches of each alternator being joined by a cross-piece.

All the principal connections between the machines and the switchboards run beneath the floor, and are of rubber insulated cable which, in the case of high-pressure mains, is also lead-covered.

Mains and Sub-Stations.—The two-phase high-pressure current is lead by means of pairs of concentric lead-covered cables to five stations. Here it is transformed down to 200 volts each phase in stationary transformers and distributed at that pressure to the consumers. In the low-pressure cables, the phases are also kept apart, and one employed on each side of the street. If a motor is required, a service line is run across the street and both phases are brought in. The high-pressure feeders, running in pairs of concentric cables whose outers are earthed at the station

switchboard, may be traced out on the map as follows: A 7/14 feeder runs to Munster-road, where it divides, 7/16 cables being "swallow-tailed" off at either side to the sub-stations 1 and 2. To No. 3 sub-station there is a 7/15 feeder, consisting, as in all cases, of a pair of concentric cables, and to No. 4 a 7/14 feeder. The latter is tapped to supply No. 5 sub-station. To avoid confusion in the map, owing to the small scale, the course of the feeders is merely shown by one dotted line whether one or more feeder runs down the street; but the above explanation makes the arrangement quite clear. Streets in which there are distributors are shaded, and it is seen that there are no distributors in close proximity to the works. The arc-lighting circuits, which are independent, have already been referred to.

All the cables have been supplied and laid by the British Insulated Wire Co., and they are lead-covered and drawn into Doulton ducts under the footpaths and into cast-iron pipes where under roadways. At road crossings, however, wrought-iron pipes embedded in concrete have been used, special reducing pieces of Doulton ware being employed for gradually changing the shape of the way from the square to the round form. B.I.W. service and network boxes are made use of, the type with brass sleeves for plumbing to the lead of the cable having been chosen. The boxes are filled up with compound. Spare ducts have been provided liberally for future extensions.



JOHNSON AND PHILLIPS HIGH-PRESSURE SWITCH EMPLOYED IN SUB-STATIONS.

There are at present five sub-stations, each of which contains two 50kw. transformers, one for each phase. Messrs. Johnson and Phillips have supplied the transformers and built and equipped the sub-stations. The switching arrangements, as well as the transformers, are placed in watertight cases, all iron work is earthed, and a Cardew earthing device fitted to each transformer. Due provision has been made for ventilating the sub-stations, which are lighted with incandescent lamps supplied off the low-pressure bars in the switch-boxes. The chambers themselves are well designed and are sufficiently large for their pair of transformers. Being lined throughout with white glazed bricks they present a clean and wholesome appearance.

We give an illustration of one of the high-pressure switches. The box itself is of cast-iron lined with micanite. The high-pressure concentric feeder enters through the lower right-hand gland, the outer conductor being connected to the upper right-hand switch contact and the inner to the corresponding contact on the extreme left. The connection to the transformers enter through the smaller glands on the top. On turning the handle fitted to a spindle coming through the bottom of the box the cross-bar making the two contacts draws away sharply. The brake of the switch itself appears small, but is said to be effective. The cross-bar carries the fuses, which are contained in ebonite reels fitting into spring contacts on the bar.

The low-pressure box has glazed doors, the fittings consisting of a pair of 'bus bars mounted on a marble base. The cables enter through glands, and the connections are made through convenient switch-fuses with substantial stoneware handles.

Street Lamps.—The public lighting is by 86 arc lamps, carried on posts of ornamental design, bearing the borough arms, and run in two circuits of about half the number on each. The lamps are 12-ampere 32-hour double carbon lamps of the General Electric Co. (Ltd.) standard type, fixed about 25ft. from the ground. Brackets are also provided on each post for two 32 c.p. incandescent lamps, which are automatically switched on by Edmunds' switches when the arc lamps are switched off or fail.

Station Lighting.—This has been carried out by Messrs. T. L. Hellyar, a local wiring firm. Except in the offices, the cables are carried in watertight "Simplex" steel conduits. There are six distribution boards, to which the current is transmitted from the works lighting board, placed under the switchboard gallery in the engine room. The inclined roadway and destructor house are lighted by eight 12-ampere Brockie-Pell arc lamps, four similar lamps being suspended from swivelling brackets, two on either side of the engine room. There is also a large number of incandescent lamps, and wall plugs have been provided at all points where hand-lamps will be required for inspecting and cleaning purposes.

Consumers.—The charge for lighting purposes is 5d. a unit, and for motive power 2½d. a unit during the hours of daylight. The meters employed are of three types, Hookham, Thomson, and Aron. No meter rent will be charged. No "free wiring" contract has been entered into, but it is satisfactory to note that the number of applications for energy already amount to an equivalent of some 10,000 8 c.p. lamps. This includes a number of lift motors.

Staff.—Mr. Russell F. Ferguson has acted as clerk of the works during their construction, and was last July appointed to be chief engineer and manager on their completion. He is assisted by Mr. Meek (destructor superintendent), Mr. H. H. E. Wood (mains superintendent), Messrs. J. Morris, A. Murdoch, and S. C. Shepherd (assistant engineers), and Mr. Liddell (chief clerk). We wish to express our thanks to Mr. Ferguson and his staff for the facilities they afforded us to inspect everything and take photographs. The General Electric Co. and Mr. Medhurst kindly furnished us with copious notes on the plant, and the company's engineers showed us every attention, and spared no pains to enable us to acquire complete information. We are also indebted to the other contractors and sub-contractors for particulars concerning their plant.

## UPON THE SIFTING OF MIXED CURRENTS.

[BY AN OCCASIONAL CONTRIBUTOR.]

By a mixed current is meant one of a type represented by $C + c \sin pt$ when C and $c$ are constants, $p$ is a constant proportional to the inverse of the period, and $t$ is time; in brief, a direct and alternating current in the same conductor. Most instruments suitable for alternating currents are applicable to direct currents, *e.g.*, a dynamometer, a hot-wire voltmeter, &c. In consequence of this, such instruments applied to mixed currents will be affected by both the direct and the alternating current.

An instrument for direct current only, such as a galvanometer of the coil and magnet type, of which either the coil or the magnet is movable, will not be affected by alternating currents, and will only measure the direct portion C, if applied to mixed currents. Now, suppose that there are two such currents of one period.

$$C + c \sin pt,$$
$$B + b \sin (pt - pk),$$

in which $k$ will represent the difference in time between corresponding phases of the two currents, or $pk$ the actual difference in phase in circular measure.

Suppose one of these currents passed through one coil of a dynamometer, the other through the second. Then the reading of the instrument will be proportional to the integrated product of the two expressions. Thus, adopting the notation that $bD_c$ is the dynamometer reading of an instrument so situated, and performing the integration in question, we shall obtain

$$bD_c = BC + \frac{bc}{2}\cos pk. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If the current in one of the conductors is passed through both the coils of the same dynamometer, we can obtain the reading of the instrument by putting

$$B = C,\ b = c,\ pk = 0.$$

Thus,

$$bD_b = B^2 + \frac{b^2}{2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$cD_c = C^2 + \frac{c^2}{2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Now B and C, as I have pointed out, may both be measured by galvanometers.

So it appears that

$$\frac{bc}{2}\cos pk = bD_c - BC,$$

$$\frac{b^2}{2} = bD_b - B^2,$$

$$\frac{c^2}{2} = cD_c - C^2,$$

and hence all the various circumstances connected with the alternating portion of the currents may be determined by the methods which have been pointed out for pure alternating currents, taking care to subtract from the dynamometer readings the products of the constant parts of the current in each coil. For instance, the difference of phase is given by

$$\operatorname{Cos} pk = \frac{bD_c - BC}{\sqrt{(bD_b - B^2)(cD_c - C^2)}}.$$

A very convenient form of voltmeter, applicable in cases of mixed currents, consists of a galvanometer, of coil and magnet type, and a hot-wire instrument connected in series.

The hot-wire instrument will give $E^2 + \frac{e^2}{2}$; the galvanometer will give E.

In these expressions, E is the constant part and $e$ the constant factor of the variable part of the P.D.

The above subject may now, perhaps, excite some interest, as the interesting experiment of Mr. Duddell's, in producing an oscillation in an otherwise direct current by means of a condenser and an arc light, involves such mixed currents. Mr. Duddell remained in doubt as to the difference of phase between the current in the arc and the P.D. of the terminals.

Suppose that in the formula for $\cos pk$ the letter $b$ refers to the condenser branch, and the letter $c$ to the arc branch. Then obviously $B = 0$, if the condenser does not leak.

And

$$\cos pk = \frac{bD_c}{\sqrt{bD_b(cD_c - C^2)}},$$

and in this case C may be measured by a galvanometer in the main circuit from the dynamo. Now if Mr. Duddell is right in supposing that the time is set by the condenser circuit, to which opinion I do not in this Paper necessarily subscribe, then the current in the condenser circuit is in phase with the P.D. at its terminals, and consequently the angle $pk$ will be the phase difference between the P.D. and the current in the arc.

Again, under the same supposition that the condenser branch sets the time (is, in fact, the musical conductor) the power in the arc circuit may be measured thus: Let E be the constant part of the P.D. at the terminals. Then EC is the portion of the power required for the constant conditions, and each factor may be measured by coil and magnet instruments.

The part due to the variables is $r \times bD_b$, where $r$ is the resistance of the conductors in the condenser branch.

Hence the power in the arc circuit is, in this case, $EC + r_b D_b$. As mentioned before, C may be read in the main circuit from the dynamo.

If we do not make the supposition regarding the setting of the time the power in the arc circuit has a different expression—viz., $EC - R_a D_a - C^2 R - r_b D_b$ when $a$ refers to the main circuit and R is its resistance.

A comparison between the two expressions would settle the question experimentally.

## X-RAY WORK AND THE SIEGE OF LADYSMITH.

At the meeting of the Röntgen Society on Thursday, Jan. 26th, the Secretary read a Paper by Lieut. and Quartermaster Bruce, R.A.M.C., on "Experiences of X-Ray Work during the Siege of Ladysmith." The Paper related to the author's practical experiences only, and avoided all scientific and technical surgical details, and it was particularly interesting as furnishing an account of the manner in which X-ray work was attempted and carried out under actual fire and in an invested town where no supply of electrical energy was available. Lieut. Bruce expected to find the latter fact particularly troublesome, but from experience up the Nile he knew that it would be useless to take the specially constructed bicycle for driving the dynamo which had been employed there. It would be well-nigh impossible to get men to drive such a contrivance with their feet for more than half-an-hour, as the power necessary for charging six cells was equivalent to that required to ascend a very steep hill on an ordinary cycle. The apparatus the author took with him consisted of an Apps 10in. portable coil with separate break, two four-cell batteries, six single cells, a dynamo without any means of driving it, McKenzie-Davidson localising apparatus, a supply of Deane's tubes, a specially-made screen, also made by Mr. Deane, a small kit of repairing tools, and the usual photographic appliances.

Lieut. Bruce reached Pietermaritzburg without mishap, and had his batteries charged up at the Royal Hotel. On travelling by train from Pietermaritzburg he had noticed that the train was lighted electrically, and, learning that large batteries were used for the purpose, he obtained two of these, which were sent to Ladysmith. On arriving there he found that Lieut. Weld, R.A.M.C., had preceded him with a second set of Röntgen ray apparatus very similar to his own, except that Lieut. Weld had lithanode cells. These cells had, unfortunately, broken down, but whether it was due to faulty charging or damage during the journey from Pietermaritzburg, he was unable to say. The author went on to speak in praise of his own cells, which were of the E.P.S. type, and had already been used successfully up the Nile.

The author then described the arrangements for the operating room and dark room; in the latter two small electric lamps, one red and one white, were worked from one of the batteries.

The first work was given by the battle of Elandslaagte, from which comparatively speaking, there were not a very large number of cases. A few had to be searched for bullets, the majority being bone injuries the extent of which had to be ascertained. All the instruments worked well, but, unfortunately, about this time the enemy had cut off the main water supply from the town, and nothing but a small and dirty service remained, with the consequence that many plates were spoilt. In the battle of November 30, commonly known as "black Monday," they had a good many cases of bullets to locate, a few of these being lodged in deep tissue. It was especially for these cases that good tubes, with a maximum of penetration and a minimum of liability to heat the anodes, became invaluable. Without these attributes, the author explained, a tube is of little use when examining deep tissue with the object of discovering small foreign bodies such as a Mauser bullet. Searching then occupies a lengthened period, and it is a great advantage to be able to carry it out uninterruptedly when once the eye gets accustomed to the screen. It is also of importance that the cryptoscope should be of the exact focal length in order that the whole extent of the screen may be seen at once.

On November 2, when the town was actually beleaguered by the enemy, unhappily the supply of electricity was giving out, as a large amount of work had already been done. As it became absolutely necessary to get the batteries charged, the following expedient was resorted to. Close to the Town Hall a flour mill, running night and day, was situated, and the dynamo was belted to one of the countershafts. This arrangement proved quite successful, and by this means it was also possible to supply Major Bruce, the chief operating surgeon, with electric light in the operating room for use at night.

Between October 30 and November 30 shells were continually dropping in the neighbourhood of the hospital, but the work had to be carried on as usual. During the firing short exposures were of the utmost importance, as when shells were heard in the immediate vicinity, the patients were certain to start and consequently spoil the plate. It being found that the hospital received too much attention from the Boer shells, Lieut. Bruce was ordered to remove with his apparatus to the neutral camp at Intombi.

In the move the Klip River had to be forded, and during this, a waggon stuck fast in the mud. In transferring its contents to another waggon a few plates were spoilt and some cases slightly damaged. However, by exercising great care, none of the apparatus itself was damaged by water. On arriving at Intombi no tent was to be had for the apparatus, and it had to be protected from the rain by a tipped railway truck for two days until one arrived from Ladysmith. During this first stay at Intombi no work could be done for three reasons: It was impossible to darken the tent sufficiently for general work, the heat was too great for developing, and Lieut. Bruce's time was completely occupied superintending the working of the Pasteur filters for supplying the sick and wounded with water. Another difficulty was that, in order to charge the batteries, they had to be taken to Ladysmith by rail and charged during the night, the people in the mill refusing to work during the day under the shell fire.

On December 15 Lieut. Bruce was ordered back to Ladysmith to be handy in case the relieving column should arrive. His request to occupy his former rooms in the Town Hall for operating purposes was, fortunately, refused; a few days afterwards both rooms were gutted by shells. With the help of Indian labour they commenced to erect a house for the purpose in a sort of nullah near the two Indian hospitals in the rear of the Generals' quarters. This, however, was flooded by a storm a few days after building operations had commenced, and everything was washed away. The next move was to the house of an inspector of police near the Congregational church, which latter was chosen as a hospital, the vestry being utilised as an operating room.

After a week, however, Lieut. Bruce was ordered to return to Intombi, leaving one set of apparatus where it was, the second set having been left at Intombi. The battle of January 6th furnished the next batch of cases and some interesting radiographs of expanding bullets were obtained, showing the lead scattered about the injuries in all directions, the mantle of the bullet remaining intact. After this until the end of the siege, the number of cases were fewer.

As regards the general results obtained by the apparatus, all were unanimous in saying that it was of the greatest assistance, not only in locating the bullets, &c., but also as an aid in the treatment of fractures generally. The E.P.S. cells remained till the last in excellent working order. As a rule they were charged once weekly, the voltage being kept up to 2 volts per cell. When the mill ceased working, Lieut. Bruce himself, assisted by a Kaffir, had to start the engine and keep it running all night for charging. The total number of X-rayed cases actually recorded during the time was 200, of which nearly one-half were photographed. In addition, a large number of cases under treatment were examined by the surgeons through the medium of the screen.

To make the apparatus more complete, Lieut. Bruce suggests the following improvements: A properly-constructed operating table is a necessity, so devised that the tube can be worked below as well as above the patient. This would enable the thorax and pelvis to be more easily examined without discomfort to the patient. Such tables were, he believed, now on the market. The chief point which has to be met, however, is the means for the generation of electricity for charging the cells, as in campaigns one cannot always depend upon an outside source of motive power. Lieut. Bruce suggests as a solution the use of a small petrol motor, such as is used for tricycles, to drive the dynamo, and possibly this might obviate altogether the necessity of carrying batteries. He is himself at present engaged in the attempt of arranging an apparatus to answer the requirements as regards weight, bulk and general effectiveness, and he hopes to communicate to the Rontgen Society the results of his endeavours if he is successful.

## BOOKS RECEIVED.

**Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.**

"*Proceedings* of the Royal Society." No. 441, Vol. LXVII. (London: Harrison & Sons.) 1s. 6d.

"*Proceedings* of the 1900 Annual Meeting of the Society for the Promotion of Engineering Education." Vol. VIII. (New York: 'Engineering News" Publishing Co.) $2.50.

"Alphabetical Lists of United States Patentees and Inventions for the Quarter ending Sept. 30, 1900. (Washington: Government Printing House.)

## ELECTRICITY WORKS ACCOUNTS.

### Lancaster Municipal Electric Supply Works.

The Lancaster accounts for the year ended March 25 last indicate a continued and satisfactory progress. Evidently the result of higher coal prices and increased charges under the heading of distribution costs, there was a slight rise in the aggregate costs. The collective management and property charges, and, under generating costs, the items of wages and repairs and maintenance at the station, exhibit very low figures.

Reductions in the tariff show their effect on the revenue from both public and private lighting. The total revenue was no more than 3·9d. per unit—a figure much under the average with municipal concerns of similar magnitude. In view of this, the ratio of the working profit to the mean expended capital of over 7 per cent. is a most excellent result.

In the matter of lamp connections the progress made is measured by an increase of nearly 22 per cent. The output was higher than in the preceding year by 35·4 per cent., and while the load factor also shows an improvement we should like to see it quite 2 per cent. higher than the actual figure of 9·48 per cent.

### Dewsbury Municipal Electric Supply Works.

It is gratifying to find from the Dewsbury accounts that the undertaking has commenced to pay its way. While great progress was necessary and has been made to arrive at this result from its former position, there is yet opportunity for further improvement. At present it may be said that the total generating and works costs are quite satisfactory, but that the management and property charges are too high. Unfortunately for the undertaking the management and property charges are swelled, not only by distinctly heavy rates and taxes, but also under management expenses, by what appears to be the unfairly high charge of £265 "Proportion of joint expenditure."

We are glad to be able to record that, with the moderate total revenue of 4·8d. per unit, there was a surplus of £201 after paying capital charges amounting to 5·15 per cent. on the mean capital.

The load factor for the year was 9·9 per cent., and the lamp connections and the output increased by slightly over 24 per cent.

**The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—**

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Jan. 19, 1900 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | June 22, 1900 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. [illegible] |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.)(Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 23, 1900 | Notting Hill (Company) | Mar. 16, 1900 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 13, 1900 |
| Cambridge (Company) | April 13, 1900 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 9, 1900 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 23, 1900 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Feb. 16, 1900 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Nov. 24, 1899 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southport (Municipal) | July 7, 1899 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Stafford (Municipal) | Aug. 17, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Sunderland (Municipal) | Nov. 9, 1900 |
| Folkestone (Company) | April 27, 1900 | Taunton (Municipal) | June 16, 1899 |
| Glasgow (Municipal) | Sept. 14, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Guildford (Company) | Oct. 19, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Wandsworth (Company) | May 18, 1900 |
| Hampstead (Vestry) | Oct. 19, 1900 | Westminster (Company) | Mar. 9, 1900 |
| Hanley (Municipal) | July 27, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrogate (Municipal) | Jan. 4, 1901 | Winchester (Company) | Oct. 26, 1900 |
| Harrow (Company) | Dec. 21, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Woking (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woolwich (Company) | Jan. 12, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kensi'gton & Knightsbr'(Co.) | Mar. 16, 1900 | Great Yarmouth (Mun.) | Dec. 24, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | | |

| | LANCASTER. | | | | DEWSBURY. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Lancaster Corporation. | | | | Dewsbury Corporation. | | | |
| *Date of Commencement of Supply* | April, 1894. | | | | December, 1894 | | | |
| *System of Supply* | 3-wire continuous current. | | | | 3-wire continuous current. | | | |
| *Chief Engineer* | W. A. Fraser. | | | | O. M. Jones. | | | |
| **YEAR ENDED** | MAR. 25, **1899.** | | MAR. 25, **1900.** | | MAR. 31, **1899.** | | MAR. 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 220,329 | | 316,749 | | 172,097 | | 213,084 | |
| " SOLD (TOTAL) | 204,686 | | 277,259 | | 161,154 | | 199,924 | |
| " sold to consumers | 177,014 | | 225,661 | | 144,957 | | 182,467 | |
| " sold for public lighting, &c. | 27,672 | | 51,598 | | 16,197 | | 17,457 | |
| " used on works | 5,261 | | 7,047 | | 1,750 | | 1,810 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 15·6 | | 21·2 | | 18·4 | | 16·4 | |
| Maximum supply demanded | 250 kilowatts | | 334 kilowatts | | 190 kilowatts | | 230 kilowatts | |
| Number of public lamps | 23 arc, 46 16 c.p. glow | | 30 arc | | 16 arc, 22 16 c.p. glow | | 16 arc, 22 16 c.p. glow | |
| Number of consumers | 363 | | 471 | | 111 | | 166 | |
| Connections to mains in 8-c.p. lamps | 17,807 | | 21,719 | | 10,500 approx. | | 13,028 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 13,100 | | 13,100 | | 8,750 | | 12,180 | |
| CAPACITY OF PLANT IN KILOWATTS | 420 | | 420 | | 280 | | 390 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | — | — | — | — | £25,000 | £89·3 | £33,920 | £87 |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | ... | ... | ... | ... | 25,000 | 89·3 | 33,920 | 87 |
| RECEIVED (TOTAL) | £25,000 | £59·5 | £35,000 | £83·3 | — | — | — | — |
| Share | — | — | — | — | — | — | — | — |
| Loan (including Debenture charges) | 25,000 | 59·5 | 35,000 | 83·3 | — | — | — | — |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | — | — | — | — |
| Share (unissued) | — | — | — | — | — | — | — | — |
| Share (uncalled) | — | — | — | — | — | — | — | — |
| Loan (including Debentures) | — | — | — | — | — | — | — | — |
| REPAID (TOTAL) | — | — | — | — | — | — | — | — |
| RESERVE OR SINKING FUND | 1,160 | 2·76 | 1,746 | 4·16 | — | — | — | — |
| DEPRECIATION FUND | 200 | 0·48 | 450 | 1·07 | — | — | — | — |
| EXPENDED (TOTAL) | 28,663 | 68·3 | 32,795 | 78·1 | 26,691 | 95·3 | 33,074 | [illegible] |
| Lands and buildings | 3,497 | 8·33 | 3,817 | 9·10 | 4,943 | 17·6 | 6,510 | 16·7 |
| Plant | 12,948 [a] | 30·8 | 14,775 [d] | 35·2 | 12,060 | 43·0 | 14,051 | 36·0 |
| Mains | 11,764 | 28·0 | 13,750 | 32·7 | 7,767 | 27·7 | 10,562 | 27·1 |
| Miscellaneous | 452 | 1·08 | 453 | 1·08 | 1,922 | 6·86 | 1,952 | 5·01 |
| BALANCE OF CAPITAL ACCOUNT | - 3,663 [b] | 8·72 | 2,205 | 5·25 | — | — | — | — |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £4,133 | 4·843d. | £4,506 | 3·900d. | £3,269 | 4·870d. | £4,031 | 4·840d. |
| Revenue from supply | 3,470 | 4·070d. | 3,851 | 3·334d. | 3,124 | 4·665d. | 3,862 | 4·635d. |
| " meters, &c. | 1 | 0·001d. | 1 | 0·001d. | 96 | 0·143d. | 122 | 0·146d. |
| " public lighting | 530 | 0·621d. | 628 | 0·544d. | — [a] | — | — [a] | — |
| " sale of lamps, &c. | 94 | 0·110d. | | — | 26 | 0·039d. | 44 | 0·053d. |
| " miscellaneous sources | 38 | 0·045d. | 25 | 0·023d. | 23 | 0·034d. | 4 | 0·005d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £1,715 | 2·011d. | £2,348 | 2·033d. | £2,263 | 3·371d. | £2,291 | 2·750d. |
| WORKS COSTS | 1,351 | 1·584d. | 1,863 | 1·612d. | 1,436 | 2·139d. | 1,368 | 1·641d. |
| *Generation of electricity* | *1,[illegible]* | *1·[illegible]d.* | *[illegible]* | *[illegible]* | *1,33[illegible]* | *[illegible]* | *1,[illegible]* | *1·530d.* |
| Fuel (including cartage, &c.) | 540 | 0·633d. | 853 | 0·738d. | 424 | 0·632d. | 495 | 0·594d. |
| Oil, waste, water, stores | 153 | 0·179d. | 138 | 0·119d. | 159 | 0·237d. | 161 | 0·193d. |
| Wages at station | 421 | 0·494d. | 501 | 0·434d. | 353 | 0·526d. | 413 | 0·496d. |
| Repairs and maintenance at station | 90 | 0·106d. | 125 | 0·109d. | 401 | 0·599d. | 105 | 0·246d. |
| *Distribution of electricity* | *57* | *[illegible]* | *[illegible]* | *0·125d.* | *[illegible]* | *[illegible]* | | |
| Wages, &c. | 12 | 0·014d. | 5 | 0·004d. | 47 | 0·070d. | | |
| Repairs, renewals of mains, &c. | 45 | 0·053d. | 111 | 0·096d. | 50 | 0·075d. | | |
| *Public lighting* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | 95 | 0·112d. |
| Attendance | | | | | 70 | 0·104d. | | |
| Renewals | 91 | 0·107d. | 101 | 0·087d. | 9 | 0·015d. | | |
| MANAGEMENT AND PROPERTY CHARGES | 364 | 0·427d. | 484 | 0·419d. | 827 | 1·232d. | 923 | 1·107d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *[illegible]* | *0·1[illegible]d.* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | *0·233d.* |
| *Management* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | *713* | *1·062d.* | *[illegible]* | *0·87[illegible]d.* |
| Salaries | 14[illegible] | 0·174d. | 212 | 0·184d. | 309 | 0·460d. | 336 | 0·403d. |
| Stationery, &c. | 32 | 0·038d. | 27 | 0·023d. | 31 | 0·045d. | 22 | 0·026d. |
| Establishment charges | 66 | 0·077d. | 107 | 0·093d. | 43 | 0·064d. | 49 | 0·059d. |
| Law charges, &c. | 21 | 0·025d. | 25 | 0·022d. | 330 [c] | 0·492d. | 318 [f] | 0·382d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. expended | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £2,419 | 9·13% | £2,157 | 7·03% | £1,006 | 3·87% | £1,741 | 5·83% |
| Sum carried to Depreciation Fund | 200 | 0·755 | 250 | 0·810% | — | — | — | — |
| Sum carried to Reserve or Sinking Fund | 277 | 1·05% | 551 | 1·79% | 765 | 2·94% | 749 | 2·51% |
| Net interest on loans (incl. Debenture charges) | 750 | 2·83% | 935 | 3·04% | 719 | 2·77% | [illegible] | 2·64% |
| BALANCE FROM LAST ACCOUNT | — | — | — | — | — | — | — | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 1,191 | 4·50 % | 421 | 1·37% | — | — | 201 | 0·673% |
| *Deficit* | — | — | — | — | [illegible] | [illegible] | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | — | — | — | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 41·5% | | 52·1% | | 69·2% | | 56·9% | |
| Expenditure per kilowatt capacity | £4. 1s. 7d. | | £5. 11s. 10d. | | £8. 1s. 7d. | | £5. 17s. [illegible]d. | |
| REVENUE PER KILOWATT CAPACITY | £9. 16s. 10d. | | £10. 14s. 7d. | | £11. 13s. 6d. | | £10. 6s. 7d. | |
| Expenditure per 8-c.p. lamp capacity | 2s. [illegible]d. | | 3s. 7d. | | 5s. 2d. | | 3s. 9d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 6s. 3½d. | | 6s. 10½d. | | 7s. 5½d. | | 6s. 7½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 4s. 7½d. | | 4s. 1½d | | 6s. 2½d. | | 6s. 2d. | |
| Price charged for lighting, per unit | 4½d. | | 4½d. | | 6d. to 3½d. [d] | | 6d. to 3½d. [d] | |
| Price charged for power, per unit | 3d. | | 3d. | | 3d. to 1½d. [e] | | 3d. to 1½d. [e] | |
| Price charged for public lighting | £20 per lamp per ann. | | £20 per arc lamp per ann. | | 6d. to 3½d. [d] | | 6d. to 3½d. [d] | |

LANCASTER.—REMARKS—a Includes £[illegible] on public lamps. b Over-expenditure. c Includes insurance £17 and auditing £1[illegible]. d Includes £[illegible] on public lamps.

DEWSBURY.—REMARKS—a Included in figure for revenue from supply. b After deducting £76 refunded. c Includes £[illegible] joint expenditure, £25 expenses of appointment of manager and £19 to insurance. d By maximum demand system, 1½ hour scale. e Maximum demand system—[illegible] hour scale. f Includes £[illegible] "proportion of joint expenditure" and £19 insurance.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*ll Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "Coutts and Co."

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | | HALF-YEAR | | QUARTER | |
|---|---|---|---|---|---|---|
| United Kingdom | 26s. 0d. | ... | 13s. 6d. | ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | ... | 16s. 0d. | ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## CENTRAL LONDON RAILWAY ACCOUNTS.

Exceptional interest attaches to the recently-published accounts for the first period of working of the Central London Railway—viz., for the half-year ended December 31st last, including the first five months of working of this railway. The interest arises not merely from the great popularity of this new addition to London's still inadequate passenger transport arrangements, but also because in the "Twopenny Tube" we have the first real exponent of a type of urban railway that is certain to be adopted by a large number of railways in the immediate future. We describe the "Tube" as the first real exponent of this type, because its predecessors in the South of London and at Waterloo were more in the nature of pioneers. The City and South London railway, it will be remembered, was originally planned to be run by cable haulage, and possesses many elements of design that would have been omitted or altered had electric traction been originally contemplated. The Waterloo and City Railway, on the other hand, is a line constructed without intermediate stations; and, for this and other reasons, its financial accounts are less generally instructive or typical than are those of the Central London Railway. Railway engineers have been paying considerable attention of late to electric traction, and the successful inauguration of the Central London Railway on July 30th last must have contributed largely to strengthen their faith in it; but it is to the regularly published statements of accounts that these men will look for the strongest and most trustworthy evidence of the superiority of electricity over steam. For such accounts combine the index of popular approval and patronage with the index of technical or engineering superiority, and they are the only true and final guide. We invite, therefore, the attention of steam railway experts and authorities, to examine the recently-published statement of the Central London Railway accounts.

Before summarising and to some extent analysing these instructive figures, we would preface our remarks with the reminder that two causes tend to make it difficult to compare closely the accounts of the "Twopenny Tube" with those of any ordinary steam railway. The most serious obstacle is the peculiar system of fares adopted on the electric line—viz., the

uniform charge of 2d. for any distance travelled. On this system the number of passengers carried serves as no guide to the passenger-mileage, which remains an unknown quantity even to the directors themselves. Accordingly, although the train-mileage is known, the average train-load of passengers is indeterminate; and the absence of the factors just mentioned renders impossible any close comparison with steam practice on a uniform basis. Another point that must be borne in mind is, that not only do the accounts before us represent the first period of working, but they also include one month prior to the opening of the line to the public. They represent, therefore, a revenue-earning period of only five months' duration.

The total capital created to date includes £2,850,000 in shares and £876,000 loans, or a total of £3,726,000. Of this, £3,512,012 has been expended on works and rolling stock. This is undoubtedly a heavy capital for a line of such limited length; but, when the costly nature of the tunnelling and the frequency of the stations are considered, the figure should not be deemed extravagant. It will, however, stand all the more to the credit of electric traction, if the undertaking steadily yields a series of good dividends upon so large a capital. During the five months working from July 30th to December 31st, no less than 14,916,922 passengers were carried, or roughly 3,000,000 per month. Enormous though this traffic is, it falls short of the original estimate of 50,000,000 per annum, a deficiency, however, which is amply accounted for by the trains not yet having been run on the short headway for which the line was designed. It will be remembered that during the first few weeks, and until the operating staff were thoroughly familiar with their duties, the trains were run on a five minutes' headway. When the contemplated loop-line cross-overs have been completed at both termini the transfer of trains between the two tunnels will be greatly facilitated, and a much more frequent service than at present will be rendered possible. The actual service train-mileage for the period now under consideration was 486,004. The revenue derived was £119,889. 18s., and the working expenses were £70,438. 19s. 7d. Steam railway engineers who may feel surprised at so high a ratio of expenditure to revenue as 58¾ per cent. should bear in mind the facts to which we have already alluded. In addition to these prejudicial influences, we learn that the high prices of fuel and other materials have seriously increased expenses. We admit that 59 per cent. is a high ratio; it is a figure considerably above the average of steam practice and far above the best steam or electric practice. It would not be condoned except in a new line; but it is specially pardonable in a line that is not only new but is also worked on an entirely novel system. We expect to see a considerable reduction in this ratio in the next half-yearly accounts; we shall not rest satisfied until it is well below 50 per cent., nor do we despair of its being reduced to 45 per cent. A little calculation shows that the net profit amounts to 2s. per train-mile, the gross revenue being 4s. 10¾d. per train-mile and the expenses 2s. 10¾d. per train mile. One word as to the distribution of profits, and we must close, reserving for a later occasion our detailed analysis of the accounts. The balance available for distribution is £49,576, and, after paying interest on debenture stock, there is a balance of £39,152. With this a dividend is recommended on the share capital at the rate of 2½ per cent. per annum, leaving the sum of £3,527 to be carried forward to the next account. While this financial result is a satisfactory one, taking all the facts into consideration, yet it cannot be regarded as a true indication of the profitableness of electric traction on railways of the class to which the "Twopenny Tube" belongs. Encouraging as are the results of the first half-year when viewed in the right light, they show that much progress remains yet to be made before the financial superiority of electricity will have been triumphantly and conclusively established. But that triumph is in the near future.

## THE DESIGN OF TRANSFORMERS.

BY W. B. WOODHOUSE, A.M.I.MECH.E.

A transformer is usually designed to a specification of:—

1. Output at a given frequency.
2. Ratio of transformation at full load.
3. Efficiency (not less than —— per cent.)
4. Maximum drop of secondary pressure.
5. Temperature rise (not to exceed —— °F.), and, sometimes, in addition,
6. No-load current (not to exceed —— amperes).
7. Means of cooling employed—air, oil, or mechanical circulation.

In specifying efficiency and pressure drop, the power factor of the circuit must be stated; *e.g.*, "to have an efficiency of not less than 95 per cent. on a circuit of power factor 0·8," the power factor being the cosine of the angle of lag of current behind E.M.F. Efficiency has usually to be guaranteed at half, three-quarters, and full load.

The method of design is tentative, a certain form of core is chosen for a given output, and the design is analysed; new proportions are then taken slightly greater and slightly less than the first; if one of these designs is found to be better than the original, then a further alteration is made in the same direction until a design is found that best satisfies the conditions of—

(1) Watts lost in iron and copper.
(2) The temperature rise of the transformer.
(3) The drop of secondary voltage.
(4) The cost of materials and manufacture.

Proportions of Core.—Modern transformers are of two types, those known as "core" transformers having short copper

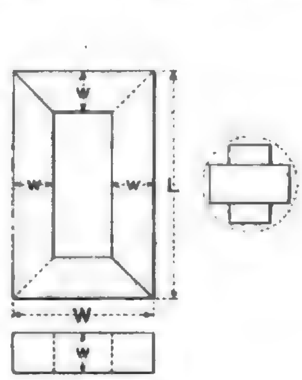


FIG. 1.

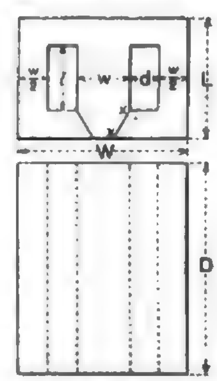


FIG. 2.

and long magnetic circuits with the windings enclosing the core; those known as "shell" transformers, in which the copper and magnetic circuits are of approximately equal length, the windings being principally surrounded by the core.

The advantages of the first type are: (1) Windings present good cooling surface; (2) accessibility; (3) easily wound, as cylindrical bobbins may be used; (4) good pressure regulation, short length of turns on winding. Disadvantages: Larger weight of copper and larger waste of material in stampings. The advantages of the second type are: (1) shorter iron path and smaller magnetising current; (2) less waste of material in stampings and less weight of copper. Disadvantages: Coils not accessible and less cooling surface.

The core of the first type may have the following proportions, the limbs being square, or two or even three sizes of

stampings being used to approximate the core section to the circular section of the bobbins, as in Fig. 1 :—

$$L = 4{\cdot}6w + 4'' \text{ to } 4{\cdot}7w + 4''$$
$$W = 3{\cdot}2w + 1''$$

The stampings are L-shaped and are built up so as to break joint. The Westinghouse core most used for shell transformers has the proportions, Fig. 2 :—

$$D = 3w \text{ to } 4w$$
$$l = 1w \text{ to } 1{\cdot}2w$$
$$L = l + w$$
$$d = 0{\cdot}5w \text{ to } 0{\cdot}6w$$
$$W = 2w + 2d = 3w$$

The stampings are cut through at x x and the sides bent back to allow the plate to be passed over the windings, when the sides are unbent to enfold the windings, the next stamping being put in from the other side and "breaking joint."

No-load Current.—A well-designed transformer has no magnetic leakage at no load ; the losses are small. Consider an alternating current, whose maximum value is $C_m$, in the primary winding ; it creates a flux, N, in the core, rising and falling with the current. This flux causes an E.M.F. in each winding, in quadrature with it (*i.e.*, with a phase difference of 90deg.), call them $E_1$ and $E_2$. As there are practically no losses, the E.M.F. in the primary $E_1$ will be equal to the E.M.F. on the mains. The maximum value of $E_1$ is proportional to the maximum value of N, the frequency of alternation ($f$), the number of primary turns ($T_1$), or at no load.

$$\text{E.M.F. on mains} = E_1 = N \times f \times T_1 \times 2\pi \div 10^8 \text{ volts.}$$

Assuming a sine wave, dividing by $\sqrt{2}$ gives the virtual volts

$$E_1 = 4{\cdot}45 \times N \times f \times T_1 \div 10^8,$$

and in the same way

$$E_2 = 4{\cdot}45 \times N \times f \times T_2 \div 10^8 \text{ volts,}$$

where $T_2$ is the number of turns in the secondary. By division $E_1/E_2 = T_1/T_2$.

This ceases to be true when we consider a loaded commercial transformer, because of the fall of voltage due to copper losses and because the flux N is lessened by leakage before it gets to the secondary winding, so that the ratio of the number of turns on primary and secondary is not the ratio of the voltages.

Magnetising Current.—A vector diagram for a transformer, having no losses, loaded with a non-inductive load, is shown in Fig. 3.

Let ON represent the flux in the core : $OC_m$, in phase with it, the magnetising current which causes it ; if a current, $OC_2$ (in phase with the secondary E.M.F., and therefore in quadrature with $OC_m$), circulate in the secondary winding, then the magnitude and phase of the primary current is obtained by drawing $OC_1$ to complete the parallelogram $OC_1C_mC_2$ or, the magnetising current of a transformer is the resultant of the primary and secondary currents.

The power put into the transformer $= E_1 \times C_1 \times \cos\phi$.
Ditto taken out of ditto $= E_2 \times C_2$.

A no-load diagram for a transformer with iron and copper losses is shown in Fig. 4.

Let V = voltage on mains, or impressed volts,
$P_h$ = watts wasted in hysteresis and eddies in the core,
then hysteresis current $C_h = P_h / V$.

This current must act just as the secondary current does, for the core plates may be considered as little short-circuited secondaries.

Set out then $OC_m$, the magnetising current; $OC_h$, in quadrature, the hysteresis current ; the no-load current is the vector sum of these.

No-load current $C_0 = \sqrt{C_h^2 + C_m^2}$.

If $P_R$ = watts lost in the primary windings, due to resistance with a current $C_0$ then the lost volts will be

$$e = P_R / C_0,$$

and setting out $Oe$ in phase with $C_0$ we obtain OV as the impressed volts, being the resultant of $OE_1$ and $Oe$. The power taken by the transformer *at no load* $= V \times C_0 \times \cos\phi$.

In most cases $e$ is negligible at no load.

Calculation of No-load Current. Magnetising Current.—
Let $C_m$ = virtual value of magnetising current,
N = maximum value of magnetic flux in the core,
$l$ = mean length of magnetic circuit in inches
A = net sectional area of core in square inches
B = max. flux density in lines per square inch = N/A.

Then from a magnetisation curve for the particular iron used, we find the "ampere-turns per inch of path" for a flux density B, and $C_m$ = ampere-turns per inch $\times l / 1{\cdot}41 \times T_1$.

Hysteresis Current.—This depends on the watts lost in eddies and hysteresis. The eddy current loss is proportional to $B^2$, (frequency)$^2$, and (thickness of plate)$^2$. It is less for an impure iron than for a pure iron, being proportional to

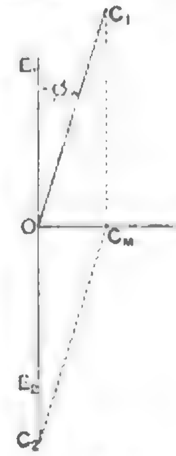


Fig. 3.

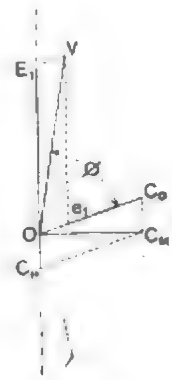


Fig. 4.

the specific resistance, and for the same reason it decreases slightly as the temperature increases. For plates 14mils. thick, best iron, it may be found from the formula, watts lost per pound $= 0{\cdot}0004\ (f/100 \times B/1{,}000)^2$, or for plates of any thickness ($t$) in inches,

$$\text{watts lost per pound} = 2(t \times f \times B)^2 \times 10^{-10}.$$

The hysteresis loss is proportional to the frequency and to $B^{1\cdot6}$; it is independent of the thickness of plate and of change of temperature within working limits. It increases with time and continued heating, and to some extent with pressure. Any iron to be used for transformers should be carefully tested as to its "ageing," or increase of losses due to continued

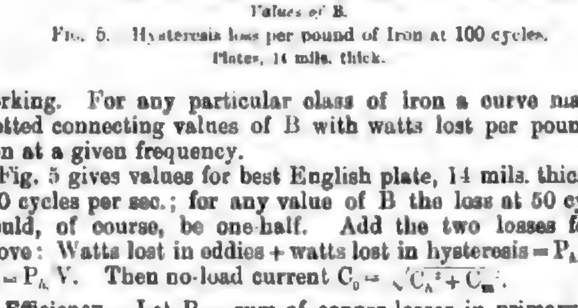


Fig. 5. Hysteresis loss per pound of Iron at 100 cycles. Plates, 14 mils. thick.

working. For any particular class of iron a curve may be plotted connecting values of B with watts lost per pound of iron at a given frequency.

Fig. 5 gives values for best English plate, 14 mils. thick, at 100 cycles per sec. ; for any value of B the loss at 50 cycles would, of course, be one-half. Add the two losses found above : Watts lost in eddies + watts lost in hysteresis $= P_h$, and $C_h = P_h / V$. Then no-load current $C_0 = \sqrt{C_h^2 + C_m^2}$.

Efficiency.—Let $P_R$ = sum of copper losses in primary and secondary at any load, $P_h$ = total iron losses, constant for all loads, $\cos\theta$ = cosine of angle of lag in secondary circuit, varying from 0·6 on a motor load to 1 on a lighting load, then

$$\text{efficiency} = \frac{E_2C_2\cos\theta}{E_2C_2\cos\theta + P_R + P_h} \times 100.$$

**Temperature Rise of Transformer.**—Heating depends upon: (1) Watts wasted per square inch of radiating surface. (2) Conditions of cooling; uncased or cased; without oil, with oil; with mechanical circulation of water through pipes in the oil; with forced air draught, &c. If we consider two similar transformers in which the linear dimensions of the one are $n$ times that of the other, then if the value of B be kept the same and the same proportion of space be occupied by the windings in each case, the cooling surface will only increase as $n^2 : 1$, while the output increases as $n^3 : 1$. Great care must, therefore, be taken in large transformers to keep the temperature rise small.

To express by a formula the rise of temperature of a transformer for a given value of the ratio—

Watts wasted/area of cooling surface,

is a somewhat difficult matter, as a badly designed arrangement of cooling surface may cause great local heating: for this reason oil cooling is much to be recommended, as it tends to equalise the temperature of the whole transformer. If only air cooling be used, greater attention must be paid to subdividing the coils and arranging air ducts between them; air ducts in the core may also be necessary.

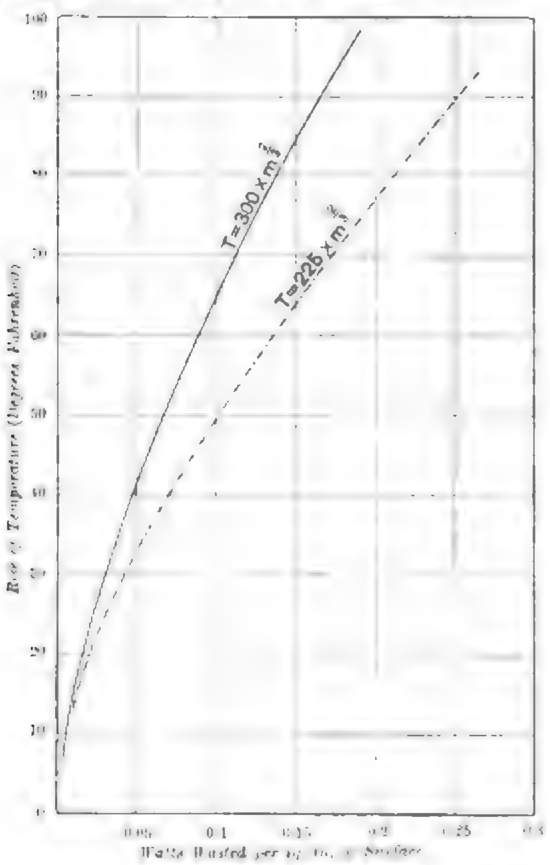


FIG. 6.

If a transformer be in a closed case the surface of the case should be as large as that of the transformer: the case may be corrugated to attain this. Generally, air-cooled transformers should be in cases allowing a free circulation of air (*i.e.*, open cases). Oil-cooled transformers are necessarily closed in; in large sizes the circulation of water through a coil immersed in the oil is recommended. Large air-cooled transformers sometimes have a small fan motor attached with an output varying from 0·25 per cent. to 0·1 per cent. of the transformer output.

The following rules will be found good, where the ratio ($m =$): Total watts wasted in transformer / sq. in. of cooling surface is not greater than 0·4.

*Air-cooled, Natural Draught.*—Final rise of temperature (°F) = 300 × $m$[illegible].

*Oil-cooled.*—Rise of temperature (°F) = 225 × $m$[illegible].

The curves corresponding to these equations should be plotted (as in Fig. 6), and used for reference.

*(To be concluded.)*

## PHYSICAL SOCIETY.

Annual general meeting held February 8th, Mr. G. Griffith, vice-president, in the chair. The report of the Council was read and adopted. Prof. Willard Gibbs and Dr. Rudolph Koenig were elected to the two vacant honorary fellowships of the Society. The following officers and council were elected for the ensuing year:—

*President.*—Prof. S. P. Thompson.

*Vice-Presidents.*—Members who have filled the office of president and T. H. Blakesley, C. V. Boys, Prof. J. D. Everett, and J. Walker.

*Secretaries.*—H. M. Elder and W. Watson.

*Foreign Secretary.*—Dr. R. T. Glazebrook.

*Treasurer.*—Prof. H. L. Callendar.

*Librarian.*—W. Watson.

*Other Members of the Council.*

Prof. Armstrong, W. R. Cooper, G. Griffith, E. H. Griffiths, Dr. R. A. Lehfeldt, S. Lupton, Prof. Perry, Dr. [illegible], W. A. Price and R. Threlfa[illegible]

Prof. S. P. THOMPSON then took the chair and delivered his

### Presidential Address.

In opening, the president gave in detail the various ways in which the aim of the Physical Society to promote the progress and study of physics had been accomplished during the 26 years of the Society's existence. Referring to the election of two honorary fellows, Prof. Thompson said they had added to their roll two men distinguished in very different walks of physics. Prof. Willard Gibbs is a United States mathematical physicist, whose work in thermodynamics, elastic solid theory of light and other specialised subjects is of the highest order, and is valued for its beauty and profundity. Dr. Rudolph Koenig, of Paris, is known as a maker of acoustical instruments—of perfect standard tuning forks in particular. He has, however, found time to extend the borders of acoustics, and to him we owe the manometric flames, the wave syren and other instruments of research. He has also published a work on the facts about the combinations of pure tones.

The president appealed to all teachers of physics in the country to make use of the Society and give it their active support. It was, he said, mainly in the interest of teachers and students that the Society had undertaken the publication of *Science Abstracts*. By means of the abstracts teachers had at hand the latest information on the subject, and could thus continually supplement their text-book knowledge. Every teacher from time to time devised new or improved modes of presenting his subject. At the Physical Society the fellows always welcome contributions of this kind, even though there might be little of actual novelty in the principles so illustrated. The routine work and administrative duties of teachers, although hampering their usefulness to science and diminishing their fruitfulness, prevented their attention, without intermission, to one subject, and produced a direction of thought over various domains of physics which was to be welcomed rather than deplored.

It has been the custom for fellows of the Physical Society to bring models to illustrate physical principles. This practice of using models was regarded by our Continental brethren as a peculiarly English matter, and one that showed a sort of mental constitution they did not quite understand. Models had become a part of our mental furniture. It never occurred to us that there was anything unusual in the habit. Faraday had used them in connection with the electrostatic field surrounding charged bodies. Lord Kelvin had made models to convey his ideas of elasticity, of the elastic solid theory of matter and of the constitution of matter itself. Maxwell's models of heterogeneous dielectrics and the mutual induction between two circuits were well known. These models were useful for teaching purposes and for enabling one to grasp that which in its nature was abstract, by contemplating the representation of it or its analogue in the concrete. The French physicist could not understand a complicated phenomenon until he had reduced it to a mathematical equation. The British physicist must construct a model which would produce mechanically the analogous operation. Both methods were right, but, judging by their fruitfulness, the method of Faraday had advantages over that of Poisson. Referring to the new teaching university of London, the president said that now was the time for fellows to offer suggestions for the teaching of physics.

---

An ordinary meeting of the Society was then held. A Paper on

### "A Mica Echelon Grating,"

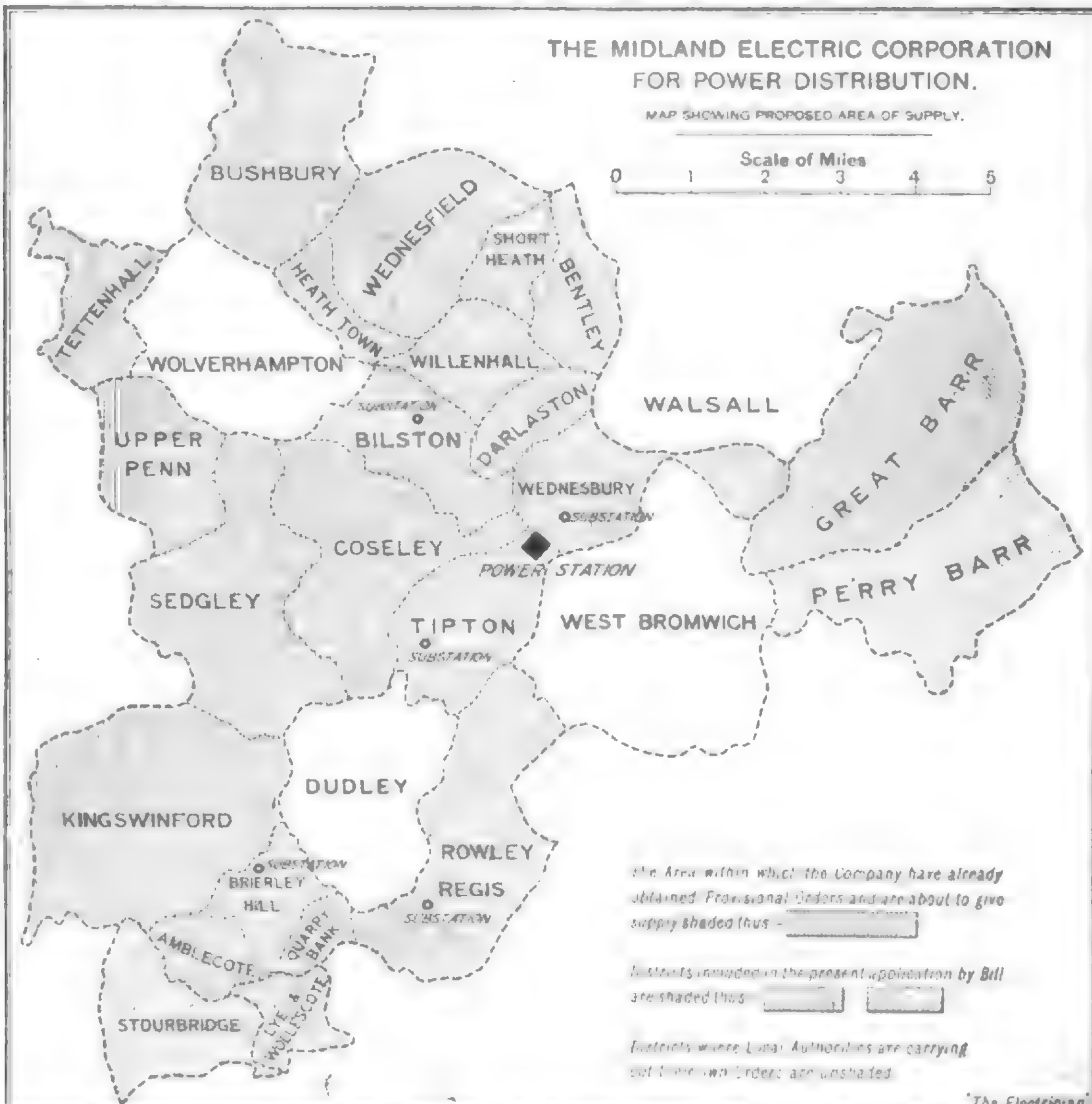
by Prof. R. W. Wood, was read by Mr. Watson. This grating occupied a position midway between an ordinary grating and an echelon with thick plates. A number of sheets of mica were examined, with the interferometer, and one selected, over a considerable portion of which the fringes were straight and unbroken. This portion was marked off and cut up into rectangles. The mica was about 0·05mm. thick, and the retardation of one of the rectangles was found to be 50 wavelengths for sodium light. Nine of these rectangles were used to

form the grating, and they were put in position under a microscope and cemented together at the edges with sealing wax. The grating space was 0·5mm. The battery was mounted on a square of cardboard over a rectangular opening of the same size, a clear space, 0·5mm. wide, being left to serve as the first grating line of zero retardation. The number of lines was, therefore, 10. The resolution of the sodium lines was beyond the power of the instrument, but the yellow mercury lines were easily separated. The distance between the lines was one-third of the distance between the spectra. For the sake of comparison a grating of the same spacing and number of lines was ruled on a piece of smoked glass, and it was found that in the first order the grating was unable to separate the extreme red and blue ends of the spectrum. The Zeeman effect can be shown with an echelon made of four interferometer plates, the light being the green rays from a mercury tube.

The Society then adjourned until February 22.

## THE MIDLAND ELECTRIC CORPORATION FOR POWER DISTRIBUTION.

From time to time we have published maps of the districts covered by the various large power schemes, and we now add



that of the area in which the Midland Electric Corporation for Power Distribution (Ltd.) is carrying on its operations. Registered on June 28, 1897, this company has an authorised capital of £200,000 in £5 shares, of which £101,085 only has been issued. The following constitutes the board of directors: W. Marriner Brigg (chairman), J. Atherton, Thomas Parker, and F. J. Leslie (managing director). Messrs. Kincaid, Waller and Manville are the consulting engineers.

This scheme differs from the power bills which received Parliamentary sanction last session in the fact that it has obtained no special act. For the whole of the districts within its area the company has had provisional orders granted to it, except in the case of a few which have been transferred to it. Its area takes in some 70 sq. miles, and, under the superintendence of Messrs. Kincaid, Waller, and Manville, the system is rapidly nearing completion, and a supply is anticipated at no very distant date. The positions of the power station and sub-stations are clearly marked on the accompanying map. An extra high-pressure two-phase system of supply has been adopted which will be provided by five Ferranti alternators, aggregating some 10,500 I.H.P. Further particulars of the equipment of the power-house, &c., were given in *The Electrician* for January 4th last, p. 380.

## THE "CLINCHER" CABLE CLIP.

Messrs. W. N. Brunton & Co., of Musselburgh, are introducing a clip for overhead cables, to replace the raw-hide clip ordinarily employed. The construction and method of employing it are seen

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

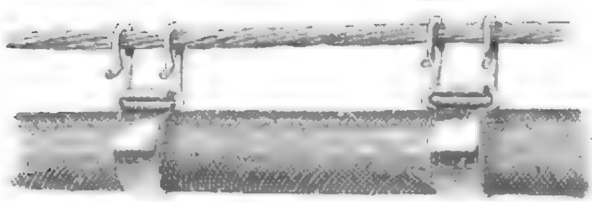


Fig. 5.

from the accompanying figures. In fixing the clip, the eye is placed flat against the strap opposite to the flap of the strap, and the hook is put into position as shown in Fig. 1. Then the strap is bent round the cable and fastened as shown in Figs. 2, 3, and 4. Fig. 5 illustrates a cable suspended from the bearer wire by one of these clips. All the above illustrations are half scale.

## AUSTRALIAN NOTES.

(FROM OUR OWN CORRESPONDENT.)

Electric Driving in Railway Workshops.—The Railway Commissioners of Queensland have recently entered into a contract with the Westinghouse Company for a complete electrical equipment of their new railway workshops at Ipswich with a two-phase system for lighting and motor driving. Considerable saving is anticipated in effecting locomotive repairs both in time and in operating expenses. The central station is being equipped with three (ultimately five) 200kw. two phase generators and Westinghouse compound engines, as well as a large Reidmer air compressor and a set of hydraulic pumps. The steam will be supplied by four 250 H.P. Babcock and Wilcox boilers with mechanical stokers, feed heaters and coal and ash handling machinery.

Electric Pumping of Sewage.—The system of low-level sewage pumping stations, mentioned in an earlier note as being installed in Sydney, N.S.W., is approaching completion. Twenty pumping stations are erected at various points along the southern shores of the harbour, extending from Balmain to Rushcutters Bay, a distance of 5 miles. The area to be drained is 1,700 acres, carrying a population of 70,000 inhabitants, and the plant being installed will be capable of dealing with 10 million gallons per diem. Each pumping station contains duplicate plant consisting of 500-volt Westinghouse motors geared by double-reduction spur gearing with raw hide pinions to differential plunger pumps by the Clyde Engineering Co., of Sydney. The whole of the plant, with the exception of the motors, is of local manufacture. The energy will be supplied by the Railway Commissioners from the Ultimo power-house at a charge of 1d. per unit, and, when complete, it is estimated that an average power of 150kw. will be required, the energy bill thus amounting to £5,000 per annum. The methods of controlling the pumping stations involves several points of interest. They will be operated by a single attendant, who will be stationed at a controlling switchboard in the Ultimo power-house. By means of floats actuating electrical indicators he is informed of the height of the water in each of the collecting reservoirs, and operates the motors accordingly by starting switches and resistances on the controlling switchboard. Delicate ammeters enable him to determine the power taken by each motor, and in order to farther ensure the detection of a defect a telephone connection enables him to listen to each pump and motor running. A contact attached to the ladder of each pump well enables him to see at a glance in which of them the greaser is, with whom he can thus communicate at once in case of a defect in another pump. The whole electrical equipment will cost when complete some £28,000. In addition to this, another low-lying area farther east, round the head of Double Bay, is already being drained electrically on another system. The motors are here situated in a single sub-station driving air compressors, whence the power is distributed to four pumping wells by the Shone system. The population of this area is some 2,000, and the amount of sewage dealt with 150,000 gallons a day, which is raised a height of 56ft. The power here is also supplied by the tramway power-house at a charge of 1¼d. per unit. Two air compressors are employed, driven by 20kw. Parker motors, and each capable of dealing with the whole of the discharge on ordinary occasions. The motors are regulated by an automatic series parallel controller, according to the pressure of air in the reservoir, stopping the motors when the pressure rises to 28lb., and increasing the speed by steps as the pressure falls. From the compressor station the air is carried in pipes to the four pumping wells, where it actuates Shone automatic hydro-pneumatic ejectors. As the result of some 18 months of successful operation, the automatic features are found to give every satisfaction. The efficiency over all amounts to 35 per cent., and the energy used 25,000 units per annum, costing £150.

Electricity in Mining.—The older Australian mines are showing great hesitation in adopting the newer means of power transmission. At Broken Hill not a single electric motor is yet employed, although each of the nine large mines has its own plant for surface and mill lighting. In eight of these low-tension direct currents are employed of 100 volts to 120 volts, Parker dynamos being the favourite type. The ninth is the Proprietary Company, who employ a 2,000-volt alternating system, the current being generated by four 25kw. Mordey alternators. Block 14 mine has a small power transmission plant under erection, and underground electric traction has been talked of for others, but with no definite results hitherto. At the Mount Morgan gold mines the application of electric power has made much more rapid strides under the direction of Mr. E. H. Hewlett, till lately consulting electrical engineer to the mines. A power plant of 500 H.P. has been erected for supplying the power for ventilating, pumping, machine driving and hauling as well as lighting. Some 2 miles of drive are already fitted for electric traction, two small locos of 500lb. drawbar pull being employed. In both districts compressed air still holds its own for rock drilling.

Sydney Tramways.—The conversion of the 60 miles of tram way owned by the Government to electric working is proceeding rapidly. The steam motors on the Glebe Point line were replaced before the end of last year, and electric cars will shortly be running in Elizabeth-street. Of the 60 miles in service 27 are now worked electrically, 31 by steam motors, and 2½ by cable car. The farther extension of the power-house at Ultimo is being pushed on. A contract has been placed with the General Electric Co. of America for three

1,500kw. three-phase 25 $\sim$ 6,600-volt generators, and the equipment for five rotatory converter sub-stations of 500kw. and 1,000kw. each. One of these sub-stations will be on the north shore, two 6,600-volt three-core submarine cables carrying the current under the harbour. The sub-stations are expected to be ready early next year, and will enable large extensions to be made in the tramway system.

## CORRESPONDENCE.

### GAS POWER FOR CENTRAL STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I do not wish to discuss at any length a subject which you have already dealt with in what is, on the whole, a favourable review, but in your issue of February 8th you say: "Where gas transmission is adopted the richest possible gas is clearly the only kind admissible." May I ask why you express this opinion so decidedly? Surely the cost of generation and transmission must be considered together, and there is no apparent and obvious reason why the cheap gas with the more expensive transmission should not be much the best in the end.

The Mond gas used by the Northwich Electric Supply Co. is delivered through a pipe line nearly a mile long, yet the firm supplying the gas could not afford to deliver the same number of heat units to the electric station if ordinary coal gas was used. We have long stretches of pipe mains in Winnington through which, with quite a moderate pressure, the whole of the Mond gas for a 100,000 H.P. plant could be delivered, and probably nowhere in the world does the transmission of energy cost so little as at Winnington. Prof. W. C. Unwin, in his book on "The Development and Transmission of Power" (1894) considered the subject of energy transmission by means of producer-gas well worth his careful study, and the favourable results at which he arrived could now be much improved upon.

You remind your readers that producer-gas contains a large percentage of carbon monoxide, which is a poisonous gas. Quite true, but water-gas contains a very much larger percentage, yet that does not prevent its introduction into private houses for domestic use or otherwise limit its useful application. I have not the least desire to claim more advantages, or less difficulties, for the system of using cheap power-gas in central stations than can be proved by actual facts and figures. Let the difficulties advanced against the scheme be real, and not imaginary ones, and I will accept them frankly.—Yours, &c., H. A. HUMPHREY.

Northwich, Cheshire, Feb. 9.

### THE BRIGHTON CABLE CONTRACT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The enclosed copy of a letter which has been forwarded to the Mayor of Brighton, may be of interest to your readers as the question of foreign competition is now attracting so much attention. The letter explains generally the circumstances of this particular case, and shows how competition may extend beyond the simple question of price, to the acceptance or rejection of harsh and oppressive conditions, which might be accepted on the chance of their not being enforced, but really leave the contractor at the mercy of some official of the purchasers.—Yours, &c., A. H. HOWARD.

London, Feb. 8.

To the Mayor and Corporation of Brighton, Town Hall, Brighton.

DEAR SIRS: I am requested to call your attention to the circumstances under which the contract for electrical cables for Brighton has been placed with the Union Cable Co., a firm which has no works in Great Britain, and proposes to obtain its cables from Germany. This company was registered in August, 1900, with a nominal capital of £25,000 in £1 shares, of which 10,000 shares have been issued, and 10s. per share paid up on them, so that the actual capital of the company is £10,000, of which £5,000 is uncalled. The shares are principally held by the Deutscher Kabelwerke, of Berlin.

In several cases the prices in the tenders sent in to the Brighton Corporation for these cables by responsible British manufacturers were substantially lower than the tender of the Union Cable Co., but in spite of this fact the contract has been placed with a German firm for cables which will certainly be manufactured in Germany. The reason for not accepting the lower tenders is stated to be that the British houses did not comply with the conditions upon which the tenders were invited. An examination of the conditions proposed by the British firms (which are those of the Cable Makers' Association, as accepted by the leading consulting engineers of Great Britain), in comparison with the conditions of the specification, does not seem to justify the action of the Corporation in subjecting the ratepayers of Brighton to an increased expenditure by placing the order with a foreign firm at a higher price than that obtainable from responsible British manufacturers.

The above circumstances seem to call for some investigation, and I should be pleased to afford any explanation of the general conditions adopted by the Cable Makers' Association, in order to show that these are perfectly fair to the purchaser as well as to the manufacturer; and that they do not necessitate any additional expenditure by the Corporation, as has been suggested. As matters stand at present, it is practically certain that no responsible British manufacturer will tender for any further supply of cables to the Brighton Corporation under the same conditions.

The importance of this matter is accentuated by the fact that tenders are now being invited by the Tramway committee for considerable quantities of cables. If the conditions as printed in the specification are again insisted upon, it seems almost certain that the order will again be placed in foreign hands at enhanced prices, and work will leave England for abroad.

I am, Dear Sirs, yours faithfully,
A. H. HOWARD
(Honorary Secretary of the Cable Makers' Association),

On behalf of the following firms:—
BRITISH INSULATED WIRE CO. (LTD.)
CALLENDER'S CABLE AND CONSTRUCTION CO. (LTD.)
CONNOLLY BROS. (LTD.)
HENLEY'S TELEGRAPH WORKS (LTD.)
INDIARUBBER, GUTTAPERCHA, AND TELEGRAPH WORKS (LTD.)
JOHNSON AND PHILLIPS.
LONDON ELECTRIC WIRE CO. (LTD.)
SIEMENS BROS. & CO. (LTD.)
TELEGRAPH MANUFACTURING CO. (LTD.)
WESTERN ELECTRIC CO.
W. T. GLOVER & CO. (LTD.)

Cable Makers' Association, 2, Queen Anne's gate, Westminster, S.W.
Feb. 8, 1901.

### MR. CAMPBELL'S PHASE-TURNING DEVICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with the interesting letters by Messrs. Campbell and Duddell which have recently appeared in *The Electrician*, referring to the phase-turning device of Mr. Campbell, I should like to draw attention to a Paper entitled "The Vector Properties of Alternating Currents," published four years ago in the *Proceedings* of the Royal Society. In that Paper I show that it is in general impossible to represent the phase relations of four voltages by straight lines drawn in space so that the angle between any two lines represents the phase difference between the two corresponding voltages. The only case in which this is possible is when one of the voltages is at every instant equal to the sum of three quantities, each of which is proportional to one of the three remaining voltages.

It follows that Mr. Campbell's geometrical figure for the voltages $X_1$, $X_2$, and the two complementary voltages of the phase-turning device, cannot in general represent the phase relations assumed; and the mathematical deductions from it can only be approximately true. Mr. Duddell is quite correct in his criticism, though afterwards he has apparently confused the three quantities $\phi$, $\eta$, and $\psi_2 - \psi_1$, since it follows from his definition that $\eta$ is equal to the first of these quantities and not to the last.

Whether the approximation to truth of Mr. Campbell's figure is near enough for practical purposes largely depends upon circumstances. In many cases it will be quite accurate enough. In some cases it will lead to hopelessly wrong results. As Mr. Duddell points out, the assumption that Mr. Campbell makes as to the phase relations of the primary and secondary voltages of a transformer is only approximately correct, and the same remarks apply. I may add that I have at various times thought out a number of testing devices somewhat similar to those recently indicated in Mr. Campbell's articles, but I have given them all up as unsatisfactory, for the reasons just indicated.—Yours, &c.,

Birmingham, Feb. 12. W. E. SUMPNER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should like to make a few remarks on Mr. Duddell's criticisms of my revised methods of using my phase turner, and also of my transformer method of measuring power.

Whilst Mr. Duddell accepts the validity of my method of measuring small voltages, he remarks that this can be more easily done by means of a low-reading electrostatic voltmeter, but he seems to forget that the very object of the method is to enable any electrostatic voltmeter to be used to measure voltages much below its ordinary range. Thus a voltmeter reading up to 1 volt might be made to read with tolerable accuracy a P.D. of 1/20 volt, and could indicate (within 15 to 20 per cent.) a P.D. of 1/100 volt. This seems to me a considerable gain.

With regard to the question of "latitudes," Mr. Duddell is quite right; the $\cos(\psi_2 - \psi_1)$ got shifted by a slip. As to the proof of the general formula, I admit that Mr. Duddell is probably right in his opinion that even the solid geometry is not sufficient here. It is not clear, however, that his example is a possible case, for he does not show that the phase-turner can be made to give a symmetrical wave-form other than a sine-curve. Still, the conclusion seems to be that the second method is only safe in the less extreme (but more common) cases—viz., when the latitudes ($\theta_1$ and $\theta_2$) are found to be small.

With regard to my transformer method of measuring power, I may first remark that in that method the secondary of the transformer is kept on open circuit. I do not doubt that the transformers tried by Mr. Duddell would be unsuitable for the method, a deficiency of 5deg. from opposition of phase being very large. Quite recently I tested a small transformer (not designed for such work), and found the lag between the primary and secondary P.D.s to be 179·85deg., the whole of the deficiency 0·15deg. being practically

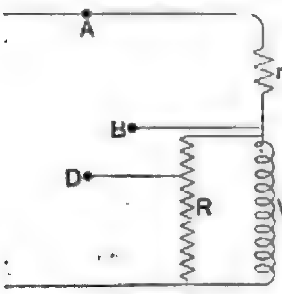


FIG. 1.

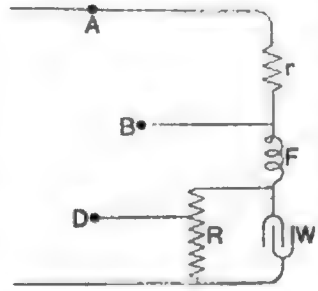


FIG. 2.

due to the primary ohmic drop $C_1R_1$. This drop might easily have been reduced to one-fifth of the observed value by increasing the section of the primary wire (which was 300 turns of No. 20 S.W.G.). By care in designing the testing transformer there seems no reason why the deficiency from exact opposition should not be reduced to (say) 0·02deg. With a power-factor of 0·01 for the power measured, such a transformer would cause an error of about 4 per cent., which is not very serious.

In conclusion, I may mention a modification of the three-voltmeter method which might be used with advantage when the power-factor is low. A low resistance $r$ is put in series with the load W, as in Fig. 1. In parallel with W is a very high resistance R, from which a convenient fraction $\left(\frac{1}{n}\text{th}\right)$ is picked by B and D. The three-voltmeter method is then applied to A, B, and D. The result multiplied by $n$ gives the power taken by W.

If W be a load with capacity, and the method of adding a small ironless choker (mentioned by Mr. Mather) be employed, this choker need only take a quite small part of the total voltage, being inserted at F as in Fig. 2.—Yours, &c.,

London, Feb. 12. ALBERT CAMPBELL.

## WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

[TRANSLATION.]

SIR: The experiments between Brussels and Antwerp with a repeater at Malines could not be attempted until the partial tests between Malines and Brussels and Malines and Antwerp had succeeded. In carrying out the preliminary experiments between Brussels and Malines, I came to the conclusions given below.

In the first place, however, allow me to point out to you that the country between Malines and Brussels is quite different to that between Dovercourt and Chelmsford. According to information which I have been able to obtain at the cartographic institute of the Belgian military college, the country between Dovercourt and Chelmsford is absolutely flat, obstacles being absent throughout. On joining the two places by a straight line, one follows the coast almost all the way. On the other hand, a straight line joining the Colonne du Congrès at Brussels with the spire of St. Rombaut at Malines, one encounters, in addition to the high part of the town of Brussels and the south-west portion of Malines, other towns, woods and numerous undulations rising to a height of 62m. (203ft.) above sea level. . . .

It must also be added that my air wires were merely temporarily installed and supported by public edifices. It is one thing to establish communication between a workshop (Chelmsford) and a permanent station (Dovercourt), and another to establish two stations (Brussels-Malines) which must be removed in a few weeks. Nor must the source of energy employed in the Brussels-Malines trials (4 amperes) be forgotten.

I thought I held the record of the communications over land—through obstacles—without recourse to captive balloons or kites to hold up the earth-wire. I did not know of the experiments between Dovercourt and Chelmsford, no scientific journal having spoken of them [see *The Electrician* of July 28, 1899, p. 472.—ED. *E.*], nor were they mentioned in the Paper by MM. Blondel and Ferrié at the Paris Congress of 1900. But since the Marconi Company has communicated over a distance of 60km. (40 miles) I leave it this record. The following are the conclusions which I referred to above:—

Having replaced the 50-wire cylinder at Malines by a simple cable of seven strands of 1mm. wire, communication became uncertain, and I had to increase the current from 4 amperes to 6 amperes in order to maintain the exchange of signals under the same conditions as those already notified. This proves that a large receiving surface is advantageous for the receiving air-wire. . . . Having replaced the lower portion of the Brussels air-wire, which was formed of a 7-strand cable by seven bell wires of 1mm. diameter, communication was possible with 3 amperes (without the 50-wire cylinder at Malines).

The following is, I think, an explanation of this phenomenon. Since 1899 I have asserted that, in my opinion, electrical radiations were *perpendicular to the wire at each point of its surface*. Prof. Tommasina, in a note recently presented to the Académie des Sciences on the photography of electric brush discharges, came to this conclusion: The radiating wire acts as a capacity, and its surface molecules transmit one or other of the oscillatory movements produced in the discharges. These movements are propagated at the same time in the surrounding ether, *in lines which are always normal near their origin*.

If an air-wire is traversed by a variable current (a small current at high pressure, that is to say with a weak magnetic field, as is actually the case in wireless telegraphy) everything happens as if the current concentrated on the surface of the conductor. At the limit, in the case of undulations of high frequency, the surface of the conductor only comes into consideration—(Bjerknes' experiments). . . . .

The ray of electromagnetic waves (in the case of small variable current at high pressure, the principal phenomenon is the electric one, the magnetic one being secondary) is perpendicular to the surface of the wire, the only important factor in the phenomenon. At each point of the propagated rays there exists an electric and magnetic force. The electric force is perpendicular to this ray and parallel to the direction of the variable current, *i.e.*, to the wire. The magnetic force is perpendicular both to the ray propagated and to the electric force; that is to say, is in the intersection of two planes, of which one is normal and the other parallel to the surface of the wire. In consequence, a cylindrical wire 1m. in height, for instance, produces an ether perturbation in a space limited

by two planes perpendicular to the extremities of the wire. If at one point of the propagated ray there is a superficial element of a conductor (receiving wire), one obtains a maximum effect of (*electric*) inductance in this element when it is *tangential* to the plane of the electric and magnetic forces.

From this is seen the advantage of employing one wire or cylindrical wires for the transmitting air-wire, instead of a stranded or even lightly twisted cable as has often been employed in wireless telegraphic experiments. In the case of a strand or cord, instead of a cylinder, the air-wire is a helical instead of a cylindrical surface. There is only what is called the surface envelope of the helix that is cylindrical; but this surface is only fictitious. Now the planes normally to the surface of the helix are not parallel to one another as the planes normal to the surface of a right cylinder. . . . They all cut one another. Thus one sees the disastrous effects: interference on the one hand and diffusions in oblique planes on the other hand. It is this diffusion in oblique planes which allows of communication between two air wires at a different level. This diffusion, again, which it is advantageous to avoid in the case of fixed stations, has enabled, and still enables, communication between ships in spite of their movements.

It results from these experiments and considerations that the maximum action between a transmitting and receiving air-wire is obtained by using as air-wire two metallic right cylinders of a certain height (length) and a certain diameter, disposed parallel to one another in the two stations, and of such a height that they are in sight of one another. Assuming that the two cylinders are of equal length, each must be included entirely between the two planes passing through the base of the other.—Yours, &c., E. GUARINI.

[Owing to the extreme length of M. Guarini's letter we have been compelled to omit certain portions more or less irrelevant.—ED. *E.*

# LEGAL INTELLIGENCE.

### Erection of Telephone Poles.

In the Pontypridd Police Court on Tuesday, the stipendiary (Mr. J. Ignatius Williams) sat as arbitrator in a dispute between the Glamorgan County Council and the Postmaster-General. The subject at issue related to the proposal to establish a telephone call office at the Llantrisant Post Office and the laying of wires between Pontypridd and that place. The County Council objected to the erection of poles, on the ground that the road is too narrow.

Sir ROBERT HUNTER, solicitor to the Post Office, said the question of decision arose under a notice served on the County Council by the Postmaster-General, in which he required them to give consent to lay telephone poles between Pontypridd and Llantrisant. The Postmaster-General was empowered by Act of Parliament to lay these lines, but could not do so without the consent of the authorities having control of the roads. Where such consent was refused the matter could be referred to the stipendiary magistrate to decide what was just between the parties. He considered that the word "just" must be interpreted in the light of convenience. There were 220 telephone subscribers in the Pontypridd area, and six persons at Llantrisant had undertaken to join the proposed exchange. Among other objections the Council also stated that they had no reason to doubt that the Postmaster-General could come to an arrangement with the National Telephone Co. for the joint use of their wires. The Postmaster-General, however, contended that the erection of that company's lines was not legal, and that he could not, therefore, take part in an illegal act by putting his wires on the company's poles. Quite apart from that, it was entirely opposed to the practice and policy of the Post Office to share poles with the National Company. In 1896 the Postmaster-General took over all the trunk wires belonging to the company, and special arrangements were made by which certain wires were used jointly, but so unsatisfactory was that arrangement that the Post Office in many cases had erected a second series of poles in order to carry their own wires. The original proposal was to place the poles on the opposite side of the road to the existing line, but with a view to meeting the County Council as far as possible the Postmaster General had proposed to erect them on the same side. Notwithstanding this, the County Council still refused to give their sanction. The Postmaster General was of opinion that it would be better, in the interests of the Post Office and the convenience of the public, that the original scheme—to erect poles on the opposite side of the road—should be carried out. The Postmaster-General was bound by the act to shift the poles in the event of the road being altered, but the County Council wanted an undertaking that the poles should be removed altogether upon application, and to this condition the Postmaster-General objected.

Mr. JOHN GAVEY, assistant engineer-in-chief and electrician to the General Post Office, said that where wires were used jointly by the Post Office and the National Company difficulty had been experienced in tracing and removing faults. The disadvantages had been so serious that the department had spent considerable sums of money to separate their wires from those of the company, and in many cases different routes had been constructed. In Cardiff and other parts of this district wires were used by the Post Office which were maintained by the company, the maintenance cost being £1 per mile per annum, whereas the cost of maintenance to the Post Office would be 5s. less.

The STIPENDIARY here asked whether the Council were prepared to give their sanction provided the poles were not placed on the metalled portion of the roads.

Mr. B. F. WILLIAMS replied in the affirmative provided they were placed where the surveyor thought they would not be dangerous.

The STIPENDIARY suggested that the county surveyor and Mr. Gavey should discuss the matter privately, and this course having been agreed to, when the parties re-assembled the following terms were agreed to: That consent be given to the Postmaster-General to place telegraph poles over roads from Pontypridd to Llantrisant upon the following conditions: (1) No pole to be placed on metalled roads. (2) Subject as aforesaid, the position of the poles to be settled between the engineer to the Post Office and the county surveyor, with reference to the magistrates if necessary. (3) The Postmaster-General to make good any damage done in the execution or maintenance of work. (4) The County Council to be at liberty to withdraw consent at three months' notice. The Postmaster-General, if he objects to remove the poles from the highway, to take immediate steps to bring the difficulty for decision to arbitrator's tribunal.

### Tamplin and Makovski v. Harding.

At Redhill County Court last week, before Judge Martineau, Messrs. Tamplin and Makovski, electrical engineers, London and Redhill, sought to recover £12. 16s. 4d., for wiring premises and supplying fittings. Defendant is a house decorator of Wimbledon. It appeared that defendant was asked to take up an agency for plaintiffs, and agreed. Goods were sent on sale or return, and defendant gave an order to have his place fitted up for the electric light, and the sum claimed for this was £6. 7s. 6d. Defendant said he was given to understand that the company would fit up his place free if he took on the agency. He had sold none of the goods, and they could be returned at once if necessary.

Judgment for plaintiffs for the amount claimed, to be reduced to £6. 7s. 6d. if defendant returned the goods to Redhill within seven days.

### Cameron v. P. C. Middleton & Co. (Ltd.).

In the Second Division Court, Edinburgh, on Wednesday, before Lords Young, Trayner and Low, the defenders appealed from a decision of Sheriff Burnet granting an interdict from carrying on their electricity works at Cults, Aberdeen, on the ground that they constituted a nuisance. Particulars of the case were given in our issue for Nov. 23. After hearing the arguments of counsel their lordships upheld the sheriff's decision, and came to the conclusion that there had been a nuisance. They continued the case in order that defenders might consider whether they could abate the nuisance by any means.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The directors of the Isle of Thanet Electric Tramways and Lighting Co. are about to appoint an electrical engineer to take charge of the running of their power station and of their electric lighting business. An advertisement contains further particulars, and applications have to be in to Mr. J. Barber Glenn, secretary, 74, Cheapside, London, E.C., by noon of Feb. 27.

An outside manager and engineer is required for a large power distribution system in the North of England supplying three-phase high-tension current. See advertisement.

There is a vacancy for a shift engineer at the Dundee Corporation lighting and traction station. Applications to the city electrical engineer, Mr. W. H. Tittensor, Dudhope Crescent-road, Dundee. See advertisement.

The Aron Electricity Meter (Ltd.) require a draughtsman and assistant engineer. See advertisement.

The Charing Cross and Strand Electricity Supply Corporation require an assistant in the distributing engineer's department. See advertisement.

Marconi's Wireless Telegraph Co. require electrical assistants with all-round experience. An advertisement gives some further particulars.

The British Electric Traction Co. are prepared to admit a limited number of qualified students as pupils. See advertisement.

Two assistant engineers are required for the staff of a large electrical manufacturing company. See advertisement.

Jointers, accustomed to B. I. W. and other paper-insulated cables, are required by Sheffield Corporation. Applications to manager (Mr. S. E. Fedden), Commercial street, Sheffield. See advertisement.

Eastbourne Electric Light committee require a clerk of works upon the new electricity station buildings. Applications to borough engineer by 25th inst.

Battersea (London) Council have appointed Mr. H. R. Forbes Mackay, chief assistant at Edinburgh, to be borough electrical engineer at £350 per annum. There were 50 applications, which were reduced to three—viz., Mr. Mackay, Mr. F. A. Nixon (on Messrs. Kennedy and Jenkin's staff), and Mr. L. Leslie Robinson (on Mr. Robert Hammond's staff).

Manchester Electricity committee recommend the appointment of Mr. Guss F. Metzger, of Bath, as city electrical engineer at £800 per annum.

Mr. Wm. Mackintosh, of Southport, has been appointed chief assistant engineer at Keighley.

Capt. F. Baylay, R.E., has been appointed instructor in electricity at the School of Military Engineering, Chatham.

Mr. D. O. Evans, A.M.I.E.E., has been appointed engineer and manager for the North Wales district by the National Electric Wiring Co. (Ltd.)

---

**Ashton-under-Lyne.**—The borough surveyor has been instructed to prepare specifications for the proposed tramways. The lines are to be worked by the Council.

**Bangor (Ireland).**—The Council have declined to sanction the electric lighting and tramways scheme of the Bangor and Donaghadee Tramways Co., some particulars of which were given in our last issue.

**Beckenham.**—The Council have voted the surveyor (Mr. Angell) an honorarium of 500 guineas for extra work in connection with the electricity supply undertaking and other public works.

**Bristol.**—Acting on the recommendation of the Electrical committee, the Corporation have increased the salaries of Mr. Phillips and Mr. Bird, assistants to the city electrical engineer (Mr. H. Faraday Proctor)—Mr. Phillips from £200 to £225, with a further increase to £250 on Jan. 1, 1902; Mr. Bird from £175 to £200, with a further increase in January, 1902, to £225.

**Bury St. Edmunds.**—The Council have applied for a further loan of £12,000 for electric lighting extensions.

**Church Stretton.**—The Church Stretton Land Co. propose to apply for a provisional electric lighting order, and are prepared to start at once to erect electricity works if the District Council will give consent.

**Coventry.**—The Electricity committee have reconsidered their scheme for the extension of the electricity undertaking which was recently referred back, and have substituted a proposed expenditure of £23,000 instead of £18,000.

**Darlington.**—A committee has been formed, with authority to enter into a contract to purchase the whole of the property of the Imperial Tramway Co. in Darlington including the light railway order.

**Dublin.**—The Lord Mayor announced at the Corporation meeting on Monday that the Local Government Board had given their sanction to the £254,000 loan which had been applied for by the Council for electricity works, and had intimated that it would be pleased to grant that amount in sums of £50,000, as required, during the course of the contract.

**Dysart (N.B.).**—Messrs. Crompton & Co. have offered to erect and supply electric current to 54 16 c.p. incandescent lamps burning till 10 p.m. at £40. 10s. per annum, and at £94. 10s. for all-night service. Terms are also to be obtained from the Kircaldy Town Council.

**Edinburgh.**—The committee recently appointed to visit English towns to obtain information on condensing plant has submitted its report. The committee were not impressed with the examples of these plants which they inspected, and unanimously recommend that at the McDonald-road station there should be neither cooling towers nor condensing plant, but that the waste steam should be sent up an iron pipe to the top of the chimney.

The Corporation have authorised the Lord Provost's committee to require the National Electric Traction Co. to transfer the powers granted to the Company under the Portobello and Musselburgh Tramways Order of 1900, for the construction of an electric tramway from the terminus of the Corporation line at Joppa to the city boundary at Magdalene Bridge.

**Electric Traction in Ireland.**—The Kerry County Council have approved the scheme of the Irish Electric Railway Co. to construct an electric railway between Castletownbere and Kenmare. The construction of the line means an expenditure of £700,000.

**Engineers' Conference.**—The Conference between the employers and employed in the engineering trades has continued, and as a result the following communication has been published by the representatives of the masters and men:—

We have discussed the points at issue, the proceedings being of an harmonious character. The employers have had explanations given them with regard to the propositions of the men which the employers' representatives have agreed to put before the Employers' Federation. A further meeting will take place in a few weeks. We have discussed the terms of the working agreement arrived at three years ago.

**Evesham.**—The General Purposes committee have been instructed to further consider the electric lighting question with a view to obtaining information as to companies willing to establish electricity works in the town.

**Egypt.**—There was a considerable increase in the total value of electric generating plant, &c., imported into Egypt in 1899 compared with the figures of the two preceding years, the 1899 imports being valued at £66,580. France comes first in her share of this trade with £24,980 and Great Britain next with £16,545. A report recently published on the trade of Egypt prophesies a growing demand for electrical apparatus in that country, as the use of electric lighting, bells, telephones, &c., is rapidly spreading. The electric tramway companies in Alexandria and Cairo being Belgian, the whole of the plant and accessories required for upkeep and extensions is imported from Belgium. The total value of machinery imported from the United Kingdom into Egypt in 1899 was £257,085.

**Failsworth.**—The Council have decided not to proceed further in the negotiations with the Lancashire Electric Power Co. for the supply of electric current in bulk, and the General Purposes committee have been instructed to engage an expert to report upon the question of the erection of municipal electricity works and refuse destructor, and, alternatively, as to obtaining current from the Manchester Corporation.

**Glasgow.**—The second annual festival of the employés of the Corporation electricity department was held in the City Hall on Wednesday. Lord Provost Chisholm presided, and among those present were Messrs. W. A. Chamen, chief engineer of the department; J. C. Ward, mains superintendent; R. B. M'Coll, chief clerk; W. G. Poole, chief station engineer; and A. J. Fuller, chief eletrical engineer at Ayr. The chairman's speech on the work of the department was followed by a concert and dance.

**Grimsby.**—Electric current for public lighting was available for the first time on Monday, and for private lighting on Tuesday. At present there are 20 arc lamps for street lighting.

**Halifax.**—Application for a further loan of £130,000 for electric tramway and lighting extensions has been made by the Council.

**Hereford.**—Sanction to a further loan of £5,000 for electric lighting has been obtained by the Council.

**Holborn (London).**—The Borough Council are preparing a statement of "the monopolies for the supply of electric current in the borough, when the same expire, and what steps will be necessary in order that every such monopoly should ultimately vest in the Council."

**Huddersfield.**—The Corporation electric tramways were opened for traffic this week.

**Keighley.**—The following charges for the supply of electric current have been adopted by the Council: For lighting up to 500 units in any half-year 5d. per unit, above this number 4½d. As an alternative, consumers will have the option of being charged on the maximum demand system, at 7d. per unit for the first hour's daily maximum demand, and beyond this quantity 3d. per unit. For motive power and heating the charge will be 3d. per unit for the first 10,000 units in any half-year, between 10,000 and 25,000 units 2¾d., between 25,000 and 50,000 units 2½d., and for all units above 50,000 at a special rate to be agreed.

**Kinning Park.**—The Council have resolved to apply for a provisional electric lighting order, and a committee has been appointed to oppose the bills of the Clyde Valley Electrical Power Co. and the Caledonian Electric Power Co.

**Lecture.**—Mr. R. A. Chattock, M.I.E.E., city electrical engineer of Bradford, delivered a lecture on Friday last to members of the Bradford Scientific Association in the Mechanics Institute on "The Design of Central Electric Generating Stations." Mr. Chattock dwelt upon the interest of the subject at the present time in view of the large extensions that are being carried out at the electricity works of the Bradford Corporation, and said that if an area of supply was not large but the population was fairly dense, then the most suitable system of supply was by direct current, which could be provided economically on the three-wire system at a pressure of from 400 to 500 volts for a distance of about 3 miles. This system was especially suitable for motive power supply; and the motors themselves were cheaper in first cost on the direct-current system than on the alternating system. If, however, the area was large and the population scattered, it is economical to supply current at higher pressures and to transform it down for distribution. If direct current supply was adopted it was advisable that the generating works should be as central as possible in order to reduce the lengths of the various feeders and to ensure efficient working. It might be taken as a general rule that it was far more economical to put down one large generating station rather than several small ones, and, consequently, the area of the site chosen should be large enough to provide for the total anticipated power required, with due allowances for stores, workshops and offices. In the early days of electric lighting the mistake of not allowing sufficient space for extensions

was almost invariably made. Mr. Chattock employed a number of lantern slides to show the arrangement of the various parts of the station buildings, and at the close of the lecture received a hearty vote of thanks.

**Leigh**. The Council have decided not to give the South Lancashire Electric Tramways Co. permission to construct and work tramways within the borough except along the main road from St. Helens to Bolton, and will themselves obtain statutory powers to construct and work tramways within the borough.

**Leyton**.—Application has been made for an additional loan of £5,000 for extensions of the electric mains, &c.

**Lewisham (London)**.—At Wednesday's meeting of the Borough Council it was decided to consent to the application of the Lewisham and District Electric Supply Co. for a provisional for Lewisham. The company are the approved nominees of the Electric Extension Co. (Ltd.), with whom the late Board of Works for the Lewisham District entered into an agreement on the subject of electricity supply.

**Light Railways**.—The application of the Crewe Council for authority to construct light (electric) railways in the district has been refused by the Light Railway Commissioners. At the inquiry strong opposition was offered by the London and North Western Railway.

**Liverpool**.—At a meeting of the Tramways committee on Saturday the recent electric tramway accident was under discussion. It was reported that certain claims for compensation for personal injuries had been received, as well as a claim for the death of a horse, but it was resolved that these claims could not be entertained. The chairman (Ald. Petrie) said they had heard and seen a great deal regarding the accident, but it was quite clear to everyone who had taken an interest in the matter that the unfortunate occurrence was entirely owing to the almost unprecedented snowstorm of Monday night, which caused a break in the telephone wires. At the time of the construction of the electric trolley wires, wherever telephone or telegraph wires crossed them, guard wires were employed. At the point where the accident happened the guards were in perfect order, but when a whole stack of some 40 to 50 wires fell, as on this occasion, some of them became entangled with the tramway wires and were charged with current. The accident showed the necessity for placing the telephone and telegraph wires underground. The National Telephone Co. had been proceeding with that work for some time. As to the overhead trolley system, after full consideration they were of the unanimous opinion that it was the best system under all the circumstances. If there was any improvement that could add to the safety of the public, no matter what the cost might be, the committee would be willing to adopt it.

The estimates of the Tramway committee for 1900 were under discussion at the Corporation meeting on Wednesday, and in moving their adoption the CHAIRMAN of the Tramways committee (Ald. Petrie) said that for the past year the committee had had a surplus of about £5,000, and £28,000 had been written off for depreciation of horses. In the current year's estimates they proposed to provide £51,572 for interest, £48,916 for sinking fund, and £350,000 for working expenses, a total of £450,488. It was estimated that the receipts would be sufficient to meet these payments, and that nothing would be required from the rates. The total receipts last year were £425,000, or more than £56,000 beyond those of the previous year. On capital account they asked for £302,000. Most of the work for which this was provided had been done. Nearly all the principal routes of the city had been completed, and were working satisfactorily as regards the number of passengers carried and car mileage. The remaining lines were mostly lines for joining up the existing main lines. In reply to a question, he said there was an understanding between the Tramways committee and the Electric Power and Lighting committee as to the price to be charged per unit for electric energy. It was entirely for their experts to say what the charge should be, and the electrical engineer has gone fully into the matter, and the charge of 1·2d. per unit had been agreed upon. He believed that price covered the whole cost of production, and was, if anything, favourable to the Electrical committee. Ald. ROBERTS was amazed that such a huge undertaking as the Liverpool tramways should have shown a profit of only £5,000. They had between 50 and 60 miles laid down, compared with 10 or 12 miles in Glasgow, where a profit of £100,000 had been made. Mr. MILES said that whereas the profit now was £5,000, it was the intention of the Electric Lighting and Power committee to increase their charge for power by about £3,000. He did not think that the committee's balance-sheet was a satisfactory one. The price per unit was likely to be 1·5d. next year, and that would completely wipe off the £5,000, showing that the working of the tramways would result in a loss in 1901. Col. PORTER said there was a loss of £40,000 on the horse traction. If the horse cars and omnibuses had been done away with there would have been a profit of £45,000. In a few weeks no horses would be running, and a handsome profit would be made. Ald. SMITH said the committee had carried in the electric cars 150,000,000 people. Eventually the estimates were approved.

**Liverpool Tramway Accident**.—The inquest on the bodies of David W. Singleton and Thomas Hankey who met their deaths in the electric tramway accident which occured in Pembroke-place, Liverpool, on the 4th inst., was opened on Thursday last. The coroner (Mr. T. E. Sampson) said he only proposed to take formal evidence of identification. Mr. Pierce, deputy town clerk, said this was the first accident of the kind that had occurred in the course of the two years that the electric tramways had been in operation, and during that period they had carried 150,000,000 passengers. After formal evidence of identification the inquest was adjourned till 20th inst.

**London County Council**.—At Tuesday's meeting it was resolved to lend £27,360 to Poplar for electric lighting.

An expenditure of £860 was authorised for the lighting of the new West Hampstead station by electricity, and £125 for 2,000 incandescent electric lamps for use at the Blackwall tunnel.

A report was submitted by the Highways committee on the four applications now before the Board of Trade for electric lighting provisional orders for St. Marylebone Borough Council, the Marylebone Electric Supply Corporation, the Lewisham and District Electric Supply Co., and the North Metropolitan Electrical Power Distribution Co. (for Stoke Newington). As these applications were for orders for districts for which the local authorities already possessed powers or were seeking such powers, the committee proposed that, following the usual course adopted by the Council, the Board of Trade should be requested not to grant any one of the three last-named orders. With regard to the price to be charged for current in all orders, the committee were still of opinion that the maximum should be 5d. per unit, and as to the system of supply considered it advisable that, excepting with the express consent of the Board of Trade, the supply should be by continuous current. The committee further recommended that the date of purchase should in every case be 42 years from Aug. 26, 1889. In respect of the three last of the four orders now under review, the committee suggested that the local authorities concerned should endeavour, in the event of the orders being granted, to secure the insertion of a clause as to purchases by the local authority similar to that obtained in the Camberwell Order of 1896, and also that the option of purchase should be exercised at the end of every period of seven instead of 10 years after the expiration of the period of 42 years.

The Highways committee reported on the question of the appointment of an electrical engineer, at a salary of £1,000 per annum, to be directly responsible under the chief engineer for the work of construction or reconstruction for electric traction of the Council's tramways other than those to be reconstructed under the supervision of Mr. A. B. W. Kennedy, and for the proper and efficient working of the generating station, plant, and electrical equipment of the tramways when so constructed or reconstructed. In reply to the Council's advertisement 25 applications were received, and the committee submitted the three following names for the final decision of the Council:—

Mr. Robert Percy Brousson, electrical engineer with the Electric Traction Co., for the construction of the Central London Railway.

Mr. Charles Herbert Gadsby, consulting electrical engineer in private practice, specialist in electric traction.

Mr. John Hall Rider, chief consulting and resident engineer for electric tramways and electric lighting to the Plymouth Corporation.

The committee recommended that Mr. John Hall Rider be appointed to the post, and this was agreed to.

**Macclesfield**.—An electric lighting installation has been fitted up at the new technical and science schools, current being available for the first time on Tuesday.

**Manchester**.—A letter received by the Tramways committee from Prof. Kennedy intimates that the Bloom-street station should not be depended upon for a supply of electric energy next winter on any tramway route other than the three already determined upon—viz., Bury New-road, Cheetham Hill, and Rochdale-road. This is taken locally to mean that no electric tramcars can be run on any other route for about 18 months, and probably not until the Stuart-street station is completed.

**Maximum Charge for Electric Current**.—The Skipton District Council have received a communication from their parliamentary agents (Messrs. Baker, Lees & Co.) to the effect that they have been informed by the Board of Trade that

Having regard to the advance made in electrical science, and to the development in methods of distribution since the maximum price of 8d. per unit was adopted, and as they understand that the price actually charged is, as a rule, much less than 8d., the Board are of opinion that the time has come when the maximum of 8d. should no longer be allowed. They propose, therefore, in the provisional orders now before them, and in all orders applied for in the future, to fix a maximum of 6d. per unit.

The Skipton Council have directed their clerk to appeal to the Board to allow the price to remain at 8d. in the Skipton order, on the ground that the Council had applied for the order on the faith of the price inserted in the Board's model electric lighting order.

**Middleton**.—Application for a loan of £37,500 for electric tramways has been made by the Council.

**Motherwell.**—The formal opening of the electricity works took place on Friday evening last.

**Municipal Telephony.**—In moving the minutes of the Glasgow Telephone committee last week Mr. James Alexander announced that the committee anticipated they would be able to connect up a few subscribers by March.

**Natural History Museum.**—Prof. E Ray Lankester, director of the Natural History Museum, has paid a visit to the Manchester Museum, Owens College, in order to inspect the electric lighting arrangements there, with a view to its installation in his department of the Museum.

**Northallerton.**—Mr. John Hutton, M P, inaugurated the extension of the Northallerton Electric Lighting Co.'s installation on Thursday last. The capacity of the present plant is equivalent to 4,500 8 c.p. lamps.

**Otley.**—The District Council's consulting engineer (Mr. Geo. Wilkinson) has submitted his report on electric lighting, and decides in favour of municipal works. The estimated capital outlay on plant capable of supplying current to 6,750 8 c.p. lamps is put at £18,000, the annual expenditure at £1,122. 15s., and the anticipated revenue at 6d. per unit (averaging 7s. per lamp per annum) £2,362. 10s. The annual gross profit is estimated at £1,239. 15s., and the net profit at £231. 15s. In comparing the scheme with the proposals to obtain a supply "in bulk" from the Yorkshire Electric Supply Syndicate, Mr. Wilkinson thinks the total annual expenditure for the latter would be £2,110. 10s., and the receipts £2,250, a net annual profit in favour of municipal works of £92. 5s.

**Paisley.**—The following have been placed on the short leet for the position of burgh electrical engineer in succession to Mr. Francis Teague resigned: Messrs. Sydney T. Allan (Plymouth), H. Howard (Leicester), Jas. Moss (Eccles), and C. F. Parkinson (Morecambe). The appointment will be made on Tuesday.

**Prestwich.**—The Council have approved the draft agreement with the Manchester Corporation for the construction and working of electric tramways in the district. The Manchester terms for laying the lines are cost price plus 10 per cent.

**Private Bill Legislation.**—The new bill of the Shannon Water and Electric Power Co. seeks power to utilise the waters of the Shannon for hydraulic and power purposes. The supply area includes those portions of the counties of Clare and Limerick as are within a radius of 30 miles of the townland of Springfield. The capital of the company is to be £365,000, in £10 shares, with power to divide into preferred and deferred half shares, and with borrowing powers to the extent of £180,000. The first directors are to be Messrs. W. Brownlow, J. Chambré, A. Lane Joynt, H. H. Montague Smith, and Baron Lurgan Brown.

The estimates deposited by the promoters of the proposed electric railway under the Solent from its junction with the Lymington branch of the London and South-Western Railway at Sway to its junction with the Freshwater, Yarmouth and Newport Railway (nearly 8 miles, of which about 2 miles and 500 yards will be in tunnel under the Solent), put the total cost at £535,250, of which the tunnel section will cost £343,000. The railway throughout its whole length will be constructed as a single line. The company will have a capital of £600,000, of which £50,000 may be expended as interest during construction.

In the report of the chairman of Committees of the House of Lords and the chairman of Ways and Means in the House of Commons under section 2 of the Private Legislation Procedure (Scotland) Act, it is stated that the provisions of the Caledonian Electric Power and Clyde Valley Electrical Power Orders are of such a character that they ought to be dealt with by private bills and not by provisional orders. The Paisley Order, so far as it relates to tramways, has been allowed to proceed, and in the case of the following provisional orders the standing orders have been complied with: Clydebank Tramways, Dundee Corporation, and Falkirk and District Tramways.

In the estimates of the engineers of the Central London Railway (Sir B. Baker and B. Mott) the capital required for the extensions, &c., of the railway is put at £465,227, of which the proposed loop line extension from the Bank to Liverpool-street is estimated to cost £398,671. Of this sum £11,000 will be expended on the actual station accommodation, and £248,330 in clearing an area of 20 poles for the Liverpool-street station. The balance will be spent on the construction of a loop line at the Shepherd's Bush terminus, which is estimated to require £59 922, and on a siding under Throgmorton-street, which will cost £6,634. Power is sought to create £600,000 additional ordinary capital, including £50,000 to be expended as interest during construction of works. The main object of these proposed loop line extensions is to enable the company to provide a more rapid service of trains by the provision of turning loops at the Bank and Shepherd's Bush termini.

**Provisional Order Revocation.**—The Swadlincote Electric Lighting Order (1897) has been revoked by the Board of Trade.

**Southport**—The Board of Trade have sanctioned a further loan of £75,000 for electric tramways—viz, £63,500 to be repaid in 30 years and £11,500, the cost of the electrical equipment, to be repaid in 20 years.

**Swindon.**—The Town Council, on Tuesday, in accepting a tender for the supply and erection of generating plant for lighting and traction, decided to adopt overhead traction for the tramways.

**Taunton**—The salary of the borough electrical engineer (Mr. E. B. Thornhill) has been increased from £200 to £300 per annum.

The accounts of the electricity department for the past year have just been presented. Last year there was a balance forward of £94, and the committee have now a balance of £706 after paying working expenses, interest and sinking fund. It is recommended that £750 be placed to reserve, and the balance (£50) carried forward. The charge for current to the public arc lamps is to be reduced by £1. 1s. per annum, and places of worship owning their own installation are to be charged 5d. instead of 6d. per unit. Consumers on the maximum demand system are to pay 3d. instead of 4d. per unit after the first hour, these alterations to take effect from Jan. 1. The profit on the year's working has amounted to £2,965, more than sufficient to pay 6½ per cent. on the capital sanctioned (£45,000). Last year, after paying all working expenses, interest, and sinking fund, they were able to contribute £300 towards the relief of the rates. The balance-sheet was adopted, and it was decided to carry £450 to reserve, the balance of £300 to go in relief of the rates. The committee reported that owing to the increasing demand for current it would be necessary very shortly to lay down additional plant, and they accordingly presented an estimate of the cost of the extensions proposed, amounting to £17,780.

**Telegraph Extension in German East Africa.**—The Budget committee of the Reichstag on Wednesday sanctioned the expenditure of 200,000 marks for the construction of a telegraph landline between Dar-es-Salaam and Mpwapwa, German East Africa.

**The Pacific Cable.**—The Pacific Cable Board has now been appointed, and will consist of Sir Spencer Walpole, K.C.B. (Secretary to the Post Office), Mr. George Edward Gleadowe (of the Treasury), and Mr. William Hepworth Mercier (one of the Crown Agents), representing the Imperial Government; Lord Strathcona and Mount Royal, High Commissioner for Canada, and Mr. Alexander Lang, representing the Dominion of Canada; the Hon. Henry Copeland, Agent-General for New South Wales, and Lieut.-General Sir Andrew Clarke, Agent-General for Victoria, representing the contracting colonies of New South Wales, Victoria and Queensland; and the Hon. W. P. Reeves, Agent-General for New Zealand.

Correspondents of *The Times* report—

1. That the New Zealand Government opposes concessions to the Eastern Extension Telegraph Cable Company as prejudicial to the Pacific cable, unless the consent of all the partners in the scheme is given.

2. That much irritation has been caused in mercantile circles in Melbourne by the refusal of the Victorian Government to accept the reduced rate of telegraphing to England offered by the Eastern Extension Company. Victorians are under the disadvantage of paying 4s. 10d. per word, while New South Wales, South Australia, Western Australia, and Tasmania only pay 3s. 6d.

3. That Mr. Crick, Postmaster-General of New South Wales, strongly criticises the threat of the Canadian Government to withdraw from the Pacific cable agreement if the rates are reduced, pointing out that Canada only pays 1s. a word to England, while begrudging a reduction from Australia to 3s. 6d. Sir George Turner considers Victoria bound in honour to maintain the 4s. 10d. rates until Great Britain, Canada, Queensland and New Zealand, agree to the Eastern Extension Company's reduction.

Lengthy consultations have, we learn, taken place between Mr. Gurr, Postmaster General of Victoria, and Mr. Crick, of New South Wales, in reference to existing cable rates, and, as a result of these deliberations, it has been decided that negotiations can safely be opened up with the Eastern Extension Company in order to take advantage of the reduction in rates offered without in any way affecting the Pacific scheme. According to recent reports Mr. Gurr and Mr. Crick have determined that the States of New South Wales and Victoria shall enjoy the reduced cable rates as from Feb. 1. The Agents General of the two States have, we understand, been instructed to sign the necessary agreement in London, and the Eastern Extension Company has been requested to take all necessary steps to give effect to this agreement.

A temperate article on the subject of the "Pacific Cable Imbroglio" appears in the *British Australasian* of yesterday's date.

The following information concerning the Pacific cable, which is being manufactured under contract by the Telegraph Construction and Maintenance Co., at the contract price of £1,795,000, is interesting: The two sections of the line—Vancouver to Fanning Island, 3,653 miles, and Fanning Island to Fiji, 2,181 miles—will cost respectively £1,067,602 and £388,358, and will be completed by the end of 1902. The other three sections—Fiji to Norfolk Island, 1,019 miles, Norfolk Island to Moreton Bay, Queensland, 906 miles, and Norfolk Island to New Zealand, 513 miles, or 2,138 miles in all—will cost £339,040, and will be completed by June 30, 1902.

**Tonbridge.**—Last week the Council decided to apply for sanction to a loan of £20,000 to carry out the electric lighting scheme prepared by Mr. Robert Hammond.

**Tube Railway Competition.**—At the meeting yesterday of the proprietors of the Great Western Railway Earl Cawdor presided and referred to the competition of the Central London Railway with the local traffic of the Great Western Co. This competition, he said, had led to a drop in the number of short distance passengers carried by the latter line owing to its diversion to the Central London Railway.

**Tynemouth.**—The Board of Trade inspection of the new electric tramway between North Shields and Whitley took place on Wednesday. The date of the opening has not been fixed. Current will be supplied by the Corporation, whose electricity works are now practically complete, and it is expected that current both for lighting and tram traction will be available in a few days.

**Waterloo and City Railway.**—A double improvement has been effected in the working of this line during the hours of busiest traffic. Trains are now started every five instead of every six minutes, and immediately upon one train leaving the platform its place is taken by the following train, and waiting and crowding on the platform is thus avoided.

**Water Power Utilisation in Austria.**—A concession for 90 years has been granted to an Austrian company, who are putting down plant to utilise the waters of the river Trisanna, in the Pazraun Valley, for the supply of electric energy to a number of small towns in the district.

**Workhouse Lighting.**—The Local Government Board have suggested to the Christchurch Guardians that the electric lighting of the workhouse should be deferred for the present, on the ground that the scheme proposed was too costly. The Board ask if the Guardians cannot obtain a supply of current from Bournemouth.

The West Ham Guardians have appointed Messrs. Owen Lucas and Pyke consulting electrical engineers at an inclusive fee of £125.

Hunslet Guardians have decided to consult an electrical expert on the lighting of their new workhouse.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Extension of Time.*—An advertisement notifies that the time for sending in tenders for the (*a*) extension of engine house, electric supply works; (*b*) car sheds, stores, workshops and dwellings; and (*c*) erection and completion of an engine and pump house for the *Wallasey* Urban District Council has been extended from Feb. 21 to March 4. These tenders were advertised in our issue of Feb. 1.

*Wallasey* Urban District Council require tenders for the overhead equipment of about 10 miles of tramways, and for the supply and erection of section boxes and rail bonding. Specifications can be obtained at the offices of the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead. Tenders to Mr. H. W. Cook, clerk and solicitor to the Council, Public Offices, Egremont, Cheshire, by March 4. An advertisement gives further particulars.

*Eastbourne* Corporation invite tenders for the supply and erection of transformers, sub stations and equipment, underground mains, conduits and road work, for private and public lighting arc lamps and posts. Specifications may be obtained at the offices of the town clerk (Mr. H. W. Fovargue), Town Hall, Eastbourne, and the work is to be carried out in accordance with the plans and specifications of the consulting engineer (Mr. W. C. C. Hawtayne), 9, Queen-street-place, London, E.C., from whom further information can be obtained. An advertisement gives further particulars, and tenders addressed to the town clerk must be delivered before noon March 4.

*Cardiff* Corporation require tenders for steam and exhaust pipes, injection and overflow pipes, feed and drain pipes, engine house flooring, switchboard gallery and central service gangway for their tramways department. Specifications, &c., may be obtained from the engineer and manager (Mr. Arthur Ellis), Old Post Office-buildings, Cardiff. Tenders to the town clerk (Mr. J. L. Wheatley) by March 18. See advertisement.

*Dundee* Gas Commissioners invite tenders for the supply of underground electric conduits and necessary jointing apparatus. Further particulars are set out in an advertisement, and specifications may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee. Tenders to the clerk to the commissioners (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Feb. 25.

*Leeds* Tramway committee invite tenders for supplying and fixing trolley wires and accessories. Specifications may be obtained at the city engineer's office, Municipal Buildings, and also at the offices of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., and 29, Princes-street, Manchester. An advertisement gives further particulars, and tenders must reach the town clerk's office by noon March 8.

*Stockport* Gas and Electricity committee invite tenders for condensing plant for their electricity works. Further particulars are given in an advertisement, and specifications can be obtained from the engineer (Mr. S. Meunier). Tenders by March 6 to the chairman of the committee, Portwood, Stockport.

The trustees of the *Clyde Navigation* invite tenders for a 3-ton electric wharf crane. An advertisement contains further particulars, and specifications, &c., may be obtained from the mechanical engineer (Mr. Geo. H. Baxter), or of the general manager and secretary (Mr. T. R. Mackenzie), 16, Robertson-street, Glasgow. Tenders to Mr. Mackenzie by noon of March 11.

*Bray* District Council invite tenders for the supply and erection of a Lancashire boiler and accessories, a 150kw. high-speed steam alternator, and a 25kw. rope-driven alternator and accessories. An advertisement gives further particulars, and specifications may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after 20th inst. Tenders must be sent to the clerk to the Council (Mr. Patrick McDonnell), Town Hall, Bray, by 4 p.m. March 14.

The Corporation of *Worthing* (Sussex) invite offers from electric wiring contractors for fitting up premises in the borough for the electric light free of initial cost to consumers. Some particulars will be found in an advertisement, and offers have to be in to Mr. W. Verrall, town clerk, Municipal Offices, Worthing, by 12 noon of Feb. 25.

*Middleton* Corporation invite tenders for the supply, delivery, and erection of a traction switchboard. Specifications may be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and 78, King street, Manchester. Tenders to town clerk (Mr. Frederick Entwistle), Town Hall, Middleton, by Feb. 28. See advertisement.

*Aberdeen* Electric Light committee invite tenders for a fuel economiser and Babcock and Wilcox boilers. Tenders to the city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, before noon, March 15. An advertisement contains further particulars.

*Aberdeen* Town Council invite tenders for the erection of an octagonal chimney stack at the Dee Village electricity works. Tenders by 23rd inst.

*Accrington* Corporation invite tenders for two steam dynamos, jet condenser, balancer, 750-ampere-hour storage battery, steam and exhaust piping, arc lamps and pillars. Tenders by 28th inst.

*Bermondsey* Metropolitan Borough Council invite tenders for a main switchboard and instruments and a battery of accumulators and accessories. Tenders to town clerk, Town Hall, Spa-road, London, S.E., by noon of 30th inst.

*Taunton* Corporation invite tenders for two 100kw. tramway generators, one engine and tramway switchboard and connections. Tenders to town clerk, Municipal Buildings, Taunton, by 2 p.m., Feb. 25.

*Halifax* Corporation invite tenders for a storage battery. Tenders by 26th inst.

*Granton-on-Spey* Council invite tenders for electric lighting. Tenders by 6th prox.

*Darwen* Corporation require tenders for steel rails, fish and sole plates, &c. Tenders by 25th inst.

*Glasgow* Corporation invite tenders for 50 carriers and 50 canopies for electric arc lamps. Tenders to Mr. J. Lindsay, City Chambers, by 22nd inst.

*Glasgow* Corporation invite tenders for the supply of 100 car equipments and spare parts. Tenders to town clerk by 5 p.m. Feb. 22.

*Glasgow* Corporation also invite tenders for steel straight track rails, curved rails, fish-plates, and steel tie-bars. Tenders by 5 p.m. Feb. 22.

The Receiver-General and Director of Contracts *Valetta* (Malta) requires tenders for dynamo and engine oil. Tenders by 28th inst.

Sheffield Corporation have placed an order with Mr. Arthur Koppel for a fan cooling tower for the electricity works at £1,775.

*Bristol* Electrical committee invite tenders for coal conveyors and elevators, coal discharging plant, including hoist, automatic weigher, tower and bridge over roadway. Tenders by noon Feb. 21.

*Bournemouth* Corporation require three dynamos and two steam-driven surface condensers, &c., also 42 electric tramcars. Tenders by noon March 2.

*Luton* Town Council require tenders for wiring the council chamber, town hall, free library, corn exchange and baths. Tenders by 4 p.m. March 4.

*Electric Haulage for Mining.*—The Ffaldau Collieries Co., Ltd., *Cardiff*, require plans, specifications and estimates of cost for providing secondary haulage by electricity from their working faces to the end of their rope haulage, the latter being operated by steam engines near the shaft. Additional information can be obtained from the Company.

*Brighton* Corporation invite tenders for continuous-current arc lamps and accessories for street lighting. Tenders to town clerk by 10 a.m. Feb. 25.

*Beckenham* District Council require tenders for boilers, steam alternator, and combined engine-dynamo and motor, pipe work, battery, and switchboard. Tenders by Feb. 25.

*Tottenham* District Council require tenders and designs for refuse destructor plant. Tenders to clerk by noon 19th inst.

## TENDERS RECEIVED AND ACCEPTED.

Colne District Council have received the following tenders for the supply of plant for their electricity works :—

*Section 1 (Switchboard).*

| | | | |
|---|---|---|---|
| *Cowans Limited | £630 | W. J. Fryer & Co. | 840 |
| Greenwood and Batley | 1,188 | Warren, Beattie & Co. | 800 |
| Heaton and Smith | 1,062 | S. H. Heywood | 800 |
| Siemens Bros. & Co. | 1,050 | British Schuckert Co. | 800 |
| Electric Construction Co. | 1,030 | Brook, Hirst & Co. | 760 |
| General Electric Co. | 1,015 | John Fowler & Co. | 752 |
| Bertram Thomas | 953 | Crompton & Co. | 720 |
| Veritys Limited | 930 | Mechan & Son | 680 |
| Brush Co. | 920 | | |

*Section 2 (Balancer Booster).*

| | | | |
|---|---|---|---|
| *Siemens Bros. & Co. | £515 | General Electric Co. | £560 |
| British Schuckert Co. | 689 | John Fowler & Co. | 561 |
| Brush Co. | 680 | Lister Electric Power Co. | 550 |
| Mather and Platt | 649 | H. M. Salmony & Co. | 545 |
| Crompton & Co. | 640 | Bertram Thomas | 528 |
| Greenwood and Batley | 598 | Lancashire Dynamo Co. | 495 |
| Bergtheil and Young | 597 | J. P. Hall & Co. | 406 |
| Electric Construction Co. | 585 | Newton Electrical Works | 369 |
| D. Bruce Peebles & Co. | 576 | Warren, Beattie & Co. | 300 |

*Section 3 (Paper Insulated Cables).*

| | | | |
|---|---|---|---|
| *B. I. W. Co. | £4,432 12 11 | Callender's Co. | £4,600 11 2 |
| G. A. Nussbaum | 6,562 10 0 | Western Electric Co. | 4,482 7 6 |
| Siemens Bros. & Co. | 4,857 0 0 | W. T. Glover & Co. | 4,444 10 0 |
| W. T. Henley's Telegraph Works Co. | 4,809 0 0 | St. Helens Cable Co. | 4,424 3 2 |
| | | Johnson and Phillips. | 4,390 0 0 |

*Section 4 (Earthenware Conduits).*

| | | | |
|---|---|---|---|
| *Albion Clay Co. | £1,193 6 8 | Johnson and Phillips. | £1,151 17 6 |
| Hosea, Tugby & Co. | 1,301 16 8 | Doulton & Co. | 1,135 16 8 |
| Maguire and Baucus | 1,186 4 2 | | |

*Section 5 (Superheater).*

| | | | |
|---|---|---|---|
| *Babcock & Wilcox | £140 | Lindsay Burnet & Co. | £115 |

*Section 6 (Accumulators).*

| | | | |
|---|---|---|---|
| Brit. Power and Traction Co. | £1,293 | Ashmore, Benson, Pease & Co. | £1,345 |
| Electrical Power Storage Co. | 1,278 | Hart Accumulator Co. | 1,669 |
| Chloride Elec. Storage Synd. | 1,961 | Tudor Accumulator Co. | 1,465 |

*Section 7 (Ejector Condenser).*

| | | | |
|---|---|---|---|
| *Korting Bros. | £58 10 | T. Ledward & Co. | £77 0 |

*Section 8 (Motor Centrifugal Pump).*

| | | | |
|---|---|---|---|
| *Greenwood and Batley | £103 | British Schuckert Co. | 150 |
| Drysdale & Co. | 205 | Lister Electric Power Co. | 140 |
| Electric Construction Co. | 200 | Lancashire Dynamo Co. | 130 |
| Mather and Platt | 180 | Warren, Beattie & Co. | [illegible] |
| W. H. Allen, Son & Co. | 170 | Morley Elec. Eng. Co. | 120 |
| Korting Bros. | 170 | Newton Electric Works | 112 |
| J. and H. Gwynne | 151 | | |

* Accepted tenders.

Battersea (London) Council recently accepted the tender of the Edison and Swan Co. for the supply of the fittings required in connection with the wiring of the new baths, but the company object to the form of the contract including the conditions as to penalties and trade union rates of wages. We learn that the Council's surveyor has been instructed to procure the fittings from the General Electric Co.

Battersea (London) Borough Council have accepted the offer of Messrs. Heathman & Co. for two telescopic ladders, at £58. 4s.

Keighley Town Council have accepted the tender of Messrs. Gabriel and Angenault for 500 230-volt incandescent lamps at £21. 17s. 6d., and that of the Brush Co. for 500 230-volt lamps at the same figure. The tender of J. H. Heathman & Co. for the supply of a telescopic ladder for trimming arc lamps was accepted at £20. 6s. 9d.

Swindon Town Council received 53 tenders, varying in amount from £9,400 to £6,046, for the supply of three steam dynamos for the combined lighting and traction scheme for the district. On Tuesday the Council accepted the tender of Messrs. Siemens Bros. & Co. at £7,355. The lowest tender did not comply with the specification. The steam engines are to be of Browett-Lindley triple expansion type, each of 350 H.P.

Brighton Corporation have accepted the tender of Messrs. D. Bruce Peebles & Co. for the supply, delivery and erection of one 330kw. and two 200kw. steam dynamos and a motor-driven booster, at £7,070, for their tramway department, and that of Messrs. R. W. Blackwell & Co. for a tramway switchboard at £745. 10s.

Yarmouth Corporation have accepted the tender of Messrs. Le Bas & Co., for 800 tons of steel rails (86lbs. per yard) for their electric tramways at £5. 16s. per ton ; also fish and sole plates at £6. 12s. per ton, screw bolts £12. 7s. per ton, cross ties at £7. 13s. per ton, holes for electric bonding 16s. 8d. per 100. The accepted tender is that of a Belgian house and was the lowest submitted. Three British and three American firms also tendered.

Sheffield Corporation have accepted the tender of the British Thomson-Houston Company for a 1,000kw. tramway generator at £3,812. 12s., and that of the J. G. Brill Co. for six motor trucks at £53. 16s. each.

The tender of Messrs. W. M. Caffyn & Sons has been accepted for the electric lighting of the Eastbourne Pier new pavilion at £1,050. Six tenders, varying from £1,050 to £1,295, were received.

Bradford Corporation have accepted the tender of Messrs. R. W. Blackwell & Co. for the overhead electrical equipment of over 5 miles of electric tramway at £6,204.

The Corporation have also accepted the tender of the British Insulated Wire Co for the supply of cable for tramway extensions to Farsley, Thackley, Idle, and Queensbury, at £3,431. 4s., and that of the Phœnix Dynamo Manufacturing Co. for two 60 H.P. motors for the cold storage department at the St. James's abbatoirs for £526.

Derby Town Council have accepted the tender of Messrs. Radford and Greaves for the erection of a new chimney shaft at the electricity station at £1,433, and that of Messrs. Siemens Bros. & Co. for re-winding a Siemens alternator at £430.

Messrs. D. Bruce Peebles & Co. have secured the contract for the supply of steam dynamos, balancers, and boosters for the burgh of Partick at £5,733. The engines are to be of the Belliss type.

Plymouth Corporation have accepted the tender of Mr. W. E. Blake for extending the electricity station buildings at £8,384.

## BUSINESS NOTICES.

**Partnership Wanted.**—A borough electrical engineer, with 19 years' experience, who has entirely designed a station containing over 3,000 H.P., and successfully run same for over four years, is desirous of joining a good consulting engineering business as partner, or would be disposed to purchase practice. See advertisement.

Mr. J. F. Simpson gives notice that he has ceased to carry on business under the style of Brown & Co., engineers and machinery importers, at 49, Deansgate, Manchester.

Communications for the Castner-Kellner Alkali Co. (Ltd.) (late the Aluminium Co., Ltd., Oldbury) should in future be addressed to Weston Point, Runcorn.

The British Electric Car Co. have purchased 5 acres of land at Trafford Park, Manchester, for works premises.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against E. J. Paterson and C. J. F. Cooper, formerly trading as Paterson and Cooper, electrical engineers, at European Works, Pownall-road, Dalston, London, N., are to be in by 20th inst. Mr. E. C. Moore, 3, Crosby-square, London, E.C., is trustee.

The London Electric Omnibus Co. (Ltd.) is to be wound-up voluntarily, and Mr. P. Mason, 64, Gresham-street, E.C., has been appointed liquidator.

Tom Flather, electrical engineer, 406, Meanwood-road (lately trading at Park Electrical Works, Speedwell-street), Leeds, has been adjudicated bankrupt. The first meeting of creditors took place at the Official Receiver's Office, Leeds, on Wednesday. Debtors liabilities were stated to be £357 with a deficiency of £325.

**Sale by Auction.**—An advertisement elsewhere gives preliminary notice of a sale by auction by Messrs. Wheatley Kirk, Price & Co., at an early date (unless previously disposed of), of a quantity of modern high-class plant, machinery, stock, and stores.

**Plant for Sale.**—Aberdeen Electric Lighting committee invite offers for two direct-coupled continuous-current Willans-Elwell-Parker sets which they have for disposal. Some information is given in an advertisement, and further particulars can be obtained on application to the city electrical engineer (Mr. J. Alex. Bell), Cotton street, Aberdeen. Tenders by noon of March 1.

Messrs. Wheatley Kirk, Price & Co. have for disposal a high-class private electrical installation, including Crossley gas engines, Johnson and Phillips dynamo, D.P. battery, &c. See advertisement.

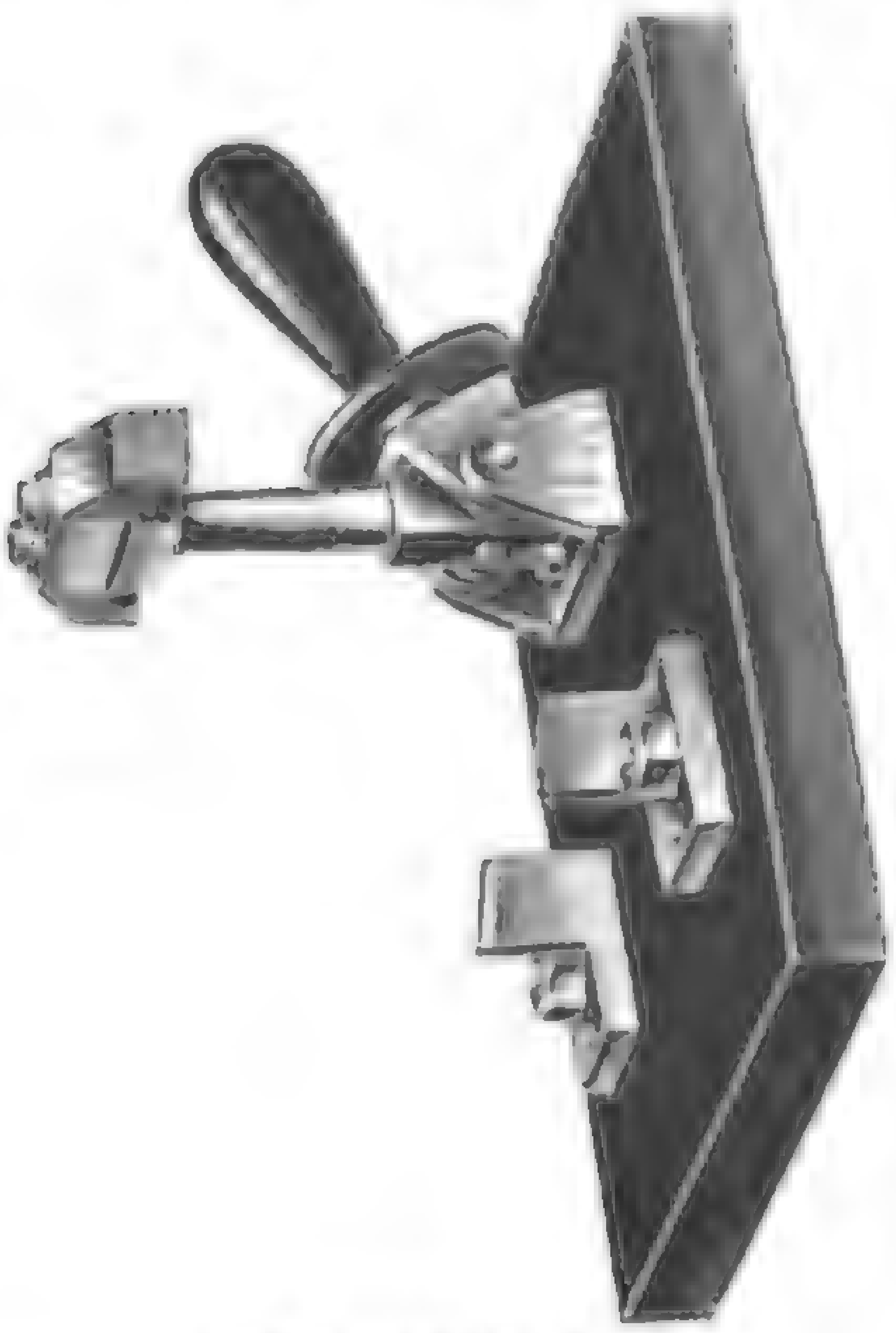
Messrs. Wake and Carr, 123, Victoria-road, Darlington, have for sale four sets of vertical marine-type triple-expansion engines. An advertisement gives additional information, and further particulars can be obtained from Messrs. Wake and Carr, Darlington, or Mr. Thos. W. Ward, Sheffield.

An advertisement also contains some particulars of eight large locomotive boilers which are for sale. Applications to Messrs. Wake and Carr, Darlington, or to Mr. Thos. W. Ward, Sheffield.

Burton-on-Trent Gas and Electric Light committee have for sale a horizontal compound engine with a single-phase alternator, some particulars of which are set out in an advertisement. Offers to manager and engineer, Mr. F. L. Ramsden.

By command of the Postmaster-General tenders are invited for the purchase of a quantity of old telegraph stores, some particulars of which are set out in an advertisement. Tenders have to be in by 10 a.m. of Feb. 27.

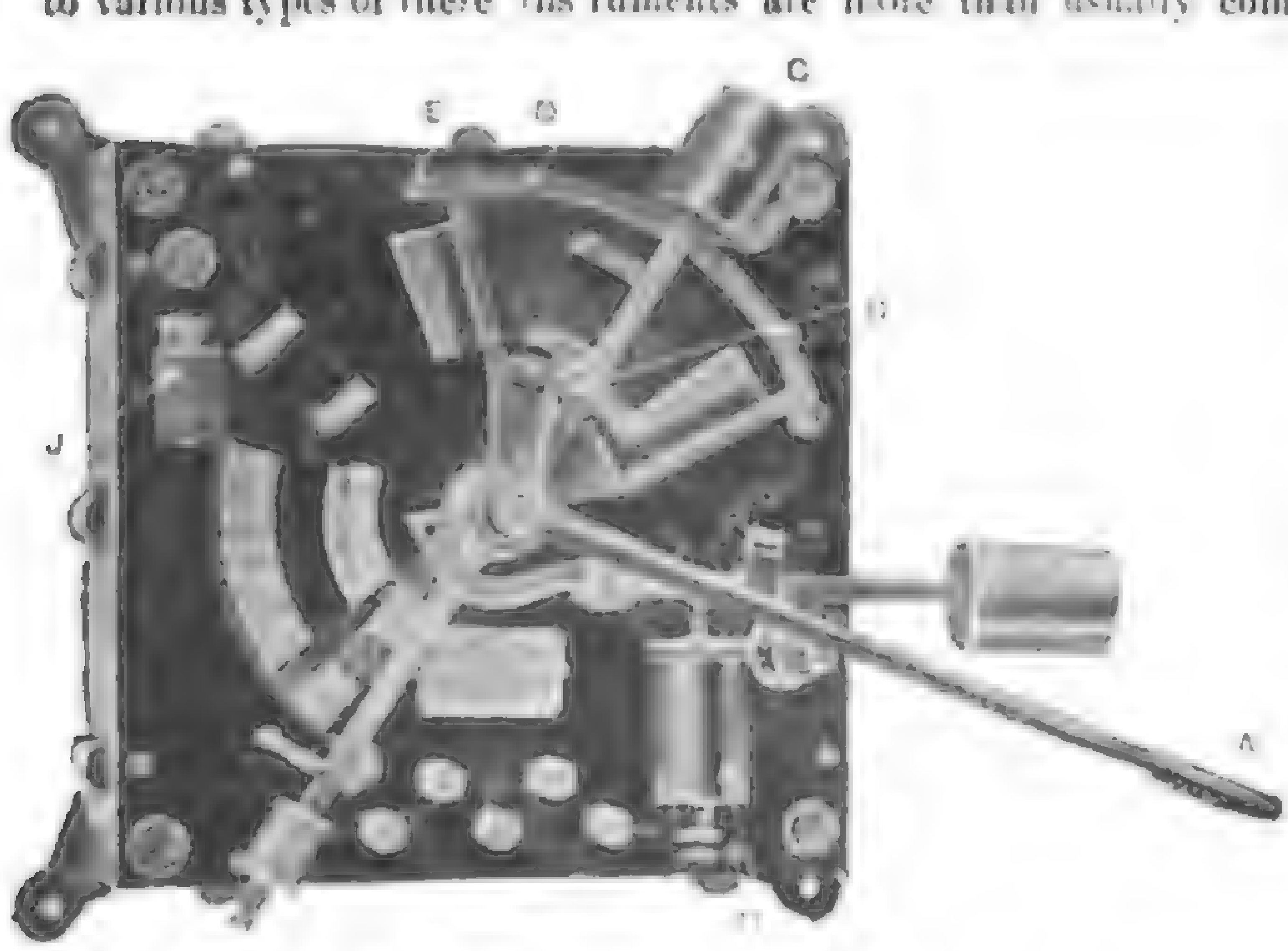
**The "Adelphi" Switch.**—The increased use of high voltages for electric traction, power and lighting, has induced the General Electric Co. to place on the market a new pattern of 500-volt switch, which they have styled the "Adelphi." The illustration shows a form of this switch designed with quick-break action, wide double break, laminated brush, effective insulation, and great mechanical strength—all properties essential to switches for large currents at this voltage. The contact brush is built up of hard-rolled springy copper strips, as shown in the illustration, and the strips are suitably



The "Adelphi" Switch.

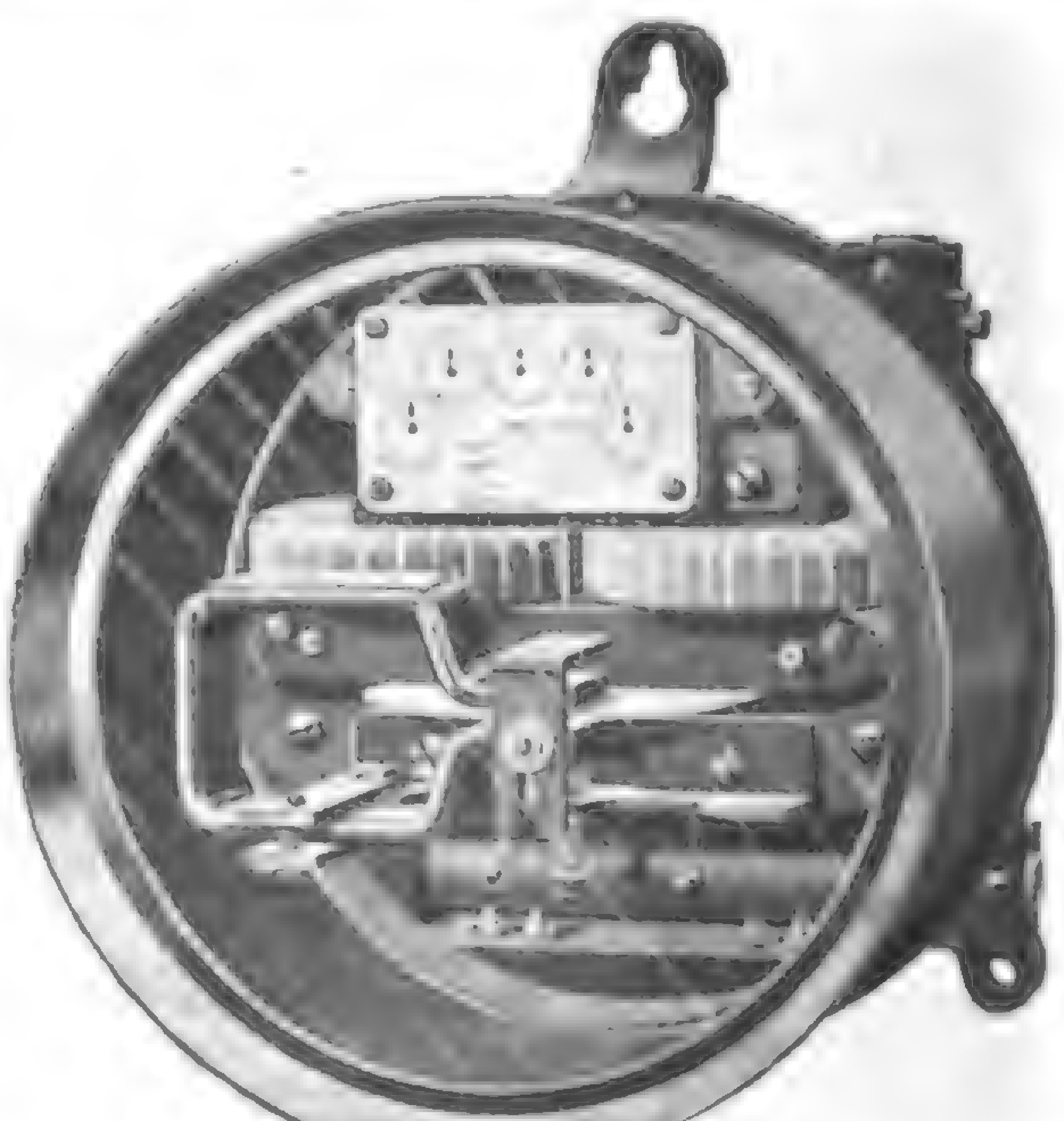
spaced in the centre to give elasticity. This brush is insulated from a powerful contact arm mounted on a spindle and held "off" by a mouse trap spring; an insulating handle with shield works loosely on the same spindle, doubly insulating the handle from the live contacts. The latter are of phosphor copper with copper bolts, and the whole of the current-carrying parts are designed for a current density equivalent to copper at 800 amperes per square inch. The switch is made in many sizes from 20 amperes to 800 amperes capacity, both single and double pole, and is provided with back connections; in addition carbon breaks are fitted when desired.

**Automatic Motor Starters, Rheostats, &c.**—Messrs. Geipel and Lange forward a useful net trade price list of Ward Leonard rheostats and circuit breakers, which forms the most comprehensive list of this class of apparatus yet published. The details relating to various types of these instruments are more than usually com-



plete, and the technical particulars accompanying the numerous illustrations will be found most serviceable, and will enable the electrical trade to place their orders with ease and facility. About 1,000 different articles are referred to, and all of these are standardised. We have also received a price list relating to automatic motor starters, one form of which (the A B type, fitted with magnetic "no voltage" release) is illustrated below. The lever A is controlled by hand, rope or chain connected with the apparatus which control the motion, such as a float in a tank or a rope for elevator or the fixed point upon the moving weight of a hydraulic accumulator. When A is lifted the arm B upon it moves the weighted lever C until it passes over the centre and falls upon the quadrant D, striking the pin E upon it. This then drives the quadrant forward, and with it the two switch plates into the contacts of the double-pole switch. At the same time the lever F is lifted and allowed to fall when the quadrant D has gone right over; this drives the lever G over the resistance contacts at a predetermined speed settled by the air leakage into the dashpot H. The lever G is eventually held up by the small coil J, which is in the shunt field circuit of the motor. Should the current fail, and consequently the current in this coil be sufficiently decreased, the lever G falls free and puts the whole of the resistance in circuit, so that there is no danger of the motor being burnt out. The motion of A, and consequently of C and D, being controlled by the tank, accumulator, &c., is quite independent of that of G. This form of automatic starter, it will be seen, gives the protection required in an automatic switch working under difficult circumstances. Simpler forms are used without the "no voltage" coil, and in some cases without any resistance, these latter forms being chiefly used in connection with series motors of small size and high resistance, or with alternating-current motors which can be started up without a resistance in the line circuit. In these switches security of operation is assured by using weighted levers in place of springs or other similar devices liable to depreciation.

**Scheeffer Recording Wattmeters.**—The Imperial Electric Supplies (Ltd.), 86, Charing Cross-road, London, W.C., are agents for the Scheeffer induction meter for alternating currents, for which certain advantages are claimed. The instrument is made by the Diamond Meter Co., of Peoria, Ill., U.S.A., and registers Board of Trade units. The accompanying illustration is from a neat pamphlet



issued by the Imperial Electric Supplies (Ltd.), and shows the Scheeffer meter with its glass front. It is fitted with a perfectly dust-proof cover, has ball bearings, and the moving element responds quickly to any sudden variation of load. The meter weighs about 11 lb.

**Siemens and Halske Plant and Apparatus.**—A portfolio of sheets of Siemens and Halske electric plant, apparatus, instruments, and accessories is to hand, and includes a large number of excellent illustrations. Copies of the list can be obtained from Messrs. Siemens and Halske, A.G., Charlottenburg, Berlin.

**Henrion Carbons**.—Mr. D. McNaughton, 79, Mark-lane, London, E.C., has now ready lists of prices, &c., of the carbons and carbon brushes manufactured by M. Fabius Henrion at his extensive works at Nancy, France, for which Mr. McNaughton is sole agent in this country. The particulars given in the printed matter before us will appeal to the trade, and are in considerable detail. A large selection of "Graphitic" carbon brushes are illustrated.

**Dynamo Sheets and Stampings.**—In a note last week (page 598) we referred to the agency of Messrs. Geo. Schultz & Co. for Messrs. W. Gilbertson & Co. (Ltd.), Pontardawe. We are asked by Messrs. Schultz & Co. to state that they represent Messrs. Gilbertson & Co. only for armature sheets and stampings, and not for other goods (including tin plates and galvanised iron) which Messrs. Gilbertson manufacture.

**High-Speed Engines.**—Mr. J. Pullar Phibbs, M.I.E.E., who is representative for the High-Speed Engine Co. of Belgium, has ready a descriptive price list of the manufactures of the Belgian Company.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 6 to Feb. 12, with the ports of destination:—

*Africa*—Alexandria, £299 (including £145 telegraph wire); Cape Town, £486; Durban, £588; East London, £8; Port Elizabeth, £175. *Argentina*—Buenos Ayres, £2,371. *Australasia*—Brisbane, £250; Christchurch, £17; Launceston, £100; Melbourne, £432; Sydney, £309; Wellington, £94. *Austria*—Trieste, £645 (telegraph cable). *Borneo*—Sandakan, £20. *British Guiana*—Demerara, £41. *Ceylon*—Colombo, £120. *Chili*—Boca, £543. *China*—Shanghai, £138. *Denmark*—Copenhagen, £18 (telegraph wire). *Germany*—Bremen, £63. *Gibraltar*—£42. *Greece*—Piræus, £40 (telegraph material). *Holland*—Flushing, £18; Rotterdam, £46 (telegraph wire). *Hong Kong*—£22. *India*—Bombay, £116; Calcutta, £1,321 (including £176 telegraph wire). *Norway*—Christiania, £133 (telegraph wire). *Sucho*, £1,412 (telegraph cable). *Siam*—Bangkok, £41. *Straits Settlements*—Singapore £90. Total £10,174, against £35,773 in the corresponding week last year (Feb. 7 to Feb. 13).

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods and apparatus imported into this country during January was £94,317, against £147,205 in the preceding month, and £63,153 in January last year.

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co. *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 1, 1900.

21,827. SOCIETA EDISON PER LA FABBRICAZIONE DELLA LAMPADE ING. C. CLERICI & CO. London. Improvements relating to electric incandescent lamps and the like. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 16, 1900, being date of application in Italy.)

December 3, 1900.

21,837. G. W. LUMMIS-PATTERSON. Newcastle-on-Tyne. Improvements in prepayment electricity meters.

21,838. G. B. BATTEN. London. An appliance or device for obtaining direct electrical impulses or currents from alternating electric sources.

21,852. E. H. TYLER and A. G. HANSARD. London. Improvements in electric traction.

21,858. M. CANTOR and THE PROF. BRAUN'S TELEGRAPHIE GESELLSCHAFT MIT BESCHRANKTER HAFTUNG. London. Improvements in or relating to electrical contacts for detecting electrical disturbances, receiving electrical vibrations or like uses.

21,860. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric meters. (E. Thomson, United States.)*

21,861. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in controlling electric boosters. (E. M. Hewlett, United States.)*

21,862. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in methods of securing pole-pieces to electric machines. (H. G. Reist, United States.)*

21,880. E. F. MOY and P. H. BASKE. London. Improvements in or relating to electrical governing or controlling apparatus.

21,886. L. E. LACROIX, jun. London. Improvements in electrical storage or accumulators.

21,903. F. J. GREEN. London. Improved means of holding the inner glass and lower carbon of an electric arc lamp.*

21,904. F. J. GREEN. London. An arrangement of electrical resistance especially adapted for electric arc lamps.*

December 4, 1900.

21,922. R. F. COLLINGE and H. H. LINDON. Liverpool. Automatically controlling the speed at which electric tramcars motors and the like may be driven.

21,933. CROMPTON & CO. (LTD.), A. J. HODGSON, and J. W. EWART, Chelmsford. Improvements in electric arc lamps.*

21,961. F. GULTING. London. New or improved self acting electric fire alarm and signalling device.

21,962. H. McGOWAN. London. An improved adjuster or height regulator and cord receiver for electric lamps and like purposes.

21,991. W. B. CLEVELAND. London. Improvements in connections for electrical conductors.*

22,010. W. B. CLEVELAND. London. An improved method of connecting electrical conductors.*

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

19,539. HOPKINSON and TALBOT. Automatic electric circuit-breakers for automatically closing the circuit after breaking.

23,316. WRIGHT and MUTUAL ELECTRIC TRUST CO. (LTD.). Electrolytic meters.

23,734. BOUILLET. Electric lighting or heating apparatus.

24,049. WILSON. Inter-communication telephone systems.

24,058. BEIN. Means for carrying off the gases generated in electrolytic apparatus.

24,175. DICKINSON. Electrically-propelled motor cars.

24,438. THE BRITISH THOMSON-HOUSTON CO. (LTD.) (Holmes). Coin controlled electric meters for motors or the like.

24,451. LAKE (Bruno). Storage batteries.

24,567. STEVENS, Major, STEVENS and STEVENS. Controlling apparatus for electric lifts and other electric machines.

24,701. SIEMENS BROS. & CO. (LTD.) and DIESELHORST. Manufacture of submarine electric conductors.

24,833. GRIVOLAS. Recording and reproducing arrangement for phonographs, graphophones and other machines for reproducing speech and the like.

24,960. LUCKOW. Method of producing electrodes for electrical accumulators.

24,968. JONAS. Process for the production of thermo-electric batteries.

25,032. CARTER. Electric driving mechanisms for geared machines generally.

# COMPANIES' MEETINGS AND REPORTS.

## St. James' and Pall Mall Electric Light Co. (Ltd.).

The ordinary general meeting of this Company was held on Tuesday Mr. EUSTACE J. A. BALFOUR presiding.

The MANAGER and SECRETARY (Mr. Frederic J. Walker) read the notice convening the meeting, and the report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, I think I may congratulate the shareholders on the position of the Company and on the results that have been arrived at on the past year's work. It is proposed that a distribution amounting to 14½ per cent. shall be made on the ordinary shares, so that the dividend will have been maintained steadily at this rate for the past four years. But if you will kindly consider the figures, you will see that not only has this result been fairly earned, but that there is every reason to anticipate that it can and will be maintained. We have added to our service during the past year the equivalent of 21,597 8 c.p. lamps, making a total at the end of the year of 166,347 8 c.p. lamps. The normal rate of increase is thus practically maintained. As has been explained to you on previous occasions, the policy of the Directors has been to make regular reductions in the charges to consumers, and the large reduction made some two years ago has already borne good fruit, for the value of the return per 8 c.p. lamp, which fell from 9s. 6d. in 1898 to 9s. 2d. in 1899, has in the past year risen again to 9s. 8d., which proves, I think, that the extra amount of electricity consumed at a lower price will more than make up for the actual loss incurred in making such reductions. Similarly, the larger output, together with the better economies which are from year to year effected in our methods, have enabled us in spite of the large increase in the cost of coal, not only to prevent an increase in the cost to us of our supply, but even to effect a small reduction. This, you will agree, is an altogether healthy sign. Unfortunately this advance in the price of fuel will be felt in equal measure in the current year, for although hand to mouth supplies might now perhaps be obtained at a lower figure, it is necessary for this Company, having important public responsibilities, to safeguard the continuity of its fuel supply by regular contract. We have, too, on the current year to face a very serious addition to our rates; in fact, an increase in actual money to be paid from £2,829 to £5,700. In view of the extra expenditure on these two items, it has been decided to make no further alteration in the charges for the present, but to devote the current year to strengthening and consolidating our resources, and in pushing on with the important extensions which we have in hand, so that everything may be ready to undertake promptly and efficiently the large increase in business which we confidently anticipate has yet to come to us. These extensions, as you are aware, consist of the works now approaching completion on this station, and of the new works of the Central Electric Supply Co. at Grove-road, and you will no doubt like to have a few particulars of these. The extensions at Carnaby-street station will be finished and complete in ample time for the next winter's supply, and consist of a second chimney shaft, a large boiler-house and engine-room, with yard for coaling, workshops, and other conveniences, which have been very much needed. The whole of the large floor space above this engine and boiler house is prepared for the plant to be used in connection with the supply from the Central Company. This Company, in conjunction with the Westminster Electric Supply Corporation, takes a half share in the construction and equipment of the works of the Central Electric Supply Co. at Grove-road, which will be employed for the service of the two companies after their present resources within their respective districts have been exhausted. The first section of the new works is in process of erection, and orders have been placed for engines and boilers and the necessary electric plant, so that everything may be finished and in readiness in good time to meet the requirements of the two companies. There is necessarily on these works a

large expenditure of capital, which for the moment cannot, of course, have any earning value, but the Directors, with their advisers, have prepared careful estimates, and, looking at the results already obtained during the past year, have every confidence that the whole scheme can be carried out to a successful issue without prejudice to the position of the Company and of its shareholders, and that, when it has been completed, the Directors will be in a position, not only to undertake all business that may be brought to them, but to continue their policy of a cheap service to their consumers and a safe and steady return to the shareholders. During the year £150,000 of 3½ per cent. debenture stock was issued at 96 per cent., and fully subscribed. The discount and expenses have been debited to capital reserve in the same way as the premiums on previous issues. The question of a further issue of capital to carry out the scheme which I have already detailed to you will have to be faced before long, and I need hardly say that this matter will receive the most careful consideration at the hands of the Board. The question of the interest suspense fund requires a little explanation beyond what is contained in paragraph 6 of the report. This Company and the Westminster Company have made large advances to the Central, on which, had they been obtained by way of loans from bankers, interest would, of course, have been paid. In the view of the Board and the Company's auditors, the same charge to the Central Company should be made on these loans. The auditor of the Board of Trade, on the other hand, regards the charge as rather in the nature of a dividend, and therefore not payable till the Central Company is at work and earning profits. Your Board dissent from this view; but as the Company is fortunate enough not to require to snatch at immediate profits, and as we are all anxious that there should not be on our accounts a single item open to question, we think it desirable that all this interest, amounting in 1899 to £1,582. 5s. 9d., and increased during 1900 to £2,694. 11s. 2d., should be set aside till the time comes when our right to deal with it will be unquestioned. I have, in conclusion, to express the great regret of Mr. Marlborough Pryor that he is unable to be present to-day. A short time ago he found it necessary to go to South America on business, but he will be back soon, and will then return to his duties on the Board. I now move the adoption of the report and accounts, and the payment of the dividends therein set out and bonus.

Mr. WALTER LEAF (Vice-Chairman): I beg to second that.

Mr. C. R. FRY said he thought the accounts showed that the policy inaugurated by the Board two years ago, and to which some of the shareholders objected, was wrong and had led to bad finance. The Chairman had drawn no attention to the net profits.

Mr. C. R. FOSTER asked in what relation the Pall Mall Company stood to the Central Electric Supply Co. (Ltd.).

The CHAIRMAN: The Central Electric Supply Co. are the landowners, and this Company are part shareholders.

Mr. FRY: Who are the Directors of the Central Supply Company?

The CHAIRMAN: In reference to the net profits, I cannot agree with Mr. Fry. I am certain that the policy we are pursuing is the right one, and will, in the end, lead to your getting a larger return on your capital. Mr. Freeman has asked about the coal supply and the probable increase of revenue from the new works. I cannot answer the second question because I dislike stating my anticipations as to profits, but in reference to coal I may say that, at the time of the recent crisis, there was a contract entered into from October 1st to midsummer—one contract runs through to them. We were obliged to make that contract to get the coal at all. Some companies failed to get coal and had injunctions applied for against them.

Mr. LEAF: The Central Electric Supply Co. is governed by a joint Board, three Directors from each company—this Company and the Westminster Corporation—with Mr. Eustace Balfour as Chairman.

The resolution was then carried.

The retiring Directors, Messrs. Walter Leaf and Bennett Fitch, were then re-elected, and Messrs. Deloitte, Dever, Griffiths & Co. were reappointed as auditors.

The CHAIRMAN: That concludes the business of the general meeting, but there is just one matter before we pass to our special meeting. I did not say, in my original remarks, anything about our staff. Nobody knows better than I do, and the other Directors, what a magnificent staff it is, and how splendidly every member of it works, and with what extreme conscientious care they look after your interests. I propose a vote of thanks to Mr. Walker, Mr. Dobson and the rest of the staff.

Mr. FRY: It would give me much pleasure, if I may be allowed, to second that motion. When one considers what our staff has done, especially the engineering staff, I think we must all feel grateful to them. We are greatly indebted to Mr. Dobson for his management of that system which he has always advocated. I refer to what is commonly known as the low-pressure system, because if we had adopted the high-pressure system I think we should not be in anything like the same satisfactory state that we are to-day. I beg to second the proposition.

The resolution was carried.

An extraordinary general meeting was then held, at which certain amendments of the Articles of Association, to bring them into line with the new Companies' Act, were approved, and the proceedings terminated.

## Kensington and Knightsbridge Electric Lighting Co. (Ltd.).

The ordinary general meeting of this company was held on Wednesday, under the presidency of Mr. GRANVILLE R. RYDER.

The SECRETARY (Mr. R. S. Erskine) read the notice calling the meeting, and the report of the Directors was taken as read.

The CHAIRMAN, said: Gentlemen, I think it is satisfactory that we are able to pay you a good dividend of 12 per cent., and to carry forward the substantial sum of £4,712. At the same time I must say that it seemed to me at first sight that the accounts were not altogether satisfactory. It appeared to me that the expenses were excessive compared to the increased amount of electricity that we had sold; but on looking into the accounts you will find that a much larger sum has been paid for coal. In fact, coal has cost us something like £2,000 more this year than it cost us the year before; and in the final three months of last year the weather in London was unusually light and free from fogs, and, therefore, we sold something like £2,000 less of electricity than in the corresponding three months of the previous year. The lighting of houses and shops has increased in numbers during the year by 214, while the number of lamps has increased by 15,635. During the year the electricity sold amounted to 2,630,482 units as against 2,463,950 in 1899, being an increase of about 166,000; but at the same time there was a very large increase—a disproportionate increase—in the cost of producing that amount of electricity. It cost £37,325 last year, as against £33,853 the year before, but that is shown at once in the price of coal, the cost of which last year was £8,603, whereas it was only £6,558 in the year before. With respect to the renewal account, we have put to it £7,594. The estimated depreciation during the year is £13,762, but the amount actually spent on renewals and repairs was £6,167, leaving the sum of £7,594, which has accrued to that account, making £37,974 standing to the credit of the renewal account. The capital has been increased during the year by the sum of £16,565 by the issue of 5 per cent. second preference shares, increasing the amount from £33,435 to £50,000. Those shares were issued at a premium of £1,656, which has been written off against the Kensington Court account, which was rather a "dead" account. At the same time the sum of £818, which was a kind of "windfall" that we received in the settlement with Mr. Lane Fox, has been taken to the credit of the mains account. With respect to the new generating station which has been constructed in conjunction with the Notting Hill Electric Lighting Co. (Ltd.), I am happy to say that it is quite approaching completion. We have already received a certain amount of electricity from it, and we expect that in two months it will be in full working order. The capital has been found for that by the issue of 4 per cent. debenture stock guaranteed jointly by the two companies and with a sinking fund over the 30 years for which it has to run. Up to the end of the year £84,479 had been taken up out of the £100,000 which has been syndicated. We anticipate very great results from this new generating station when it is in full working order, both in convenience and also in the cost of producing electricity. During the year we have created a new transformer station, intending to discontinue the one in Queen's-terrace-mews. The new station is at the back of the Albert Hall, and is in every respect convenient, well found, and well equipped. That is finished. With respect to the new capital subscribed by the shareholders to the amount of £30,000, that brings our ordinary share capital up to £105,000. We expect very shortly to get a quotation from the Stock Exchange, which will, no doubt, facilitate the sale and probably increase the price of our shares. I do not know that there is anything else I have to say, but I shall be very happy to answer any questions.

Sir F. J. BRAMWELL, Bart., F.R.S., seconded the motion, which was carried unanimously without discussion.

The CHAIRMAN afterwards proposed a resolution approving the payment of the interim dividend of 6 per cent. for the half-year ended June 30 last, and the payment, on and after the 14th inst., of a further dividend of 6 per cent. for the half year ended Dec. 31 last.

Sir CHARLES GRANT, K.C.S.I., seconded the resolution, which was carried unanimously.

The retiring Directors, Mr. A. S. Bolton and Sir F. J. Bramwell, were re-elected, as were also the auditors, Messrs. Price, Waterhouse & Co.

A vote of thanks to the Chairman and Directors was afterwards passed, and the proceedings terminated.

## Central London Railway Co.

The eleventh ordinary general meeting of this company was held on Wednesday, under the presidency of Sir HENRY OAKLEY.

The CHAIRMAN, in moving the adoption of the report, stated that the number of shareholders had increased during the half-year from 2,008 to 2,381. After a sympathetic reference to the death of Her late Majesty, and reminding the shareholders that the King, when Prince of Wales, opened their railway, the chairman stated that the capital expenditure during the half-year had been £158,000, of which £127,000 was paid to the contractors, the balance having been expended on sundry works enabling them to conduct the service better. With reference to the progress of the company, at the time of their last meeting the line had only been open a few days. They began with carrying an average of 80,000 passengers a day, but up to the end of December the number carried averaged 101,000 daily, including Sundays, and for the past month the daily average had been 106,000. A few interruptions had occurred owing to failures of some small portions of the electrical machinery, but the traffic had only been momentarily interrupted, and no real inconvenience had been caused to the public. The directors were gaining experience every day in the management of the line. He had no doubt that they would continue to attract an increasing number of passengers from whom very few complaints were received. He had little doubt that they would be able to make their undertaking—as they intended at the start—a model for all future underground railways. During the five months' working the number of passengers carried had been about 15,000,000, of whom rather less than 1,500,000 were workmen who booked before half-past seven in the morning, and who were carried at a return fare of 2d. The traffic between stations and for comparatively short distances was steadily increasing, and what they called their daily traffic, that was, their Oxford-street or shopping traffic, was thriving admirably, being only interrupted, in fact, by unfavourable weather. The only points about

which the directors had been in doubt were being gradually cleared up. At certain times in the morning and evening many of their trains were too crowded, but overloading under present arrangements was unavoidable. The manager and many of the directors had been to Paris to see the working of the underground railway there, and they found that it had been constructed with a loop at each end of it, which enabled the trains to be run round continuously. Such a loop at Shepherd's Bush would cost only between £50,000 and £60,000, but in the City the cost would be far more serious—about £400,000. Nevertheless, the directors were satisfied that the company would be repaid for the outlay by the additional traffic they would obtain if they constructed a loop in the City and provided an additional station at Liverpool-street, and, acting under the advice of the engineers, a bill had been deposited in Parliament asking for power to construct the loops mentioned. The gross receipts of the company for the five months had amounted to £118,000, and their earnings per train-mile had been 4s. 10½d. Comparing this with the average earnings of other similar railways, they found that they were in a very satisfactory position indeed, earning more per passenger and considerably more per train-mile than any other electric railway of which they had been able to obtain information. The expenditure was more than they had hoped it would be, but in the first two or three months, until the line was got into good working order, they had made the question of expense subordinate to that of efficiency. They believed that every half-year an improvement would be seen in regard to the cost of working. In the one item of coal he believed they were expending £200 a week more than they would have to spend under normal conditions. Under the circumstances stated, however, they had really earned a dividend of 3 per cent., for the five months, but they would be obliged to declare only 2½ per cent. as they had no power to pay this half-year any further interest out of capital. They would probably at a future date recommend the shareholders to assent to the establishment of a fund to meet depreciation instead of setting aside an amount each half-year for renewals.

In the discussion which followed several shareholders took part, attention being chiefly drawn to the question of fares, some of the speakers supporting an increase, while others regarded the present system of a uniform fare as best in the interests of the company.

The CHAIRMAN replied, and stated that the decision of the directors to charge a uniform fare was only arrived at after full consideration; but they were above prejudice in regard to this question, and if they should find that the fares were not remunerative, they would have no hesitation in altering them. The law suits alluded to had reference to questions of damage alleged to have been caused during construction, but any compensation that might have to be paid on this account would fall on the contractors; nor did the directors believe that there was any liability on the company in regard to the question of vibration.

The report was adopted, and resolutions were afterwards passed declaring the dividend recommended, approving the bill referred to, and authorising the conversion of the shares into capital stock.

## National Telephone Co. (Ltd.)

The report of the directors for the half-year to Dec. 31 is issued, and states that the income for the half-year amounted to £732,093. 4s. 1d., compared with £663,523. 1s. 11d. for the corresponding period of 1899. The working expenses amounted to £404,652. 16s., compared with £359,302. 14s. 5d., the net result (after deducting the Post Office royalties amounting to £71,609. 2s. 5d.) being a profit balance of £255,831. 5s. 8d., compared with £240,043. 19s. 6d. for the December half-year of 1899. The rentals carried forward for unexpired terms of running contracts amount to £696,568. 5s. 7d., compared with £631,590. 5s. 9d. Out of the available balance of £204,697. 19s. the board recommend the payment of a dividend at the rate of 6 per cent. per annum (less tax) on the first and second preference, 5 per cent. per annum (less tax) on the third preference, and 5 per cent. per annum (less tax) on the ordinary shares. £85,000 is transferred to reserve; £5,697. 19s. carried forward.

£468,548. 9s. 10d. has been expended on capital account during the half-year in the erection of 11,794 additional exchange and private lines, and in the construction of underground lines.

In reviewing the progress of the business during the half-year, as well as that of the entire year 1900, several important considerations present themselves. In the year, 23,490 additional exchange and private lines have been erected—a larger number than in any previous year. Of these, 16,776 have been for subscribers on the message rate system—paying a low annual charge in respect of the cost of installation, and an additional 1d. for each call made. So far as this experiment has gone, it has had the effect of reducing the average receipt per subscriber without any commensurate reduction in the working expenses. Indeed, the working expenses, in the whole, have considerably increased, owing largely to an exceptionally heavy outlay in repairing damages caused by the snowstorm in the early part of the year.

The report proceeds: "The effort to popularise the telephone may possibly justify the message rate business when it has been further developed. Meanwhile interest on the large capital expenditure involved at once accrues, and tends to diminish the balance available for dividend. The policy of the company in the face of possible competition must, however, be to maintain the effort to attract new subscribers and increase as far as practicable the universality and efficiency of its services. These reasons, amongst others, have weighed with the board in the decision to recommend the payment of a dividend for the past half-year at the rate of 5 per cent. per annum, so as to enable a reasonably large sum to be carried to reserve."

At the shareholders' meeting on Thursday, Feb. 21, resolutions will be proposed authorising the directors to convert the 590,000 fully-paid ordinary shares and 10,000 of the unissued ordinary shares (when the same shall have been issued and fully paid) into one-third preferred and deferred stock, the preferred stock to carry a fixed non-cumulative dividend at the rate of 6 per cent. per annum, and, in the event of the winding-up of the company to rank for repayment of capital, together with a bonus of 5 per cent. in priority to the deferred stock. The deferred stock to confer a right to the surplus profits, and, in the event of a winding-up, to the surplus assets of the company, to which the holders of the ordinary shares would, but for this conversion, have been entitled. And, further, that the board shall be authorised to issue 200,000 of the unissued ordinary shares as preferred shares, ranking with the preferred stock referred to in the first resolution, and to convert the shares so issued, when fully paid, into preferred stock.

It is also proposed to modify the articles of association so that, upon any offer of shares to the public for subscription the company may pay a commission, at a rate not exceeding 5 per cent., to any person in consideration of his subscribing, or agreeing to subscribe, whether absolutely or conditionally, for any shares in the company, or procuring or agreeing to procure subscriptions, whether absolute or conditional, for any such shares.

The following table gives interesting particulars of the income, working expenses, royalties paid to Post Office, percentage of working expenses, &c., for the seven years, 1894-1900:—

| Year ending Dec. 31. | Income accrued in respect of business of year. | | | Less Post Office royalties. | | | Net income. | | | Working expenses. | | | Net result for year. | | | Percentage working expenses to net income. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | £ | s. | d. | |
| 1894.. | 738,680 | 16 | 6 | 67,222 | 13 | 8 | 671,458 | 2 | 10 | 392,281 | 17 | 2 | 279,176 | 5 | 8 | 58·42 |
| 1895.. | 819,084 | 14 | 1 | 74,674 | 13 | 1 | 744,410 | 1 | 0 | 424,164 | 12 | 8 | 320,245 | 8 | 4 | 56·98 |
| 1896.. | 870,745 | 18 | 0 | 79,266 | 15 | 9 | 791,478 | 19 | 9 | 469,972 | 13 | 1 | 321,506 | 6 | 8 | 59·37 |
| 1897.. | 964,556 | 14 | 11 | 89,238 | 16 | 1 | 875,317 | 18 | 10 | 544,882 | 2 | 2 | 330,435 | 16 | 8 | 60·80 |
| 1898.. | 1,119,666 | 5 | 0 | 101,029 | 18 | 7 | 1,018,636 | 6 | 5 | 615,565 | 11 | 2 | 398,072 | 15 | 3 | 61·92 |
| 1899.. | 1,266,163 | 5 | 1 | 123,061 | 6 | 7 | 1,143,101 | 18 | 6 | 686,800 | 12 | 5 | 456,301 | 6 | 1 | 60·08 |
| 1900.. | 1,432,096 | 6 | 7 | 140,074 | 7 | 11 | 1,292,021 | 18 | 8 | 808,180 | 16 | 6 | 484,441 | 0 | 2 | 62·52 |

## Liverpool Overhead Railway Co.

The half-yearly meeting was held at Liverpool on Tuesday.

The DEPUTY CHAIRMAN (Mr. Richard Hobson) presided, and said although their traffic figures showed that they had carried a larger number of passengers during the past half-year than in the corresponding period of 1899, as a matter of fact that was elusive to this extent, that it included the passengers carried during the past half-year on the tramways. The number carried on the railway proper showed a considerable diminution. But there was no cause for discouragement or thinking that the railway was losing its popularity. On the contrary, compared with 1898, there was a small difference in the traffic proper on the railway, although then they were running to the Dingle without the opposition of the Corporation electric tramways. Their own tramway lines to Great Crosby had answered their expectations in every way, a substantial profit being earned after meeting all incidental charges, including interest on capital outlay. When they decided to construct the tramway they did not consider they were going to make a great amount of money out of it, but they thought it would be of the greatest value as a feeder of the railway, and it had realised expectations in that respect. Their expenses had increased as well as their traffic. They hoped soon to get to work with the promised accelerated train service, and had every reason to suppose that the result of that would be very beneficial to the company, not only as giving a quicker service to the public, but in the matter of cost of working.

## Bristol Tramways and Carriage Co. (Ltd.).

The report of the directors for the year ended Dec. 31, 1900, states that the gross receipts amounted to £165,115. 15s. 7d., and working and general expenses and renewals to £110,794. 12s. 3d., leaving a net revenue of £54,321. 3s. 4d. After deducting £31,944. 12s. 9d. for interest on mortgage debenture stock, dividend on preference shares, and interim dividend on ordinary shares, it is proposed to pay a dividend at the rate of 8½ per cent. per annum on the ordinary shares (absorbing £20,187. 10s. and making 8 per cent. for the year), and to carry to reserve and renewals £2,189. The receipts from the tramways department show an increase of £4,270, and those of the carriage department £2,126. The total number of passengers carried during the year by the company was 26,971,606. The electrical conversion and extension of the tramways, as well as the building of the central power station and additional depôts have been completed, involving the expenditure of £650,000. In consequence of delay on the part of contractors in the delivery of the plant, the general opening of the new system for public traffic was not possible until the end of December.

GUERNSEY RAILWAY CO. (LTD.)—The directors' report for the year ended Dec. 31 states that the expenditure on capital account had been £45. 15s. 8d. on equipments and £162. 18s. 9d. on a new boiler house. The railway traffic receipts amounted to £5,408. 16s. 10d., against £5,637. 1s. 10d. in 1899. The gross receipts of the railway department amounted to £5,963. 2s. 5d., compared with £5,968. 10s. 5d. in 1899. The working expenses showed a decrease of £185. 1s. 11d. The profit on engineering and foundry work showed the satisfactory increase of £154. 12s. 6d., and redounded largely to the credit of the manager (Mr. A. L. Davis) for his ability in planning and superintending almost all kinds of engineering work. In addition, the company had benefited to the extent of £89. 7s. 4d., through the professional services of Mr. Davis as States consulting electrical engineer, &c. Out of the amount at credit of net revenue (£1,084. 14s. 6d.), after paying debenture interest (£360), writing off £605, placing £300 to general renewals reserve, and providing for a dividend of 5 per cent. on the preference, the directors recommend a dividend of 4 per cent. on the ordinary shares, leaving £66. 6s. 10d. to be carried forward. Mr. C. J. Anderson has resigned from the board, owing to his leaving the island.

**METROPOLITAN DISTRICT RAILWAY CO.**—The directors' report for the half-year ended Dec. 31 states that the proceedings at the special general meeting of the company on Jan. 7 to authorise the raising of capital for the "electrisation" of the company's railways had been printed and sent to all classes of share and debenture holders. On that occasion the causes which have led to the deplorable falling off in the traffic and revenue were fully set forth, and were properly attributed almost wholly to the competition of the Central London Railway and the novel principles upon which that company had started its business. These may in the particular circumstances prove to be sound, but may still be very difficult of application to lines situated as the District and Metropolitan are, with their extensions east and west and their complicated relations with other companies. The questions involved (continues the report) must not be solved in panic. Apart from the vital question of adopting electric traction, there may be found means of qualifying in favour of the older companies the severity of the competition now existing. Having regard to the resolutions passed at the extraordinary meeting, the directors believe that it may not be necessary to proceed with the financial clauses of the bill deposited by the company, but as it contains further powers with regard to the electrical working and some minor matters it may be found necessary to submit it to the proprietors in Wharncliffe meeting at a future date. Numerous bills have been deposited in Parliament by various promoters for the construction of electric railways, some of which if sanctioned would seriously affect the District Railway. Bills have also been deposited by the London County Council and others for the construction of electric tramways, which would also compete with this company's railway. These bills will be carefully watched, and all necessary steps taken to protect the company's interests.

**SCARBOROUGH ELECTRIC SUPPLY CO. (LTD.).**—The annual meeting of this company was held on Friday last. The report of the directors stated that the number of consumers had increased to 592, from 465 in 1899; the equivalent number of 8 c.p. lamps connected to 33,343, from 27,171; and the units sold to 331,266, from 257,412. The total revenue amounted to £7,788. 4s. 0½d., against £6,235. 12s. 11½d. The balance to be disposed of (£3,721. 2s. 5d.) the directors recommended should be dealt with as follows: Depreciation, £529. 18s. 1d.; dividend at 6½ per cent. per annum, £3,088. 10s. 6d.; carried forward, £102. 13s. 11d. The capital expenditure stands at £53,193. 17s. 9d., an increase of £9,120. 10s. 2d. during the year. The outlay has been mainly incurred in enlarging buildings and in making additions to the plant at the generating station. Of the 5,000 additional shares mentioned in the last report 1,000 have been issued, and £6 per share had been called up thereon up to Dec. 1, 1900. The report and accounts were adopted.

**SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.).**—The first annual general meeting was held at Liverpool on Monday. The chairman (Sir John A. Willox, M.P.) said the prospectus was issued in December last, when debenture and preference shares were offered for public subscription. The directors allotted the applicants £500,000 of debenture stock, in respect of which £111,992 had already been received in cash. A great deal of preliminary work had to be done before the construction of the lines could be commenced. That preliminary work was well in hand. An efficient staff of engineers had been appointed, and they were busy in the detailed survey of the routes and in preparing plans and specifications. In a short time the directors would be in a position to invite tenders for the construction and equipment of the lines. The first section to be taken in hand would be the line from Prescot to Liverpool. St. Helens would be connected with Liverpool by electric tramways. They hoped the Corporation of Liverpool would lose no time in making the short connecting link between Old Swan and Knotty Ash, and they were sanguine enough to hope that this through line from St. Helens to Liverpool would be in actual operation before next summer. The next sections to be taken in hand were those from Haydock through Newton-in-Makerfield, Lowton, Leigh, and Atherton to Bolton, from Bolton to Westhoughton, Hindley, Abram, Ashton-in-Makerfield, to Haydock; from Hindley, Hindley Green, Atherton, to Tyldesley. The generating station would be erected at Leigh, and would be equipped with electrical plant sufficient to operate the whole of the system detailed above. The lines indicated covered 35 miles of track. The local authorities through whose district the lines pass could do much to assist in facilitating progress. The policy of the directors would be to co-operate cordially with the local authorities and to work with them for the interests of the public. The teeming population of South Lancashire desired cheap and rapid travelling accommodation, and the company was prepared to provide such facilities, looking with confidence to the local authorities to assist in realising that hope.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BECK AND MOSS (LTD.).**—Registered Feb. 1, with a capital of £2,500 in £1 shares, to acquire the Faraday works and premises belonging to William Moss, electro-metallurgist, Cannon-street, Hanley, and the goodwill of the business of electro-metallurgists carried on by William Moss and Karl P. Beck, trading as Beck and Moss, also the goodwill of the business of electro-metallurgists carried on by Joseph B. Parry and Richard Larsen, as Larsen & Co. at Elm-street, Hanley, and to carry on the business of electro-metallurgists, enamellers, electrical and general engineers, nickel mounters and spinners, art metal workers, &c. The subscribers are William Moss, electro-metallurgist (700 shares); Karl P. Beck, electro-metallurgist (600 shares); J. B. Parry (300 shares); R. Larsen, electro-metallurgist (425 shares), F. A. Groom (50 shares); S. A. Green (100 shares); and G. G. Quinn, science teacher (100 shares). The first directors are William Moss, Karl P. Beck, Joseph B. Parry, Richard Larsen and Henry Howlett.

**BRABY AND TOMLINSON (LTD.).**—Registered Feb. 8, with a capital of £10,000 in £10 shares (900 preference), to acquire the business now carried on at 15, Hart-street, Bloomsbury, W.C., as Pritchetts and Gold, and to carry on the business of electrical and mechanical engineers, contractors for the supply and fixing of lamps, motors, bells, telephones, telegraphs, &c. The subscribers are I. Braby (electrical engineer), E. T. Tomlinson (electrical engineer), A. Child, W. Braby (zinc merchant), H. C. Winchworth, E. Morgan (electrical engineer), and N. Braby. The first directors are I. Braby and E. T. Tomlinson and another to be appointed by them.

**CITY AND SUBURBAN ELECTRIC CARRIAGE CO. (LTD.)**—Registered Feb. 9, with a capital of £500 in £1 shares, to carry on the business of cycle, carriage, &c., builders, electricians, mechanical engineers, suppliers of electricity for motive power, traction, light and heat, &c.

**LONDON AND PROVINCIAL ELECTRIC CONSTRUCTION CO. (LTD.).**—Registered Feb. 5, with a capital of £75,000 in £1 shares, to apply for, obtain and deal with any parliamentary powers or other rights or concessions relating to the incorporation of a company or companies for the construction of underground and overground railways and tramways to be worked by electricity, to carry on the business of railway, tramway, omnibus proprietors, electricians, electrical and general engineers, &c., and to adopt an agreement with Louis Bernt.

**OKONITE CO. (LTD.)**—Registered Feb. 7, with a capital of £120,000 in £2. 10s. shares (32,000 preference), to acquire the undertaking of the Okonite Co. (Ltd.) (in liquidation), with the assets and liabilities thereof (excepting the debentures issued by the company in liquidation), to manufacture and deal in insulated and other wires and cables, and to carry on the business of manufacturers of and dealers in okonite and other insulating materials, engineers, electricians, contractors, &c. The first directors are F. C. Jones, H. D. Cleaver, W. L. Candee, J. H. Cheever, and W. F. Gaston.

**WALTER SCOTT AND MIDDLETON (LTD.)**—Registered Feb. 7, with a capital of £250,000 in £10 shares, to adopt an agreement with W. Scott, J. T. Middleton, C. T. Scott and T. T. Middleton, to carry on the businesses heretofore carried on by Walter Scott & Co., and to construct, equip, develop and work railways, tramways, electrical and other works, &c. The first directors are Walter Scott, John T. Middleton, Charles T. Scott and Thomas T. Middleton (all permanent ordinary directors), and Walter Scott and John T. Middleton are also managing directors.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4½ per cent. (Feb. 7, 1901). Price of silver 27$\frac{13}{16}$d. per oz. (Feb. 14). Consols (2¾ per cent.) 97$\frac{1}{16}$–97$\frac{3}{16}$ for money, 97$\frac{3}{16}$–97$\frac{5}{16}$ for account; 2½ per cent. 96¾–97¼ (Feb. 14). Consols Pay Day March 1. Stocks and Shares Continuation Days, Feb. 26 and Mar. 12; Ticket Days, Feb. 27 and Mar. 13; Pay Day, Feb. 28; Mining Share Carry-over Days, Feb. 25 and Mar. 11.

**CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)**—A dividend for the half-year ended Dec. 31 at the rate of 9½ per cent. per annum (making with the interim dividend distributed for the half-year to June 30 last, 9 per cent. on the ordinary share capital for the year) is recommended by the directors. The lamps connected during the past year amounted to the equivalent of 39,431 8 c.p. lamps.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | | Amount. | Inc. or Dec. | No. of weeks. | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|---|
| | 1900–1 | | £ | £ | | £ | £ |
| Aberdeen Corporation... | Feb. | 2 | 512 | – 11 | 35 | 24,257 | + 3,254 |
| *Birmingham Tramways. | „ | 9 | 4,030 | + 318 | 5 | 19,818 | + 176 |
| *Blackburn Corporation.. | „ | 9 | 299 | – 27 | 5 | 2,183 | + 195 |
| Blackpool Corporation... | „ | 7 | 143 | + 10 | 45 | 29,190 | + 7,695 |
| Blackpool and Fleetwood | „ | 9 | 139 | + 11 | 6 | 814 | – 55 |
| Bolton Corporation ...... | „ | 10 | 1,302 | ... | 45 | 60,797 | ... |
| Bradford Corporation... | „ | 10 | 761 | + 466 | 45 | 27,010 | + 9,743 |
| Brisbane Trams ......... | Dec. | 26 | 2,539 | + 300 | 25 | 48,144 | + 8,637 |
| *Bristol Trams & Carriage | Feb. | 8 | 3,321 | + 958 | 6 | 21,606 | + 5,877 |
| *Buenos Ayres & Belgrano | Jan. | 13 | 2,708 | + 427 | 2 | 6,032 | + 1,097 |
| Carlisle Trams. Co. | Feb. | 9 | 100 | ... | 6 | 659 | ... |
| Central London Railway | „ | 9 | 6,129 | ... | 6 | 36,707 | ... |
| City & South London Ry. | „ | 10 | 2,020 | + 871 | 6 | 11,999 | + 5,260 |
| Cork Elec. Trams ......... | „ | 7 | 335 | + 56 | 5 | 1,843 | + 111 |
| Dover Corporation ...... | „ | 9 | 152 | + 11 | 45 | 9,709 | + 613 |
| Dublin & Lucan Rly. ... | „ | 9 | 86 | + 37 | 6 | 419 | + 109 |
| Dublin United ............ | „ | 8 | 2,964 | + 263 | 6 | 9,239 | + 2,073 |
| Dublin Southern Dist.... | „ | 8 | 632 | + 87 | 6 | 4,472 | |
| *Dundee Corporation ... | „ | 6 | 452 | + 109 | 38 | 17,527 | + 2,379 |
| *Glasgow Corporation ... | „ | 9 | 8,189 | – 736 | 6 | 54,161 | + 2,790 |
| Hull Corporation......... | „ | 9 | 1,569 | + 865 | 32 | 45,969 | +24,[illegible] |
| *Liverpool Corporation... | „ | 2 | 7,348 | + 877 | 5 | 39,499 | + 6,402 |
| Liverpool Overhead Rly. | „ | 10 | 1,516 | + 171 | 6 | 8,913 | + 16 |
| Portsmouth Corporation | „ | 9 | 600 | – 153 | ... | ... | ... |
| *Sheffield Tramways ...... | „ | 10 | 2,852 | + 1,232 | 6 | 16,200 | + 5,460 |

* Partly electrical.

**DUBLIN UNITED TRAMWAYS CO. (LTD.)**—At a meeting on Tuesday, the chairman (Mr. W. M. Murphy) said the Dublin United Tramway system receipts showed an increase of £12,639 during the half-year. The Southern District Company's accounts for the Dublin and Dalkey line showed an increase of £1,119 in the receipts. The net profits of both systems made a total of £53,722 for the half-year. The company were appealing to the highest tribunal on the question of their liability to sand the streets, and hoped to get the decision reversed in their favour.

**EASTERN TELEGRAPH CO.**—An extraordinary general meeting of this company was held on Wednesday, under the presidency of Mr. J. Denison-Pender, when the resolution passed at the extraordinary meeting held on Jan. 28 was confirmed asa special resolution.

**NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)**—This company, which has a capital of £200,000 in £1 shares, has made an issue of 100,000 shares. The lists closed yesterday (Thursday).

**NORTH STAFFORDSHIRE RAILWAY CO.**—At the half-yearly meeting, on Tuesday, the chairman (Sir T. Salt, Bart.) said there had been a decrease of 400,000 in the number of passengers, representing £2,000 in fares, and this decrease was entirely due to the competition of the electric tramways in the district. They must not complain, however, as the electric trams were a great convenience to a district like the Potteries, and they hoped that in time the trams would prove not competitors but feeders to their more important stations.

**SANITAS CO. (LTD.)**—The balance to credit of profit and loss account to Dec. 31 is £15,526, and the directors propose to place to depreciation £500, to reserve £1,500, and recommend payment of a further dividend of 4½ per cent. and a bonus of ½ per cent., making, with interim dividend, a total distribution of 7½ per cent. for the year. £2,016 is carried forward.

**STOCK EXCHANGE NOTICES.**—Application has been made to the Stock Exchange committee to appoint a special settling day in and to grant a quotation to 13,363 6 per cent. cumulative preference £5 shares of *Edmundsons' Electricity Corporation (Ltd.)*, and to allow the same, as well as 20,000 ordinary £10 fully-paid shares (Nos. 1 to 20,000) and £250,000 4½ per cent. first mortgage debentures of £40 each (Nos. 1 to 6,250) of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted in the official list. The latter is a renewed application.

**WIGAN AND DISTRICT TRAMWAYS CO. (LTD.)**—The directors' report states that their application for the construction of a light railway from Newtown to Ashton-in-Makerfield has been approved by the Light Railway Commissioners, and the order has been submitted to the Board of Trade for confirmation. Negotiations with local authorities are pending with regard to the extension of leases, and the conversion of the tramways to electric traction.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 6. | | Price Wednesday, Feb. 13. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Feb. 13. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ½ | ⅝ | ½ | ⅝ | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13½ | 13½ | 13½ | 3 16 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 103 | 103 | 100 | 103 | 4 7 5 | ... | ... | ... |
| 19,061 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7 | 8 | 7½ | 8½ | 3 10 7 | ... | 7½ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 9½ | 9½ | 3 13 6 | March and September | ... | ... |
| 20,000 | 5 | 1/3 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 6½ | 6½ | 7 | ... | ... | ... | ... |
| 80,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 8 1 | February and August | 10 | ... |
| 80,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6½ | 6½ | 6½ | 3 18 3 | " " | 5½ | ... |
| 24,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6½ | ... |
| £130,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 107 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,670 | 10 | 6/0 | City of London Electric Lighting Ord. | 7½ | 8½ | 7 | 8 | 5 0 0 | February and August | 8 | 7½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 18 9 | June and December | ... | ... |
| £100,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (60% pd.) (red.) | 61 | 63 | 61 | 63 | ... | ... | 62½ | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 30,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | ... | ... |
| 10,100 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10½ | 11½ | 11 | 12 | 4 7 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. [Deb. Stk. (red.)] | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| £ 3,000 | Stock | 22/0 | Kensgtn. & Kngtsbg. Cont. Notting Hill Co. (Jnt. Stn.) 4% | ... | | 102 | 104 | ... | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | 1½ | ... |
| 40,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £ 80,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 12 | 13 | 4 4 7 | April and October | 12½ | 12½ |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 5 | June and December | ... | ... |
| £180,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 10 8 | ... | 97½ | 97½ |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 15 | 16 | 15½ | 16½ | 4 4 10 | March | 15½ | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | 1⅛ | 1¼ | 1⅛ | 1¼ | 13 6 8 | ... | ... | ... |
| £185,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 70 | 80 | 63 | 73 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 190 | 4 8 11 | April and October | ... | ... |
| £113,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 104 | 103 | 105 | 4 7 5 | " " | ... | ... |
| 40,000 | 5 | 5/0 | St. James's and Pall Mall Electric Ordinary | 14½ | 15½ | 14½ | 15½ | 4 13 7 | February and August | 14½ | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | 9½ | ... |
| £150,000 | Stock | 10/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 11,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | 2⅛ | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | 3 | 2½ |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 39,100 | 5 | ... | Do. Do. | 11½ | 12½ | 11½ | 12½ | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 15,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 6% | Do. Cumulative Preference (fully pd.) | 10½ | 10½ | 10½ | 10½ | 5 13 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 15,000 | 10 | 5/0 | British Columbia Electric Railway 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 6 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 13½ | 14½ | 14 | 15 | 5 18 4 | ... | 14½ | 13½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11 | 13 | 12½ | 12½ | 4 6 11 | February and August | 12½ | 12½ |
| £340,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 121 | 123 | 4 1 4 | ... | 122½ | 121½ |
| 40,000 | 5 | 2/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ | 4½ | 4½ | 5 | ... | ... | 4½ | ... |
| £210,000 | Stock | 5% | Do. 6 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 95 | 93 | 85 | 93 | 5 7 0 | ... | ... | ... |
| 206,287 | 10 | 3/0 | Central London Ordinary | 8½ | 8½ | 8½ | 9 | 3 8 7 | June and December | 8½ | 8 |
| £356,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 50 | 54 | 47 | 51 | 2 9 0 | February and August | 51 | 49 |
| 37,500 | 10 | 1/3,1 | Do. Ordinary (Nos. 24,331 to 60,000) | 4½ | 5½ | 4½ | 5½ | 2 13 9 | " " | 4½ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 135 | 140 | 135 | 140 | 3 14 9 | " " | 13½ | 13½ |
| £200,000 | Stock | 5% | Do. (1896) | 130 | 135 | 130 | 135 | 3 14 1 | ... | ... | ... |
| £244,215 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 116 | 120 | 116 | 120 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | ... | Dublin United Trams (1896) Ltd., Ordinary | 13½ | 14½ | 13½ | 14½ | ... | ... | 14½ | ... |
| 53,987 | 10 | ... | Do. 6 per Cent. Preference | 15½ | 16½ | 15½ | 16½ | ... | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 20½ | 21½ | 21 | 22 | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 14 8 | " " | ... | ... |
| £200,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | 9½ | 10½ | ... | May and November | ... | ... |
| 37,400 | 10 | 3% | Liverpool Overhead Railway Ordinary | 8½ | 8½ | 8½ | 8½ | 4 11 2 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13½ | 13½ | 13½ | 13½ | 3 11 1 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 16 10 | January and July | ... | ... |
| $340,000 | $1,000 | 5% | London Street Rly. (Ont.) 1st Mort. 5% Debs. (red.) | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| £3[illegible],744 | Stock | 3½ | Lond. Utd. Trams 4½ 1st Mt. Db. Stk. Prv. Certs. (£ pd.) | 61 | 61 | 61 | 61 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 101 | 105 | 104 | 106 | 4 15 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 101 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 40,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | 15 | 17 | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | 10½ | 10½ | 4 13 0 | " " | ... | ... |
| 12,384 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | 12½ | ... |
| $10,000 | 10 | 5/0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | 10½ | ... |
| £125,000 | Stock | 37 0 | Do. 4½ per Cent. Debenture Stock | 102 | 105 | 102 | 105 | 4 5 9 | ... | 103 | 103½ |
| £140,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 1 9 | June and December | 9½ | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 6. | Price Wednesday, Feb. 13. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Feb. 13. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | Highest | Lowest |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 102 | 99 102 | 3 18 5 | January and July | ... | ... |
| 26,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 65 75 | 60 70 | ... | ... | — | — |
| £827,720 | Stock | 15/0 | Anglo-American | 55 56 | 56 57 | 5 12 9 | Feb., May, Aug., Nov. | ... | ... |
| £3,099,640 | Stock | 30/0 | Do. Preferred | 99 100 | 100 101 | 6 0 0 | " " | 101 | 100 |
| £3,099,640 | Stock | 27/0 | Do. Deferred | 9½ 9¾ | 9 9½ | 14 4 2 | " " | 9⅛ | 9½ |
| 13,333,300 | $100 | 8¼ | Commercial Cable Capital Stock | 170 180 | 170 180 | 4 9 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,039 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 104 | 102 104 | 3 16 11 | " " | 103 | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 8 9 | 8 9 | 6 3 3 | February and August | 8½ | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 17 | 16 17 | 5 17 8 | " " | ... | ... |
| 13,000 | 5 | 1/0 | Direct Spanish Ordinary | 3½ 4½ | 3½ 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | — |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 103% 104% | 100% 101% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 1/0 | Direct United States Cable | 10 10½ | 10 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10½ | ... |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 to 1,200) (red.) | 99 102 | 99 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 143 145 | 143 151 | 4 11 0 | Jan., Apr., July, Oct. | 150 | 141 |
| £1,626,000 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 92 93 | 92 94 | 3 11 5 | " " | 91½ | 95 |
| £1,452,300 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 103 113 | 113 115 | 3 9 7 | May and November | 111 | 112½ |
| 250,000 | 10 | 2/6 | Eastern Extension | 14 14½ | 14½ 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14¾ | 14⅛ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £4 pd., 15s. 0d. at 63pm, all pd | 13½ 14½ | 13½ 14½ | ... | ... | ... | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 110 115 | 110 115 | 3 9 7 | February and August | ... | ... |
| £900,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 103 | 99 101 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 100% 103% | 101% 104% | 3 17 8 | May and November | ... | ... |
| 150,227 | 10 | 1/0 | Globe Telegraph and Trust | 10 10½ | 10 10½ | 5 0 0 | Jan., Apr., July, Oct. | 10⅛ | 10½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 17 5 | " " | 16 | 15 |
| 180,000 | 10 | 5/0 | Great Northern of Copenhagen | 33 34 | 33 34 | 3 13 6 | January and July | ... | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos. 1 to 1,300) (red.) | 90 102 | 99 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 47 51 | 47 51 | 4 11 0 | May and November | 4[illegible] | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1934 | 104 107 | 104 107 | 5 13 1 | March and September | 105 | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 102 | 99 102 | 3 18 5 | June and December | ... | ... |
| 11,320 | 8 | 4/0 | Reuter's | 7 8 | 7½ 8½ | 4 14 1 | April and October | ... | ... |
| 3,361 | £100 Cert. | 6% | Submarine Cables Trust | 124 129 | 124 129 | 4 14 0 | " " | 121½ | ... |
| 15,600 | 10/0 | ... | West African Telegraph | 3½ 3¾ | 3½ 3¾ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 102 | 99 102 | 4 19 6 | March and September | ... | ... |
| 30,000 | 3½ | ... | West Coast of America | ½ 1 | ½ 1 | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 103 | 99 103 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ¾ 1 | ¾ 1 | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 6 7 | 8 11 6 | " " | 6¼ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 11 4 | January and July | ... | ... |
| 207,980 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 14 14½ | 14 14½ | 4 15 7 | Mar., June, Oct., Dec. | 14¾ | 14½ |
| £76,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 16 2 | June and December | — | — |
| £343,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 105 | 3 18 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 3½ | 3 3½ | 5 14 4 | August | 3⅛ | — |
| 214,000 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 3/9 4/3 | 3/6 4/3 | 6 13 4 | April and October | ... | — |
| 72,000 | 1 | 3½% | Monte Video Telephone Ordinary | ½ ¾ | ½ ¾ | 6 0 0 | November | ... | — |
| 26,432 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | — |
| 530,000 | 5 | 3/0 | National | 4 4½ | 4½ 4¾ | 6 17 2 | February and August | 4½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 14 | 13 14 | 4 5 9 | " " | 13½ | 13¼ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 13 | 11 13 | 4 12 4 | " " | ... | ... |
| 150,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 4½ 5½ | 4½ 5½ | 4 15 3 | " " | 4½ | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 97 | 95 97 | 3 12 2 | June and December | 96½ | 96½ |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 100 | 97 100 | 4 0 2 | ... | 101½ | 91 |
| 171,504 | 1 | 6/6 | Oriental | ¾ 1½ | ¾ 1½ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ 5½ | 4½ 5½ | 6 13 4 | July | 4½ | 4½ |
| 16,630 | 5 | 2/6 | Do. 6% Cumulative Pref. (Nos. 1 to 16,630) | 4½ 5½ | 4½ 5½ | 4 15 3 | June and December | 4½ | ... |
| 23,361 | 5 | 1/3½ | Do. do. (Nos. 16,640 to 40,000) | 4½ 5½ | 4½ 5½ | ... | ... | ... | — |
| £178,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 105 108 | 105 106 | 4 14 9 | June and December | ... | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 1s. | Alliance Electrical Co. 6% Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 140,000 | 1 | †1¼d. | Aron Electricity Meter 6% Cum. Pref. | 1¼ 1½ | 1¼ 1½ | 7 3 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ¼ ½ | ¼ ½ | ... | — | ... | ... |
| 80,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ½ ¾ | ½ ¾ | — | — | ... | ... |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 95 97 | 95 97 | 4 7 8 | ... | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ 11½ | 10½ 11½ | 5 13 11 | July and February | ... | ... |
| 70,000 | 5 | 5/0 | Do. 6 per Cent. Preference | 6½ 6¾ | 5½ 6¼ | 4 16 0 | January and July | ... | — |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ 4¾ | 4½ 4¾ | 6 6 4 | — | ... | ... |
| 90,000 | 2 | 1/3½ | Brush Electrical Engineering | 1½ 1¾ | 1½ 1¾ | 6 8 4 | September | ... | ... |
| 16,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 6 per Cent. Pref. Non-Cum. | 2 2½ | 2¼ 2½ | 5 9 8 | " | 2½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £123,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 105 110 | 105 110 | 4 3 7 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 103 | 4 7 5 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 13 14 | 13 14 | 5 7 2 | " " | 13½ | ... |
| 40,000 | 5 | 2/6 | Do. 6 per Cent. Cumulative Preference | 5½ 5¾ | 5½ 5¾ | 4 6 11 | " " | 5½ | ... |
| £30,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 113 | 109 113 | 3 19 11 | November and May | ... | ... |
| 150,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 1¼ | 1 1¼ | 6 8 0 | — | ... | ... |
| £140,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 97 | 94 97 | 4 12 9 | — | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1¼ | ¾ 1¼ | 5 6 8 | — | — | — |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3½ 3¾ | 3½ 3¾ | 6 0 0 | January and July | 3½ | — |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 99 102 | 100 103 | 4 17 6 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | — |
| 99,261 | 3 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1¾ 2½ | 1¾ 2½ | 8 0 0 | February and August | 1½ | — |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ 4½ | 3½ 4½ | 6 13 4 | " " | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 88 90 | 88 90 | 4 8 11 | June and December | ... | ... |
| £100,000 | Stock | [illegible] | Do. 5% 2nd Deb. Standing Prov. Certs (all pd) | 95 100 | 95 100 | ... | — | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ 5 | 4½ 5 | 5 10 0 | Half-yearly | ... | ... |
| £76,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 105 | 103 105 | 4 5 11 | — | ... | ... |
| 112,100 | 3 | 1/2½ | Electric Construction Co. (Limited) | 1½ 2½ | 1½ 2½ | 5 13 2 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ 3 | 2½ 3 | 4 13 4 | July | 2⅝ | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 16 11 | January and July | ... | — |
| 110,000 | 1 | ... | Gilfre Electro Chemical and Power Co. Ord. | ½ | ½ | ... | ... | ... | ... |
| 30,000 | 5 | 6/0 | Henley's Telegraph Works Ordinary | 13½ 14½ | 14 15 | 5 0 0 | February and August | 14½ | 14½ |
| 10,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6 | 5½ 6 | 3 15 0 | " " | ... | — |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 112 | 108 112 | 4 0 4 | " " | ... | ... |
| 30,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ 21½ | 20½ 21½ | 4 13 0 | " " | 21½ | 20½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 8 | March and September | ... | ... |
| 37,350 | 12 | 12/0 | Telegraph Construction and Maintenance | 39 43 | 41 43 | 4 0 0 | March and July | 41 | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 104 | 101 104 | 3 17 0 | January and July | ... | ... |
| 15,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 10 11 | 10 11 | 5 15 2 | ... | 10½ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | — | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ 11½ | 10½ 11½ | 4 1 9 | April and October | 10½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ 7½ | 6½ 7½ | 4 2 0 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 107 | 105 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

# WILLANS CENTRAL VALVE ENGINES

FOR

## Electric Lighting

AND

## Traction.

**15**

**1,200 H.P. SETS**

HAVE BEEN SUPPLIED FOR THE

LIVERPOOL
CORPORATION
TRAMWAYS.

***STANDARD SIZES UP TO 3,000 H.P.***

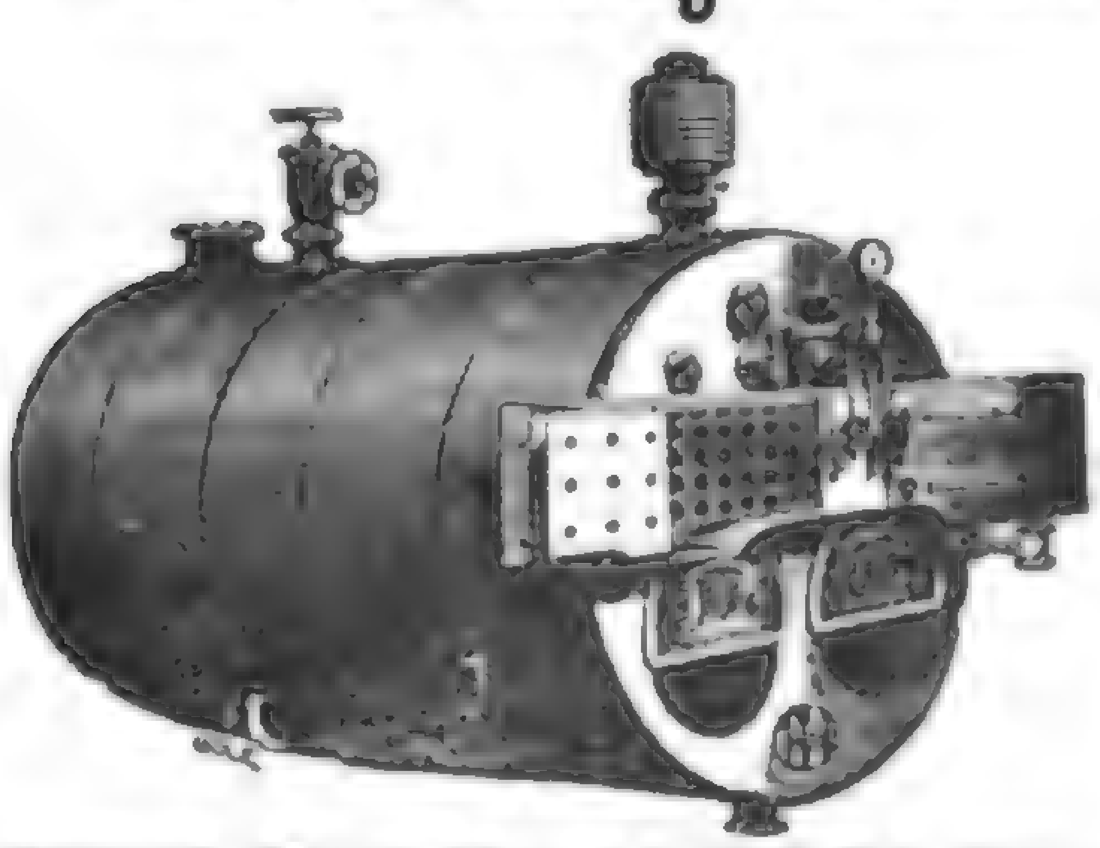
1,200 H.P. Set.

## WILLANS & ROBINSON, LTD., *RUGBY, England.*

## DAVEY, PAXMAN & CO., Ltd., Engineers, COLCHESTER.

MAKERS of a GREAT VARIETY of STEAM ENGINES and BOILERS.

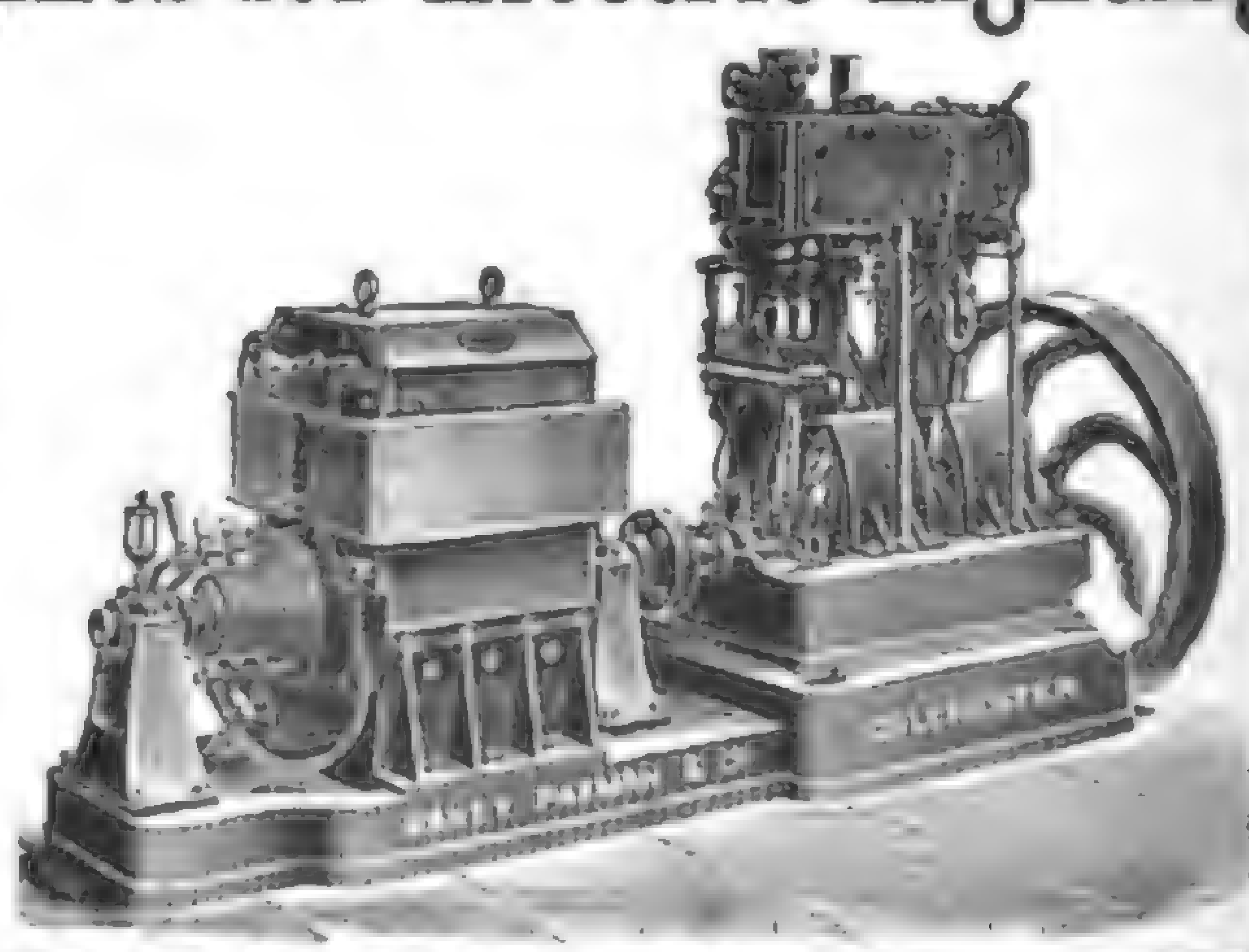
SPECIALITY: **Steady Running Engines for Electric Lighting.**



Paxman's Patent "Economical" Boiler, from 8 h.p. upwards.

This Boiler is one of the Best Steam Generators before the public, not only for Efficiency, but for Economy and Durability. It contains particularly good features and high qualities.

PAXMAN'S PATENT
AUTOMATIC EXPANSION GEAR
and
ADJUSTABLE GOVERNORS
Ensure a Steady and Constant Speed
in any emergency.



"Windsor" Vertical Compound Engine, with Dynamo combined made in all sizes.

Telegraphic Address: "PAXMAN COLCHESTER."

Catalogues and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ltd., Engineers, Colchester.**

LONDON OFFICE—78, QUEEN VICTORIA STREET, E.C.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,188. [No. 18. Vol. XLVI.] FRIDAY, FEBRUARY 22, 1901. PRICE SIXPENCE (by post, 6½d.). Abroad, 8d., or 16 cents, or 80c., or 70pf.

### CONTENTS OF THE CURRENT NUMBER.

## NOTES.

THE coroner's jury inquiring into the fatal trolley-wire accident at Liverpool, pronounced an unanimous verdict yesterday afternoon. It was to the effect that the cause of death was shock consequent upon the victims becoming entangled in telephone wires, owing to the wires breaking and coming into contact with the tramway trolley-wire, a self-evident conclusion. But a rider was added that, whilst of opinion the occurrence was due to accidental causes, the jury thought that the accident might not have happened if the telephone standards had not been so far apart.

WHETHER the span of 120 yards may be deemed excessive in this case or not, we are of opinion that the jury would have been better advised had they drawn attention to the inadequate protection of the trolley-wire itself—not that the Corporation is to blame in this matter, seeing that the particular guard employed by them had been passed by the Board of Trade only a few weeks ago. This accident has shown that the earthed guard wire, which also the Board of Trade approves, is a better protection than the wooden guard-strip. Had a number of wires made contact with such a guard wire this would have put it, as well as the telephone wires, in contact with the trolley-wire, and as a result the latter would have been earthed, and the cut-out at the station would have switched off the current from it. It is to be hoped that in future the wooden guard-strip will be condemned. The only absolute preventative, however, is to place the telephone wires underground.

A PAPER on the important subject of the training of electrical engineers was read by Dr. J. T. NICOLSON on the 12th inst. before the Manchester Section of the Institution of Electrical Engineers. The first part of a reprint of this Paper appears in our issue this week. Dr. NICOLSON has had considerable experience in that portion of the training which is given in colleges and technical institutions, and he has formulated decidedly definite ideas as to the character and order of an engineer's studies. The individual experiences of teachers induce in them a variety of theories as to what is the best course for a student to pursue; and, in the present instance, the theory is expounded with an inflexible rigidity and elaboration of detail which is not altogether commendable. A little more imagination would have shown the author that such rigidity is really not admissible. No hard and fast line of training can be laid down. Students are not all alike to begin with, neither are they all destined to follow precisely similar careers in the end. Dr. NICOLSON has expressed the view that the two years' workshop training should take place between school and college education. In this he ignores the provision made by scholarships and exhibitions for the college course to follow directly upon the school; he also overlooks the important fact that by taking the workshop practice after the college studies the student enhances his opportunity of being retained in the works after his shop training is over. Thousands of young men have received from their employers important posts, at home and abroad, directly after their apprenticeship.

WITH regard to laboratory teaching, we sympathise with Dr. NICOLSON in his desire to see electrical engineering laboratories stocked with specimens of the most recent and best plant. We feel, however, that the inducement he suggests will not be regarded by makers as sufficient for keeping up a constant circulation through laboratories of their newest patterns of plant. Makers would probably attach less value to the results of tests made by students than to the work carried out by their own testing staff at their works. Generous manufacturers, however, often do show a sufficient amount of enlightened self-interest to induce them to make presentations of new types of plant to colleges; and this

generosity is to be greatly commended and encouraged. After all, more depends on the teacher than on the laboratory equipment. A really good teacher can teach a great deal of modern practice with quite obsolete apparatus. It is the principles—the spirit of the thing—that the laboratory is designed to teach; not the flesh and blood of actual tangible forms.

Some years ago considerable interest was aroused in this country concerning the Hermite electrolytic process for disinfecting and sterilising sewage. The process, as many of our readers no doubt remember, consisted in the electrolysis of sea water, and in the application of the diluted solution of sodium and magnesium hypochlorites obtained in this manner to disinfecting and sterilising the raw sewage. The process was much written up, and practical trials were instituted at Ipswich, Lytham, Netley, and other places. These installations were not successful, and, we believe, that there is not a single one of the experimental installations running at the present moment. Our excuse for referring to this ancient history is the recent publication, in *Electricity* (New York), of a report by Major Reed, surgeon, of the United States army, upon the experimental trials of a practically identical system of sewage treatment at Havana, in Cuba. The system in this case was that patented in the United States under the name of Woolf, and some details concerning it have already appeared in our pages (see *The Electrician*, Vol. XL., p. 4). When the Americans took over the public control of the city of Havana they found the harbour was practically an open cesspool, and, in such a climate, was necessarily the cause of a large amount of sickness and disease. With a reforming zeal which was highly creditable, they at once appointed an army commission to advise upon the best means for remedying this evil, and the authorities finally decided upon the Woolf system of electrolytic disinfection. This was over two years ago, and we believe that the Woolf system has been in regular operation since July, 1899. The report, to which we have referred above, must be rather unpleasant reading for those who advised the installation of the Woolf system, since it states that the purification is "inadequate," and that "better results at less cost" could have been obtained by the use of chloride of lime. In view of the extended trial and failure of a practically identical process in this country, this result of the trials at Havana might have been foreseen. It is reasonable to presume that the United States army commission made independent inquiries before recommending the Woolf system of disinfection, and we can only express our surprise that these inquiries do not appear to have extended to the English technical literature of the subject.

A chairman, presiding over a meeting of the Institution of Electrical Engineers, has undoubtedly a difficult task when the number of speakers wishing to take part in a discussion and the length of their remarks are out of proportion to the time fixed for the termination of the debate. The Council having decided that the discussion on Mr. Mordey's Paper should terminate last week, Prof. Perry was in the unenviable position of having to discriminate between the claims of the various members who had signified a desire to speak. Probably, whatever his action, he would have been criticised; but in this instance, we fear, he has given his critics some material for fault-finding. It has always been the custom, in the case of an adjourned debate, to permit the reader of the Paper to open the discussion on the second day with some supplementary remarks, and members have nearly always availed themselves of this privilege. Moreover, even were there no precedent, it would be only reasonable to accord this privilege when, as in this case, a month has elapsed since the Paper was put before the Institution. Nevertheless, contrary to the clearly-expressed wish of the audience, Mr. Mordey was peremptorily cut short in his remarks. This was the more open to comment, as at the previous meeting Prof. Ayrton had been permitted by Prof. Perry to speak for about half an hour; and the gentleman who read the remarks of Mr. Mather, Prof. Ayrton's chief assistant, was allowed to proceed much longer than the regulation 10 minutes, and was interrupted finally, not by the president, but by the clamour of the meeting. Besides Mr. Mordey, there were members present engaged practically in alternating-current work and cable manufacture who could have contributed to the discussion, but were not afforded an opportunity to speak. The chief engineer of one of the largest cable manufacturing companies, who, we believe, had come down from the North of England especially for the occasion, was one of these. Our report of the discussion is continued in this issue, and we reserve our comments on the subject of the Paper until the whole debate has been reported in our columns.

**Opening of the Fulham Electricity Works.**—The official opening of the combined electricity supply and dust destructor works of the Fulham Borough Council took place yesterday afternoon. A full description of these works appeared in our last issue.

**Royal Society.**—Among the Papers down for reading yesterday were the following: "An Attempt to Estimate the Vitality of Seeds by an Electrical Method," by Dr. Waller, F.R.S., and "On a New Manometer, and on the Law of Pressure Gases between 1·5 and 0·01 Millemetres of Mercury," by Lord Rayleigh, F.R.S.

**A New Marconi Station.**—A daily contemporary states that the Marconi International Marine Communication Co. is establishing a wireless telegraphy station at Withernsea, a town on the coast of Yorkshire. By establishing a station there vessels from the Baltic and North Continental ports making for the Humber may be signalled.

**The Electrical Engineer (R.E.) Volunteers.**—It is announced that the Commander-in-Chief of the Army has approved of officers of the Electrical Engineer Volunteers who have rendered good service in South Africa being granted, at the close of the war, honorary rank in the Army corresponding to the rank held whilst on active service.

**Pacific Cable.**—Reuter's agency states that an announcement appears in the Melbourne *Argus* that the Victorian Government is communicating with the Governments of Queensland and New Zealand with a view to forwarding a combined message to the Pacific Cable Board suggesting a joint-purse arrangement with the Eastern Extension Telegraph Co.

**The Radio-Activity of Matter.**—M. Henri Becquerel, in this week's *Nature*, reviews the progress made (since his discovery in 1896 of the radio-activity of uranium) in the study of the salts of metals which emit an invisible radiation. According

to recent experiments, the activity of uranium is due in great part, if not altogether, to a small quantity of actinium or of another radio-active body.

**Telephonic Receiver for Space Telegraphy.**—With reference to the telephonic receiver of MM. Popoff and Ducretet, described on page 495 of our issue of January 25th, we have been informed that a somewhat similar arrangement was patented in 1897 by the Rev. F. J. Jervis-Smith., F.R.S. This patent, 19,420/97, was for a combination of a telephone and carbon detector of Hertz waves.

**Personal.**—Mr. George W. Smith, who for 30 years has been the manager in France of the Persan Works of the India Rubber, Gutta Percha, and Telegraph Works Co., has received from the French Government the Cross of the Legion of Honour, and on the 9th inst. about 700 workpeople, as a demonstration of their esteem and affection for their chief, presented him with a cross of that order in brilliants.

**Cable Interruptions and Repairs:**—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | — |
| Pernambuco—Ceara | Nov. 29, 1900 | — |
| Marseilles—Barcelona | Jan. 7, 1901 | — |
| Shanghai—Amoy | Jan. 17, 1901 | — |
| Fao—Bushire | Feb. 6, 1901 | Feb. 20, 1901 |
| Havre—Waterville | Feb. 13, 1901 | Feb. 20, 1901 |

**Coventry Technical Institute.**—At the annual prize distribution at this Institute on the 15th inst., Dr. Oliver Lodge, in the course of an address on educational matters, mentioned that the affiliation of the educational institutes in the Midlands was definitely contemplated in the charter of the University of Birmingham, and ordinances or regulations were now being drafted. Early specialisation had evils, and the educational race was to the strong and persevering, and not to the pampered and luxuriant. There was no short cut to education; it was a life's work. The prizes were afterwards handed to the successful students by Ald. Tomson.

**New Series Alternate-Current Arc Lamp.**—The Reason Manufacturing Co. is exhibiting an alternate-current arc lamp at the Croydon electricity works. The lamp is of the enclosed type, and there are 12 lamps on view which run in series on a 1,000-volt circuit. There is a choking coil in parallel with each lamp, and in the extreme case of 30 per cent. of the lamps failing the remainder continue to act without a flicker. We understand there are two sets of 38 of these lamps already on order for lighting along the tramway routes at Croydon. The lamp is well made, and as it has several novel features we hope to publish technical details in the near future.

**Engineering Congress at the Glasgow Exhibition.**—A general engineering congress is being arranged to take place during the Glasgow Exhibition, and the council of the Institution of Electrical Engineers has undertaken to organise and control the electrical section of this. The dates upon which this latter section will meet are September 3rd, 4th, 5th, and 6th. So far the only details decided upon are that on the mornings of September 3rd, 4th, and 5th meetings will be held for the reading and discussion of papers, while the afternoons of these days will be spent in visits to works. The whole of September 6th will be devoted to visiting works. Further particulars will shortly be forthcoming.

**The Manchester Section of the Institution of Electrical Engineers.**—A meeting was held at Owens College, Manchester, on the 12th inst., Dr. E. Hopkinson in the chair. The chairman announced that, in consequence of an application on the part of the Manchester Society of Junior Electrical Engineers, a students' section for the Manchester district was in course of formation, and there was a promise of a large number of applications for membership from the junior society and from students outside the society. The students would have a right to attend the meetings, and to enjoy the other privileges of the Manchester section. Dr. J. T. Nicolson's Paper "On the Training of Electrical Engineers," was then read, and a discussion took place, in which Prof. G. Wilson, Dr. Lees, Dr. Hopkinson, Messrs. W. G. Rhodes, C. H. Wordingham, A. F. Guy, and W. H. Gee took part. A vote of thanks to Dr. Nicolson concluded the proceedings.

**Royal Institution.**—The evening discourse on "Electric Waves," delivered by the Right Rev. Monsignor Gerald Molloy last Friday, was almost a model of what an elementary or "popular" lecture on this difficult subject should be. The lecturer opened with an explanation of the difference between ordinary transverse, longitudinal, and light waves, and indicated lucidly in simple language the nature of Hertzian waves and the method employed for their generation. His experiments were equally simple, consisting chiefly of the interposition of various substances between an oscillator and coherer placed each at the focus of two parabolic mirrors. The transparency of glass, wood, and rubber was satisfactorily demonstrated, and the opacity of iron, and the well-known polarisation experiment with a wire grating was also shown. Those, however, who had expected to see new or delicate experiments, such are, as a rule, offered to Royal Institution audiences in the case of Friday evening discourses on scientific subjects, were doomed to disappointment.

**The Prevention of Trolley Wire Accidents.**—A device (now the property of the British Insulated Wire Co.) has been patented by Mr. R. C. Quin, the electrical engineer to the Blackpool Corporation, which ensures a trolley wire becoming instantly "dead" should it be broken and fall into the road, or should any obstruction, such as telephone wires, drop on to it. The contrivance was invented two years ago, and has now been approved by the Board of Trade, who have tested it in London. Last week Mr. Quin gave a public demonstration on the Blackpool tramways, where he has installed the apparatus, and proved the effectiveness of it first, by allowing some six or more telephone wires to fall across the trolley wire, and himself personally holding the wires in his hand, and then by cutting the trolley wire and holding the end of this in his hand, the other end being grasped by Mr. Brodie, chairman of the Blackpool Tramways committee. During the experiments cars were running on the remaining sections of the tramway system, thus testifying to the fact that only that particular section was cut out. A large gathering of officials and others were present, including Mr. Dane Sinclair, H. Haskayne (superintendent engineer to the Post Office at Manchester), the Corporation electrical engineers of Carlisle, Blackburn, Wigan, and Darwen, members of the Manchester, Salford, Egremont, and other Town Councils, and representatives of various tramway and other companies, among them being the Blackpool and Fleetwood Tramroad Co., Burnley Tramways Co., and the British Insulated Wire Co.

**Capacity in Alternate Current Working.**—Dr. de Hoor asks us to make a correction in the letter he sent us for our issue of February 8th. Instead of 0·048 for the power-factor ($\cos \phi$) of a 10,000-volt cable, near the top of p. 592, it should be 0·0157; and a few lines further down after the values for a 20,000-volt cable, read "for 1km. length of such a *three-phase* cable," instead of "for 1km. length of such a cable." Dr. de Hoor also adds now the following calculated data for 20,000-volt *concentric cables* of 100 + 100 sq. mm. section:—

1. Working at 50 ~ and under a $\frac{dV}{dn}$ nearly twice as great as in the 10,000-volt cable. It will be found:

| Impressed E.M.F. | Cap. current. | Watts hyst. work. | Mfd. | Cos $\phi$. |
|---|---|---|---|---|
| 20,000 | 1·44 | 360 | 0·23 | 0·0125 |

or taking into account the variation of the specific inductive capacity, approximately

| | | | | |
|---|---|---|---|---|
| 20,000 | 1·15 | 340 | 0·184 | 0·0148 |

2. For a cable of exactly the same material as the 8,000 or 10,000-volt cables, working under the same $\frac{dV}{dn}$ as the 10,000-volt cable, we find the following approximative data:

| | | | | |
|---|---|---|---|---|
| 20,000 | 1·02 | 310 | 0·163 | 0·0152 |

per kilometre of length.

Finally, Dr. de Hoor remarks that the hysteresis work of 3,000–6,000-volt three-phase cables of ordinary pattern is much lower—nearly the half of the figures given for the concentric cables of the same copper section.

**"Telephone Letters."**—In support of our contention (see the first page of *The Electrician* of February 1st) that the public knew little of the various facilities offered—we may almost say grudgingly offered—by the Post Office in connection with the National Telephone Co.'s telephone exchanges and the Department's telegraphic and express delivery services, we quote the following letter from Saturday's *Times*. It is headed "A Useful Discovery," and signed "Discoverer"!

I am a bachelor living in chambers and employ one servant, who, like other domestics, occasionally has an evening off. On Sunday evening last, during his absence, I was desirous of telegraphing to a friend at Kensington, and, lacking the means of sending to the nearest post office which might be open, or sending a cab with the letter, it struck me that I might make use of my telephone. After a diligent perusal of the instructions in the directory of the National Telephone Co. and the regulations of the Post Office Guide, I discovered that I could telephone to the post office nearest my friend's residence and have my message delivered by an express messenger of the G.P.O. I did so, and after a short interval was informed by the official at the Kensington post office that I could dictate 30 words, which would be delivered as an express message at the charge of 3d. I have since heard that this message was delivered within 15min. Surely the public should know of such a convenience existing between the telephone and telegraph services. To have sent a telegram from the nearest office to me—Charing Cross—would have cost 6d. for 12 words, in addition to the cost of the messenger employed by me, and would naturally have taken a very much longer time. Of course, we are not all subscribers to the telephone, but doubtless the same convenience is available to all who employ the National Telephone public call offices. The advantage is so great and so little known that I am sure your readers will be obliged if you can see your way to give publicity to this letter.

For the information of "Discoverer," we may add that he is wrong in assuming that this service is available from the National Telephone Co.'s call offices. It can only be used by telephone subscribers who have a deposit account with the company for these post-office facilities or in respect of the trunk or telegraph service.

**The Institution of Junior Engineers.**—At a meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel on Friday, February 8th, the chairman, Mr. Percival Marshall presiding, a Paper was read by Mr. L. F. Awde on "Electric Power Supply in the Metropolis." After emphasising the importance of the subject of a cheap and general supply of electricity for power purposes, as evidenced by the attention devoted to the large power distribution schemes during the last session of Parliament, the author referred to the comparatively small amount of electric power at present used in London, and dealt with the difficulties attending the supply of electricity for power purposes from the existing stations in the metropolis at a price that could really be considered reasonable, and which would induce the manufacturing community to adopt this form of energy generally for machine driving, &c. The disadvantages attaching to the positions of most of the various stations and their results upon the working costs, were dealt with at some length, and in this connection a curious fact was adduced—viz., that the average works costs for 1899 were exactly the same for both local authorities and companies, being 1·91d. per unit in both cases, the advantage resting with the local authority only in the matters of rates and management to the extent of 0·37d. per unit. After a reference to the attitude of the local authorities as to assessments of electric supply stations—when these were not their own property—the author protested against their proceedings with respect to the much-vexed question of smoke nuisance, and spoke strongly upon the action of the colliery proprietors last year in cornering the coal market, the results of which were so severely felt by all the electrical undertakings. He expressed himself in favour of one large station down the river, generating for power purposes and street lighting only, and submitted detailed estimates for such a station of a plant capacity of some 38,000 H.P., the whole scheme involving a capital expenditure of over one million sterling, distributed as follows, the station estimates providing for five triple-expansion sets of 3,500kw. each, and two sets of 2,500kw.:—

| | |
|---|---|
| Lands | £30,000 |
| Generating station | 645,000 |
| Mains, &c. | 105,000 |
| Distributing centres | 288,000 |
| | £1,068,000 |

The system proposed was a three-phase generation and distribution at extra high pressure to transforming centres, the low-pressure distribution to consumers' premises being at 500 volts from rotatory converters and batteries. The costs of working were set out in detail, showing a total cost of under ½d. per unit, the maximum selling price being suggested at 1¼d. per unit, or 1⅓d. per horse-power-hour. In the case of factories in the immediate neighbourhood of the generating station, and with a view to encourage the erection of such factories, the special price for these was put at the low figure of 1⅛d. per unit, equivalent to very little more than ¾d. per horse-power-hour.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), February 22nd.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Rooms of the Chemical Society, Burlington House. Papers to be read: (1) "How Air subjected to X-Rays loses its Discharging Properties and How it Discharges Electricity," by Prof. E. Villari; (2) "On the Propagation of Cusped Waves and their Relation to the Primary and Secondary Focal Lines," by Prof. R. W. Wood; (3) "On Cyanine Prisms and a New Method of Exhibiting Anomalous Dispersion," by Prof. R. W. Wood.

LONDON COUNTY COUNCIL.

*3.30 p.m.* Opening of the L.C.C. Generating Station for lighting the Victoria Embankment, adjoining Charing-cross Railway Station (D.R.), by Mr. W. H. Dickinson, Chairman of the Council.

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Extra Meeting to take the adjourned Discussion on Mr. J. Ashford's paper, "Light Lathes and Screw Machines."

ELECTRO-HARMONIC SOCIETY.

*8 p.m.* Concert (Ladies' Night) at the St. James's Hall Restaurant (Banqueting Hall), Regent-street, W.

ROYAL INSTITUTION.

*9 p.m.* Evening discourse by Sir W. Roberts-Austen, F.R.S., on "Metals as Fuels."

**SATURDAY, February 23rd.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*11 a.m.* Students' visit to the City of London Electric Lighting Co.'s works at Bankside, S.E.

INSTITUTION OF JUNIOR ENGINEERS.

*2.30 p.m.* Visit to the Willesden Station of the Metropolitan Electric Supply Co.

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture I. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

**MONDAY, February 25th.**

INSTITUTION OF ELECTRICAL ENGINEERS—NEWCASTLE-ON-TYNE SECTION.

Meeting at the College of Science, Newcastle.

**TUESDAY, February 26th.**

INSTITUTION OF ELECTRICAL ENGINEERS—MANCHESTER SECTION.

*7.30 p.m.* Meeting at Owens College, Manchester. Paper to be read: "The Use of Storage Batteries in connection with Electric Tramways," by G. A. Grindle.

**WEDNESDAY, February 27th.**

INSTITUTION OF CIVIL ENGINEERS.

*2.30 p.m.* Students' visit to the Electrical Works of the London United Tramways Co., 88, High road, Chiswick.

INSTITUTION OF ELECTRICAL ENGINEERS—BIRMINGHAM SECTION.

*8 p.m.* Inaugural Meeting at the University Buildings, Edmund-street, Birmingham, when Dr. O. J. Lodge will deliver an Address.

**THURSDAY, February 28th.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Paper to be read: "Cables," by Mr. Mervyn O'Gorman.

**FRIDAY, March 1st.**

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel. Paper to be read: "Carburetted Water Gas," by Mr. S. Cutler.

**SATURDAY, March 2nd.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture II. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

Students' visit to the Generating Station of the London United Tramways Co., 88, High road, Chiswick.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

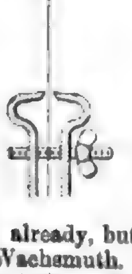
*Thermo-electric Ores.*—E. van Aubel has subjected Abt's electromotive series of thermo-electric substances to a searching investigation. It will be remembered that Abt constructed the following series:—Chalcopyrite, pyrolusite, bismuth, zinc, nickel, copper, cadmium, nickel oxide, arc carbon, iron, pyrohotite, antimony, and pyrite +, and maintained that this series followed the law of thermo-electric force which applies to the metals to a near approximation. Thus the E.M.F. between pyrolusite and carbon would be 815·2 (arbitrary scale), between carbon and pyrite 615·6, and, hence, between pyrolusite and pyrite 930·8, which differs very little from the observed value, 933·2. This approximation is, however, by no means general. Thus, since the pyrite zinc couple shows an E.M.F. of 600·5, and the pyrite-iron couple an E.M.F. of 685·9, iron should be further removed in the series from pyrite than zinc should. But this is contradicted by the figures derived from pyrolusite coupled with iron or zinc. It appears that a definite series cannot be made to include these minerals.

[E. van Aubel, *Ann. der Physik*, No. 2, 1901.]

*Propagation of Wireless Waves.*—E. Lagrange has endeavoured to throw some light on the part played by the earth in the propagation of the electric waves used in space telegraphy. He concludes that the earth behaves as a conductor and not as a dielectric. A coherer was buried in the ground 1ft. deep, at a distance of some 100yds. from a 25cm. spark-gap provided with an air-wire 2m. long. Before the earth was covered over the coherer the latter responded well, and a relay actuated by it exploded a dynamite mine with the greatest ease. But when the wooden box containing the apparatus was covered with earth to the depth of 1ft. all action upon the coherer and upon the mine ceased. The author says nothing about the quality or the moisture of the soil. He believes the waves are partly absorbed and partly reflected by the soil, as they would be by a conductor, and points out that the explosion of underground mines cannot be carried out with the apparatus described.

[E. Lagrange, *Comptes Rendus*, January 28, 1901.]

*Frequency of Alternate Currents.*—A good many simple devices for determining the periodicity of an alternating current have been described already, but probably the simplest yet devised is that of R. Wachsmuth. It consists of a piece of watch spring (see diagram) clamped in a vice, and provided with a small square piece of white paper stuck on by means of a bit of wax. When this is illuminated by a source fed by an alternating current and set vibrating, it will appear to stand still when the frequency of the current equals its own frequency of oscillation. The latter can be calculated from the formula, N = 7,920 thickness in mm. (length in cm.)², but in practice a graduation could be easily marked on the spring itself. A small correction must be added for the paper in the case of light springs. The method is very convenient, and can be used for frequencies up to 150 per second, beyond which the springs become too stiff.



[R. Wachsmuth, *Ann. der Physik*, No. 2, 1901.]

*Testing of Magnets.*—I. Klemencic has found that the magnets which show the greatest permanency when exposed to shock do not at all necessarily possess the greatest resisting power to other demagnetising influences, but rather the contrary. Magnets should be tested with the same patience as standard cells, and their examination should occupy a corresponding interval of time. Experiments extending over a whole year showed that a magnet which in the first 27 days was placed near the end of the series of permanency advanced to the first place in the course of subsequent tests. This was largely due to its dimensions, and it appears that generally those magnets have a better chance in which the ratio of length to cross section is great. The decrease in the moment is particularly great within the first few days after magnetisation, after which it becomes much slower. This indicates two causes of diminution, one of them being the "magnetic after effect" and the other the structural changes connected with the hardness of the metal. In magnets which are not exposed to rough usage, as for instance in magnetometers, specimens with small coercive force are more advantageous. Even soft iron, when preserved from shock, maintains its remanent magnetism for an extraordinary length of time.

[I. Klemencic, *Ann. der Physik*, No. 2, 1901.]

*Magnetic Images.*—A brilliant series of researches on magnetic images has been carried out by H. Jaeger. His first experiments were made with a linear conductor and thick steel or iron plates. He showed that the latter modified the field in such a manner as if there were another linear current in the positive of the optical image of the first as reflected in the plate. This is the well-known magnetic image effect. The author proved further, with the aid of a solenoid instead of a linear conductor, that the property of ferro-magnetic substances, by virtue of which they produce magnetic images, is a function of their hardness. As the mechanical hardness increases the image effect decreases. An interesting development of the magnetic image is the "kaleidoscopic" effect obtained by the author by means of two plates inclined at an angle to each other, between which the conductor passes. The resulting field is the same as if further conductors were placed in the positions of the multiple optical images of the real conductor. The author suggests the examination of curved ferro-magnetic mirrors, which may lead to startling results.

[H. Jaeger, *Ann. der Physik*, No. 2, 1901.]

## MAGNETIC EXPANSION OF IRON AND NICKEL.

BY PHILIP E. SHAW, B.A., B.SC., AND S. C. LAWS, B.SC.

I.—Preliminary.

§ 1. A considerable amount of research has been done on this subject since the time when Joule* first looked for the effect and failed to observe it. In Joule's* second attempt, he used, connected to the rod of iron, two levers, and, with a powerful microscope, observed the movement of the end of the second lever. He recorded an elongation of about $\frac{1}{720000}$in. for the current used. Nothing further seems to have been done until Tyndall†, using an optical lever, verified Joule's observations. Mayer‡, also using an improved optical lever, made more accurate readings than his predecessors. Barrett‖ made a considerable advance in precise measurement showing that whereas Joule's value for the maximum elongation of iron was much too small, Mayer's was somewhat too large. He also was the first to determine the phenomena for cobalt and nickel.

§ 2. Shelford Bidwell¶ worked with rings and rods, but finally adhered to the latter. His investigations placed the subject on a higher level of experimental accuracy, for in his hands the optical lever was much improved, and he made full allowance for permanent magnetisation, and carefully annealed his specimens. By using very strong fields he pushed the investigation so far that he was able to prove that the movement approached an asymptotic limit for the two metals in question.

* *Phil. Mag*, Vol. XXX., 1847 pp. 76, 225.
† "Researches in Diamagnetism." London, 1870.
‡ *Phil. Mag*, Vol. XLVI., 1873, p. 177.
‖ *Nature*, October 12, 1882.
¶ *Proc.* Roy. Soc., Vol. XL., 1886, pp. 109, 257, and *Phil. Trans.*, 1888, p. 205.

Nagaoka* advanced the subject by making investigations nearer to the origin, his improved optical lever enabling him to trace the small movement for nickel of $2 \times 10^{-7}$cm., which was about $\frac{1}{7}$th of the size of Bidwell's smallest reading ($1{\cdot}4 \times 10^{-6}$). This was a splendid contribution, for the author was enabled to trace a complete cycle of continuous movements with direct and reversed magnetisation, thus obtaining symmetrical hysteresis loops. The results were of great interest, and constituted a triumph of minute experimental work.

A further research was published by Nagaoka and Honda† but no smaller measurement was made, or has been made by anyone, than the one above cited.

More‡ first produced curves showing the relation of magnetic intensity ($\mathfrak{I}$) to change in length ($\delta l$), which relation we might expect to be alike for rods of all diameters if of the same material and length. The curves of previous writers had always shown the relation of magnetic field (H) to change in length ($\delta l$), the consequence being that the curves in different cases were various and apparently unconnected. This was a useful beginning in the very necessary work of bringing the experimental facts into line, with a view to their ultimate explanation. The curves were further modified by More by deducting from the known changes of length the change produced throughout the material by the tractive-force $\left(\frac{B^2}{8\pi}\right)$, which would, of course, be a retraction in all cases. The resulting curve would therefore express the change in length, supposed due solely to the magnetic rotation of particles for known magnetic intensity.

The above sketch indicates roughly the high-water mark of the subject so far.

§ 3. It should be observed that in every previous research the optical lever method, or a modification of it, has been adopted for measuring the minute changes of length. The present Paper will show that these changes can be observed by an entirely different method, which has the advantages of greater delicacy and much greater range. The current used for producing the magnetic field was measured by the Crompton potentiometer method, which gives great accuracy and scope. This, also, is a novelty as regards this branch of experimental magnetism.

### II.—Length-Measuring Apparatus.

§ 1. One of us has lately published an account of an instrument, the Electric Micrometer,‖ suitable for measuring small movements. Put in brief, the principle is to have a screw and set of levers moved at will by an experimenter. Any movement made by the screw head is minified by the joint action of the levers (whose arms are unequal), say 1,000 times. The lever farthest from the screw carries a contact bead of iridio-platinum, and is arranged near a plate of iridio-platinum fixed to the body the amount of whose movement is to be observed. The contact bead and plate, if they touch, complete an electric circuit which includes a telephone used by the experimenter. Thus any small movement of the body in question may be followed and measured. Figs. 1 and 2 and subsequent explanation will render this clearer.

§ 2. A modification of the form seen in the Paper, referred to above, was used, the main changes being (1) six levers resting on horizontal surfaces instead of three pivoted; (2) the movements of the screw head, levers, and experimental body were all in a vertical plane; (3) more minute measurements could be taken, the smallest reading looked for in each set of measurements being about $5 \times 10^{-8}$cm.—this is our unit of scale; (4) a rigid system was arranged for holding firmly the rod under investigation over the contact place.

¶ A rough idea is given in Fig. 1, which shows the skeleton of the apparatus in side elevation. MC is the magnetising coil having the rod of iron or nickel under investigation in its core. The upper end of the rod is screwed and soldered into a brass lug, which is itself screwed rigidly into firm supports. The lower end of the rod is also screwed and soldered into a brass lug which is screwed to MC and carries a plate of iridio-platinum *b*.

First, suppose there is no current in MC, then let the screw *Sc* be rotated so that the screw head rises and the train of six levers moves carrying the contact *a* slowly towards *b* until it touches it. On touching, a circuit, Fig. 2, is completed and a discharge occurs in the telephone T, which the observer carries on his head. Whilst the observer is listening for the sound in the telephone he is watching, by a telescope and mirror, the disc at the bottom of the screw *Sc*, which is graduated like a spherometer; thus, by taking the disc reading ($R_1$) when the sound occurs, he will determine the exact position of the surface *b*.

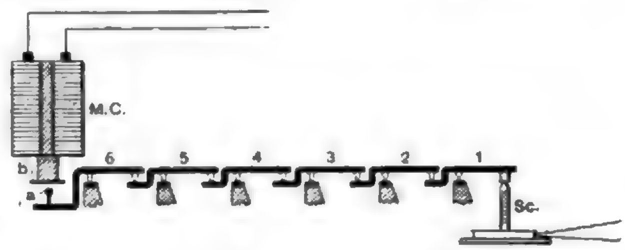


Fig. 1.

Now let him put on a current in MC, and suppose the rod retracts, he will follow up the movement of *b* by rotating *Sc* until a new contact is made, the reading ($R_2$) of the disc being again taken. The difference ($R_2 - R_1$) gives the movement of the rod in disc units for a known current.

Knowing (1) the pitch of the screw, (2) the number of divisions of the disc, and (3) the joint leverage of the six levers, the movement can be worked out in centimetres.

§ 3. No more will be said about the details of the Electric Micrometer except that the precautions mentioned in the previous Paper* were intensified, the greatest care, above all things, being taken to have every part of hard material and rigid, so that looseness, permanent strain, and back-lash of the parts should be minimised.

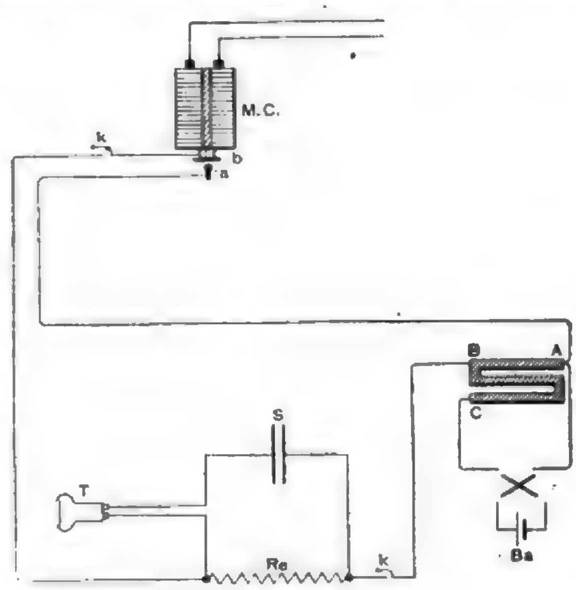


Fig. 2.

But the contact circuit (Fig. 2) needs some more explanation The battery *Ba* has a reversing key which joins it to the ends of a resistance box, ABC. The resistance in the part AB is small (say 1,000ω) compared with the whole ABC (11,000ω), so that we have a potential divider, taking off for the contact only a small part of the whole. The use of this is to reduce the fall of potential across *ab* and so save the contact surfaces. The remaining parts of the circuit are *Re*, a resistance of

* *Phil. Mag.*, January, 1894.
† *Phil. Mag.*, April, 1900.
‡ *Phys. Rev.*, November and December, 1895.
‖ P. E. Shaw, *Phil. Mag.*, Dec., 1900.

* *Loc. cit.*

100,000ω, then a condenser S (of $\frac{1}{2}$ mfd. capacity), and the telephone T are put as a shunt across the ends of *Rc*.

It will be obvious that at each make and break at *ab* the telephone will sound.

III.—Magnetising Current Circuit.

In Fig. 3 is shown some of the apparatus by which (1) the bar under experiment was magnetised, or (2) demagnetised, or (3) by which the magnetising current could be accurately measured. Taking these in order:—

§ 1. *Magnetising.*—The current from the battery B*a* passes through the key $k_1$, the standard resistance S*t*, the resistances $R_2$ and $R_1$, then the key $k_2$, then by terminals 3 and 4 to the magnetising coil MC, and through terminals 2 and 1 back to the battery. The standard S*t* will be mentioned below. $R_2$ is an open wire adjustable resistance (up to 100 ohms) for large currents, and $R_1$ is a box of resistances (up to 10,000 ohms) for the small currents. MC is a coil of copper wire, 1mm. in diameter, consisting of 14 layers each of 76 turns, and 8·6cm. long. It will thus carry a large current and give a strong field in its core without producing

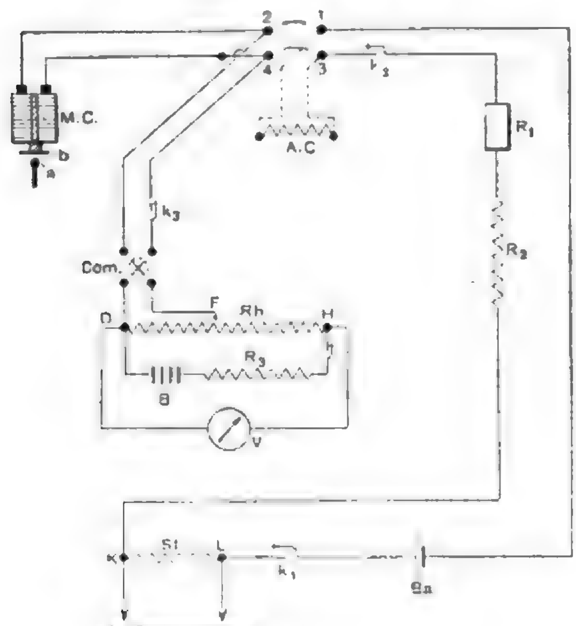


Fig. 3.

much heat. It was necessary to guard most carefully against heat from the coil reaching the experimental wire in the core, so the coil was wound on a thick boxwood former and was surrounded on all sides by two layers of asbestos sheet. This arrangement proved so effectual that it was easy to work for short times with as large a current as 2·3 amperes without causing much expansion due to temperature change of the rod in the core. Now a rise of temperature in the rod of 1°C. would give a movement at the end of the rod of 10,000 of the instrument's scale divisions; from this statement it will be seen how necessary is temperature equilibrium for successful working.

§ 2. *Demagnetising.*—After taking a reading of length for a given current, then, when we take off the current some lines of (permanent) magnetism remain in the rod, and there is a corresponding change in length. This must be removed before putting on a new current and taking another observation of length. To do this we have a special circuit joined to terminals 2 and 4; the battery B sends a current through a large adjustable resistance $R_3$ and a rheostat R*h*. The voltmeter V shows the fall of potential along R*h*. If we put the sliding contact F at the point H we shall have the whole fall of potential V acting through the commutator, but if F is placed at D the fall of potential is nil.

The process of demagnetising is as follows: Put down the key $k_3$ and let $k_2$ be up, then put F at H, rotate the commutator (giving about 15 reversals per sec.), and slide F from H to D. Then the coil MC will experience alternating currents which commence large, grow less and finally vanish, the whole change in current being down a smooth curve from the highest until it vanishes. These rapid reversals of decreasing current cause demagnetisation.

The 'battery' we used was a lighting circuit of 200 volts, and $R_3$ was a row of six incandescent lamps in parallel, which could be turned on or off singly. We found that when $R_3$ consisted of one lamp the fall of potential across DH was 2 volts, while when two lamps were in parallel, the fall was about 4 volts, and so on. It is evident, then, that we can vary the demagnetising current according to the magnetising current and so have our means of 'wiping out' the permanent magnetism varied according to requirements.

§ 3. When measuring the current we put in action a Crompton potentiometer attached to the ends of the standard S*t*, at the same time joining to the terminals 1 and 3 the alternative coil AC in place of MC. By this means the current can be measured at our leisure without the coil MC being heated. We took care to have exact equality between MC and its leads on the one hand, and AC and its leads on the other. The terminals of S*t* are mercury cups, and we had four standards of about 100, 10, 1, and $\frac{1}{10}$ ohms respectively, their exact resistances being accurately known. Our battery consisted of seven secondary cells, any number of which we could put on at will. If we were working with small currents the large standard was used, and as the currents were increased so the resistance of the standard used was decreased. It will thus be seen that we can keep the fall of potential from L to K between convenient limits, say 1 volt to $\frac{1}{10}$ volt. The Crompton potentiometer measures the fall of potential from L to K by direct comparison with a Clark cell so that knowing the resistance of S*t* we obtain the current flowing in the magnetising circuit at once from Ohm's law.

Readers who are unfamiliar with the use of the Crompton potentiometer will find a very full account in the back numbers of *The Electrician.** In principle, it is a Clark potentiometer having an adjustable resistance at one end of the slide wire, thus giving a very open scale of measurement. It also has a great many admirable conveniences and fittings.

*(To be continued.)*

## THE PROPOSED ELECTRIC CONDUIT FOR THE LONDON COUNTY COUNCIL'S TRAMWAYS.

As promised in our last issue we illustrate herewith the electric conduit which has been devised by the London County Council's engineers for use on the routes between Westminster Bridge and Tooting, Kennington Gate and Blackfriars-road, St. George's Circus and Waterloo road. Continuous current will be supplied at 500 volts from the generating station at Camberwell Green and from a sub-station at the Balham depôt. The cars are to be double-decked on bogies, similar to that shown in operation on the Westinghouse track last week. The seating capacity is to be 64 to 70, and the speed, within a 4 miles radius of Charing-cross, is to be 10 miles an hour. In accordance with the London County Council's Act of 1900, a description and drawings have been submitted to the Board of Trade for approval, and also to the metropolitan boroughs of Lambeth, Southwark, and Wandsworth. The last-named borough suggested some modifications, and, these having been made, has intimated to the Board of Trade its approval of the system. The other road authorities have been informed of these modifications, and it is expected that they also will signify their approval.

Fig. 1 gives a general view of the conduit, and Figs. 2, 3, and 4 are line drawings, showing sections through the insulator pit, through the concrete tube, and across the cast-iron yoke respectively. The tramways will be double track throughout, the gauge being 4ft. 8½in., and the track rails, of steel girder section, weighing 102lb. per yard, will be laid in

* W. Clark Fisher's articles in *The Electrician*, early part of 1897 (Vol. XXXVIII.). See also W. C. Fisher's book on "The Potentiometer and its Adjuncts." *The Electrician* Series.)

the same position as those which now exist. The slot rails are of steel, Z section, weighing 50lb. per yard, with a drip lip along the inner edge of the slot. The width across the heads of the two rails will be 4½in. The rails are bolted to the yoke jaws, and further fixed by wooden wedges, the width of the slot being kept as near ¾in. as possible.

The conductors are two in number, of soft steel tees weighing 23lb. per yard, and carried on insulator supports at 15ft. intervals, the supports being arranged midway between the yokes (see Fig. 1). The insulators are of glazed brown earthenware, with double petticoat (see Fig. 5), mounted on cast-iron stems, which are cemented into the concrete. The curved brackets down to the conductor rails are of gunmetal, concrete 2ft. 1½in. The greatest width of the yoke measured across the track is 26in., and the section at the bottom is as shown in Fig. 6. The conduit tube is of concrete.

The covers over the insulator pits give an opening 1ft. square, and will be filled in with artificial granite, or whatever material is used as paving between the track rails.

Wherever the conduit is drained, a larger box with opening 19in. by 12in. gives access to both insulator and drain pit, and a similar size of box will be employed wherever a section insulator is used, the conductor tees being divided into lengths of about half-a-mile.

Having now described the proposed conduit, we feel it our duty to criticise it, and we may say at once that, unfortunately,

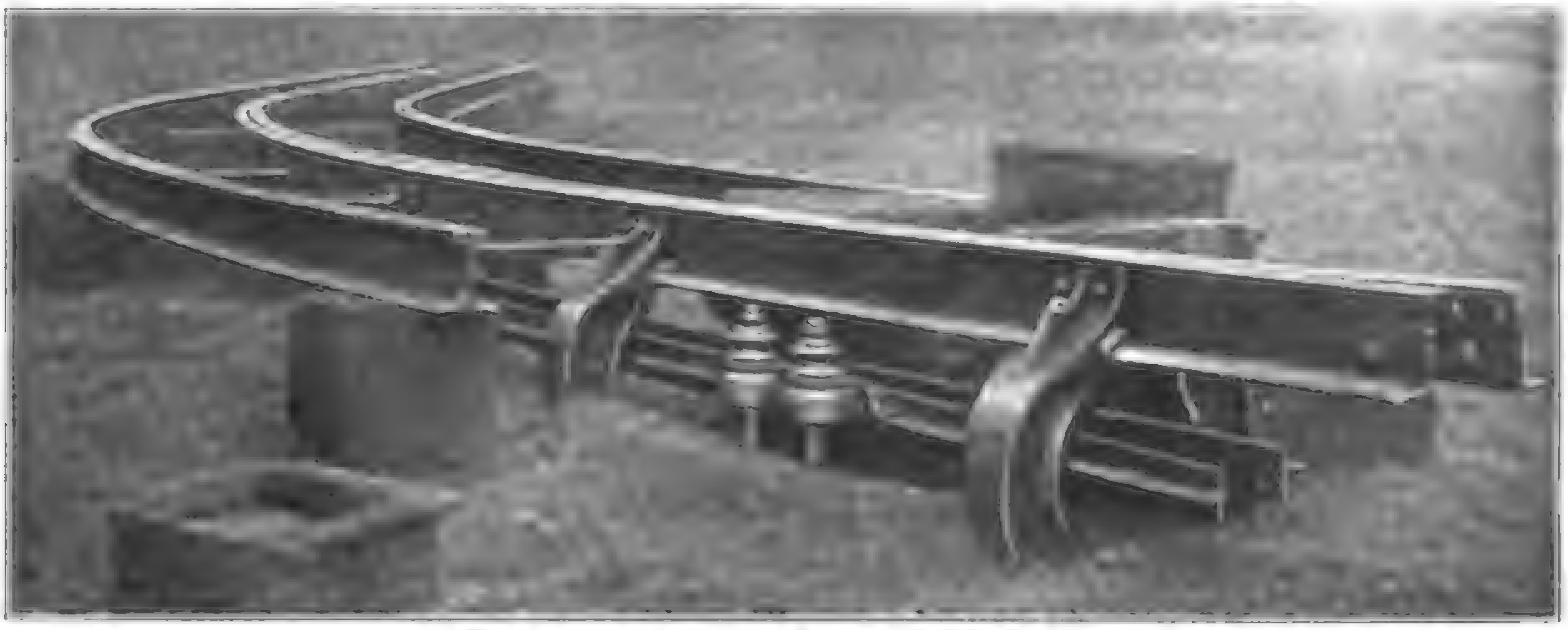


Fig. 1.—General View of Proposed L.C.C. Conduit.

and the insulators are fixed by a nut and washer at the top of the stem, leather washers being provided to pinch against. A bell-shaped pot cover is placed over all to deflect any drippings clear of the insulator.

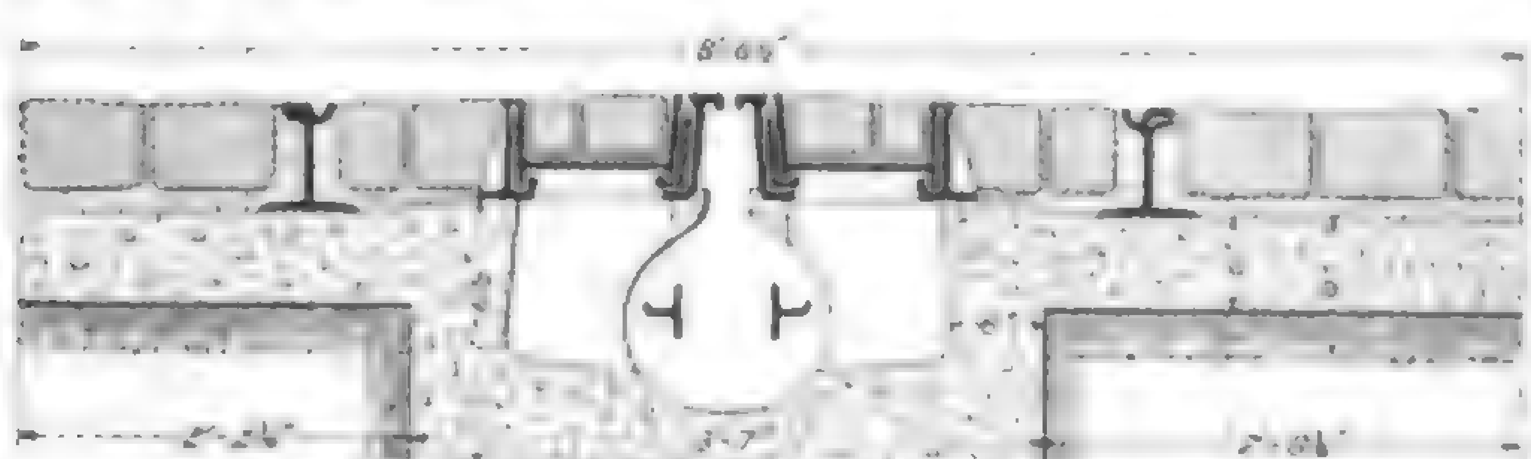


Fig. 2.—Section through Insulator Pit and Road Box.

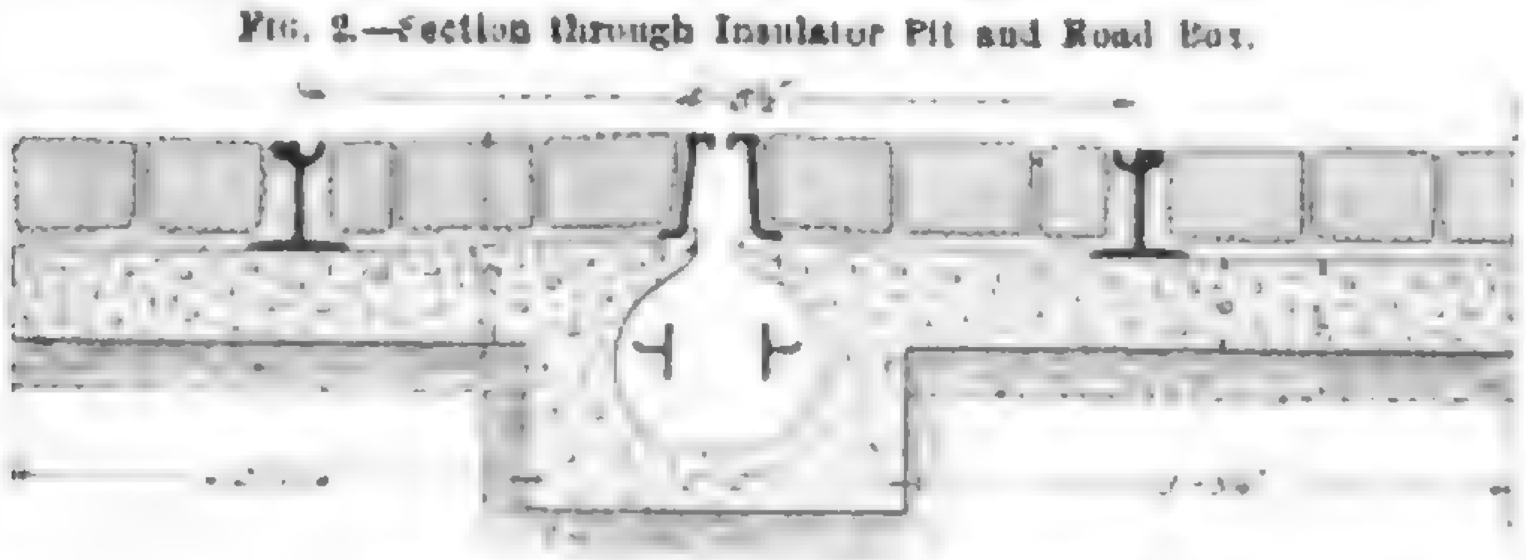


Fig. 3.—Section through Concrete Tube.

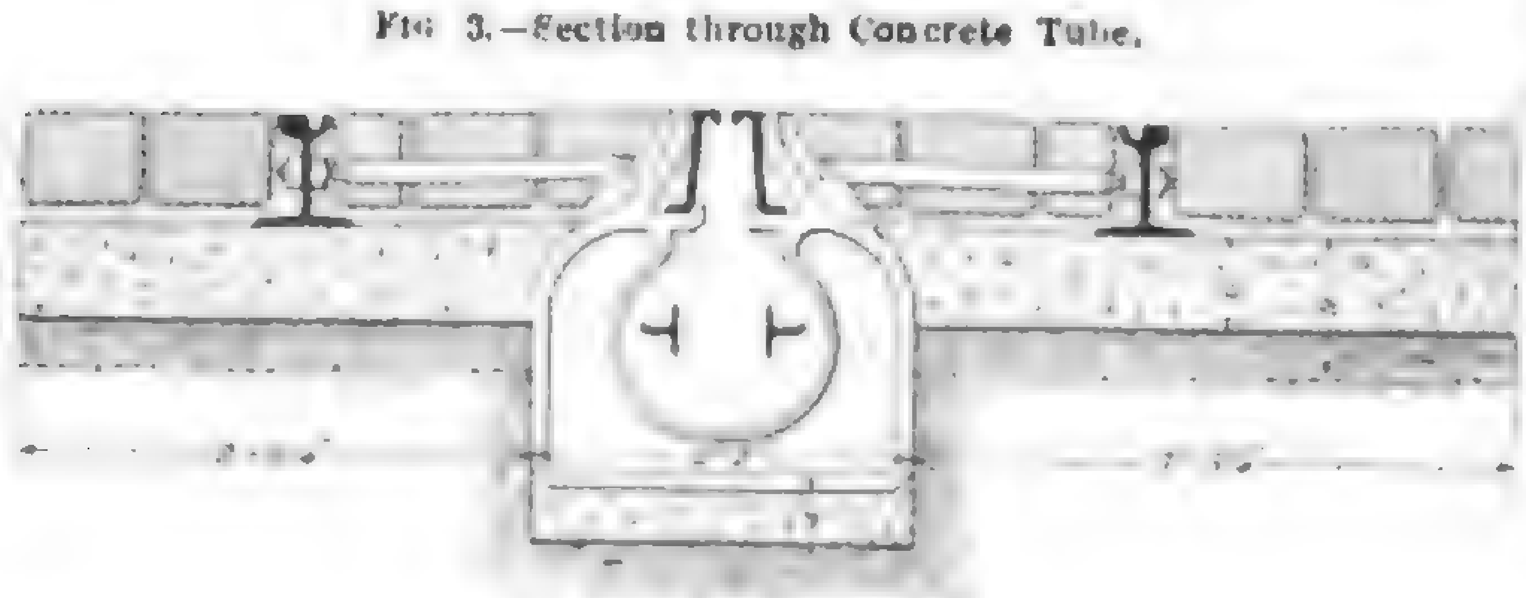


Fig. 4.—Section through Yoke.

Figs. 2, 3 and 4.—Sections of L.C.C. Conduit (Insulator Supports for Conductor Tees not Shown).

The cast-iron yokes are spaced 5ft. apart, the depth from the top of the slot rail to the bottom of conduit tube being 1ft. 9½in., and to the base of the yoke where it bears on the the remarks we have to make will be mainly of an adverse nature. There has been more trial and error in electrical conduit design than with anything else in connection with electric traction, and those conduits which are now successfully at work in Washington, New York, Paris, and elsewhere are the outcome of an immense amount of actual experience. It seems a pity, therefore, that the designers of the L.C.C. conduit should have departed so considerably from what has almost come to be considered the standard method of laying such tracks. Dearly bought experience has proved that, before all else, every legitimate effort should be taken to prevent the closing in of the slot from lateral pressure due to traffic, changes of temperature, &c. This has been effected in

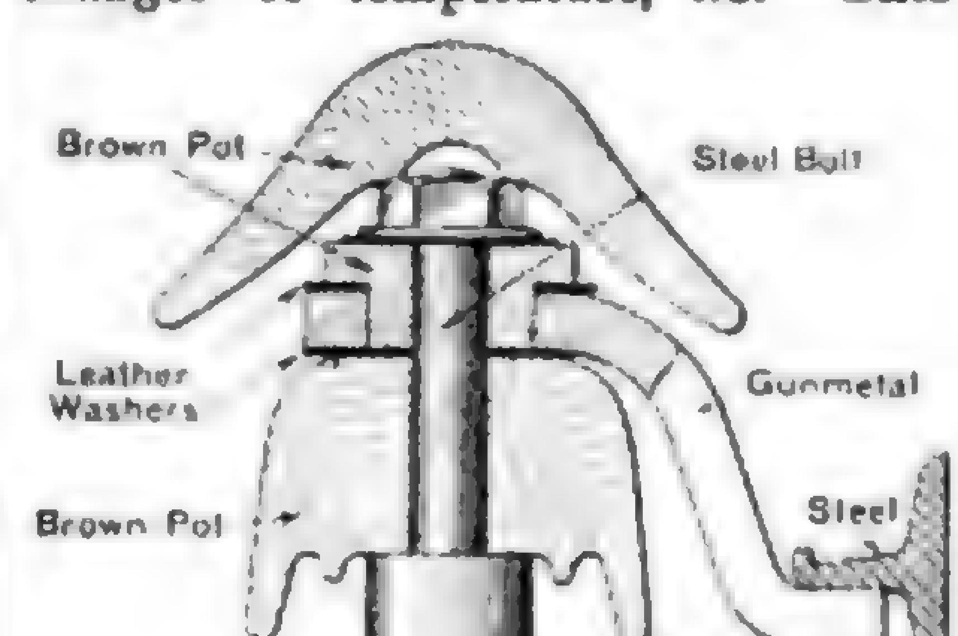


Fig. 5.—Sketch of Insulator in L.C.C. Conduit.

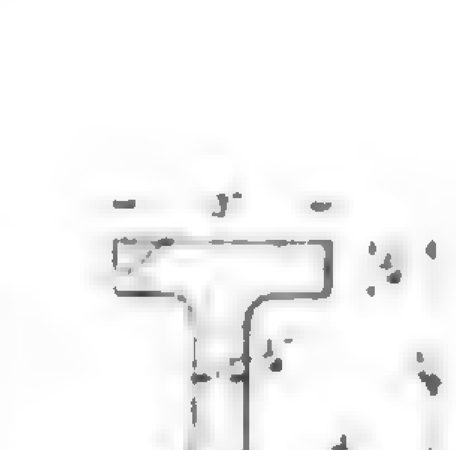


Fig. 6.—Section at Bottom of L.C.C. Conduit

central slot conduits now successfully running electrically by extending the yoke outwards to the bases of the track rails, and so rigidly connecting the whole together that widespread settling or spreading of track rails and conduits is entirely prevented. Of course, if the yoke stands by itself, as in the case of the Brussels conduit * for example, where the slot is in one of the track rails, then the yoke-casting must

* It may be mentioned that the engineers at Brussels did not attempt to make the width of the slot so small as is proposed for London, the dimension being 1¼in. There is, further, very little traffic on those boulevards where the conduit is used. Obviously the London conditions—that is, comparatively narrow roads and exceedingly heavy traffic combined with the narrow ¾in. slot—call for a much more solid construction.

be made extra strong to withstand the pressure. This is the condition of the L.C.C. conduit, except that it is midway on the track, and yet we find that the dimensions of the yoke-casting are smallest where one would have expected them to be greatest. Thus, from Fig. 6 it will be seen that the depth from the bottom of the tube to the bottom of the yoke-casting is only 4in., whereas in the Westinghouse yoke* (see Fig. 7) the dimension is 7½in., besides being wider in a direction parallel to the track. Quite independently of the strength to resist closing of the conduit due to its being extended under the track rails, have some doubts as to whether the shopkeepers in the Westminster Bridge-road and elsewhere will like noisy sets being re-introduced.

The one thing to be said for the L.C.C. conduit is that as the yoke is only 20in. wide the excavation will be less than if the yokes spanned right across the track. Seeing that the track rails have to be re-laid, however, it is doubtful whether there will really be much saving, for the extended yoke need not be rectangular as shown in Fig. 7, but can be of the more commonly employed triangular shape as in Fig. 9, which is an illustration of one of the New York tracks.

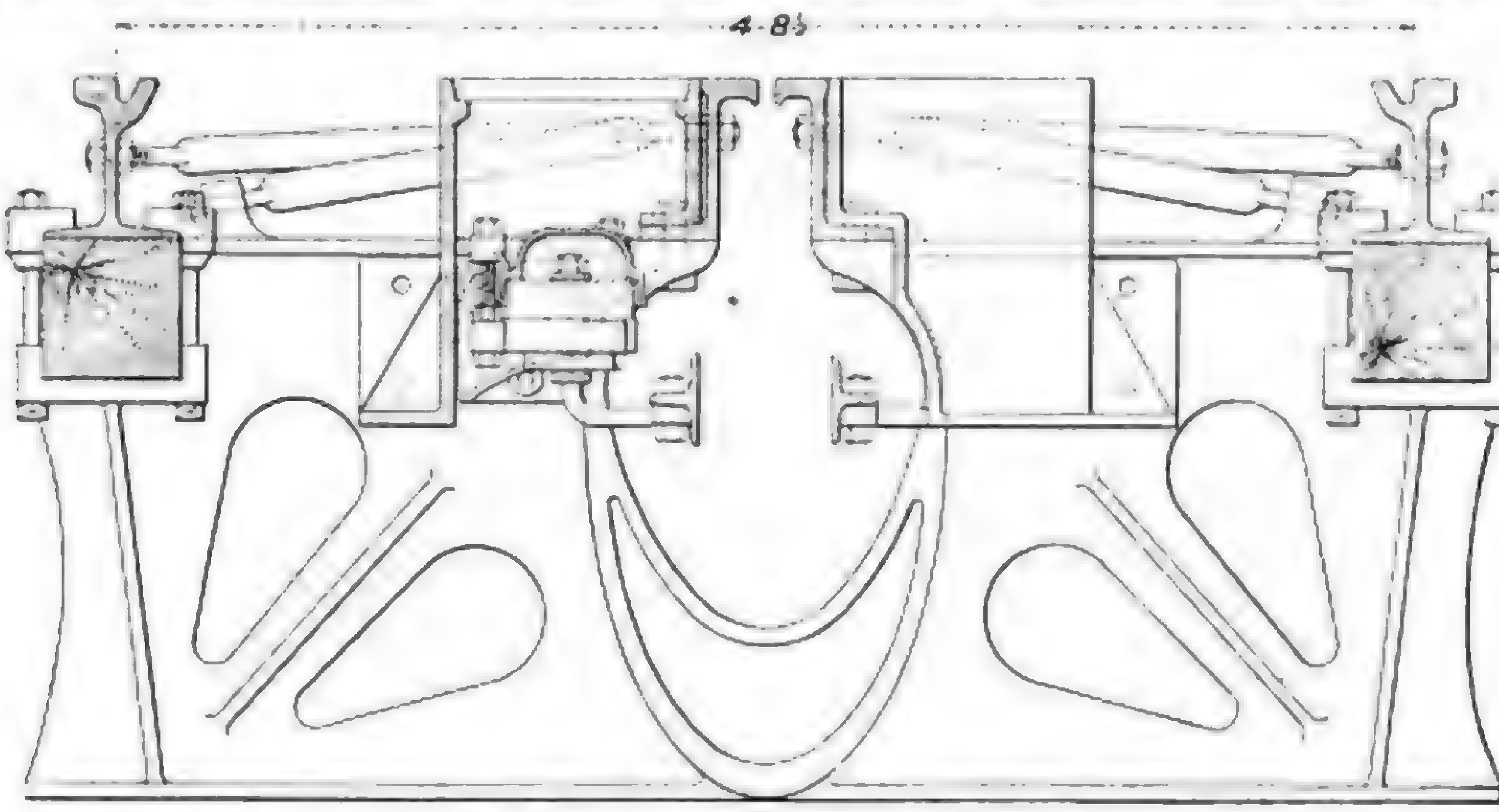


Fig. 7.—Section of Westinghouse Conduit.

the Westinghouse yoke is many times stronger than the L.C.C. yoke, and the New York and Paris yokes are also stronger than the L.C.C. yoke.

Experiments are to be made to see exactly what pressure is required to break the L.C.C. yokes as they now stand. We feel sure, however, that no electric conduit in successful work could be found which would exhibit such scanty yoke dimensions, and we cannot help thinking that it is taking unnecessary risk to depart so much from recent and *proved practice* in this respect. We understand that on no account is wood pavement to be used between the track rails, so that

Practically all mistakes in the past have been traceable to attempted economy in first cost—either the conduit was skimped, concrete too shallow, badly drained, or else the yoke castings too light.

Having pledged themselves to the conduit system of electric traction we do not think the L.C.C. is justified in considering too nicely the expense of constructing the conduit. They must face the drawback of expense properly as becomes the representative body of the leading city of the world.

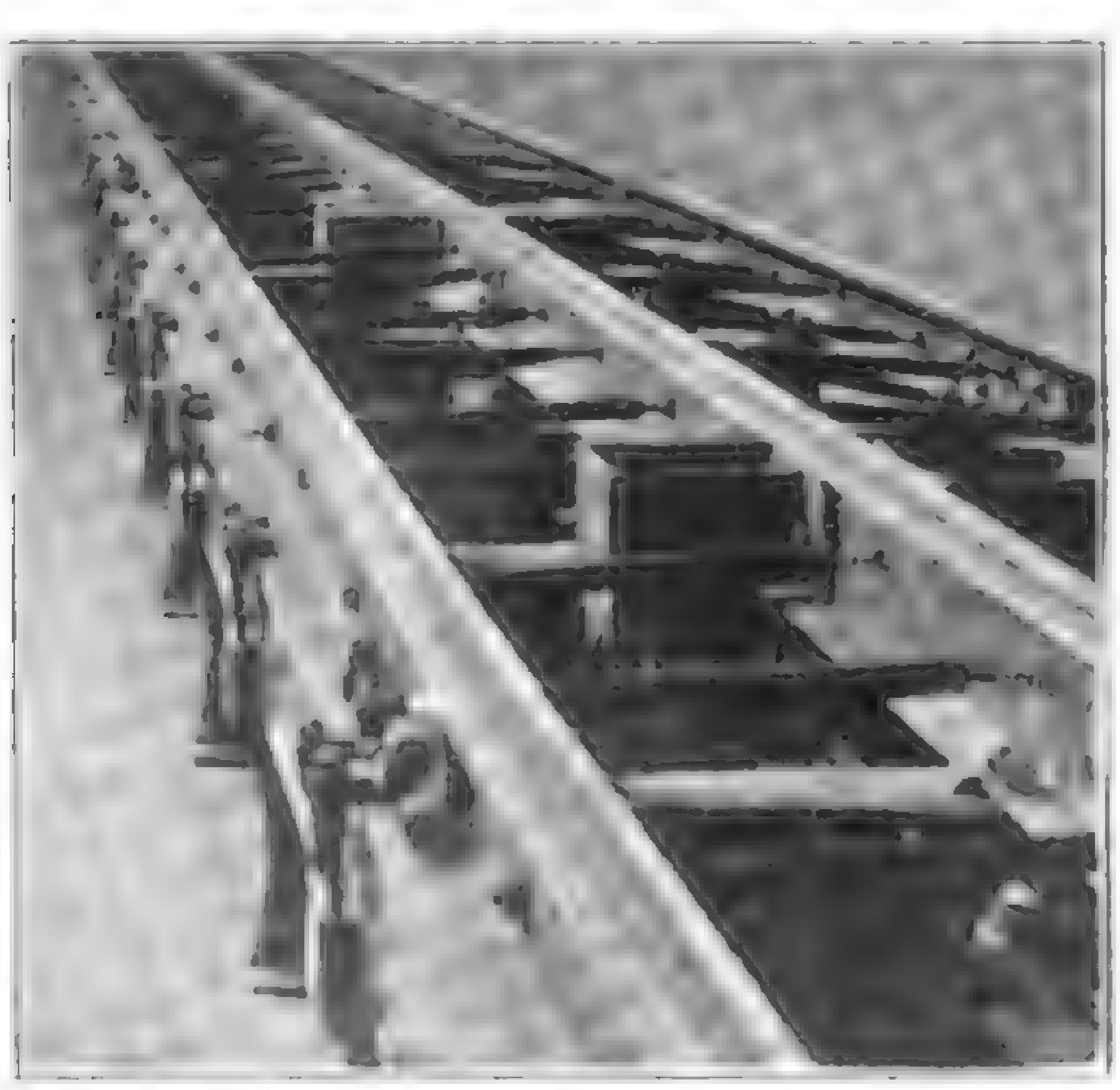


Fig. 8.—Photographic View of Westinghouse Conduit.

Fig. 9. New York: Line of Yokes Inverted over Track Excavation before Fixing.

there will not be the difficulty from wood expanding when wet. We take it that the various authorities interested clearly understand this, and that they agree to granite sets, but we

The way we lay down our railway tracks, bridges, &c., is the admiration of American engineers: shall we, then, reverse all this and put down tramway tracks which are inferior in construction to the work in similar tracks in New York and Paris, and all for the sake of a little extra excavation and a few more tons of concrete and cast-iron? Further, it should be remembered that it is the standing charges which form the

* It may be pointed out that the conduit system which was shown in running order at Camberwell is the same length of track, the same car, &c., as formed part of the Westinghouse exhibit at the Agricultural Hall, London, last summer (see *The Electrician*, Vol. XLV., p. 361, and also October 26, 1900, p. 3).

greater percentage of the expense. It is not much more expensive to excavate right across the track once the road is opened up.

There are other points in the L.C.C. design which appear to require modification. Thus the depth from the conductor rails to the bottom of the tube is surely too shallow, when we consider the dirtiness of London streets. With the insulators supported on a cast-iron stem from the bottom of the conduit there is risk of débris accumulating round the insulators and causing a short circuit between the stems and the gun-metal arms or the conductor rails. Such a thing might, for instance, easily occur in cleaning out the tube, by wet paper and similar material being pushed to one side and clinging round insulator stems.

It is a fact that in the earliest electric conduits the *conductors were secured to insulators carried on pedestals*, and in *every* case it was found impossible to preserve a good insulation owing to creeping and splashing of mud, &c. The first conduit line put down in the Lenox Avenue, New York, had pedestal insulators, but after a short time they proved to be quite impracticable, and the suspended insulators now in use had to be substituted. A feature which we take exception to is the use of wooden wedges between the yokes and the slot rails. These wedges are bound to rot in time, and then there is nothing to prevent the slot rails heeling over. In fact, we should say that a heavy road-roller would probably displace the slot rail even with the wood wedge in good order.* A point in connection with the conductor rails is that the horizontal web is beaded upwards for its full length, the object being to provide a fish for a few inches at either end. This ledge will naturally retain muddy water, &c., which may fall on the conductor, and when insulation is of such great importance it seems foolish to do anything which looks at all like lowering its efficiency. If the fish were really necessary (which we much doubt, as it is not used on systems which have been running for years) the bead could be made at the ends only and on the under side. This should be cheaper than rolling a special bead right along the tee iron.

FIG. 10.—GENERAL VIEW OF EXPERIMENTAL TRACK AT CAMBERWELL.

* It should be remembered that a street tramway track is not like a railway line where the wedges in the chairs are always in view and can be replaced or tightened up without trouble.

Another small matter which appears to require attention is that whilst the tie-bolt connecting the track rail with the yoke is firmly fixed to the web of the track rail by back nuts, the other end is merely placed in a slot in the yoke casting. As there is quite an eighth of an inch clearance, it is difficult to see the use of this bolt.

In conclusion, there are two points which should be fully borne in mind in getting out a conduit—one is the possibility that at some future date the pressure will be increased above the 500 volts continuous, may in fact be changed to a higher pressure alternating; the other is that, however strong the yokes are when first put down, the continual rust and vibration will make them gradually deteriorate. The vibration in an electric conduit is not nearly so great as in a cable conduit, because, of course, there is no running rope or guide rollers. Nevertheless, there is a good deal of vibration from traffic and other causes which in time tend to alter the character of the cast-iron and make it less able to withstand severe stresses.

## ON THE TRAINING OF ELECTRICAL ENGINEERS.*

BY JOHN T. NICOLSON, D.S.C., M.INST.C.E.

Electrical engineering differs from the other branches of the profession of the civil engineer in being based on theoretical principles whose application give predicted results which closely accord with those practically obtained, and in this department we have not been so notably troubled with a division into the two camps, of which we have heard so often, of those who believe in theory and those who believe in practice. The reason for this difference from the civil, mechanical, or mining branches of engineering seems to lie in the circumstance that, in electrical engineering practice has been largely directed by a consummate theory, whereas in other departments theory has, at its best, only endeavoured to understand and explain practice.

The other distinguishing feature of electrical engineering which must be carefully borne in mind in the same connection is the unparalleled growth of electrical industries in the past 10 or 15 years, and their present increasing rate of development. So much is this the case that the task of keeping the professional training of the students of this branch of engineering abreast of current practice seems also a hopeless one. This raises the all-important question whether it is within the province of engineering schools or colleges to impart technical instruction, properly so-called—to supply, viz.: up-to-date information as to the practical details and processes of manufacture of machines, and to give instruction in such like mechanical arts—or whether it is their duty rather to confine themselves to the scientific principles that underlie engineering in general, and its several branches in particular.

I think the proper answer to this question has now been found in the general adoption of the laboratory as the proper adjunct and complement of every first-class school of applied science. Without the means of making experiments the study of applied mechanics was closely analogous to and, in fact, was, an extension of the study of rational or theoretical mechanics. There were then certain data conceded as founded upon professional experience, and the course of instruction was confined to the consideration of the results flowing from reasonings based on these data, and to the working of problems and exercises in the application of these theories which were intended to form an introduction to the actual office work of the engineer in practice. It must be allowed that much of this excellent work is still and will always be necessary. Resting on a strong foundation of mathematics, physics and chemistry, the knowledge of the engineer must always include such pure sciences as those of kinematics, dynamics, hydro-dynamics, thermo-dynamics, and electro-dynamics. A sound elementary acquaintence with all of these is necessary, and a specialised knowledge of that one more particularly useful to the engineer in his own branch must be obtained. It is, for instance, quite hopeless to try to explain to a man who has no knowledge of dynamics upon what principles one proceeds in endeavouring to balance a locomotive. No amount of laboratory experiment will enable him to dispense with a knowledge of the mechanical principles involved. Again, the fundamental principles of thermo-dynamics may not be of much use in helping a man to fix the size of the cylinders of a steam engine; but they will at all events keep him from wasting his time in trying to design a perpetual-motion machine; and they will show him how far he can hope to go in the direction of the improvement of his heat motors or other energy transformers.

* Abstract of a Paper read before the Manchester Section of the Institution of Electrical Engineers, February 12, 1901.

But the province of the laboratory in the scheme of engineering education is: First, to extend scientific knowledge by providing more experimental data; and, second, to show to the student the scope, value and limitations of the theories he has studied in the class room. Without laboratory work the young engineer is in danger of supposing that an engineering problem has been solved when a certain mathematical solution has been obtained from a basis of given physical assumptions. The *critical* or *engineering sense* is not developed in the class room. The student cannot be expected to know which of the assumptions underlying his mathematical work is really close to practice; and which other, although the best that can be made, is far from being true. Since applied mechanics, or engineering, is not a complete science, but is constantly being revised as to its data and being added to as to its experimental laws, it is not sufficient to deal with it as with an abstract science having immutable laws and finally reasoned out consequences; on the contrary, the young engineer must be trained to exercise a salutary scepticism as to all generalisations from experience, and, as far as possible, to prove things in detail for himself.

Reverting to the question of instruction in up-to-date engineering practice, it may be added as the third function of the laboratory—and more especially of the electrical engineering laboratory—that it should contain machines and instruments of the newest types procurable, which may serve as object lessons on the general trend of electrical engineering design. To avoid becoming an old curiosity shop it will be necessary in most schools to rely upon the assistance of manufacturers who are willing to lend their recent patterns of machines to the laboratory for testing and examination purposes for a reasonable time, in return for the supply of the experimental data and results obtained from the machine under test.

At the commencement of this Paper reference was made to two features which distinguish electrical from other branches of engineering. From these it would appear that, of the three uses of the laboratory in the school of engineering just mentioned, obtaining new experimental data, and the exemplification of recent practice in design are of the greater importance in electrical engineering laboratories, inasmuch as the more closely a theory already seems to approximate to the actual phenomena obtained, the smaller is the need for overhauling this theory by checking its results by means of laboratory work. Yet one might argue that this close agreement only shows that the smaller and more intricate variations of the natural from the assumed laws are nearer to discovery; and that a closer examination and study of the phenomena, and more refined experimental work have become necessary. In any case the personal verification of the data of his subject is very necessary for every student as a good working foundation to build from; and as being the surest way of obtaining a real knowledge of and love for his adopted profession.

I am, I suppose, to-night expected to state what I should consider the best or ideal training one would give to a youth entering the electrical engineering profession if the choice were open. In reply, I say, in the first place, that in the case of a really clever student whose heart is in his work it is my experience that his course or mode of training matters very little. Even if he be trained on a very bad system, or not trained at all, he will acquire all the knowledge and experience he needs in spite of and in the teeth of the bad training. The desire to know, and the love for his subject is enough for *him*. But for the ordinary youth of mediocre abilities, whose inclinations have to be carefully coached in the right direction, and whose all too easily flagging energies husbanded as much as possible, the sequence of his physical and mental treatment is of real importance.

In the first place, I hold strongly the opinion that, after leaving school, the boy who intends to become an electrical engineer should first spend at least two years in the workshops of a *mechanical engineer*. Here he will learn the elements of smithing, moulding, pattern making, fitting, machine work and erecting. In this time he cannot help picking up the names and appearance of the common implements and processes fundamental to all kinds of engineering practice. A boy of 16 having just left school, has for a time had enough of bookwork, and will turn gladly, and with great advantage, to the complete change the workshop affords him. Here I may seem to be at variance with the views expressed by Prof. Perry in his recent address; I would point out, however, that the workshop course here proposed is merely the preliminary or first part of the student's professional training. If he has left school with the usual stereotyped stock of Euclid, algebra, and elementary physics and chemistry, I would have him take mathematics, physics, and chemistry classes in the evenings; but more especially mathematics, during these two years of workshop practice. Classes ought to be everywhere organised to teach mathematics for engineers in the manner proposed by Prof. Perry, so as to enable such a boy to learn as much useful mathematics as possible in the short time he has available. I should advise the addition of another year of workshop practice in the shops of a dynamo manufacturer, if time permitted; but this will more usually have to be supplied by the laboratory of the college through which he must pass.

I have always found it extremely difficult to arouse, in the case of boys coming directly from school to the professional college, a lively and intelligent interest in their subjects of study. Even with the help of a large and well-equipped college workshop they cannot get the relation of their work to engineering practice properly established. They fail to realise the important bearing the theoretical work they are doing has upon their future careers unless their curiosity has been first stimulated by a period of probation in the workshops, and a spirit of inquiry fostered by long-continued contact with actual engineering practice. I have had some considerable experience in these matters, having served a four years' apprenticeship, worked in a number of drawing offices, studied in one and taught in two other universities; and my experience, both as a learner and a teacher, lead me to recommend most strongly that, whenever possible, a period of workshop practice should intervene between school and college.

Having then put in two years in a mathematical engineering workshop, our ideal student ought to enter an engineering college at about the age of 18, and he ought to study there for not less than three years. The first year of this college course will usually have to be spent on mathematics, physics, chemistry, dynamics; mechanical, geometrical, and freehand drawing; and the study of French and German, which is so necessary for enabling him to read foreign technical literature. In the second year the electrical engineering student must specialise in the physical laboratory in the direction of electromagnetic theory. He must study the magnetic qualities of iron and the hysteresis loss; and in doing so he must learn the construction of the instruments such as the galvanometers, voltmeters, and ammeters he uses in his work, and the methods of their calibration. All this experimental work should, of course, proceed hand in hand with instruction in theory and numerical exercises in the class room; where he should be working at electromagnetism and the theory of the direct-current dynamo. In this same year he must apply a considerable portion of his energy to the study of thermodynamics and hydraulics, and their application to steam and water-power plants; and he should devote great attention to the study of machine design and mechanical drawing. The electric engineer must have a special knowledge of applied electricity; but he must be above all an *engineer*, and not a mere electrician.

In his final year three-fifths of the student's time should be spent in the laboratories, one-fifth in the electrical engineering designing room, and the other fifth upon lecture courses connected with his laboratory work. About one-third of his laboratory time should be devoted to experiments on the strength of materials, on the simpler hydraulic phenomena, and to trials of steam engines and boilers. I think that at least 30 days of eight hours each should be spent in this way in his third year. Another third of the time spent in the laboratory in his last year would be occupied in completing the elementary electrical laboratory course he began in his second year. He would, after completing his work on magnetic testing, begin a study of the dynamo. For this purpose the laboratory would probably be provided with a number of direct-current dynamos of various types and styles of construction, of from 2kw. to 10kw. capacity, which can be operated either as dynamos driven from a constant-speed prime mover, or as electric motors. Using the ordinary commercial instruments such as voltmeters and speed counters, he should determine the strength of the fields of these machines when the armature windings are known and the speeds and pressures measured. He should compare the results obtained from the machines when running with those calculated from their dimensions. This will give the student an idea of the control which his class-room theories require from practical results, and to what extent uncertainty enters into his estimations. Tests of the magnetic circuit of dynamos, the regulation of dynamos and motors with different forms of field winding, characteristic curves, and efficiency testing should naturally follow; and it is an excellent plan to make the student draw up tables and make curves of the variations in the principal proportions of machines of different types and sizes, in order that he may obtain an idea of the changes involved by particular conditions of service and output.

The data of this kind available in an engineering school are seldom of the latest, unless the teacher spends his summer in obtaining them. The instructor in electrical engineering has, as already mentioned, the special difficulty of the newness and constant development of his subject to contend with; but if he follows the practice of every year visiting the plants of the manufacturing companies and typical light and power stations, information is obtained which cannot be found in engineering literature, and which has the highest value for educational purposes. The cultivation of close relations between the college and the practising profession should indeed be part of the duty of instructors, and ought to be eagerly reciprocated by the members of the profession as one of the surest ways of meeting foreign competition. The professional status of the teacher of engineering in this country is not by any means so high as we find it to be abroad. In *The Electrician* of Feb. 1st I read:—"It is announced in *Electrotechnische Mittheilungen* that Herr von Dolivo-Dobrowolski, chief electrician of the Allgemeine Electricitäts Gesellschaft, is shortly going to St. Petersburg to take over the direction of the new Government electro-technical institute there." The same journal

states that "Herr Gorges is giving up his position as engineer-in-chief of the firm of Siemens and Halske to fill a professorship at the Dresden Polytechnic." I have yet to learn of any appointment in a college or technical school in Britain whose attractions could induce its acceptance by the engineer-in-chief of any of our great companies. The fact is, the Germans and Russians have come to realise the value of the scientific and technical training they provide in their polytecknikums to the national industry and well being; whilst in Britain we are still content to muddle along in our honest but stupid old way.

To return to our third-year student. The remainder of the second third of his laboratory time will be filled up by work in electro-chemistry and alternate current work. The former subject seems now to demand a laboratory equipment almost on a par with that of the dynamo room itself in a first-class school. The latter is usually better represented; and the enormous importance of polyphase currents in power transmission renders it necessary that every effort should be put forth to give sound instruction in this field. The effects of inductance and capacity are at the root of a large proportion of alternate current phenomena, and the fundamental studies in this department accordingly have reference to the study and measurement of these properties. The object of the teacher must be to convey to the electrical student as lively and practical a working conception of inductance and reactance as that usually given him of Ohm's law and its results. The student should have at his disposal a number of coreless solenoids for the direct measurement by ammeters and voltmeters of their self-inductances, using an alternating current of known frequency; and the comparison with their mathematically determined coefficients. He should also be able to make by the use of ammeters and ballistic galvanometers the direct measurement of mutual inductances; and to compare self-inductance and mutual-inductance with capacity. He should then extend his measurements to circuits with iron cores. Carefully wound long and short solenoids having known constants, condensers of known capacity, bridges, alternating current ammeters and voltmeters, the ballistic galvanometer and secohmmeter are the instruments he will employ most at this stage.

The student should then pass on to the study of the alternator and to single-phase currents. The wattmeter and the alternate current curve-tracer must be put in his hands; and the relations of the current and pressure waves in circuit must be studied from the curves, as well as from measurements of the true and apparent energy in the circuits. This study is finally applied to transformers of various types of construction. For the study of polyphase currents it would seem best to have in the laboratory a rotary converter, so that currents of variable frequency may be obtained. Induction motors of representative types of construction ought also to be available. A large part of the work here specified on alternate current machinery must, however, be relegated to the next division of the laboratory work of his final year, when he will have more time for uninterrupted experimental work, and be left more to his own initiative. The great matter is to instil habits of personal investigation and critical study into the mind of the young engineer, so that his college course may form really a graduated introduction to the work of his whole life.

This last portion of his laboratory time should be devoted by our embryo electrical engineer to what is, in America, called "thesis" work. This is of the nature of an experimental research, carried out either by the student himself or by a small group of students of which he is one. Very much valuable information has been obtained in American colleges in this way regarding the various types of new apparatus continually coming out; and it is found that the students learn, in the course of such work, to assume responsibility by being in a large measure left to their resources. Such investigation usually requires either special apparatus or the loan of new types of machinery; but good work may also be got by making progressive tests of an operating plant either in the college or elsewhere. The interest and even enthusiasm with which this part of the work is taken up and carried on by the students is very striking; and encouraging, and was such as to lead the writer to adopt the "thesis" system in his late laboratories at McGill College, Montreal, although quite contrary to his preconceived prejudices against the utility of allowing undergraduates to undertake research work. With regard to the one day per week of the student's last year, which was told off for work in the electrical drawing office, my friend, Prof. R. B. Owens, of McGill College, has found it an excellent plan to take up the design of a complete line of machines to meet given commercial conditions. Each student takes one; and the advantage of having all the students in the class working on machines of the same type, but of different dimensions, is that by comparing notes they are able to see clearly the change necessitated in the dimensions, as the output, or conditions of running, vary.

A set of both direct and of alternate-current machines should always be taken up. A good plan is then to submit the data compiled and the drawings prepared to the criticism of someone whose business it is to design machines for the maintenance of a reputation and the earning of an income on money invested in the manufacture of electrical machinery. In this way the attempt may be made to impart to the student information possessing a real market value without sacrificing the study of broad principles to unnecessary detail.

An important expedient for bringing the electrical engineering college into close contact with the ever-varying practical development of the subject is to obtain the services of specialists in the several fields of current work, in giving courses of lectures on the status and probable development of their special line of activity. Courses of from six to ten lectures each, upon which the student should be examined, as upon work given by the ordinary instructors, are best adapted for dealing with such special topics. One or two lectures by a distinguished engineer, although interesting, do not meet the requirements.

Another most important study which ought to be mentioned in this connection is what is called by the Germans "Wirthschaftlichkeit," and which may, perhaps, be rendered the "economics of engineering design." Its object may be most easily explained by taking an example from the work of an American college which is due to my friend Prof. Owens.

It was required of every electrical engineering student in this college, that towards the end of his course, he should figure out the design of either a lighting or street railway plant. A number of scale drawings of towns of various sizes were available, and from known or assumed conditions the position of the station was assigned. Then, in the case of a lighting plant, the locations of the individual customers was taken as given, with particular load diagrams for each. From these isolated diagrams the nature of the station was determined, and the machinery and circuits laid out. All the circuits were calculated and were shown on the map, together with poles and the more important accessories. Outline plans for standard machines were readily obtainable, and the station was arranged by their aid. Full specifications for the plant were then drawn, definite as regarded the results to be obtained, but impartial as regarded different types of plant. Lastly, a bill of material was made out and the costs estimated for some one type of standard machinery, using price lists and allowing for labour; and the expense of operation and maintenance, together with the income necessary to render the installation a paying investment were determined. Such plans and estimates were then checked by a constructing engineer, whose business it was to be in touch with such matters.

This department of study, which really constitutes the daily duty of the designing engineer, has been to my knowledge almost wholly neglected in all save one or two German and American colleges. Such a worked-out example as the above places in due perspective the relative value of the various portions of the pupil's whole curriculum. Hitherto we have mostly been content to discuss with all elaboration the design of our machines in regard to their general convenience and adaptation to their purposes, keeping in view simplicity and safety of operation, easiness of adjustment, and facility of repair; we have also exhaustively treated the elements of strength and rigidity, and the balancing of the rotating or other moving parts; in some instances the ideas of harmony of proportion and of elegance of detail has even been entered into; but very seldom have the really vital questions of cost of construction and total cost of production of different designs, in relation to the respective expenses of their maintenance for operation and for repairs, and of their durability, been duly approached in the professional college or school. Yet these are the governing factors in the everyday settlement of engineering problems!

The course of training for an electrical engineer, which has been somewhat hurriedly, and I fear incompletely, sketched in the above remarks, nevertheless outlines the curriculum which a not inconsiderable experience in such matters leads me to recommend as being best adapted—not in any sense to produce a complete electrical engineer—but to impart to a youth of moderate ability and unflagging devotion the capacity to follow with success that arduous calling. It must be recollected that the British engineer of the new century will need not only to know and to be able to use that which has been perfected by his predecessors; but to be continually experimenting and improving upon what already exists, to be devising new lines of activity, and to be discovering fresh fields of operation, if we are to maintain not merely our industrial supremacy, but even our national independence, in the tremendous struggle for commercial existence which is now impending.

In conclusion, I would press upon the members of this Institution the strong conviction I hold of the expediency, from the point of view just referred to, of at once establishing some arrangement whereby the more eminent young employés of our manufacturing houses may be enabled and encouraged to return, for periods of months at a time, to the laboratories of their schools or colleges, for the purpose of spending their whole energies in the prosecution of industrial research for the benefit of the firms employing them. This system is already partly in vogue in Germany and America, and has produced most gratifying results. But this and all the other questions in regard to the proper education of our young engineers is entirely in the hands of their future employers. If the leaders of British industry do not realise the national significance of such higher scientific training as is here proposed, it is futile for the heads of our colleges and technical schools to seek to thrust forward their projects in their despite.

## A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.*

BY MICHAEL B. FIELD, A.M.INST.C.E.

A problem which often confronts the central station engineer is the measurement at the power-house itself of the voltage obtaining at distant parts of his network which supplies current for, say, lighting and power purposes. In fact, it is very often of far greater importance that the engineer in charge should know accurately the value of the voltage existing at the distributing network, or, better, the lamp terminals or motor terminals, as the case may be, than that obtaining at the central station 'bus bars themselves. In cases where the distributing network lies at some considerable distance from the power-house, and is fed with current by means of "feeders" the drop of voltage in the latter may vary from zero, when the network is very lightly loaded, to 10 to 12 per cent. when the network is heavily loaded. Under such circumstances the engineer requires, of course, so to regulate his generators that the voltage at the network or lamp or motor terminals remains constant; in other words, he must raise the 'bus-bar voltage in the power-house above the normal by an amount equal to the drop in the feeders. In such cases a very usual course to adopt is to mount on the switchboard in the central station, voltmeters which are connected to points of the network by means of "pilot" wires, and thus indicate the true voltage existing at those points. The engineer in charge can then readily regulate his generators so that, under varying conditions of load, the voltage indicated by these voltmeters is maintained constant.

In the year 1882 Dr. Hopkinson patented an arrangement for effecting the same purpose without resorting to the employment of pilot wires. His method consisted of compounding the shunt windings of electromagnetic voltmeters with a few turns of thick wire, through which the main feeder current, or a proportionate part thereof, flowed. In this way a voltmeter connected to the near end of a pair of feeders might be compensated for the drop along the feeders, and would thus indicate the voltage existing at the far ends, and obviate the necessity of employing pilot wires. There is, of course, no great disadvantage in employing pilot wires for the purpose named beyond the cost of the same, which will amount to at least £90 per mile per twin wire. If it be possible to save this sum, which, especially in the case of long-distance transmissions or networks covering extensive areas, will amount to a very considerable sum, by merely adding a suitable arrangement of resistances at the switchboards, it will, of course, be advantageous to do so. Moreover, by obviating the pilot wire, we obviate the trouble often connected therewith; and, while speaking on this point, I would call attention to the fact that it is by no means uncommon for pilot wires to give trouble. What the reason usually is I do not know. Whether it is that while laying them they are considered as an adjunct of no vital importance, and therefore the necessary care is not devoted to their instalment, or whether it be for other reasons, is not a matter for discussion here.

Compounding coils of the above description are, of course, quite inapplicable to voltmeters constructed on the D'Arsonval principle, *e.g.*, Weston voltmeters, and in consequence of the almost universal preference shown by central station engineers for instruments of this class for continuous-current work, the writer some little while ago devised a method whereby any voltmeter whatever may be compensated for the feeder drop of either a two, three, or multiple wire system without necessitating constructional modifications of any kind, and, beyond that, can be arranged to indicate the *average* voltage obtaining at *any group* of distant feeding-points. The method is capable of very general application, but three instances of its use are of special interest to central station engineers, and it is the object of this short Paper, firstly, to describe briefly these three applications, and, secondly, to investigate analytically the accuracy of the same. The three cases for consideration are:—

(*a*) The measurement on the same instrument not only of the actual voltage existing at various feeding-points of a two-wire network, but also the *average* of the voltage at all the feeding-points, or the average voltage at any desired group of feeding-points of the network.

(*b*) The measurement of the individual feeding-point voltages and the average voltage at any group of feeding-points of a network on the three, five, or other multiple-wire systems.

(*c*) The measurement by means of a low-tension electrostatic multicellular voltmeter of the voltage at the far end of a long single or multiphase-power transmission line working at extra high tension, and possibly possessing a comparatively large self-induction.

Let us imagine a large distributing network supplying current for lighting and power purposes over a considerable area. It is evident that a voltmeter in the power-house so arranged that it indicated directly the average of the voltage all over the network would provide the engineer in charge with much more valuable information than one arranged only to indicate the actual voltage at some particular point of the network, for it is clear that the engineer should strive to maintain the average voltage at the normal value. Now, although it is not easy to obtain the true average of all points of the network, this may be approximated to by measuring the average voltage existing at all the feeding-points; this information would, as a rule, be a sufficient guide to enable the central station engineer to maintain the average voltage over the network itself at its normal value. It might further be advantageous for the engineer to be able to measure the average voltage existing at some one group or other of feeding-points—*e.g.*, during one portion of the day he might perhaps wish to pay most attention to keeping the average voltage throughout the commercial portion of the town constant, and at another time it would be of more importance to maintain the average voltage throughout the residential portion of the town constant. He might further wish to know at any instant what was the actual voltage at the end of some one long feeder supplying an outlying district, more especially if this feeder contained a booster so that the voltage was capable of independent regulation; all of these conditions become possible by the method about to be described.

*Case A.*—The additional switchboard apparatus necessary for this case—for, say, a continuous-current system—consists of a low-reading Weston voltmeter with a suitably graduated scale (*e.g.*, an ordinary 600-volt Weston with the series resistance removed would serve perfectly), a multiple contact voltmeter switch, a set of voltmeter resistances which would be mounted in an out-of-the-way place at the back of the switchboard, and, further, a series resistance for insertion in each feeder circuit. These latter resistances would be similar to those usually supplied with Weston ammeters, and would be

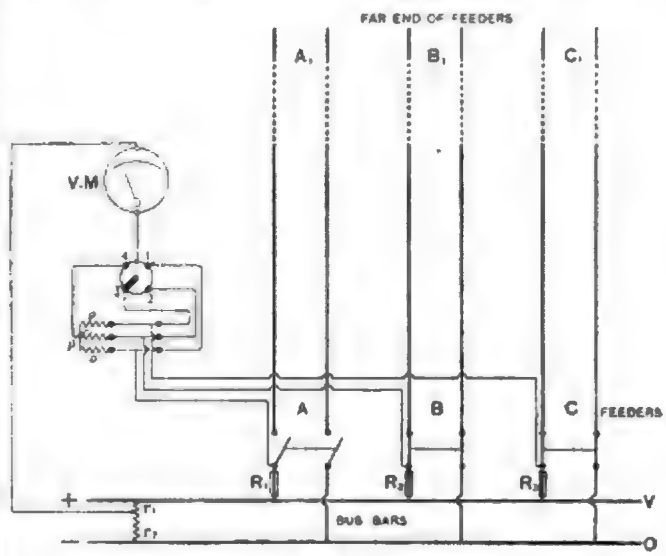


FIG. 1.

such that the drop across them with the maximum current would be of the order of two-tenths of a volt, or less where exceptionally heavy feeder currents are dealt with. The multiple contact switch would be arranged for as many "positions" as groups of feeding points required. Suppose, for example, three feeding circuits A, B, C left the station, a four-way voltmeter switch might be advantageously employed. With the switch successively in the first three positions the voltmeter would indicate the feeding-point voltage of the network at $A_1$, $B_1$, $C_1$ respectively, while with the switch in the fourth position the voltmeter would indicate the average voltage at the feeding points $A_1$, $B_1$, $C_1$.

Two distinct arrangements are shown in Figs. 1 and 2. Fig. 1 shows the simpler of the two, but involves the disadvantage that the average voltage of $A_1$, $B_1$, $C_1$ can only be obtained if all three feeding circuits are switched in. It is, moreover, only possible to determine the individual values $A_1$, $B_1$, and $C_1$ if the corresponding feeders be switched in.

In Fig. 2, on the other hand, a modification is shown whereby the individual voltages $A_1$, $B_1$, $C_1$, and the average of $A_1$, $B_1$, $C_1$, are given correctly by the voltmeter with the switch in the corresponding positions, whether some of the feeder circuits be switched in or not. This involves extra complication in the multiple contact switch, in which case it may conveniently be constructed on the same lines as a miniature tramcar controller. In Fig. 2 the contact cylinder has, for the sake of clearness, been developed on a plane. $R_1$, $R_2$, $R_3$ are the inserted series resistances in the feeder circuits; shunt resistances (divided into $r_1$ and $r_2$) are connected in Fig. 2 across each pair of feeders, in Fig. 1 across the 'bus bars. The letter $\rho$ represents that the particular connecting wires so distinguished must have sufficient resistance to prevent any appreciable interchange

* Paper read at a meeting of the Glasgow Local Section of the Institution of Electrical Engineers, February 13.

of current between the various feeder circuits when the switch is in the fourth position. VM is the voltmeter, and $s$ a shunt which is connected across the terminals of the voltmeter when the switch is in the fourth position, in order to keep the calibration of the voltmeter correct.

Briefly explained the principle involved is as follows: If $r_1$ be one-$n$th part of $r_1+r_2$, the drop of pressure down $r_1$ will be one-$n$th part of the 'bus bar volts. Again, if $R_1$ be one-$(n-1)$th part of the whole feeder (go and return) resistance the drop along $R_1$ will be one-$n$th of the total drop. The voltmeter then, if connected to one feeder, measures one-$n$th part of the 'bus bar voltage less one-$n$th part of the drop, *i.e.*, one-$n$th part of the voltage existing at the far end of the feeder. If a number of feeders be simultaneously connected to the same voltmeter, this latter will indicate the average of all the individual voltages. The connecting wires, must, however, as already stated, have sufficient resistance ($\rho$) to avoid any appreciable interchange of current between the different feeder circuits. The action of the shunt $s$, which is necessary with the arrangement shown in Fig 2, but not with that shown in Fig. 1, will be found fully explained in the analytical treatment of the subject.

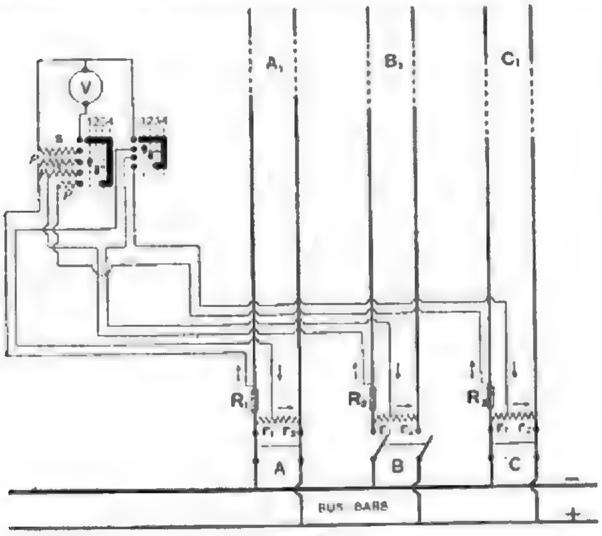


FIG. 2.

It may here be mentioned that the writer, on subsequent investigation, found that particular cases of his method had been anticipated by Mershon in America, and by Crompton and Ashley, and later by Heap, in England.* Mershon's patents relate exclusively to alternating currents, since he bases them fundamentally on the use of either current or potential transformers, or both. Fig. 3 shows one of Mershon's arrangement, though many equivalent arrangements are illustrated in his patent specifications. Mershon's object is to compensate the voltmeter, not only for the ohmic but also for the inductive drop of the line, and his arrangement is only used in connection with single lines—*i.e.*, it corresponds to case ($a$), where the number of feeder circuits is unity. As is evident from Fig. 3, the shunt resistance $r_1+r_2$ of Fig. 1 is replaced by a potential trans-

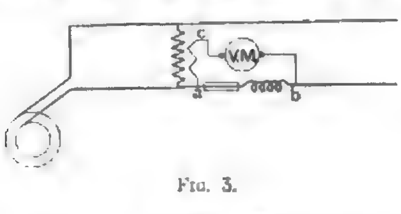


FIG. 3.

former whose ratio is $n:1$. Further, a resistance and a self-induction are inserted in the line whose values are one-$n$th times those of the line resistance and self-induction respectively. Referring to Fig. 3, we see then that the drop from $a$ to $b$ will be one-$n$th of the whole drop and in phase with it, whereas the secondary voltage of the transformer is one-$n$th of the generator voltage, and, if the terminals be correctly chosen, in phase with it. Thus the voltage $bc$, or that measured by the instrument, is one-$n$th of that existing at the end of the line.

The anticipations of Crompton and Ashley, and later by Heap, are merely case ($a$), where the number of feeder circuits is unity—*i.e.*, they compensate the voltmeter for the drop of voltage in a single pair of feeders by using shunt and series resistances, as explained. The diagram of connections for this simple case is shown in Fig. 4, and needs no further comments.

Neither Mershon, Crompton and Ashley, nor Heap, however, give any method for obtaining the average voltage at any desired group of feeding points, nor, with one exception referred to later on, is any method given in the above-mentioned patents applicable to case ($b$)—*i.e.*, when unequal currents exist in the go and return feeders, as in the case of three-wire systems and the like. This case, however, is just as important as the foregoing, owing to the extensive use now made of the three-wire system.

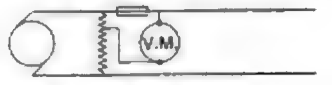


FIG. 4.

In such cases the voltage at the network between the neutral and each outer may be required to be known. The switchboard apparatus needed is very similar to that already described, the difference being that in this case series resistances must be inserted in *each* main, and the potential resistances are somewhat differently arranged. Fig. 5 shows the arrangement as applied to but one set of feeders. The voltmeter V will then be compensated for the combined drop both in the outer and neutral mains with which it is connected. If the average voltage between, say, the positive outer and the neutral at several feeding points be required, the arrangement of multiple-contact switch as in Fig. 2 may be employed. The principle involved in this case is somewhat different to that of case ($a$), and may be best understood by comparison with a Wheatstone's bridge.

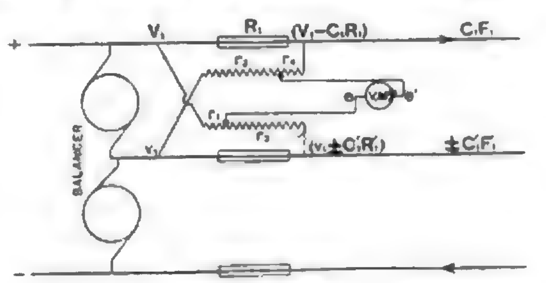


FIG. 5.

Fig. 6 may be considered as equivalent to Fig. 5 if we consider the potential differences called into play by the drop across R and $R'_1$, as replaced by opposing E.M.F.s. If now the ratio arms of the Wheatstone's bridge be slightly out of balance, it is clear that the current through the voltmeter will be proportional to the expression $\{V_1 - v_1 - (\alpha C_1 R_1 + \beta C'_1 R'_1)\}$. Where $\alpha$ and $\beta$ are numerics the value of which may be adjusted as desired by merely altering the resistance of the ratio arms. If, therefore, they be adjusted so that $\alpha R_1$ equals the resistance of the outer, and $\beta R'_1$ the resistance of the neutral, it is clear the voltmeter indications will be proportional to the voltage obtaining at the far end between outer and neutral.

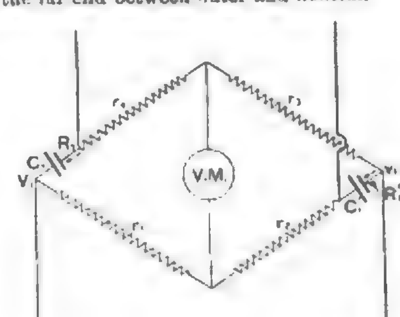


FIG. 6.

With the device just described it is of utmost importance to select as sensitive a voltmeter as possible in order to minimise the losses which take place in the shunt resistances. In the latter portion of this communication this is shown to be the case, the following result being arrived at analytically:—

If the method be applied to a three-wire system with 400 volts between outers, and if the series resistances in the outer and neutral mains are as large as is at all practicable to make them, *e.g.*, the drop of volts along $R_1 = 0{\cdot}2$ volts and along $R'_1 = 0{\cdot}4$ volts with an average full load—the drop along the resistance $R'_1$ may be taken higher than along $R_1$ since the current in the former case is much less

* Mershon: American Patent 551,982: dated December 24, 1895.
" " " 571,839: " November 24, 1896.
Crompton and Ashley 6,695: " ... 1898.
Heap ... 8,348: " ... 1898

than in the latter, so that a larger drop does not necessarily imply a large loss of power), and if the voltmeter required $\frac{1}{100}$th ampere to give the full scale deflection, then the resistance of $(r_1+r_2)$ and $(r_3+r_4)$ could not well be more than 890 ohms. This would involve in them alone a continuous loss of nearly 90 watts. Instruments of the dead-beat suspended coil D'Arsonval type made up in switchboard form, with a needle swinging in a horizontal plane as in a Kelvin low-tension electrostatic voltmeter, would, therefore, be best for this purpose, for with suspended coil voltmeters of this description not only can the values of the resistances $(r_1+r_2)$ and $(r_3+r_4)$ be increased to 3,000 ohms or 4,000 ohms, but the maximum drop of volts across $R_1$ and $R'_1$ may also be greatly reduced.

When employing this method for determining the average of several feeding-point voltages, a multiple contact switch, as shown in Fig. 2, is necessary. It is also necessary to shunt the voltmeter by means of the resistance S, but the resistance $\rho$ of the various connecting wires may be made as low as is convenient, since the resistances $r_1, r_2, r_3, r_4$ will themselves prevent any appreciable interchange of current between the various feeder circuits. Fig. 7 shows

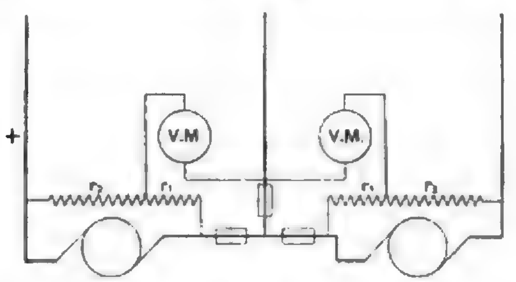


FIG. 7.

a particular case where the voltage at the end of a set of three-wire feeders may be simply arrived at. The figure is a sufficient explanation of itself. It is, however, clear that this case is rarely applicable in practice.

*(To be concluded.)*

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

### LECTURE II.—ELECTRIC RESONANCE.

Your attention was drawn in the last lecture to the fact that the electrical oscillations set up in a low resistance discharge circuit connecting the surfaces of a Leyden jar have a frequency (N) expressed by the formula:

$$N=\frac{3\times10^{10}}{2\pi\sqrt{LC}}$$

where L is the inductance of the circuit in electromagnetic measure, and C the capacity of the jar in electrostatic units. You are no doubt perfectly familiar with that great generalisation of Faraday's, in which he formulated the view that every case of electric charge is similar in nature to the charge of a condenser or Leyden jar. It is impossible to communicate to a conductor a charge say of positive electricity, unless to some other body or bodies there is given an equal charge of negative electricity. Accordingly, an electrically charged and insulated sphere placed in a room forms with the walls of the room, which carry an equal and opposite charge, a condenser or Leyden jar, and the energy of that charge resides, as we now know, in the dielectric or space between them. In the same manner if we have two spheres or conductors, one connected with one terminal of the secondary circuit of an induction coil and the second with the other, we have, when these conductors are oppositely charged, a system of lines of electric strain stretching from one conductor to the other.

Every case of electric charge is therefore an instance of some form of Leyden jar or condenser. If we discharge a charged conductor, say by presenting the knuckle to an insulated charged sphere, when we ourselves are standing on the ground, a small spark passes, and that spark is, as we have seen, a line in the air along which the air has become conductive. Accordingly, this is equivalent to connecting the coatings of a charged Leyden jar by a very short conductor, and we have all the conditions requisite for setting up electric oscillations Such a discharge spark is therefore in most cases an oscillatory spark, and the charge of the conductor does not disappear at once but alternates, being first positive and then negative, but decreasing in quantity at each alternation of sign. We might, if it was worth while, represent the electrical history of the charged sphere during discharge by a kinematograph slide, which would show the decrescent and alternating charges. The interval of time between two successive charges of the same sign is called the "time period" or *oscillation period* of the conductor. Every conductor thus has a natural oscillation period. We can, of course, make a forced oscillation of any period, just as we can take hold of a pendulum or spring and force it to vibrate, whilst controlling it at any required frequency, but if we give it an impulse and leave it to itself, it settles down after a short time into oscillations which have a frequency determined by the inertia and elastic control of the vibrating body.

What is true in the case of a mechanical vibrator is true electrically of every conductor or conducting circuit: it has a natural free period of electrical oscillation determined by its geometrical form and the nature of the surrounding medium—in other words, by its inductance and capacity. Suppose, for instance, we take the case of a conducting sphere and create a disturbance of its charge by bringing near to it another electrified body, or, as above explained, by discharging the sphere when charged and insulated. The mathematical investigations to determine the free periodic time of oscillation of the charge are not very simple, but they have been given by Prof. J. J. Thomson ("Recent Researches in Electricity and Magnetism," p. 270), and he has shown that the electrical oscillation period $t$ of a conducting sphere of radius $r$ (in centimetres) is given by

$$t=\frac{4\pi r}{3\times10^{10}\sqrt{3}}=\frac{r}{4{,}135\times10^{6}}\text{ sec.}$$

Thus the time period of a free oscillation of the charge on a sphere of about 32in. in diameter is $\frac{1}{100000000}$th of a second.

If the earth as a whole be considered as a charged sphere, its electrical time period is about $\frac{1}{6}$th of a second, and that of a sphere the size of the sun, $16\frac{9}{10}$ sec. Prof. J. J. Thomson has also calculated the time period of oscillation of two concentric spheres of nearly equal radii, one charged positively and the other negatively. The expression for the time period in this case is—

$$t=\frac{\pi\sqrt{2}\,r}{3\times10^{10}}=\frac{r}{6{,}756\times10^{6}}$$

If we consider that the earth as a whole is charged, and that the complementary charge of opposite sign resides in the upper conducting layers of the earth's atmosphere, then the natural time period of oscillation of this system would be $\frac{1}{11}$th of a second.

Now in connection with this part of the subject there is one point of great interest. Both theoretical and experimental research show that in the case of conductors of a certain form the electric oscillations die away with great rapidity. Thus, in the case of the sphere, Prof. Thomson shows that the maximum amplitude of oscillation dies away to $1/\epsilon$ $(\epsilon=2{\cdot}71828)$ of its original value in a time $2r/V$ (where $V=3\times10^{10}$) of a second, that is in the time which light would take to travel over the diameter of the sphere.

In the time occupied by one complete vibration the amplitude falls to $\frac{1}{\epsilon^{2\pi/\sqrt{3}}}$ of its original value, or to about $\frac{1}{38}$th of its initial magnitude. Hence these electrical oscillations when set up in a sphere decay away very rapidly. The damping factor is large. This decay is not due to resistance but to the fact that the energy of the oscillations is expended in making electric waves, the study of which will occupy us in the last lecture.

We find therefore that conductors of some forms radiate very well the energy of their oscillations, but in other cases the oscillations persist for a long time unless frittered away by resistance. As an example of the latter class of electrical vibrator, we may instance a nearly closed ring of metal. If oscillations are set up in such a circuit the charge may oscillate several hundred or thousand times before it comes to rest. In the case of a conducting sphere the disturbed charge hardly makes two oscillations before they practically cease. Hence we must classify electric circuits and conductors into good and poor oscillators, or into bad and good radiators.

We must think of a good electrical radiator as analogous to a small hot body having a large surface covered, say, with lamp-black. It radiates its heat very quickly and cools rapidly. A poor electrical radiator or persistent oscillator is, on the other hand, analogous to a large hot body having a surface of polished metal and radiating therefore very slowly. Generally speaking, we may say that open circuits such as rods, spheres, ellipsoids, &c., are good electrical radiators, but nearly closed circuits, such as rings and loops of wire, are bad radiators. In all good radiators electrical oscillations set up are damped out very quickly, not by resistance dissipating the energy as heat, but by electrical radiation removing it as wave energy.*

Another case of importance, as we shall see subsequently, is that of a conductor formed of two spheres connected by a straight wire. This, from the resemblance to a familiar object, is called a *dumbell* radiator. If the capacity of either sphere is C, then the capacity of two spheres in series is C/2, and if we may neglect the capacity of

* Cantor lecture delivered before the Society of Arts, December 4, 1900.

* See a note on the "Decrement of Electrical Oscillations," by M. V. Bjerknes—*Comptes Rendus*, June 22, 1891; or *The Electrician*, Vol. XXVII., p. 302.

the wire, then assuming that the inductance, L, is wholly in the wire, and the capacity, C/2, wholly in the spheres, we have as the expression of the time of vibration, $t$, where

$$t = 2\pi\sqrt{\frac{C}{2}L} = \pi\sqrt{2CL}.$$

It is important to note that the capacity of the spheres is to be reckoned in series, and that we are concerned with the capacity of both of them. In one of his investigations Hertz, who first used this form of radiator, omitted to notice this fact, but it was pointed out subsequently by Prof. Poincaré.

The expression for the time of vibration of the dumbell radiator becomes more complicated if we take into account the variation in the value of the inductance of the wire which takes place by reason of the concentration of the current at the surface. As, however, the full mathematical treatment of the problem involves some considerable complexities, those who are desirous of further detailed information may be referred to Prof. J. J. Thomson's book, "Recent Researches in Electricity and Magnetism," p. 328, where a complete treatment of the subject will be found.

We have in the next place to notice the effect of impressing upon a circuit an E.M.F. which is periodic and agrees in period with the natural time period of that circuit. Everyone is familiar with the effects of timing the impulses on a body capable of mechanical vibration so that they fall in with its natural vibration period; we know that in this manner in a short time feeble but properly timed impulses can create vibrations of great amplitude. Acoustics furnishes us with numerous examples of the effect, such as the *resonance* effects produced when a tuning fork is held over a tall glass jar filled up to a certain height with water, thus forming a resonant air column of an appropriate length. Another instance of a similar kind is presented when we attach to the prong of a tuning fork a

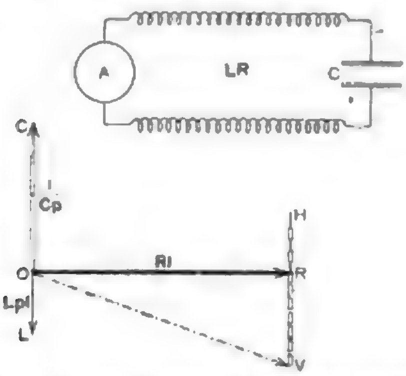


FIG. 1.—C (upper diagram) represents a Condenser or Concentric Cable closing the Circuit of an Alternator, A, through an Inductive Circuit, LR. (The lower diagram represents the relative phase of the impressed, effective, and condenser E.M.F.s.)

cord, the length and tension of which can be varied. It is found that under certain conditions as to tension the cord is thrown into vibrations of considerable amplitude. This occurs when the tension and length of the cord is so adjusted that its natural oscillation period agrees with the period of the impulses applied to it by the tuning fork to set it in vibration. A pretty application of this mechanical resonance principle is made in the instrument called "Campbell's Frequency Teller," used to determine the frequency of an ordinary alternating current. In this instrument the length of a steel spring is adjusted until its natural time period agrees with the period of the alternating current flowing in the coils of an electromagnet which sets it in vibration by its periodic attractions. The principle here involved was suggested in 1899 by Profs. Ayrton and Perry (see "Laboratory Notes on Alternate Current Circuits," *Proc.* Inst. Elec. Eng., Vol. XVIII., p. 310).

Electrical resonance effects have long been known in connection with low-frequency alternating currents. To electrical engineers it is an exceedingly familiar fact that if an alternator is connected to a concentric cable, for a certain length of cable and frequency of alternation, the voltage between the two members of the concentric cable will become much greater than that which would exist between the terminals of the alternator if kept at the same speed and excitation and the cable removed (see Fig. 1). This exalting effect takes place to the maximum degree if the frequency N of the alternator becomes equal or nearly equal to $\frac{1{,}000}{2\pi\sqrt{CL}}$ where C is the capacity of the cable in microfarads, and L the inductance of the circuit in henrys. Effects of this kind, very much misnamed "Ferranti effects," were found in connection with long concentric cables laid from Deptford to London. When the system of the London Electric Supply Corporation was first put into operation these cable effects were discussed and described by me in a Paper on some "Effects of Alternating-Current Flow in Circuits having Capacity and Self-Induction."* In this Paper were described also some experiments made at the works of Messrs. Siemens Bros., many years ago, in which a variable length of gutta-percha-covered cable immersed in a tank was connected to an alternator through a transformer, the alternator being kept running at the same speed and excitation. The length of the cable was varied so as to alter the capacity of the system, and corresponding to a certain definite capacity the voltage across the alternator terminals rose very quickly from a normal value, which it would have had if the cable had been disconnected, to an augmented

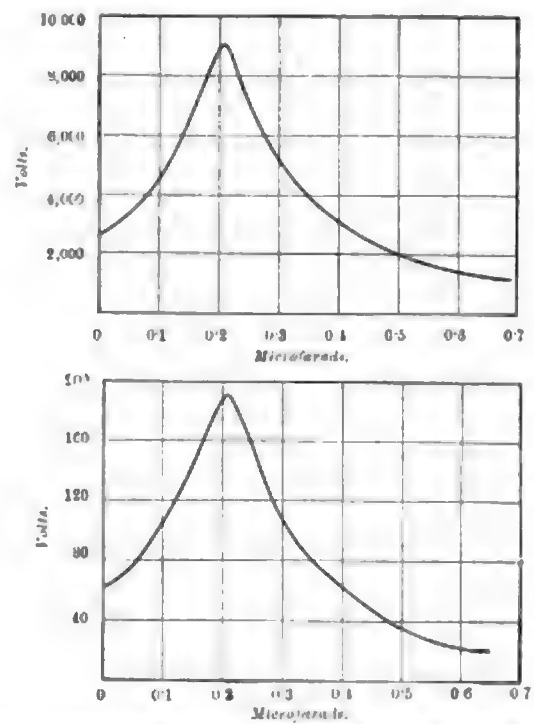


FIG. 2.—Variation of Voltage at Terminals of an Alternator when closed by a Condenser through an Inductive Circuit.

value of about four times as great. This variation in voltage is shown by the curves in Fig. 2. Very similar effects were found by Hertz in the case of experiments which will occupy our attention later. In these experiments electrical oscillations were set up in a conducting rectangle, the circuit being open and terminated by spark balls. By varying the capacity of this circuit by attaching to its ends two parallel wires, Hertz found that for a certain length of these wires the sparking distance was a maximum, but that it diminished if the wires were either shortened or lengthened in a similar manner. The sharpness with which this curve rises to a maximum is an indication

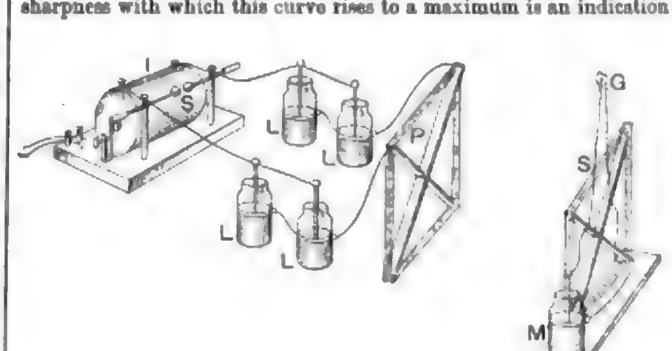


FIG. 3.—Secondary Oscillations set up in a Tuned Resonant Circuit, S, by Oscillations in a Primary Circuit, P.

of the fact that the increase of the amplitude of the electrical oscillations, due to electric resonance, only takes place when the tuning is fairly exact.

We may tune one electric circuit to another either by varying the capacity of one circuit, as in the experiment just described, or by varying the inductance. If it is desired to produce this last effect with-

* See "*Journal* of the Proceedings of the Institution of Electrical Engineers," Vol. XX., p. 362 (J. A. Fleming).

out varying the resistance, the most convenient way to do it is by forming the conducting wire into a spiral, the ends of which are connected to the plates of a condenser. We can then, as already shown, vary the inductance of a circuit by bringing the turns of a spiral more or less together, and we can thus set up a state of electric resonance by making the time of free vibration of the circuit what we please within certain limits. In order that two electrical circuits may be "in tune" or sympathy with each other, it is clear that we have to adjust one or both so that the product of capacity and inductance of one shall either be equal to that of the other, or to some integer multiple of it.

We have already seen that an electrical oscillation set up in a primary circuit can create by induction other electrical oscillations in a secondary circuit. It is easy to show by an experiment that this inductive effect is greatly enhanced if the secondary circuit is tuned to the primary. Thus, for instance, we may set up electrical oscillations as shown in the previous lecture, in a large circuit of wire wound on a square frame (see Fig. 3). I place near this primary (P) a secondary circuit (S) of the same form, and insert one or more Leyden jars and an adjustable coil of wire; also a small incandescent lamp is employed to close the circuit. The secondary circuit thus consists of a coil of wire in series with a condenser and a lamp as a current indicator. If the primary and secondary coil are within a short distance of one another then, as you see, even if the condenser and adjustable inductance are short circuited, the lamp lights up. We can, however, remove the secondary coil to such a distance that under the above conditions the carbon filament is no longer visibly incandescent, because the secondary oscillations are too feeble. We can then restore the light of the lamp by inserting the condenser or Leyden jars in series with it, and making a suitable adjustment of the variable inductance coil. The secondary circuit has now been

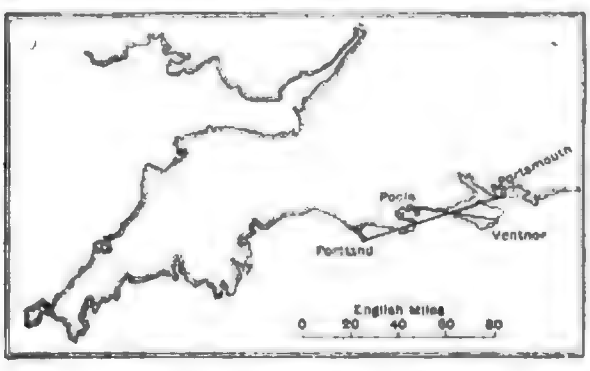


Fig. 4.—Marconi Wireless Telegraph Stations.

tuned to sympathy with the primary circuit, and as a result, the electromotive impulses created in it by the co-linked oscillatory magnetic field of the primary circuit are able to set up secondary circuits of much greater strength than if the secondary circuit had a time period different to the primary.

Two such adjusted circuits are called resonant or sympathetic circuits, and this principle of tuning is of enormous importance in connection with the utilisation of electrical oscillations. Although easy to describe, it requires, however, great dexterity and skill to effect the required tuning; when once it is achieved and two circuits made perfectly resonant, it is exceedingly remarkable how very little change in the capacity of one circuit entirely destroys its power of receiving electrical impulses from another circuit. Mr. Marconi has made great use of electrical resonance in experiments he has been conducting during the last two years in developing his system of wireless telegraphy, and he has already achieved some very remarkable results in establishing independent wireless telegraphic communication between pairs of places in the same area, and yet entirely preventing interference between them. Thus communication was long ago established by the Marconi system for the Admiralty between Portsmouth and Portland, two places about 65 miles apart in a straight line, and having hills 800ft. high in the line of sight. Across this line of communication and included in it there is another 30-mile Marconi circuit between stations at Niton, in the Isle of Wight, and Poole, near Bournemouth. These two lines—Portsmouth-Portland and Niton-Poole—cross each other at a not very great angle (see Fig. 4). By the employment of properly tuned receiving and transmitting circuits Mr. Marconi has rendered these circuits quite independent of each other, so that no signalling which goes on between Poole and Niton interferes with or can be read on the Portsmouth-Portland stations. What has been done here can be carried out indefinitely, and the objections as to interference of stations which imperfectly-informed persons are in the habit of raising with regard to Mr. Marconi's system of wireless telegraphy, as a matter of fact no longer exist.

It is important, however, to direct attention to one condition which must exist in order that well-marked resonance may take place. Resonance, whether mechanical, acoustic, or electrical, essentially depends upon the accumulated effect of numerous properly timed and small impulses. In order that we may have resonance effects produced it is necessary that the motive impulses shall not merely be properly timed, but be maintained. In other words, tuning cannot be produced unless the periodic impulses are kept up for some time. Accordingly, if the electromotive impulses acting on a secondary circuit die away very quickly we have no longer the proper conditions for exhibiting resonance effects. To set a pendulum in vibration by puffs of air we must not only time the puffs properly, but keep on puffing for a considerable period.

It is, therefore, clear that an electrical circuit which is a good radiator is not one suitable to act as the primary circuit of a resonant system unless it has a large store of energy to draw upon. As an illustration of the rate at which a good electrical radiator gets rid of its energy, we may take a case given by Hertz.* He considers a radiator consisting of two metallic spheres each 15cm. in radius connected by a wire 100cm. in length; and in the middle of that wire is a spark-gap of 1cm. The spheres are supposed to be charged up to a difference of potential such that a spark passes across the gap and the electrical charge then oscillates. The difference of potential between the spheres at the moment of sparking is then about 36,000 volts (see Fig. 5). Hence the total energy stored up in the system just before sparking, as electrostatic energy, is—

$$\tfrac{1}{2} \cdot \frac{15 \times 36 \times 36 \times 10^6}{9 \times 10^{11}} = \frac{54}{10^4} \text{ of a joule.}$$

Now Hertz shows that in the case of such a radiator the loss of energy in each half oscillation is given by the expression—

$$\frac{\pi^4 Q^2 l^2}{3\lambda^3} \dagger$$

where Q is the charge of each sphere, $l$ the length of the connecting wire, and $\lambda$ is the wave length of the radiation, which in this case Hertz determined to be 480cm. Hence the loss in energy by radiation in each half period is easily found to be 2,400 ergs, or 24 $10^5$ joules. Accordingly, it is clear that after 11 half oscillations or five and a-half complete periods, half the original store of energy will have been dissipated, and therefore that at this rate 10 complete oscillations cannot take place before the stored energy is practically all radiated.

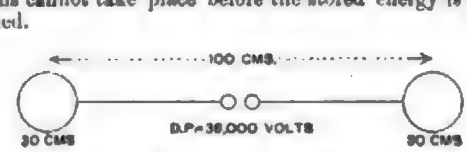


Fig. 5.—Dumb-bell Oscillator.

Since the wave length is 480cm., and the velocity of propagation $3 \times 10^{10}$cm. per second, it follows that the time period is 1·6 hundred-millionths of a second. Hence in about 16 hundred-millionths of a second the radiator sends out energy equal to 54 $10^4$ of a joule. In other words, it is radiating at a rate equal to nearly 45 H.P. Hence, in order to keep up this radiation without intermission the oscillator would have to be supplied with energy at the rate of nearly 25,000 foot-pounds per second from some source of energy. This is about equal to the energy furnished per second to 1,000 8 c.p. 100-volt incandescent lamps all fully alight at once. As a matter of fact, however, the methods already described only result in the production of intermittent trains or groups of oscillations, with comparatively long intervals of silence between them.

The rate of decay or the damping in open circuit radiators has been discussed mathematically by many writers. M. Planck (*Annalen Phys. Chem.* 63, 1, pp. 419-422, 1897), has treated the case, just considered, of two spheres united by a wire of length. He has shown that the logarithmic decrement or the logarithm of the ratio of the amplitude of one vibration to the next is given by the expression—

$$\sigma = \frac{16\pi^4 l^2 C}{3\lambda^3}$$

where C is the capacity of the condenser or vibrating system, $l$ the distance between the spheres or plates, and $\lambda$ is the wave length. Hence it is easy to show that to secure prolonged oscillations or small damping, we must make use of large capacity or large inductance in the radiating circuit.‡

(*To be concluded.*)

* "Electric Waves." English translation by D. E. Jones, p. 150.

† This result is confirmed by Dr. Larmor. See "Æther and Matter," p. 225.

‡ See also S. Lagergren "On the Damping of Resonators," *Annal. Phys. Chem.*, 64, 2, p. 290, 1898.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*ll Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, |
| Postal Union ... | 30s. 0d. | 15s. 6d. | 8s. 0d. | payable in advance. |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## COMPANIES V. MUNICIPALITIES—"IN BULK."

An interesting event has just occurred which will constitute a landmark in the history of both municipal electricity supply and wholesale electric power distribution or, to use the popular phraseology, "electricity supply 'in bulk.'" During the last session of Parliament, the North Metropolitan Electric Power Supply Bill was promoted by the Electric Power Distribution Co. This company already held provisional orders for Hertford and Barnet, and the North Metropolitan Electric Supply Co. was to be formed in order to give a wholesale supply of electric power in a large district to the north of London. A map of this district and particulars of the scheme appeared in *The Electrician* at the time (see Vol. XLV., p. 207, &c.) and the debates on the bill on its way through Parliament were also duly reported in our columns. The area in question extended from the rural districts of Welwyn, Hertford, and Ware in the north, to Hendon, Wembley, Finchley, Hornsey, and Tottenham in the south (Willesden having been dropped out of the bill, as the local authority there was building its own works). On the west it included St. Albans and Barnet, and on the east the urban districts of Waltham Cross, Chingford and Walthamstow. It was intended to erect a large generating station at Ponder's End, near the works of the Edison and Swan Company, and to offer a supply of electric power wholesale to the various local authorities, who could then distribute it retail to consumers and utilise it for public lighting; and also to obtain provisional orders where the local authority itself would not supply. The two provisional orders, Barnet and Hertford, held by the Electrical Power Distribution Co., were to be transferred to the new company, and the generating stations being erected there converted into sub-stations. It may be added that a further incentive to the company was that it would in all probability be called upon to supply current for traction in various parts of its area. The opposition to the scheme was comparatively slight, and by counsel rather than witnesses, the argument urged against it being mainly that no public or local advantage would accrue from a supply of electricity in the district. Small modifications only were therefore made in the bill —viz., the powers in Edmonton and Hornsey were limited

to laying mains, and no immediate powers were granted in Walthamstow, through which, as it lies in a corner of the area, it would not be necessary to lay mains to other districts. Supply could, however, be given in these three districts if the express consent of their urban district councils was obtained in each case. Thus modified, the bill received Royal Assent on August 6, 1900.

On July 19th, however, while the North Metropolitan Electric Supply Bill was before Sir J. KITSON'S Committee, there appeared a circular issued to the ratepayers of Tottenham by the Tottenham Urban District Council. This circular stated that, on the previous day, a conference of representatives from Edmonton, Southgate, Enfield, Wood Green, Finchley and Tottenham had met, and was unanimously of the opinion that a bill should be promoted in the next session of Parliament for conferring powers for electric supply upon a joint committee for these six urban districts—or, rather, seven urban districts, as Friern Barnet was also to be included. The number of these was subsequently reduced to five by the withdrawal of Finchley and Friern Barnet. These five districts formed a large corner in the North Metropolitan Company's area. It was—to say the least—surprising that, having just put forward the view that no public advantage would accrue from the supply of electricity in the districts under their jurisdiction, these logical councillors should themselves desire to furnish such a supply. One of the learned counsel engaged on the committee stage of the company's bill, on being shown this circular, observed that it effectually proved the bill's preamble. The next step was the retention of Mr. HAWTAYNE to prepare a preliminary report on the scheme for a joint committee of these five districts. Mr. HAWTAYNE proposed a two-phase system, and submitted estimates of the capital expenditure, the yearly expenditure on working, and the corresponding revenue. This report was then submitted to Mr. HAMMOND; and Mr. HAWTAYNE was requested to consult with this gentleman and send in a final report expressing their joint views. Mr. HAMMOND, who is well-known to have "plumped for three-phase," converted Mr. HAWTAYNE to his opinion, and also slightly increased his estimates, with the result that the total capital expenditure was put down at £345,000 for a total plant capacity of 4,000kw. (1,000kw. of which was reserve plant), the revenue on the sale of 3½ million units at £46,400, and the annual expenditure (not including interest and redemption) at £22,000. The contents of this report and various items of the estimates are given more in detail on p. 595 of our issue of February 8th. It is interesting to note, however, in passing, that out of the total capital expenditure no less than £28,000, or 6·7 per cent., is assigned to legal, expert and engineering fees and contingencies; and that nearly a quarter of the total units sold are put down for public lighting at 2d. per unit—the price at which the company offered to supply it to the several local authorities.

The project has not survived the test of public opinion. Exception was taken to the large expenditure, and in one district only was the proposition carried. That was Southgate, where a poorly attended statutory mass meeting voted in favour of it, and no poll was demanded. At Enfield and Edmonton polls of the ratepayers were taken, and large majorities were recorded against the Council in each case, the voting being 2,734 to 1,691 and 1,597 to 1,027 respectively. At Wood Green matters had proceeded more slowly, and the meeting of the Council to confirm its previous resolution was only being held last week when the Edmonton and Enfield figures were announced, and the resolution in favour of the scheme was thereupon negatived. At Tottenham a poll was to have been taken this week, but was also abandoned in view of the Enfield and Edmonton result.

Thus was sealed the fate of a scheme that should never have been put on foot. We do not wish, however, to declare ourselves inveterately opposed to the general principle of joint municipal electricity supply schemes. Municipal trading, although in general inadvisable, has shown itself to be tolerably successful in the case of the general supply of electricity for lighting. Now that it has been proved that in electrical supply, just as in manufacturing industries, great economies can be produced by wholesale production, it is evident that the erection of separate small electricity works in neighbouring districts is unwise on commercial grounds, and they must be replaced by wholesale or "bulk" systems of supply. Where companies are willing to undertake this, however, they should be encouraged, as consumers are adequately protected from extortion by the provisions of the electric lighting acts. It is not wise that small local authorities should embark in large financial schemes on the security of the rates. Cases do arise, however, in which a supply of electrical power is desirable and no company has offered to undertake it; then by all means let two or three small townships combine to erect a generating station of an economical size if means can be found to secure a workable system of joint control. Parliament has still to settle this latter problem, however. Again, small urban and rural districts surrounding large provincial towns already provided with electricity works will do well to buy electrical energy from their neighbour instead of generating it for themselves. But, in general, the enormous business of wholesale electricity supply, necessitating as it does the employment of the latest developments of electrical engineering, and a continual trial of new machinery and methods, often barely out of their experimental stage, is obviously one to be undertaken by private enterprise. It would be indeed a sad thing if this new industry, which promises to quicken the industrial sluggishness to which even our politicians are now drawing attention, should be smothered in its infancy by the swaddling clothes of municipal management.

## REVIEWS.

(Copies of any of the undermentioned works can be had from *The Electrician* office post free, on receipt of published price.)

**The Construction of Large Induction Coils.** By A. T. HARE, M.A. (London: Methuen & Co. 1900. 6s.)

To the amateur desirous of building his own coil this book should prove invaluable, for it is a detailed yet clear and orderly description of the construction of all the parts of a coil. The author, who is apparently one of those enthusiastic amateurs who revel in the actual materialisation by their own hands of their own designs, gives, too, many hints and "wrinkles" which even the experienced manufacturer could read with profit. For instance, Mr. Hare very strongly and rightly insists on the thorough baking and dessication of the paper destined when paraffined to insulate the units of the secondary winding. We doubt, however, whether the blotting paper recommended for this purpose forms when waxed as strong an insulator as some of the tougher forms of cartridge paper similarly treated. The author, by-the-way, is not quite right in claiming novelty for the twinned grouping of the sections of the secondary. We know of at least one large manufacturer of coils who follows precisely this method of secondary building. But he is right in speaking highly of the immense advantages of the twinning system; and the manufacturer who introduces the process into his works will save money and improve his product.

On picking up the book we had hoped to find in coil design some radical step proposed tending towards the greater efficiency

of the instrument regarded as an energy transformer. But we were in this respect disappointed. The book is intended, of course, as merely a workshop handbook. But now that the induction coil has been given, by the discoveries of Hertz and Röntgen, important practical applications, it is not a little surprising that the instrument is still built in its archaic form. It seems that the induction coil still awaits its Hopkinson.

**Die Atmosphärische Elektrizität**, ihre Vertheilung und wahrscheinlichen Ursachen. By C. Liebenow. (Halle-a-S.: Wilhelm Knapp.) 1900. 2m.

Herr Liebenow in this brochure sets forth fully, yet not quite convincingly, that theory of the origin of atmospheric electricity with which his name is now associated. This theory is based on the thermodynamic deduction by the author of an electrical effect accompanying the flow of heat in conductors and resulting, or tending to result, in the establishment of potential differences throughout the medium. To test his theory quantitatively, Herr Liebenow takes Le Cadet's balloon observations of the potential fall per metre in the atmosphere at different elevations, and constructs therefrom an empirical formula. Using an extrapolation from this in his mathematical expression of the heat-flow electrical effect, he deduces the specific resistance of air under standard conditions. This figure he compares with a value obtained from certain of Coulomb's experiments, and the agreement shown he considers to prove his case. Most of his readers will, however, not be convinced by this demonstration—though they may be favourably impressed by the qualitative concordance between the conclusions derivable from the theory and the observations of several modern experimenters. The discussion of the origin of electrification in clouds is interesting though somewhat indefinitely sketched. It is a bold attack on an intricate problem. The author's attempt on the polar aurora is more difficult to follow and to us seems unsatisfactory. The book should be read carefully by all specially interested in atmospheric electricity, though doubtless the judgment will be that far too much is laid on the back of a single hypothesis.

**Fortschritte der Elektrotechnik.** No. 1 of 1900. Edited by Dr. Karl Strecker. (Berlin: Julius Springer, 1901).

As a preface to this quarterly number it is stated that with the beginning of the year 1900 the Elektrotechnischer Verein is taking over the proprietorship. It is pointed out that the number of users of such a publication must far exceed the number of subscribers to it, so that its publishers have found it hard to make both ends meet on the venture. A number of firms as well as the Verein have granted subsidies towards the publication since 1890, but even then the publishers suffered a loss on it. Under the new proprietorship, the Verein itself is still unable to grant a sufficient sum to pay expenses, but a larger number of firms are now assisting with subsidies. Dr. Strecker continues as editor, assisted by a large staff of abstractors, and Herr Springer as publisher, and moreover the form of the publication remains as before. It is to be hoped, however, that its preparation will now be somewhat accelerated, as for engineers and scientific men desiring to be up to date an epitome of three months' progress published nine months after the end of that period is not so valuable as if it were produced promptly. The value of the work would also be enhanced if the explanation of the various reference marks and abbreviations were published with each number instead of once a year.

**Induction Motors in a Tobacco Factory.**—Mr. F. E. Bausch in the *American Electrician* gives a description of an electric power plant in the factory of the M. C. Wetmore Tobacco Co. of St. Louis, which turns out 100,000lb. of tobacco daily. The alternator is three-phase, and rated at 200kw. There are 23 220-volt induction motors ranging from 1 H.P. to 30 H.P. Illustrations are given showing motors driving a leaf steamer, wrapper caser, and various other machines.

## CAPACITY IN ALTERNATE-CURRENT WORKING.

The following is an abstract of the conclusion of the discussion on Mr. Mordey's Paper on the above subject at the Institution of Electrical Engineers on Thursday, February 14th. The Paper and first part of the discussion appeared in our issues of January 18th and 25th.

Mr. W. M. Mordey first made a few remarks in order to clear up a few matters which, he said, were left in a state of uncertainty at the previous meeting. The Paper had been criticised by his friend Prof. Ayrton with his usual energy—he would not say his wattless energy. Prof. Ayrton's criticisms amounted to this: what was new was wrong and what was old was his. In the first place, he wished to make a correction or addition to the first part of the Paper in which he drew attention to the well-known fact that provided the volts, periodicity, and capacity were known, the current could be calculated. He had also advised central station engineers, instead of measuring capacity by the ordinary methods of ballistic galvanometer and so on, simply to use an ammeter to take the current and determine the capacity in that way. Prof. Ayrton had thought that credit had not been given to him for having known that fact a good many years ago. But, of course, he was perfectly aware that everybody knew that fact. It was, as he had already stated, the Ohm's law of the subject; but since the last meeting, seeing that all the scientific people claimed a perfect knowledge of this fact, he had looked into the matter a little further, and came to the conclusion that, under ordinary commercial conditions of electrical distribution by alternating currents, the advice he had given to central-station engineers was not wise. He had found that the current might vary 200 or 300 per cent. for a given capacity, depending upon whether the E.M.F. was a sine function. But there was not one word said in the warning given by Prof. Ayrton as to the enormous correction that might have to be applied in the use of this formula, which they had been assured Prof. Ayrton had been using for many years. The rule was not applicable within any degree of accuracy at all unless with a sine function machine.

The President (Prof. Perry): If you are going to reply now, Mr. Mordey, you will not have time at the end.

Mr. Mordey: I will ask for the ten-minute rule, Sir.

The President: You have no right to speak at this moment. You told the Council you only wanted a minute or two, and I shall have to rule you out of the discussion if you proceed now.

Mr. Mordey went on to say that this latter fact which he had just referred to introduced a new definition of power-factor—viz., if the current varied for a given voltage the power-factor might vary in the same proportion. This was very important, and he would ask those gentlemen who did him the honour of discussing the Paper, if referring to any results they had obtained, to state whether the power factor obtained by them was one that was based on the ratio of the true watts to the apparent watts or whether it was based on the current that would be given with a sine function machine working on a given capacity. There were other points he would like to refer to, particularly as he had given a pledge at the previous meeting to give some further information on the point as it was left then; but if it was preferred that he should not do it at once, he would only ask to be allowed to do so at a later time. He thought, nevertheless, that it might put the matter on a little more satisfactory basis if he referred that evening to these matters.

The President said, that in spite of the evident wish of the meeting that Mr. Mordey should proceed, he wished it to be quite understood that the chairman had power to regulate the arrangements of the meetings as he pleased. He therefore called upon Mr. Sparks to continue the discussion.

Mr. C. P. Sparks drew attention to the commencing paragraph of Mr. Mordey's Paper in which capacity in cables was referred to as a serious drawback to alternating-current work. This, he said, was true at times of very light load, but it could be largely neutralised by energising a minimum number of cables. In most extra high-pressure stations there were two or more feeders leading to every distributing station, and extra mains could be connected as the load increased, thus reducing any inconvenience, due to the leading capacity current, to one half or one-third the maximum amount as the case might be. As most of the apparatus connected to such systems with the exception of the incandescent lamps, was of an inductive character, the capacity of the cables became a positive advantage and improved the load factor. The capacity current and power factor of cables varied with the character of the dielectric and the form of wave curve given by the alternator. The instance given by Mr. Mordey was for a rubber dielectric in which the power factor and capacity were abnormally high. Had a paper dielectric been used the capacity current would not have been more than 30 to 40 per cent., thus decreasing any inconvenience from capacity to about one-third. Since the date when these cables were set to work, paper had almost entirely replaced rubber as a dielectric for such purposes, which was due not only to its lower capacity but also to its very much lower price and greater durability. He next mentioned Mr. Mordey's reference to the low efficiency of a large alternator running to supply the capacity current. Up to now, with the limited number of extra high-pressure stations in England, the length of cables had in no case been such as to make the capacity current beyond the capacity of a small unit, and although greater economy might have been obtained by using still smaller units at times of light load, it was necessary in case of a sudden demand, to have some reserve of power on the working plant. Under these circumstances little advantage would be felt in any existing station if the capacity current was balanced by means of chokers at times of light load, so as to cut down the size of the unit

He then gave some explanation of the origin of the figures on which Mr. Mordey based part of his Paper—viz., those referring to the loss of energy in dielectric hysteresis in this concentric rubber cable. Some 11 months ago Mr. Mordey had obtained from him permission to make a test on one of the County of London and Brush Co.'s cables, using his method of balancing the capacity current with choking coils, and had offered to construct a choking coil to demonstrate the reduction. Since this date, as was pointed out in the Paper, it had been discovered that the method was patented by Mr. C. S. Bradley in 1897. The first tests were made in March last, and the current was reduced from 6 to 1·6 amperes, the connections being as shown in the diagram (Fig. 4, p. 469, *The Electrician*, Jan. 18). Following these tests Mr. Mordey had asked him to consider the application of this method to the County of London Company's system, and had offered to construct another choking coil which would reduce the idle current still further. Before coming to any decision, the further test given in the Paper relating to loss of energy was made. These, he might mention, were ordinary current tests made for the company's own purposes and not specially in view of their being used for any publication. The figures obtained were as follows (supply was from an up-and-down transformer the main being disconnected from the switchboard):—Periodicity 100 ∿; pressure 2,000 volts; watts in cable alone, 1,509; watts in choker alone, 530; watts in choker alone with keeper on, 495. The meter revolved in one direction when connected with the cable, and in a reverse direction when connected to the choker. The watts were then taken with both choker and cable in circuit, the choker having the keeper removed. The energy shown was 2,015, or within 24 watts of the test made separately with leading and lagging currents. Assuming a low power factor in the first tests, they must have had a much higher power-factor in the second, as the apparent watts were 3,200 input into cable and choker, as against 12,000. These figures had been forwarded to Mr. Mordey in May last, and he had accepted them, with 530 watts taken in his choker, although he (Mr. Mordey) pointed out that the calculated loss was 218. (His reasons for this were given in the Paper.) With regard to the use of Mr. Mordey's shell energy meter for the purpose of measuring energy, similar instruments had been subjected to the following test, the standard of comparison being a Kelvin electrometer wattmeter specially arranged for alternating energy testing under the supervision of the late Dr. John Hopkinson. In testing instruments and the transformer against this standard, it was found that a particular instrument could be adjusted to read true watts on a periodicity of 100, working on a non-inductive circuit, the pressure being supplied by an alternator giving a sine curve. The same instrument read energy within 1 per cent when connected to a non-inductive circuit of 50 periods. Thus, under these conditions, there was no periodicity error. On connecting the pressure coil of the instrument to an independent circuit displaced 90deg., $\cos\phi$ thus equalling nothing, the instrument no longer revolved, although the full lead current was passing through the series coil. The same instrument calibrated with a $\cos\phi$ of 1, 2, and 3 read true energy within 3 per cent. at these phase differences, the instruments giving identical readings, whether supplied with a lagging or leading current. These instruments had been used to check the transformer core losses, and had been found to agree with the figures obtained by other methods of measurement. From a perusal of Prof. Ayrton's remarks at the previous discussion it appeared that exception was taken to the loss of energy given, and a prediction had been made that if tests were carefully made the loss of energy would be found to be one-tenth the figure given. Under these circumstances he had thought it advisable to supplement the figures previously taken by some other system of measurement, having in view the fact that a possible error might have arisen in the energy meter used, as, owing to it having been standardised on a machine giving a sinusoidal curve and used under different conditions, there might have been a periodicity error when working at a low-power factor. The method chosen was to measure the difference of power required to drive a generator driven by a direct-current motor. The set consisted as follows:—(a) Two-phase 50-period machine, having a capacity of 50kw. per phase; (b) a single-phase 100-period machine, having a capacity of 100kw.; (c) a direct-current machine, used for exciting the two alternators and alternatively for starting them for this purpose. The machine was constructed for carrying a large over-load for a short time. The capacity of the direct-current machine was 60 volts by 125 amperes (or 75kw.). On commencing this system of measurement the first difficulty met was the finding of a current largely in excess of that given by the well-known formula $C = \frac{V \times \sim \times K \times 2\pi}{10^6}$, the capacity current was 2·1 times the amount given by the formula. In order to check whether the difference was due to some wrong connection an alternator giving approximately a sine curve was connected by the change of one connection only, when it was found that the capacity current taken by the cable at once fell to the value expected from the formula. On repeating the tests on the alternator previously used, the current at once rose to the value as above given. The motor-generator readings of power when using the machine giving this abnormal result, were as follows:—In-put into the continuous-current motor running the alternators at normal speed for 100 periods, the 100-period machine being excited to give 2,000 volts from an independent source, 8kw. The cable was then connected, when the power required to drive the motor rose to 14,400. Subtracting from this the light-load losses, and also adding the $C^2R$ loss in the motor and alternator, gave a balance of 3,160 watts loss unaccounted for. The power-factor, taking the apparent watts observed on the cable, was 0·069, or from the watts calculated from current given by the formula 0·146. The above results were a mean of two separate tests. From this it appeared that the abnormal wave form of this machine at 2,000 volts pressure gave a power of 316 watts absorbed per mile at 100 periods. Another test was then made on one phase of the other alternator at 50 periods on the same cable, the alternator being excited to give 2,000 volts from an independent source. The results, taken in the same manner as the previous test, gave as a minimum reading a power-factor of ·04 on the observed current and ·043 on the calculated current; as the maximum power-factor ·06 and ·071, the mean result being ·06. The wave form of this machine must approximate to a sinusoidal curve, the difference in the capacity current being only 9 per cent. from the calculated amounts, the watts in the mean result in this case being 63 per mile at 50 periods and 2,000 volts. Since making these experiments he had received a letter from Prof. Ayrton offering Mr. Mather's services in making an independent test on the particular length of cable referred to by Mr. Mordey. These experiments were only made that morning, and he had just received a copy of the results from Prof. Ayrton. The tests were made by energising a 5¼-mile length of main from a transformer situated in the County of London Company's Peckham sub-station at a pressure of 2,250 volts. The inflow of current to the main was 6·8, which showed that the transformer was giving approximately a sinusoidal wave. The current into the choker, which he understood had a weight of 80lb. of copper and no iron, was 6·6. The actual current required to supply the main and choker was 2·7. The energy was measured by means of a Ganz wattmeter, which was of a similar principle to the Siemens dynamometer, having the moving coil wound with fine wire and connected through a large non-inductive resistance with the pressure side of the system. The ammeters were hot-wire instruments, the pressure being measured on the electrostatic voltmeter, the periodicity being taken with a periodicity recorder, and the wave form examined with Mr. Duddell's oscillograph. The energy taken by the cable alone measured by this wattmeter was 522 watts; the energy in both cable and choker was 798 watts; deducting from this the $C^2R$ losses, a result of 503 watts was obtained. The test was then made with the choker in series with the cable, when the energy was found to be 703 watts; deducting $C^2R$ losses in the choker of 281, the energy taken by the cable was 482 watts. The current flowing into the cable was approximately that given by the formula for sine curves and the curve was checked by being examined on the oscillograph. The power factor in each of these cases was 0·034, the power loss per mile with the cable at 100 periods and 2,225 volts being 96 watts. The cables had been constructed for an ultimate working pressure of 6,000 to 6,600 volts at 50 periods. On the assumption that the power-factor remained the same when the pressure was raised from 2,000 volts to this amount, the loss of energy will increase, taking the lowest power factor found, viz., 0·034, from 96 watts, as it is at present, to 335 per mile. To take a practical example: Assuming there were 50 miles of cable connected to a generating station feeding a sub-station 12 miles away, the maximum power allowed to be transmitted by such a feeder was 600kw. Taking the load factor at 10 per cent., *i.e.*, 60kw. per mile, and multiplying that by the total number of units generated, this would give 1,752,000 and the total losses would be 146,000. Thus with such a cable working at 6,000 volts with the power-factor mentioned, the total losses would amount to 8·3 per cent. By substituting for this cable a paper dielectric having a capacity of about one-third, and a power-factor of about 0·025, there would be a total loss of 2·1 per cent. of the units generated at the station wasted in hysteresis instead of 8·3 per cent. Under these circumstances he considered the thanks of the society were due to Mr. Mordey for having pointed out the importance of dielectric hysteresis, which, although undoubtedly known to some, has not had the attention of the many. He was aware that by using other dielectrics a lower power-factor might be obtained, but from tests on other dielectrics it was clear that in the best cables the power factor was about 2½ times the amount suggested at the last meeting by Prof. Ayrton, while it was possible, as shown by the figures he himself had given, to find in exceptional cases a power factor which was 3½ times the amount, and under special conditions to get a power factor of as high as 0·07 on the observed current of the cable, or 0·16 on the calculated.

Prof. J. A. FLEMING said that he would only deal with the question of the dielectric loss in the cable. Mr. Mordey stated that his experiments had shown the true loss in this 5¼ miles of indiarubber insulated cable to be about 2 H.P. and the power-factor about 0·12 or 12 per cent., these measurements having been made with a recording wattmeter. But no details were given of the experiments which Mr. Mordey doubtless undertook to prove the correctness of this wattmeter. They were simply informed that it was tested on a circuit of low power-factor, and found correct. He reminded Mr. Mordey that 10 years ago he brought a Paper before the Institution in which a number of measurements were given of the Ferranti cables, and the large capacity current which these cables took was found to be 44 or 45 amperes, at a pressure of 10,000 volts, which was something like 600 apparent H.P. The chief thing that concerned those connected with the London Electric Supply Corporation was how much of this 600 H.P. was real H.P. At that time there was not a wattmeter capable of dealing with these high pressures, but Mr. D'Alton, then the chief engineer to the company, attacked the problem in a very practical manner. He first took very careful indicator diagrams of his engines. Then he switched on to the alternator the cables one by one, taking diagrams in between each connection, and in that way proved that the real work done in these cables was about 10 H.P. or 12 H.P. He had not been able to put his hands upon the exact figures observed, but could trust his memory to this figure. One thing, however, which he was was absolutely certain of was that the power-factor was nothing like 12 per cent. It was something like 0·02 or 2 per cent. If it had been 12 per cent., or anything like Mr. Mordey's figure, it would have meant that 50 or 60 real H.P. were taken up in the Ferranti cables, which was not the case. Then came the question as to whether the difference was due to the dielectric or to the difference in measurement. Mr. Mordey would probably remember that some six or eight years ago they were all very much concerned in discussing the differences of phase of open and closed magnetic-circuit transformers, and that, in consequence of the question resting very much between Mr. Mordey and Mr. Swinburne it was agreed that each should put a transformer in his (Prof. Fleming's) hands to be tested, and that he should act as a sort of umpire. Mr. Mordey sent

a closed iron-circuit transformer and Mr. Swinburne an open one. Mr. Swinburne accompanied his transformer with a wattmeter which he had had made for the purpose, and when this was applied to his own transformer it measured exactly the core loss, but applied to Mr. Mordey's it registered something like 50 per cent. higher. Mr. Swinburne also sent some condensers because he was very much interested in annulling the enormous magnetising current of these open-circuit transformers, and when this interesting little wattmeter was applied to measure the true loss in the condensers it measured 300 per cent. too much. There was a good deal of discussion upon this, and he believed it was Dr. Sumpner who suggested that it might be accounted for by the fact that eddy currents were set up in the metallic parts of the wattmeter construction, and ever since that time he had made wattmeters in which he had not even used brass screws, and an instrument of that kind was very much more satisfactory than the beautiful productions of the instrument maker. Mr. Mordey should re-examine this question with another wattmeter and use a confirmatory method of this kind. He should take a continuous-current motor and put on to the shaft a couple of slip rings, and connect these with brushes so as to draw off a single phase alternate current. Run that motor from secondary batteries and the power put into it could be measured with a potentiometer. Switch on to the slip rings the open circuit cable, and if any true power were taken up in the dielectric it must show itself on the continuous current side, and there were no difficulties with phase measurement. This was practically a refinement of the method which Mr. D'Alton employed years ago at Deptford. He (Mr. D'Alton) ascertained for himself what was the real loss in the Ferranti cables, and he did not trouble himself about the differences of phase. As an engineer he had applied a simple and practical method of doing it. With regard to the Mordey wattmeter, he said Mr. Mordey had constructed a very ingenious instrument in which one circuit was made to do duty as the secondary circuit of the auxiliary transformer and the movable part of the wattmeter, but there was no means of ascertaining by any experiment precisely what was the continuous current in the movable circuit as compared with the impressed E.M.F. on the primary terminals of the transformers. This was important because a very little difference in phase made an enormous difference in the result of the true wattmeter reading. They were told that this wattmeter showed a power factor of 0·12, that the current was about 83deg. in advance of the E.M.F., and that 2 H.P. were taken up in the cable. If the current had been 90deg. in advance of the E.M.F. there would have been no power taken up in the cable at all, and no proof was given that this wattmeter was right to that extent. If the difference had been 3½deg. in error Mr. Mordey would have been 50 per cent. wrong in his estimate of the power, and, therefore, considering the wattmeter was, to use a popular expression, a very "slim" instrument. Mr. Mordey should check his readings by some simple commonplace method such as he had suggested.

Dr. W. E. SUMPNER dealt with two points—viz., the power-factor and a factor which he said Mr. Mordey had altogether left out, and which was equally important as the power-factor in determining what his power was intended to represent—viz., the ratio of the capacity current to the load current. If the capacity current was half the load current, taking Mr. Mordey's power-factor the loss in the cable would be 6 per cent. of the load, or about one-sixth or one-eighth of the load current. Still supposing Mr. Mordey's power-factor was true, the loss in the dielectric was only 1·2 per cent. What was the proportion? This depended upon one thing which Mr. Mordey had referred to, but about which he had given no precise information—viz., the percentage drop in volts allowable in the line. What was that percentage drop? Taking the 5½ miles of cables referred to in the Paper and assuming the drop in the line was 4 per cent. (this was the case at Deptford 10 years ago) and working this at 6,000 volts pressure and a periodicity of 50, the capacity current came out at 9 amperes, the load current at 77 amperes and the amperes per square inch were 500. Therefore, the load current compared with the capacity currentr was more than eight times as much, and if Mr. Mordey's power-facto was correct theloss in thedielectric was only 1½ per cent. of the full load, or if, taking what he considered to be the true power-factor, and which had also been mentioned by Dr. Fleming—viz., 0·02, the loss in the cable was only ¼ per cent of the full load. In this latter case, the cable could be run for 16 hours at the full voltage without losing more energy than would correspond to the heating of the copper in one hour at full load. This ratio was a factor which had been entirely left out of the Paper, but which he contended was just as important as the power-factor in determining the importance of this dielectric loss. With reference to Mr. Mordey's choking device, he said that Mr. Mordey had not compared the loss in the choker to the loss in the line. Taking the power-factor at 2 per cent., and 4 or 6 per cent. for the choker, the power lost in the choker was two or three times the power lost in the line. Mr. Mordey had given a figure for the power factor which nobody had ever obtained and which did not coincide with the best yet obtained, and therefore he agreed with Profs. Fleming, Ayrton and others. Although he personally had not had the opportunity of testing long lengths of cable, he had tested a large number of condensers, and had always found the power-factor varied between 0·025 and 0·015, and in a great majority of cases it was about 0·02. How was it then that Mr. Mordey had got this high result? He could suggest several possible explanations. But there were two points in the Paper upon which he would like information in Mr. Mordey's reply. In the early part of the Paper it was stated that the wattmeter used when testing the cable had been specially tested on circuits of low power-factor. He was not going to dispute that at all, but it was quite possible for a wattmeter on a circuit of low power-factor to measure very nearly accurately, say, 0·02, if the circuit took a lagging current, and yet it was quite possible for the same wattmeter to read absolutely wrongly and even negatively if the circuit took a leading instead of a lagging current. Thus it was possible to have a wattmeter to read negatively on a condenser circuit. It was easily explained, and if the very low power-factor of a condenser were taken into account, they would see how it was. With a condenser which had a power-factor of, say, 0·02, the phase difference between the volt current and the ampere current was 88·4deg.; it only differed from 90deg. by 1½deg. If, therefore, the lag in the volt coil was more than 1½deg.—and this was a very small amount—the phase difference became not only 90deg., but more than 90deg., which meant that the wattmeter read negatively. He had found it so experimentally. Therefore was there anything in the conditions of Mr. Mordey's test which would produce a lag of 1½deg. or more? He thought Mr. Mordey must have had something in the shape of a transformer connected in the circuit with his wattmeter. At all events, perhaps he would mention whether he used a transformer or not. If this were so, the assumption usually made that the volts in the primary and secondary circuits were in the same phase was only approximately true. Under ordinary circumstances it was quite true that there was always a difference of 4deg. or 5deg. between the voltages, and if the load currents were anything like the normal load currents of the transformer the phase difference might be very considerably more, and such a difference could produce some very extraordinary results. He had tested a condenser, whose power-factor was perfectly well known, by means of a wattmeter to which a transformer was attached. He used a transformer of commercial size (not one like that in Mr. Mordey's wattmeter, which was a toy transformer), and which had no more magnetic leakage than was usual in good makes. It was also a machine of three-unit capacity, very much under loaded, and with comparatively small currents in the coils, and was tested under all sorts of conditions. But this was what had resulted: According to the way the transformer was connected up, the effect on the reading might be to increase or decrease it—make it negative or positive. Taking, therefore, a condenser whose power-factor was 0·02, he had obtained power-factors from +0·02 to +0·06 right up to +0·04. He had also obtained negative power-factors from −0·007 to −0·03. If the wattmeter was calibrated on a non-inductive circuit, the constant of the wattmeter would be wrong because of the influence of the leakage of the transformer. Under these conditions it was possible, when applied to a condenser, to get a negative power-factor of −1·6, which was absurd—and which was absurd because of the assumption made in the tests that the transformer voltages were in the same phase. Therefore he imagined that the phase difference produced by Mr. Mordey's toy transformer would be serious, and he believed if that wattmeter were utilised to test a condenser the result would be negative. There was sufficient in the Paper to show that the instrument was erroneous. Mr. Mordey had pointed out that the constant of this instrument depended upon the frequency, but it could only depend upon this owing to the lag in the volt coil influencing the reading, and if this were so, it influenced it not only for frequency, but also for the power-factor it had to test. Therefore this was a useful instrument to test what was known, but it was not safe for anything not known.

Mr. J. SWINBURNE, speaking first of all on the question of putting a self-induction in parallel with a capacity, said he did not know that there was really very much question of priority of the general principle in this. He did not think there could be, but Mr. Mordey had been hunting up the history of the subject and had come to him and asked what he knew about it, and, being unable to get any information, Mr. Mordey had been down to Silvertown and discovered there an apparatus which had been made by him (Mr. Swinburne) 10 years ago, but which he had forgotten all about. It was really a thing for testing cables with a small dynamo. There was a big self-induction, and the chokers took something like 90 apparent units. Among other things Mr. Mordey hunted up was the Ferranti affair. But this had been put before the society as if the question of the Ferranti cables had been solved by the various professors, and that the unfortunate engineers were in the dark, and did not know what they were about. But he happened to be writing a Paper for the Physical Society at the time of this Ferranti affair, and he stuck in at the end of this Paper what he believed to be the explanation. He had pointed out that there was a cable that had a capacity, and therefore took a current: that there was a dynamo at the other end, and that the dynamo had armature reaction. They did not like to run the dynamo at 10,000 volts, but preferred 2,500, and then they put in a transformer to make it up to 10,000 volts. It was then found there was a very big capacity effect which disappeared when the transformer was taken out. The professors had all stated that it must be due to resonance. But if they would think of it, when the transformer was in circuit the dynamo was working with a quarter of its right field only and four times its current. The result was that the reaction in the dynamo was enormous when the transformer was in, and when it was out and the dynamo was working at its normal current and strongly-excited fields, there was very little effect. Of course the transformer had a slight effect due to its magnetic leakage, but this was small. However, immediately that Paper was written there was an ugly rush of "mathematiculists" and professors to explain that the whole action was due to resonance. They did not even wait until the Paper was published, but assumed he had never heard of such a thing—could not possibly have heard of it—so that they explained in an elementary way what it was in case engineers did not know. The reason he had brought this up was because he did not want a discussion on chokers and capacities to degenerate into a discussion on professors and engineers. Lately engineers had been informed in the kindest and nicest possible way that they really were all a pack of incompetent duffers. But the professors ought to meet them a little and think a little more highly of electrical engineers and not assume that they knew nothing whatever about the elementary mathematics of their subject. In the present case it was simply a case of buried knowledge. Mr. Mordey had brought prominently before the Institution certain things which were known no doubt to many people in a cloudy sort of way, but which were not brought prominently before the average electrical engineer, and if all Papers were debarred from the Institution which would not stand the test of the Law Courts and patent suits, he was afraid there would be very little to read before the Institution. When

there was a Paper that had new things or things not well known like these, he thought they ought to thank Mr. Mordey and realise the great benefit derived from them. He next dealt with the question of the measurement of capacity in terms of current, which he said was an old thing from an engineering point of view. The old condensers he made were all measured in that way. Prof. Ayrton had stated that it was his suggestion, but it was the practice long before Prof. Ayrton suggested it, simply because, as engineers who had to deal with currents, they had thought it best to label the thing in currents instead of microfarads. As to dielectric loss he did not think this had been fully appreciated until quite lately, and he thought the credit for bringing attention to it was certainly due to Mr. Mordey whether his figures were accurate or not. Evidently there was some loss, and, apparently, considerable, but how considerable he did not know. It was a most important thing, and he remembered 10 years ago, when this subject was up before the Institution, to some extent pointing out the great loss in glass. As regards condensers, the power-factor of those mentioned by Prof. Ayrton had struck him as being very much higher when they were first constructed than the figure given by Prof. Ayrton, but they might have deteriorated as they were very old now. In connection with hysteresis he mentioned that Maxwell had an idea which seemed to have something in it. He had pictured a dielectric which lost power, as consisting alternately of condensers and resistances. If a lot of condensers and resistances were put in series, such an arrangement would stop a permanent current like a condenser, but it would give a loss under an alternating current corresponding to the loss in an ordinary dielectric. He (Mr. Swinburne) was of the opinion, however, that the actual loss in cables varied from cable to cable, and he did not believe that the same make of cable would be constant, because the dielectric loss in paper and such things depended enormously on the question of moisture. In the present method of manufacturing cables, the moisture was not taken out as carefully as it might be; at the same time there was a chemical difficulty in getting all the moisture out of cellulose. It began to decompose before it was quite dry. There was one way of getting over the difficulty of dielectric loss, which ought to be very pleasing to Prof. Forbes, and that was to use a low frequency. As regards the wattmeter, there was no real difficulty in making a wattmeter quite accurate. The way they were checked in the early days was by means of a two-phase dynamo. He connected up the leads of two resistances, then took a reading, and after that changed the connections, so that the coil that was on one phase was put on the other. If there was any error due to the dynamo not being quite accurate, or to it not being quite a quarter of a period out of step, this cancelled one, and only the error of the wattmeter was left. In dealing with wattmeters, great care should also be taken with the series resistance. The way he used to make them was, instead of winding the coil doubly, to wind it with one layer, then turn the bobbin round in the lathe, and wind a second layer in the opposite direction. This was the easiest form of resistance for high pressures, as it had no appreciable self-induction error and no capacity error.

Mr. T. MATHER, in a communication which was then read by Mr. Cramp, said: Mr. Mordey's Paper has been useful in drawing attention to the importance of dielectric hysteresis losses in concentric cables. There are, however, several points in his Paper which cannot pass without criticism. The chief of these points is, that *a concentric cable absorbs a considerable amount of power when subjected to high alternating pressures*, and since nearly half the Paper is based upon this *alleged* fact, it demands first place in the discussion. I may preface my comments by saying that to avoid ambiguity I shall use the expression "volt-amperes" instead of "apparent watts," and restrict the word "watts" to *real* power. Mr. Mordey says that cables have power-factors as high as 0·124, *i.e.*, they waste, at light load, about one-eighth the volt-amperes supplied to them. It should be carefully noted that this number is the result of a single experiment on *a single cable*, and does not seem to have been repeated or checked by any independent method, and yet Mr. Mordey has the *courage* to base half his Paper on it, and work out tables of losses for cables of *various capacities* working at *various voltages*, as if his power-factor, 0·124, was like the "law of the Medes and Persians." That this value 0·124 is far above the average is conclusively seen from the number given in Table I. The loss found by Mr. Mordey is so large that it would have been quite easy to measure it in several well-known ways, and, in my opinion, the high figures should not have been published until there was no doubt whatever about their substantial accuracy. For in effect, Mr. Mordey's result condemns cables for high-pressure alternate-current working on the uncorroborated evidence of a single specimen. How would Mr. Mordey like all his alternators condemned because the tests on a particular alternator of some other make showed, or seemed to show, it to be a very poor one? For even had the loss been what Mr. Mordey makes it out to be for the particular cable, it would still have been desirable to test many other cables before drawing generalised conclusions intended to apply to all cables. Ordinary wattmeters, and especially so-called "recording wattmeters," are very inaccurate at low power-factors unless special precautions are taken to ensure the current in the pressure coil being strictly in phase with the applied P.D., so that Mr. Mordey's method of measuring the loss, even though his meter, as he asserts, had been tested at low power-factors, was not a very fortunate one. A convenient method of measuring dielectric losses is to use an "*ironless*" choker of inductance suitable for bringing the current in, or nearly in, phase with the alternator P.D., and using a moderately good wattmeter to measure the power in cable and choker. The loss in an "*ironless*" choker can be found very closely by $C^2R$, and the differences between $C^2R$ and the wattmeter reading gives the loss in the cable. Two arrangements are possible:—1. *Cable and choker in parallel* (Fig. 1) an "ironless" choker being used, as suggested by Prof. Ayrton in *The Electrician* of Jan. 18. In this case a wattmeter suitable for high P.D.s must be used, and the current coil of the instrument placed in the alternator circuit.

2. *Cable and choker in series* (Fig. 2) as suggested by me in *The Electrician* of Jan. 25. Here a wattmeter suitable for low pressures will suffice, and only a *low* P.D. is required. As the alternator, cable and choker are in series the circuit is perfectly simple. The current coil of the wattmeter is, of course, included in the same circuit, and the pressure coil connected with the alternator terminals. In either arrangement it is desirable to use *electrostatic* voltmeters to show the pressure to which the cable is subjected. Results taken by these two methods as well as by measurements on the cable only, are given in Table I. These numbers have been obtained by Prof. Ayrton and myself assisted by Messrs. Caine, Denton, Henry, and Mair, students of the Central Technical College, to

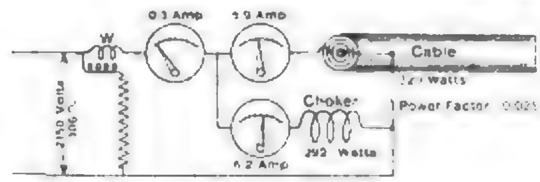


Fig. 1.

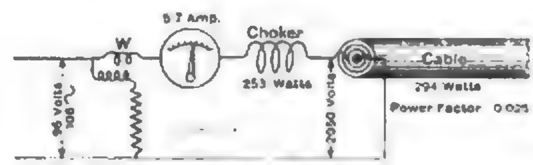


Fig. 2.

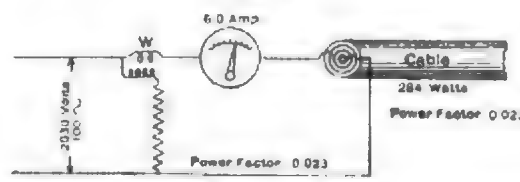


Fig. 3.

Dielectric Hysteresis Tests at the British Insulated Wire Company's Works, Prescot.

whom our best thanks are tendered. Each value of the power factor thus given is the mean of a large number of consistent observations, and obtained in some cases, in totally different ways. There is, therefore, no doubt whatever as to the accuracy of the results.

**Table I.**—*Dielectric Hysteresis Losses of Long Cables.*

| Material. | P.D. in volts. | Frequency. | Power factor. | Maker. |
|---|---|---|---|---|
| Oiled paper* ..... | 2,017 | 100 | 0·024† | British Insulated Wire Co. |
| Jute ........ | [illegible] | 71·5 | 0·027 | Callender & Co. |
| Indiarubber ........ | 2,000 | 105 | 0·028 | Silvertown Co. |
| Indiarubber, County of London cable .. | 2,230 | 100 | 0·029† | " " |
| *Mr. Mordey's Experiments.* | | | | |
| Indiarubber, County of London cable... | 2,040 | 100 | 0·124 | Silvertown Co. |

It is significant to notice that Mr. Mordey's tests on the County of London cable gave *a power factor more than 400 per cent. larger than our value*. The figure 0·029 obtained in our tests on the same cable is the mean of no less than 16 separate experiments made in the three different ways, shown in Figs. 1, 2 and 3, none of which differed from the mean (0·029) by more than 1 in the third decimal place. Hence we conclude that *Mr. Mordey's results are hopelessly inaccurate*, and should not be applied in any case.

Turning now to the secondary parts of the Paper, I may remark that there is no novelty whatever in measuring capacities by alternating currents, nor in supplying the "idle" currents of cable by inductances or chokers. Both have been common knowledge for the past 10 years. Mr. Mordey's treatment of capacity measurements is very unequal in the detail given. For example, he considers it necessary to tell "engineers who have not hitherto considered the subject" that the unit of capacity is the farad, and that it is too large for practical purposes. He then states that "the charging current for a cable is easily found if we know the capacity of the cable," and gives the formula:—Capacity current in amperes = volts × periods per second × microfarads × $2\pi$/1,000,000. No hint or word of caution is added (except an obscure note on page 469) to remind these engineers that the current taken by a cable depends very largely on the *wave form* of the alternator and on the *load* under which the machine is working. Then follows the statement that *one microfarad takes 0·0283 amperes at 2,000 volts 50 ~*, and a suggestion that station engineers should have ammeters graduated in microfarads. How puzzled the poor engineer who requires to be told about the unit of capacity would be in, making capacity

* Low-pressure cables tested at over 2,000 volts.

† Tested in three different ways with very concordant results.

measurements by such a method to find that a particular cable had all sorts of capacities depending on the time of day at which his measurements were taken, for (as Dr. Fleming has well shown in the case of the large alternators belonging to the City of London Company the wave form of the pressure supplied depends on which alternators are being used, and on the load under which they are working. The differences in capacity current as dependent on wave form is well illustrated by the following table taken on condensers of some 60 microfarads:—

**Table II.**—*Capacity Currents as influenced by Wave Form.*

| Machine used. | Frequency n. | Current at 100 volts. | Capacity from $F = \frac{A \times 10^6}{V 2 \pi n}$ | True capacity. |
|---|---|---|---|---|
| Ferranti alternator ...... | 100 | 3·0 amps. | 47·8 mfds. | 49·4 mfds. |
| Pyke & Harris alternator | 100 | 4·6 „ | 73·2 „ | „ |
| Wenstrom converter...... | 43 | 1·18 „ | 43·7 „ | „ |
| „ „ ...... | 58 | 1·69 „ * | 46·5 „ | „ |
| Gramme converter ...... | 25 | 0·7 „ | 44·5 „ | „ |

**Table III.**—*Effect of Load on Capacity Current.*

Pyke and Harris 6kw. alternator run at constant speed and constant P.D.

| Frequency. n. | Load current in amperes. | Capacity current at 100 volts. | Capacity from $F = \frac{A \times 10^6}{V 2 \pi n}$ | True capacity. |
|---|---|---|---|---|
| 100 | 0·0 | 4·6 | 73·2 mfds. | 49·4 mfds. |
| „ | 0·6 | 4·5 | 71·6 „ | „ |
| „ | 1·2 | 4·35 | 69·3 „ | „ |
| „ | 3·5 | 3·95 | 62·9 „ | „ |
| „ | 7·0 | 3·6 | 57·3 „ | „ |
| „ | 13·5 | 3·3 | 52·5 „ | „ |
| „ | 30·0 | 3·2 | 50·9 „ | „ |

These tables show capacities differing by 53 per cent. according to the alternator used, and with the same alternator differently loaded by putting lamps in parallel with the condenser, a change of nearly 50 per cent. These are by no means extreme cases. As the wave form of most alternators differs considerably according to load and is *greatly affected by putting in circuit a capacity*, it will be seen how utterly impractical is Mr. Mordey's idea of graduating ammeters in microfarads, unless a minute specification of the wave form is made. With the first method used at Prescot, when the choker and cable were in parallel and the pressure supplied direct from the machine, we could not reduce the alternator current below 3 amperes, when about 6 amperes went through the coil, and about 6 amperes into the cable, no matter at what frequency the alternator was run, the machine being a Mordey's so-called "sine wave alternator." But when the 2,000 volts supplied by the alternator was first transformed down to 100, and then up again to 2,000, and a choker also inserted, the current supplied to the arrangement shown in Fig. 1 went down to about 0·3 amperes at 106 frequency. Hence the Mordey alternator does not give a pure sine-wave, and it was necessary to insert the transformers and choker to reduce the higher harmonics. Mr. Mordey's own experiments point to the same conclusion. The subject of chokers for supplying the idle currents to cables is dealt with and the design of a choker given. In my opinion the use of iron in a choker for such a capacity is a great mistake. The late Mr. Gordon, in the early eighties, showed at Paddington how *not* to make chokers, and a few years later Mr. Swinburne brought out a greatly improved choker in the shape of his "Hedgehog" transformer. He opened the magnetic circuit and used only a small amount of iron, and yet Mr. Mordey brings out a choker in the beginning of the twentieth century with a large amount of iron and a power-factor as large as 0·041 for one of 12,000 volt-amperes capacity. Surely this is a serious retrograde step. Everyone knows that a closed magnetic circuit in a choker is very wasteful of power, for the power-factor is usually of the order 0·6 or 0·7 for transformers on no load. Opening the magnetic circuit, although it necessitates rather more copper, greatly improves the power-factor, and the more open the magnetic circuit is the smaller the factor becomes. The logical conclusion to which these considerations tend is, *remove the iron altogether*, and the power-factor is reduced to a small value. The numerical magnitude of the power-factor depends on the amount of copper put in the coil, and may, in fairly small chokers containing about 100lb. of copper, be reduced to about 0·02 at 100 ∿ and 12,000 to 15,000 volt-amperes. On the table before you is the choker that has been used in most of the dielectric hysteresis tests shown on Table I. A comparison between Mr. Mordey's choker and the "ironless" one is given in Table IV.

**Table IV.**—*Comparison of 12,000 volt-amperes Chokers.*

| — | Mr. Mordey's choker. | "Ironless" choker. | Ratio. |
|---|---|---|---|
| Total weight ............................ | 260lb. | 92·5lb. | 2·8 |
| Weight per kilo-volt-ampere ........... | 22lb. | 7·7lb. | 2·8 |
| Loss at 2,000 volts 100 periods......... | 500 watts | 250 watts | 2·0 |
| Power factor at 2,000 volts 100 periods | 0·041 | 0·021 | 1·9 |
| Cooling surface per watt ............ | 1·2 sq. in. | 1·7 sq. in. | 0·7 |

The "ironless" choker contains 81lb. of No. 14 copper wire, has a total weight of 92½lb., an inductance of 0·53 henry, and a power factor of 0·021 at 2,000 volts 100 ∿ (when warm). In predetermining the winding, calculation gave the number of turns as 1,367, and after winding it was found that 1,348 turns gave the required inductance. You will therefore see that calculation, taken in this case only to a first approximation, gave a result true to within 1¼ per cent. In the coil before you we have a choker *not much more than a third the weight of Mr. Mordey's having half the loss, about half the power factor and a greater cooling surface per watt*, whilst the simplicity of construction is such that the cost must be considerably less. Much more might be said on the subject of chokers of fixed or variable inductance, but these matters I hope to bring forward in a separate Paper on which I am now engaged. My sincere thanks are hereby tendered to the following gentlemen for the facilities and assistance so kindly given:—Prof. Ayrton, Mr. Duddell, Messrs. W. Gray, R. K. Gray, Stuart Russell, and Mr. Grafton, of the Silvertown Company; Messrs. T. Callender, J. Callender, and Mr. Goodman, of Callender's Cable Co.; Mr. G. H. Nisbett, of the British Insulated Wire Co.; Messrs. Sparks, Smoût, Dallas, and Butler, of the County of London and Brush Co.; Messrs. W. Cramp, W. H. Hainsworth, T. L. James, W. Templeton, and T. R. Sowerbutts, my colleagues at the Central Technical College; and Messrs. Ablett, Blennerhassett, Duncalfe, Fasola, Griffin, and Harrold, students of that Institution.

(*To be concluded.*)

* Machine sparking a little at commutator.

## ELECTRIC TRAMWAYS AND EARTH RETURNS.

The secretary of the London Chamber of Commerce has sent us a copy of the circular referred to by Mr. George Livesey at the meeting of the South Metropolitan Gas Co. last week. This circular, he points out, shows more fully than the reports of Mr. Livesey's speech what is the actual position so far as the Chamber is concerned. The circular was sent to promoters of tramway and light railway bills and provisional orders through the medium of the Electrical Trade Section of the Chamber, and, it will be seen, merely supports regulations already laid down by the Board of Trade, after full discussion and inquiry, which it is desired shall be embodied in any regulation during the coming session. Such regulations were only arrived at by a Joint Committee of both Houses after hearing the fullest representations from the gas, water, and electrical interests. The fact is that an attack is now being made upon the electrical industry by the gas and water companies, and not vice versa, as suggested by Mr. Livesey, assuming, of course, that the reports of his speech are correct. So far from the Chamber being only willing to "take up the cudgels on behalf of one particular industry," it may be pointed out that, if the gas and water companies wished to utilise the machinery of the Chamber in the same way as its electrical section has done, similar facilities would be afforded to them, as the organisation of the Chamber expressly provides for the furtherance of sectional interests when desired.

[Copy of Circular.]

Botolph House, Eastcheap, London, E.C.,
February 8, 1901.

EARTH RETURNS, &c.: JOINT COMMITTEE CLAUSE.

Dear Sir: At the last meeting of the Electrical Trades Section of this Chamber I was requested to write you with reference to the contemplated action of the associated gas and water companies in connection with what is known as the "Joint Committee Clause." You will remember probably that prior to 1893 the telephone companies were in the habit of opposing all tramways companies seeking electrical powers with the object of obtaining a clause absolutely protecting the telephone companies' wires. In many cases such a clause was given by promoters to avoid the great expense of fighting the Telephone Company, and when the question was fought committees gave varying decisions. In 1893 a Joint Committee of the two Houses of Parliament was appointed to consider the whole question, and by the terms of reference the question of interference with gas and water pipes by electrolytic action, as well as that of interference with telephone wires, was referred to the Committee.

The report of this Committee is, no doubt, well known to you. As regards electrolytic action, the decision was contained in the following clause, which is now inserted in all bills and orders authorising the construction of tramways and light railways:—

47. The carriages used on the railway may be moved by animal power or mechanical power, subject to the following provisions (that is to say):—

(a) No mechanical power shall be used except with the consent of, and according to, a system approved by the Board of Trade:

(b) No animal power or steam locomotives shall be used except with the consent of the local authority, and of the road authority, but that consent shall not be unreasonably withheld, and any question which arises as to whether such consent is unreasonably withheld shall be referred to arbitration under this order.

49. The following additional provisions shall apply to the use of electric power under this order, unless such power is entirely contained in and carried along with the carriages (that is to say):—

(1) The company shall employ either insulated returns or uninsulated metallic returns of low resistance.

(2) The company shall take all reasonable precautions in constructing, placing, and maintaining their electric lines and circuits and other works of all descriptions, and also in working the undertaking so as not injuriously to affect by fusion or electrolytic action any gas or water pipes or other metallic pipes, structures or substances, or to interfere with the working

of any wire, line, or apparatus used for the purpose of transmitting electric power, or of telegraphic, telephonic, or electric signalling communication, or the currents in such wire, line, or apparatus.

(3) The electric power shall be used only in accordance with the Board of Trade General or Special Regulations and in such regulations provision shall be made by the Board of Trade Special Regulations for preventing fusion or injurious electrolytic action of or on gas or water pipes, or other metallic pipes, structures, or substances, and for minimising as far as is reasonably practicable injurious interference with the electric wires, lines, and apparatus of other parties and the currents therein, whether such lines do or do not use the earth as a return.

(4) The company shall be deemed to take all reasonable precautions against interference with the working of any wire, line, or apparatus if and so long as they adopt and employ, at the option of the company, either such insulated returns, or such uninsulated metallic returns of low resistance and such other means of preventing injurious interference with the electric wires, lines and apparatus of other parties, and the currents therein, as may be prescribed by the Board of Trade Special Regulations; and in prescribing such means the Board shall have regard to the expense involved, and to the effect thereof upon the commercial prospects of the undertaking.

(5) At the expiration of two years from the commencement of this order, the provisions of this section shall not operate to give any right of action in respect of injurious interference with any electric wire, line or apparatus, or the currents therein, unless in the construction, erection, maintaining and working of such wire, line and apparatus, all reasonable precautions, including the use of an insulated return, have been taken to prevent injurious interference therewith and with the currents therein by or from other electric currents.

(6) If any question arises between the company and any other party with respect to anything hereinbefore in this section contained, that question shall be referred to arbitration under this order.

(7) In this section the expression "the company" includes any company or person owning, working or running carriages on the railway or on any portion thereof.

The gas and water companies are now endeavouring to get the various authorities to depart from this clause, and to have the following clause inserted:—

*(Extract from Wrexham Tramways Bill.)*

Notwithstanding anything contained in the Wrexham District Tramways Act, 1873, or the Wrexham District Tramways Order, 1899, the promoters shall be liable for any loss or damage to the water mains or pipes of the Wrexham Water Works Co., resulting from fusion or electrolytic action caused by any currents generated or used for the purposes of electric traction on any of the tramways authorised by the said act or order.

The prejudicial effect of this and its far reaching consequences upon the electrical traction industry will be seen at once.

It is most desirable that no promoters should give way upon the point or agree to any modification of the Joint Committee Clause, and arrangements are being made to fight a test case during the ensuing session in the general interests of the electrical industry.

The Electrical Trades Section of this Chamber is prepared to give advice and assistance to all interested in the question, and I shall be glad to hear that you agree with the views of the section and will co-operate with it in effecting its object.

Awaiting your reply, I am, Dear Sir, yours faithfully,

KENRIC B. MURRAY, *Secretary.*

## THE CHISLEHURST MOTOR-CAR TRIALS.

Detailed accounts of the recent electric motor-car trials at Chislehurst have already appeared in our columns (see *The Electrician*, November 9, 16, and 23, 1900). The judges' report, now issued, is to a large extent a repetition of what we have already published, but we append below some of their additional remarks:—

*Distance Trials.*—The first and last days' runs were arranged so as to give the heavier cars an opportunity of showing what they could do, the trials on each occasion being for an unlimited distance, the driver to declare to the observer when the run was to be considered as finished. The distances run in these tests are given in the table in next column, and also the units per mile run. The latter figure, however, has been omitted in the case of the first day's run, because it was impossible to ascertain how much the batteries contained on starting out. Efforts were made to obtain a record of the current output during the run, but the results were considered unreliable, and have consequently been disregarded.

It is no doubt of value in an electrically-driven car that the speed should be capable of reduction on heavy grades, to as to relieve the battery as much as possible from large overloads. Efforts were made during the tests to ascertain the currents taken by the different cars on certain grades. Such observations are only of value if the corresponding speeds are taken, and this it was so difficult to do that the current readings have not been published.

*Batteries.*—The batteries used were of different types. That driving car No. 1 was peculiar in many respects, the time required to charge being remarkably short. This is a feature of importance. On the other hand, the judges have had no opportunity of ascertaining what loss these or any of the cells show during an interval between charging and discharging. Certain battery renewals were rendered necessary by the excessive currents taken on the hills, and might no doubt have been avoided by a better system of control. The arrangements for coupling up the cells were

*Electric Car Trials. Chislehurst, November 6, 1900.*

| No. of car. | 1 | 11 | 12 | 13 |
|---|---|---|---|---|
| No. of passengers carried .. ......... | 2 | 2 | 4 | 2 |
| Weight of car including passengers | 48 5 cwt. | 30¼ cwt. | 18½ cwt. | 26¼ cwt. |
| Ditto battery in lbs. ..... ...... | 3,300 | 1,416 | 756 | 1,042 |
| Ratio weight of battery to total weight | 0·6 | 0·414 | 0·365 | 0·3 |
| Normal voltage .. ..................... | 150 | 61·5 | 80 | 86 |
| *Tuesday's run*, miles ... ............ | 59 | 33 | 23 | 33½ |
| Average speed, miles per hour ...... | 10·92 | 8·25 | 12 | 7·5 |
| Open circuit volts, beginning ...... | 158 | 60 | Not | 86 |
| Ditto end of run ...... | 128 | 45 | given. | 71 |
| Tuesday night's charge, units ...... | 63·4 | 26·9 | 11·6 | 16·5 |
| *Wednesday's run*, miles ............... | 24¼ | 21¾ | 21¾ | 21¾ |
| Average speed, miles per hour ..... | 12 | [illegible] | 11·25 | 8·6 |
| Ditto up Knockholt, ditto. | 8·34 | 6·52 | 9·66 | 5·78 |
| Open circuit volts, beginning ...... | 156 | 61·5 | Not | Not |
| Ditto end of run ..... | ... | 59·3 | given. | given. |
| Units per mile run, based on previous night's charge ......... ..... | 2·59 | 1·235 | 0·533 | 0·757 |
| Wednesday night's charge, units... | 59·7 | 19·9 | 9·0 | 14·1 |
| *Thursday's run*, miles ....... ...... | 29¼ | 29¼ | 29¼ | 29¼ |
| Average speed, miles per hour ...... | 12 | 8·3 | 8·68 | 7·63 |
| Open circuit volts, beginning ...... | 158 | 60 | Not | 86 |
| Ditto end of run ...... | ... | 48 | given. | 80 |
| Units per mile, based on previous night's charge ......................... | 2·04 | 0·682 | 0·308 | 0·482 |
| Thursday night's charge, units...... | 51·8 | 19·8 | 8·6 | 14·8 |
| *Friday's run*, miles .................. | 60 | 14¾ | 17* | 35¾ |
| Average speed, miles per hour ...... | 9·8 | 7·2 | 11·3 | 7·4 |
| Open circuit volts, beginning ...... | 155 | 60 | Not | 86·5 |
| Ditto end of run ...... | 100 | 55 | given. | 54·5 |
| Units per mile, based on previous night's charge .... ........... | 0·865 | 1·34 | 0·505 | 0·414 |
| Total mileage for four runs .. .... | 172½ | 98¾ | 91 | 120¼ |
| Average speed, miles per hour ...... | 10·97 | 8·22 | 10·75 | 7·66 |
| Best day's run, miles ......... ....... | 60 | 33 | 29·25 | 35·75 |
| Miles per cwt. of car ................ | 1·242 | 1·09 | 1·58 | 1·36 |

* Ball-bearing on motor shaft broke, preventing longer run.

NOTE.—No speeds in excess of 12 miles an hour are recognised or entered.

extremely bad in some of the cars, and could hardly fail to cause trouble on a long run. Besides the renewals of the cells above referred to, several small failures of parts were noted, which are recorded in the extracts from the observers' log books.

*Recuperation.*—Much had been expected from recuperation, whereby the motors act as generators in descending a hill and return current into the battery. The experience of the observers, however, was unanimously to the effect that this action really amounted to very little in practice. Considerable currents were no doubt returned, but for such short intervals of time that the saving of energy was practically nil. An indirect advantage of recuperation may perhaps be found in the case of those batteries which tend to become polarised. In such cases a return current no doubt has a beneficial effect in depolarising the plates.

*Passenger Accommodation.*—Some of the cars which ran were capable of carrying four passengers, or three with the driver, but car No. 12 was the only one which actually did so. In a few instances one or more of the passengers had to dismount on the hills.

*Cost of Running.*—The cost of running, so far as current is concerned, may be arrived at by reference to the table, where the number of units per mile run is given. The price paid for current at different stations varies from 2d. to 8d. per unit.

The judges are of the opinion that the weight of the respective cars should not be credited to them in forming an opinion of their merits, and they have therefore not given any figures showing the units of electrical energy used per ton-mile. They consider that the number of units per mile run is a fairer estimate of the capability of the cars, since the heavy cars had ample opportunity of showing what they could do on the runs of unlimited distance. The judges have, however, refrained from attempting to class the cars in order of merit and have confined their efforts to stating, in a way easily accessible for reference, the actual observations made during the trials, believing that this course would be the most serviceable. They wish, however, to call attention to the excellent record made by car No. 12. This car weighed only 18½ cwt., with 7 cwt. of battery, and while carrying four persons made a high average speed on all the trials and the highest speed in ascending Knockholt Hill.

*Mr. Llewellyn Preece's Services.*—The judges wish to place on record their thanks for the valuable services of Mr. Llewellyn Preece and his staff. Mr. Preece and his assistants not only controlled the arrangements for recording current supplied to the various cars, but prepared from the records taken at Chislehurst curve-charts and tabulated matter, copies of which were forwarded to every member of the judges' committee before their meeting. The work, which has been very considerable, has been excellently carried out.

*Mr. Hanning.*—The engineer of the Chislehurst electric light station, Mr. Shakespeare Hanning, was indefatigable in his efforts to provide satisfactory charging arrangement, and spared no pains or self-sacrifice in order to ensure efficiency. The judges' committee here record their thanks to him.

*The Honorary Observers.*—The judges' committee also thank the gentlemen who acted as observers. Their task was neither light nor pleasant, requiring, as it did, constant attention and frequent records throughout journeys made during far from pleasant weather.

Mr. Henry Edmunds was good enough to lend his 6-horse car for the purposes of selection of routes.

Mr. Harmsworth kindly lent his 6-horse car for the purpose of the examination of the roads selected for the electric trials.

The report is signed—C. V. Boys, C. A. Carus-Wilson, Hugh Erat Harrison, H. C. L. Holden, W. H. Preece, David Salomons, Bt., James Swinburne, Alex. P. Trotter.

The cars referred to above were:—

1. The British and Foreign Electrical Vehicle Co.'s "Powerful": A Kriéger car for two persons, with Lecoll batteries, type 30 E.E. 60 cells, and Postel-Vinay motor.

11. A similar car, but with a four pole enclosed series motor.

12. A "Still" car by the Canadian Electric Motor Co. for four persons, with "Ideal" battery and Still Motor Co.'s motor.

13. The Electrical Undertakings' car for three or four persons, with Leitner battery and Lundell motor.

We have already published descriptions of all these.

## CORRESPONDENCE.

### CAPACITY IN ALTERNATE-CURRENT WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the tests made at Silvertown and Prescot on dielectric losses, instead of arranging all the drums of cable merely in series, we tapped the inner and outer conductors at several points along the length so as to reduce the copper loss in the cable to a negligible amount, and thus get a more exact value of the hysteresis loss.

In testing the laid cable of the County of London Company on Thursday, the 14th inst., it was, of course, impossible to reduce the copper loss in the way mentioned above, and the number given by me at the meeting of the Institution of Electrical Engineers for the power factor of that cable—viz., 0·038—included the copper loss. Making, however, the necessary corrections for the copper losses in cable, leads, and instruments, the power factor for dielectric hysteresis alone is, I find, reduced to as low a value as 0·029, a number in close approximation to the 0·028 which we obtained at Silvertown on February 1st on another long indiarubber cable.—Yours, &c., T. Mather.

London, Feb. 19.

## LEGAL INTELLIGENCE.

### Bailey v. George.

At the Gloucestershire Assizes last week, Messrs. S. G. Bailey & Co. (Ltd.), manganese and carbon merchants, Stroud, sued W. J. George (Ltd.), of Birmingham and London, electrical and chemical apparatus manufacturers, for 100,000 carbons at 50s. per 1,000, and 100,000 carbons at 13s. per 1,000, or alternatively damages for an alleged breach of contract. By consent the case was tried by the judge (Mr. Justice Day). Plaintiffs claimed that they received a verbal order for the goods, part of which order was executed. For the defence it was contended that no order was given, although defendants did agree to take a quantity of a certain carbon, the price of which was very much in their favour. They admitted receiving 2,000 carbons, but said that the price agreed upon was 48s., not 50s.

The Judge said he did not think he could make defendants liable for the unbusinesslike ways of plaintiffs' servants. For so large an order as the one now in dispute there should have been an agreement in writing. At the same time he did not think defendants had paid sufficient into court (£47. 17s. 11d.). They should take another 2,000 carbons at 50s. per 1,000, making £50. He found for defendants on the main issue as to a contract, with costs, and for the plaintiffs on the agreement to accept 4,000 carbons at 50s. per 1,000, with costs on that issue. No general costs of the action would be allowed.

### Hull v. London County Council.

This case came before Justices Bruce and Phillimore on Saturday for reserved judgment on an appeal by plaintiff from the decision of the magistrate at Clerkenwell (London) Police Court, who convicted him under an information preferred by the defendant Council on the charge of unlawfully extending a projection beyond the general line of buildings in Seven Sister's-road and Campbell-road, Islington, without the Council's permission, contrary to sec. 73 (8) of the London Buildings Act, 1894. Appellant had entered into an agreement with an advertising agent to let a position covering the corner first floor window of his premises for the erection of an electric advertising sign at a yearly rental of £20. The electric advertisement sign was put up and connected to a wooden case with a glass front, the case being attached to the external wall of the premises by iron brackets, a space of 6in. intervening between the back of the case and the wall, and a portion of the apparatus working the sign being within the room on the first floor. The sign measured 10ft. 6in. in height by 7ft. in breadth, and, including the iron brackets, projected 16in. beyond the external wall of the premises. The corner of the shop front, which was below the sign, projected 20in. beyond the external wall of the premises, so that the sign projected 4in. less than the existing projection of the cornice. The sign did not project over the highway. In March, 1900, a notice was served on the appellant requiring him to comply with the law, and charge complained of was lodged on the following May 17, the offence having been, it was alleged, committed on or about Dec. 19, 1899, the date on which it was brought to the attention of the Council. The magistrate found, as a fact, that the sign did project beyond the general line of buildings in the streets as defined by the superintending architect, and held that the offence was a continuing offence, hence the present appeal.

Their Lordships now held that the sign did not constitute a projection within the meaning of the section, and further, that the prosecution for the alleged offence was barred by lapse of time under section 11 of the Summary Jurisdiction Act, 1848. The conviction was therefore reversed, and the appellant awarded the costs of the appeal.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Lincoln Corporation require an engineer and manager for their electricity works. An advertisement contains further particulars, and applications must be sent to the deputy town clerk (Mr. W. T. Page, jun.), 5 and 6, Bank-street, Lincoln, by 10 a.m. March 11.

A third shift engineer is required for the Stepney Borough Council electricity works. Applications to engineer (Mr. W. C. P. Tapper), 27, Osborn-street, London, E. See advertisement.

Woolwich Borough Council require a clerk in their electricity department. An advertisement gives some additional information, and further particulars can be obtained from the borough electrical engineer (Mr. J. B. Mitchell), Council Offices, Maxey-road, Plumstead. Applications to town clerk (Mr. Arthur B. Bryceson), Town Hall, Woolwich, by noon 25th inst.

The Council of the Institution of Electrical Engineers require an accountant-clerk. An advertisement gives further particulars, and applications must be sent to the secretary (Mr. W. G. McMillan), 28, Victoria-street, London, S.W., by March 9.

An outside manager and engineer is required for a large power distribution system in the North of England supplying three-phase high-tension current. See advertisement.

A motor inspector is wanted by the Bradford Corporation. Applications to city electrical engineer (Mr. R. A. Chattock, M.I.E.E.), Town Hall, Bradford. See advertisement.

Manchester Electricity committee require a shift engineer. An advertisement gives additional particulars, and applications, addressed to chairman, must be delivered at the Town Hall, Manchester, by March 4.

A firm of dynamo and motor and electrical crane makers require a first-class man to take charge of the electrical department. An advertisement gives some further particulars, and replies have to be sent to N. T. S., *Electrician* office.

The British Electric Traction Co. are prepared to admit a limited number of qualified students as pupils. See advertisement.

The directors of the Isle of Thanet Electric Tramways and Lighting Co. require an electrical engineer to take charge of their power station and electric lighting business. Applications to secretary, 74, Cheapside, London, E.C., by noon Feb. 27.

Bath Electric Lighting committee require an electrical engineer. Applications to chairman, 3, Wood-street, Bath, by 28th inst.

At the adjourned meeting of the Manchester City Council on Wednesday the appointment of Mr. G. F. Metzger, city electrical engineer at Bath, as chief electrical engineer to the Corporation, at a salary of £800 per annum, was approved.

Mr. L. D. Price, engineer of the Central London Railway, has been appointed chief assistant electrical engineer at Manchester at a salary of £300 per annum.

Mr. A. Davis, of Manchester, has been appointed electrical clerk of works at the Winwick Asylum of the Lancashire Asylums Board.

Mr. T. H. U. Aldridge has been appointed municipal electrical engineer at Shanghai. The appointment was advertised in *The Electrician* for Jan. 4.

In consequence of the resignation of Mr. E. W. Dunton, Mr. P. J. Watts, assistant engineer at Manchester, has been appointed borough electrical engineer at Whitehaven at a salary of £250 per annum with an additional £50 for the instruction of pupils now engaged at the works.

Mr. Charles F. Parkinson has been elected, out of 50 applicants, to the position of burgh electrical engineer at Paisley in succession to Mr. Francis Teague, who recently resigned.

**American Exports in 1900.**—The export of electrical machinery from America increased from $3,000,000 in 1898 to $5,225,000 in 1900 out of $6,788,000 worth of scientific instruments, including telephones and telegraphs. $1,000,000 worth came to the United Kingdom.

**Association of Chambers of Commerce**.—At the forthcoming annual meeting of the Association the following, among many other resolutions, will be submitted :—

Urging His Majesty's Government to complete arrangements for electrical communication of the lighthouses and lightships of the United Kingdom with the telegraph system of the kingdom, either by cable or by wireless telegraphy ; and, in addition, the establishment of day and night signal stations at important points on the coasts, such as the Fastnet and the Smalls.—(*Proposed by the Liverpool Chamber.*)

That immediate efforts be made and actively continued until all parts of the Empire have lines of telegraphic communication with each other as well as with the mother country, without such lines passing through any foreign countries or possessions.—(*Newcastle and Gateshead Chamber.*)

That every reasonable support be given by the association to the Imperial Telegraph Committee of the House of Commons in their efforts to promote inquiry into the questions of telegraphic communication between the different parts of the Empire, and the charges for the same, with a view to increased efficiency and economy in the telegraph service for commercial purposes ; and also into the cable arrangements for Imperial defence.—(*Liverpool Chamber.*)

That, in view of the growing trade of this country with the continent of Europe, and of the active competition for such trade, the Government be strongly urged to establish additional and improved telegraph and telephone cables between the United Kingdom and the Continent, and to arrange for more direct wires to the principal European centres of commerce and manufacture.—(*Liverpool Chamber.*)

That, considering the great inconvenience caused to the general public, and especially to mercantile men, by breakdowns of telegraphic communication, the Post Office be urged to continue northwards the main underground cables now laid between London and Birmingham.—(*Edinburgh Chamber.*)

That to meet the pressing requirements of trade, a more efficient telegraphic and telephonic service between the commercial and manufacturing centres of the United Kingdom is imperatively necessary : and that in certain districts the usefulness of the trunk telephone service is much impaired by its inadequacy to meet the demands made upon it, and that, if increased facilities were provided, and the delays at present experienced in obtaining communication avoided, the volume of telephone business would be immensely increased.—(*Liverpool Chamber.*)

That the address (not exceeding four words) should be allowed free of charge in all British and colonial telegrams, and that telegraphic communication should be extended to rural districts where practicable.—(*Wakefield Chamber.*)

That the cost of commercial telegrams and registration fee for telegraphic addresses should be reduced, and that, if the funds at the disposal of the department are not otherwise sufficient, it would be expedient to revise the existing arrangement with regard to Press messages, which at present entail a heavy loss to the revenue. (*Cardiff Chamber.*)

1. That serious injury is inflicted upon British and colonial industry and commerce in consequence of certain grave defects in our patent laws. 2. (*a*) That an applicant should be entitled to claim in one patent only one invention. In patents which cannot be defined by drawings he should furnish, if demanded by the Patent Office, specimens of ingredients and of the patented article sufficient in quantity for the purpose of experiment. (*b*) That every patentee should mark each article or each package in which the article is made up and sold with the word "patented," together with the day and year of the patent ; and (*c*) if the article consists of a mixture of which a part only is patented this fact should also be stated. 3. That provision should be made for granting patents of addition, free of charge, to a patentee for improvements in his original patented invention, such additional patents to expire simultaneously with the original patent.—(*Manchester Chamber.*)

**Ballymena (Ireland)**.—The question of lighting has been under discussion, and it has been decided to take a plebiscite as to whether electric or gas lighting shall be adopted.

**Bath**.—The Electric Light committee presented a report to the Council on Tuesday, recommending the expenditure of about £11,000 additional on extensions of the electricity works, but as Mr. G. F. Metzger, the city electrical engineer, is going to Manchester, the committee withdrew the report for the present.

At a special meeting of the Electric Lighting Works committee, on Monday, Mr. G. F. Metzger handed in his resignation as city electrical engineer, in view of his appointment at Manchester. The resignation was accepted, but Mr. Metzger applied for permission to leave at once, as he was urgently wanted at Manchester, and the committee, whilst congratulating him on his appointment, were of opinion that he could not lay down his management until his successor had been installed, and a sub-committee was appointed to arrange for the appointment of a successor.

**Charge of Stealing Telephone Wire**.—At the County of London Sessions on Wednesday, before Mr. W. R. M'Connell, K.C., Robert Connolly pleaded guilty and was sentenced to six months' hard labour for stealing, in December, nearly 2,000yds. of telephone wire belonging to the National Telephone Co.

**Dalkeith**—The agreement with Messrs. Crompton & Co., for the erection of electricity supply works was approved by the Council on Tuesday.

**Devonport**.—The foundation stone of the electricity station buildings was laid yesterday (Thursday) by the mayor, Mr. Harman Graves.

**Dundee**.—The engineer of the waterworks has submitted a report to the Water committee on the electrolysis of the water mains. The committee recently gave permission to the city electrical engineer (Mr. Walter H. Tittensor) to connect the negative bar of the tramway switchboard to the water main in Lochee-road, so that it would not be necessary to provide earth-plates. The water engineer reported that on inquiry he was of opinion that such connection was detrimental to the water pipes, and advised that the permission be withdrawn. He explained that the result of the electric connection was to soften the lead at the joints of the pipes and also to cause pitting of the pipes. The committee have accordingly withdrawn the permission.

**Dunfermline**.—Electric lighting is to be adopted at Co-operative Society's central premises in Randolph-street and High-street, at a cost of about £4,450.

**East Middlesex Electricity Bill**.—A ratepayers' meeting was held at Southgate last week, at which a resolution to support the course taken by the District Council in joining with the neighbouring municipalities in applying to Parliament for a bill to supply electric current for all purposes in the district was approved. This is the only district out of the five concerned where the matter has not been left to the ultimate decision of a poll of the ratepayers.

At a public meeting at Edmonton, a resolution approving the bill was carried, but the result of the poll taken at Edmonton was declared last week, when the figures were :—For the bill 1,027, against 1,597 ; majority against, 570. About 50 per cent. of the ratepayers took part in the poll.

The result of the poll at Enfield was also declared last week, and was as follows :—For the bill 1 691, against 2,734 ; hostile majority 1,043. Here again only about half the ratepayers voted.

At Tottenham a poll of the ratepayers was to have been taken this week, but owing to the result of the pollings at Edmonton and Enfield the Council have abandoned the poll.

The Wood Green Council has, like Southgate, withdrawn from the proposed joint electricity undertaking, which has therefore been abandoned.

**Electric Railway and Omnibus Competition**.—At the half-yearly meeting of the London Road Car Co , on Tuesday, the chairman (Mr. J. Howard Moore) stated that during the early months of 1900 they became aware of a shrinkage in the traffic receipts of all their cars running in the central districts of London. Investigation showed that, owing to the condition of the streets, through the breaking up of their surface for telephones and public works, the main thoroughfares were in the hands of contractors. This condition of the roadways had been a decided advantage to the Central London Railway, which had gained by the omnibus companies' loss.

**Electric Railways in Spain**.—A concession has been granted to Don Eugene Grasset for a period of 99 years for the construction and working of an electric railway from Los Monteras de la Rumia to Puente de los Fierros, on the line of railway from Leon to Gijon. The waters of the River Pajares are to be utilised for the generation of power for this line.

**Electric Tramway Accidents in Germany**.—An official inquiry undertaken by the Minister of Public Works and the Minister for Home Affairs in conjunction with the Police Authorities and the Berlin tramways companies, with a view to obviating accidents to passengers and others on the electric tramcars, has concluded, and we understand that it is intended to introduce new brakes on the cars and to carry out a series of experiments with different types of brakes. The tramway company has been requested to formulate suggestions for providing the space between car and trailer with a safety contrivance which would render it impossible for the passenger to fall between the motor car and the trailer car. It is further proposed to reduce somewhat the speed of the cars, especially on curves and at crossings.

**Electric Tramways v. Railways**.—At the half-yearly meeting of the Great Northern Railway Co. on Friday, the chairman (Right Hon. W. L. Jackson, M.P.) said there had been a decrease in the number of passengers in Yorkshire and Lincolnshire, the falling-off in the former county (mainly in Bradford and Halifax) being due to the severe competition of the electric tramways affecting the short-distance traffic.

**Fraud**.—At the Sussex Winter Assizes, on Tuesday, Walter Vernon Scott and Charles Willis surrendered to answer a charge of unlawfully conspiring to defraud their employers, the Brush Electrical Engineering Co., of £1. 16s., and other moneys, amounting in all to £135, and with making false entries in certain books and papers of the company, at Arundel, between Sept. 26, 1899, and

Jan. 8, 1901. Prisoners pleaded not guilty. (The case was reported in our issue for Jan. 25.)

Mr. JOHNSTON, secretary, engineering department of the Brush Company, said that last year the company were executing work at Arundel Castle, and Scott was assistant engineer in charge, and Willis was leading hand. Willis kept a book with the names of the workmen in it, and each workman kept a book. On Tuesday in each week the books were compared and the time sheets made out from them, signed by each workman, vouched by Scott, and forwarded to London, when they were scrutinised, the pay sheets made out, and the money forwarded to Arundel. The name of W. Fletcher, fitter, was included in the books sent in for a long period, but no such workman was employed by the company during that period. The total of the wages credited to this person was £103. 4s. 8d. Scott had been engaged on the work at Arundel Castle for 2½ years.

For the defence, Mr. LANE said his case was that there was no fraudulent intent. He called

SCOTT, who said he was an electrical engineer of 17 or 18 years' standing, and was engaged by prosecutors in 1898 to supervise the work of electrically lighting Arundel Castle. The consulting engineer of the Duke of Norfolk and the superintending engineer of the company required complete sets of plans of the wiring, and, as it would have been very expensive to have got a man specially down from London for the purpose, he approached a man named Russell, who was working for another firm at the Castle, and asked him to prepare them. He agreed to do so on the condition that he was paid weekly, and that his name should not appear as having made the plans. The reason for that was that he might be accused of neglecting his own work. Altogether Russell prepared about 150 or 200 plans from September, 1899, to the time of his (witness's) arrest. In order that Russell's name should not appear, witness did not communicate the matter to the company, but indiscreetly and unfortunately adopted the method of putting a dummy name on the time-sheet, and he received the money and paid it to Russell weekly. Approximately he paid him £130 or £140, of which about £30 was by cheques, which were produced. Witness had not received a penny of the money, but was, in fact, out of pocket by the arrangement. Had some one been sent from London to prepare the plans he estimated the cost would have been £300. He directed Willis to draw up the time sheets in the way in which they were prepared, and told him he would take the responsibility. Willis did not receive a penny of the money. He admitted entering the names and figures in the time and pay-sheets, but he was not aware that that was forgery, or that the handwriting was feigned. It followed, he supposed, that he intended to deceive the company.

JOHN G. RUSSELL, contractor's head foreman of works at Arundel Castle, confirmed Scott's account of the arrangement under which he prepared the plans, and said he was paid weekly. He did the work in his spare time, but did not wish his employer to know that he was doing other work.

Mr. H. A. MIDDLEDITCH, resident electrical engineer at Arundel Castle, gave formal evidence.

WILLIS, in answer to the judge, said he paid Russell various sums on Scott's behalf, sometimes more and sometimes less than the amount down in the sheet as due to Fletcher. He did not consider there was any fraud on the company in the arrangement. He admitted entering another workman as having worked 1¼ hours for every hour he actually worked. That was by Scott's instructions, and was done because the man wanted 10d. an hour, and the other men only received 8d. He was put down in the sheet at 8d., and the extra time allowed made up the difference. Scott told him the firm knew about his arrangement with Russell.

Mr. LANE, in his address to the jury, admitted on behalf of Scott his responsibility for the entries, but urged that they were not made with the least intention to defraud, but in all good faith and in the best interests of his employers. Scott took full responsibility for Willis's action.

Mr. BOXALL, for Willis, submitted there was no evidence to support the charge which had been made against his client, whose conduct had been reprehensible, but not felonious.

Mr. Justice CHANNELL pointed out that the fact that no profit was made out of it would not negative an attempt to defraud. If Scott's story was true it was difficult to understand why the company was not told about it. There was a great difference between the two prisoners, because it was far more possible Willis thought the other prisoner had authority to do this than it was to conceive how Scott himself could have thought so.

The jury found Scott guilty and Willis not guilty. The foreman said they did not believe the whole of the money was handed to Russell.

Letters testifying to prisoner's high character from the Duke of Norfolk and other gentlemen were put in, and Mr. Lane urged his Lordship to deal leniently with the prisoner.

His LORDSHIP passed a sentence of nine months' imprisonment.

**Grenada (West Indies).**—The telephone system of this island, which is wholly unconnected with the Post Office, was originally established at a cost of £4,733 in 1899. There are now six exchanges and 106 miles of trunk lines with 164 connections. Owing to the mountainous nature of the colony communication by land is difficult and slow, and the telephone is found of great advantage in the conduct of business, and leads to saving in time, money and sometimes in life.

**Grimsby.**—Electric current was supplied to private consumers for the first time on 18th inst. The public arc lamps will not be in regular use until March 31, but in the meantime they are lighted from 7:30 p.m. to 10 p.m. on Thursdays and Sundays, and from 7:30 p.m. to 11 p.m. on Saturdays.

**Hanley.**—The salary of the borough electrical engineer (Mr. C. A. Cowell) has been increased from £250 to £300 per annum, and that of the chief assistant (Mr. W. Adams) from £150 to £175 per annum.

**Hornsey (Middlesex).**—At the meeting on Monday of the District Council, Mr. Burt (chairman of the Electric Lighting committee) said they were ready to proceed with the work of erecting the electricity works, but had not yet obtained the sanction of the Local Government Board for the borrowing of the necessary moneys. Applications were constantly being received for the supply of electric current. It was unanimously decided to forward a strongly-worded request to the Board for its decision on the subject. Powers are sought to borrow £80,000.

**Hove.**—On Saturday last Mr. Councillor Carden gave a public address at the Town Hall on the subject of cheap electricity, its various applications, and how it can be obtained. Councillor Carden reviewed the progress in electrical science and industry during the past 10 years, and especially referred to the works carried out by the Brighton Corporation, stating that per head of population the consumption of electric current was greater in Brighton than in any other town in England. The total output was only exceeded by Liverpool, Manchester, and Edinburgh. After the first hour's supply of current, which was supplied at 7d., the Brighton users of electric current could burn a 16 c.p. lamp for 16 hours for 1d., and at this price electricity was absolutely the cheapest form of illuminant. 1½d. per unit was charged for street lighting, and this was equivalent to gas at 10½d. per 1,000ft. Last year 1¼ million units were sold at 7d and 2¾ million units at 1d. One user of current for motive power obtained his supply at an average of 1·08d. per unit, another for 1½d., and so on. Electricity supply was so popular at Brighton that they had now to build a new generating station and had obtained Parliamentary powers to spend £400,000 on these works. He believed that in the new generating station plant equivalent to 5,000 H.P. would be erected. These works they hoped to have in operation by the end of next year. He recommended the purchase by the Hove Council of the undertaking of the Hove Electric Lighting Co. (Ltd.) and that a supply of electric current should be taken in bulk from the Brighton Corporation, who could supply them 10 per cent. cheaper than they could supply themselves. A discussion followed, and Councillor Carden received a hearty vote of thanks for his address.

**Huddersfield.**—The profit on the electricity department for the year ended Dec. 31 amounted to £110, against £2,828 in the previous year. In moving the adoption of the Electricity committee's report, at the Council meeting on Wednesday, the chairman (Ald. Calvert) said the balance was very small, but they must be thankful that there was a balance on the right side, in view of the great advance in the price of coal. They had paid £1,400 more than in the previous year for coal, and salaries had gone up from £695 to £1,025.

**Jedburgh.**—The Council have sealed the agreement with Messrs. Crompton & Co. for establishing electricity works. Messrs. Crompton & Co. are applying for a provisional order.

**Kettering.**—The Council are recommended to purchase land in the Rockingham-road as a site for a generating station, and to engage Prof. Kennedy to prepare an electric lighting and refuse destructor scheme.

**Leeds.**—A special committee, consisting of the chairmen of the standing committees, has been instructed to consider, in view of the expense and inconvenience caused by pulling up streets for electric and gas lighting, &c., the advisability of providing subways in any projected new streets in the crowded parts of the city. A subcommittee is to visit various cities to obtain information with regard to subways.

**Light Railways.**—The Board of Trade have, after modification, confirmed the Long Melford and Hadleigh, and the Sheerness and District Light Railway orders.

The Worcester and District Light Railways Order, 1901, has been submitted to the Board of Trade for approval. Objections by March 12.

The Light Railway Commissioners inquired at Worcester on Monday into the application of the Worcester Tramways Co. (Ltd.), for power to construct light (electric) railways to Powick, Eastwood Cemetery and Shrubhill Station, and from the Bull Ring, St. John's, to Henwick Station. Applicants were represented by Mr. Sydney Morse. The town clerk (Mr. Southall) said the Corporation were, if possible, a little more in favour of the lines than the promoters themselves. The Corporation had, in fact, presented a scheme to the Commissioners last year, but an agreement had been arrived at with the company in regard to the construction of the lines. The Corporation would supply electric current to the company at 2d. per unit for a minimum of 200,000 units, and this minimum would be paid for by the company whether it was or was not required by them, so that it was to their interest to complete the lines as quickly as possible. The Commissioners intimated that they would recommend the Board of Trade to sanction the scheme.

An enquiry was held at Halesowen, on Tuesday, into the application to authorise the construction of light (electric) railways in the district. The consulting engineer (Mr. R. P. Wilson) said the whole length of the proposed lines would be about 10 miles, and the overhead trolley system would be adopted. The probable capital expen-

diture would be about £100,000. Owing to opposition one of the lines, the Bromsgrove route, was withdrawn.

The Blackpool and Garstang light railway order has been issued by the Light Railway Commissioners.

**Liverpool.**—The city electrical engineer (Mr. A. Bromley Holmes) has submitted to the Watch committee suggestions as to the best means of avoiding fatalities such as those attending the electric wire disaster of the 4th inst. He recommends that constables who may be required to rescue persons from the entanglement of fallen wires should be provided with rubber gloves, and the Tramways committee are to be asked to purchase a number of pairs, and to keep some at each police or fire station, where they can be easily got at in cases of emergency. A hooked stick or a folded newspaper, suggests Mr. Holmes, also might be used in the event of rubber gloves not being immediately available, but an umbrella must on no account be utilised. The Watch committee have decided that these and other suggestions of Mr. Holmes shall be embodied in a general order to be issued to the police force.

The accounts of the electricity supply department for the past year give the total receipts at £109,814. 1s. 8d., including £72,055. 13s. 3d. for the sale of current for private lighting and power, £1,764. 3s. 8d. for street lighting, and £30,596. 17s. 6d. for current supplied to the electric tramways department. Generation expenses stand for £42,765, cost of distribution £3,229, management expenses £8,536, and rent, rates, and taxes £6,707. After meeting special charges (£1,055) and allowing £44 for bad debts, £47,478 was carried to net revenue. Interest absorbed £2 148. 9s. 11d. and sinking fund instalment £17,833. 8s. 10d., and the balance (£3,496. 10s. 11d.) was transferred to renewal fund. The total capital expenditure at the end of 1900 amounted to £1,048,559, an increase of £278,970 during the year.

**Liverpool Tramway Fatality.**—The inquest on the deaths of Thomas Hankey and David Singleton, from the electric tramway accident of the 4th inst., was resumed on Wednesday. (The opening proceedings of the inquiry were reported in our last issue).

The deputy town clerk (Mr. Pierce) explained that to prevent fallen telephone or telegraph wires coming in contact with the Corporation tramway wires, guard strip protectors were employed. The tramway route on which the accident happened had received Board of Trade sanction only on Jan. 21.

Police-constables White and Robertson, Police-inspector Hammond, and others, gave particulars of the accident and of the condition of the streets at the time, &c.

John Mitchell, manager of a wine and spirit business, said he saw Singleton lying by his shop door, and, thinking he had been struck by lightning, went for a bucket of water. When he returned another man was trying to get the wires from Singleton's body. There were flashes coming from the trolley wires, and the man who was with Singleton asked for a pair of rubber gloves, but he was unable to furnish them. Ultimately Singleton was got free, but not until he had been dead, witness considered, fully 10 minutes. He had been entangled half an hour. It was a dark night, snow was falling, and witness could not see the trolley wires. The strip-guard was in position over the trolley next morning when he looked.

Dr. Arkle deposed to examining the deceased Singleton. *Rigor mortis* was setting in when he was brought to the hospital. A watch in his pocket was still going. Coins in the pocket were covered with a kind of black deposit, which he thought was due to the formation of copper salt. A silver coin was not affected. He made a short examination of the body then, and made a post-mortem on the 7th. The clothing on the body was wet. Those next to the body exhibited pale bluish discolouration, caused by stains of sulphate of copper. He found numerous scars on the body. There were a considerable number of burns, and the scars were mostly due to recent burns. The conditions of the organs suggested alcoholic history. A box of matches in deceased's pocket was unaffected. He should say that death was due to shock.

Dr. Pest said the body of Thomas Hankey was brought into the hospital and was well nourished. On the right side of the small of the back there was a large patch, in the centre of which the skin was torn into strips. There were two similar patches across the upper part of the calves of the legs and some green discolouration. Just above the right ankle was a burn about the width of a wire. On the top of the head there were some recent abrasions. There were a number of marks of scorching on the clothing corresponding in size and position with the burns on the body. One of the hands bore a mark across the fingers and thumb as if the man had clutched a heated wire. The cause of death was due to electric shock.

Prof. Paul said he thought it would be more accurate to say that death was due to exhaustion consequent upon electrisation, because there was so much reason to believe that the shock inflicted but once would have produced slight damage. The circumstances present on the occasion were extraordinarily favourable to the conductivity of electricity—the wet, the coiling of the wires, and the salt mixed with the snow on the street. He was of opinion that death was due (1) to the large surface of contact formed by several coils of wire round the body, (2) the prolonged contact, (3) an intermittent or repeated contact, as the victim rolled about, (4) good conductivity of clothing and skin due to the wet, and (5) great increase of conductivity of skin due to salt.

The Coroner: Assume the salt to be absent, would it make some difference.

Prof. Paul: Yes, but a difference which would have been counterbalanced by more minutes exposure. The salt would make the conduction better, and the shock would be more severe to the patient. Assuming that the men had been able to lie perfectly still, would, he supposed, have made a great deal of difference, because every time the current was broken and re-made it would cause a most harmful shock. He did not presume they could have lain absolutely still, but the breaking and completing of the circuit was a serious matter and a source of increased grave injury. *Rigor mortis* following so quickly after Hankey's death was a sign that he had died from shock, or that the muscles had been subjected to prolonged exhaustion in a general way. If a man died from fright *rigor mortis* would occur instantaneously. In the case of accidents occurring in similar circumstances the only thing persons in contact with the wires could do was to get clear of the wires as quickly as they could. If they kept their heads cool, and made use of any dry articles of clothing to touch the wires they would do some good. Those men grasped the wire with the naked hand. Of course rubber gloves could not be supplied, but dry articles of clothing could. To lose their heads and struggle was the worst thing possible.

Mr. T. Davies, civil engineer, gave the result of inquiries and inspections he had made regarding the accident. The span where the wires were alleged to have fallen across the trolley wires in London road was one of 120 yards. He understood that an average span was 80 yards. From a standard in Pembroke-court to a standard in Pembroke-place the span was over 120 yards. A portion of this fell down on the date of the accident. On the standard there were 98 wires. Of these 47 fell and 51 remained. He had tested the wire which was handed to him, and it broke at a tension of 161·5lb. The wire was bronze, No. 18, equal to $\frac{1}{20}$th of an inch in diameter. That was the usual size. The breaking strain was supposed to be 200lb. The weight of one wire from standard to standard in the Pembroke-place span would be 2·8lb. The maximum strain to which the wire would be subjected in stretching into position would be about 50lb., so that an extra strain of 109lb. was obviously introduced before the wire broke. He had ascertained that on the date in question between 32deg. and 33deg. of frost were registered at Bidston Observatory, and the wind at about the time of the accident was registered at 20 miles an hour. The wires in winter were stretched from the lower temperature. Assuming that the wires were covered with a mixture of ice and snow in equal portions, to exert a force of 109lb. the wire and coating together would be $1\frac{1}{16}$in. thick. The wire was that which it was customary to use, but it was not sufficient to stand such conditions as had been described. The span in Gill-street was a large one—352ft. He was led to the conclusion that the current in this case must have come from Pembroke-place. In London-road the trolleys had no guards when he was there two days after the occurrence. The up-line had clips on, as though there had been guards. There was a gap of about 2in. between the guards at the spot where the accident in Pembroke-place happened. He thought it advisable that the guard strips should extend to the bow of the insulator. It was possible that tugging at the wires might have made the gap mentioned, or the falling of the telephone wire might have disturbed the slip. He should say it was a difficult matter to fix those guards. With the passing of the trolley over the wire the guards were somewhat easily detached. He could not suggest a better method of fixing. It was a difficult matter. Since this occurrence the telephone wires had been gathered into cables at the points in London-road and Pembroke-place. It seemed to him that the Corporation depended upon the telephone service, which, becoming disorganised, prevented their communicating with certain persons, and it was also apparent that the guards and drivers, and apparently policemen, were not familiar with the mode of cutting off the current. He suggested that it was advisable that the guards and drivers of the cars and the police should be instructed as to the proper place to cut off the current. Of course, those persons should be provided with rubber gloves, and, in view of there yet being overhead wires, it was advisable that nippers should be provided. In such conditions as prevailed on the night of the accident it was almost certain that some wires would fall. He did not know that the wire was tested by a testing machine before delivery was accepted by the Telephone Company. There were two forms of guard available for trolley wires—the overhead wire and the guard strip, as used in Liverpool. There was a controversy as to which was the better system. The objection to a strip guard was that it was almost impossible to secure it to the trolley wire. The telephone wires also unfortunately dropped in coils, and coiled underneath the trolley wire. Regarding the guard wire, he thought the opinion generally was that the more metal wires there were the greater the danger, owing to the additional possibility of the guard wire itself falling on to the trolley. Seeing that the Corporation had decided to have the overhead system, the proper course was to do away with all overhead telephone wires. Until the Telephone Company could put their wires underground, they should encase them in cables. He believed the Telephone Company were considerably hampered in their work by the difficulty they had in obtaining wayleave.

By Mr. Quilliam (for the relatives of the deceased): Witness did not think the smoke from the blue manufactory in Kempston-street would be prejudicial to the life of the wire, or that the smoke from the railway cutting would be injurious, the only element that might affect the wires being the sulphur in the smoke. On the night of the accident half a gale was blowing.

By the Coroner: An overhanging trough, encasing the trolley wires on three sides, would certainly prevent fallen wires touching the trolley wire when they coiled, assuming that such a trough could be fixed.

By Mr. Quilliam: If the Telephone Company were unable at present to put their wires underground or in cables, it would be an advantage if they increased the number of standards, so as to decrease the spans of wire. It had been reported to him that the current from the trolley wire was conveyed to the telephone boxes in subscribers' houses, but he had not heard of much harm having been done, or that some of the boxes had been set on fire in consequence.

WILLIAM LAMB, tramway linesman, said on hearing of the accident he made arrangements for turning off the current. He had his rubber gloves and insulated nippers, and immediately released three men who were entangled in the wire. It was snowing heavily at the time. The tower waggon then arrived, and he mounted it. He commenced to cut the telephone wires from all the trolley wires, but, finding it a long job, descended and released three other men. There were a lot of wires down. The guard-strip, which is $\frac{3}{4}$in. in width, was in perfect order, but in cutting the wires it was impossible to avoid damaging it. Snow was on the fallen wires, and those in the stack above appeared about $\frac{3}{4}$in. diameter with the snow.

WILLIAM WALSH, tramways inspector, said when he saw where the accident had happened he turned off the current at the box which governed the current at the scene of the accident. Had he known exactly where to go at first he could have cut off the current much sooner.

Mr. MATTINSON (who appeared for the National Telephone Co.) pointed out that the electric energy which caused the accident was supplied by the Corporation wires. Mr. Pierce (who represented the Corporation) had said that the Corporation had their trams in the street under statutory authority. The same remark applied to the Telephone Company. That particular route of trams had been running for only two or three weeks, while the wires of the Telephone Company had been there for two or three years. He hoped to be able to show that the wires had not been in position for a longer time than was consistent with a fair margin of safety. The Telephone Company was anxious to get rid of overhead wires, and in fact all the main wires in Liverpool were underground, the overhead wires being distributing wires. During the last 12 months the company had put underground between 1,600 and 1,700 wires which had formerly been overhead.

Mr. DANE SINCLAIR, engineer-in-chief to the National Company, said they used for that particular kind of work phosphor bronze wire, which was of the quality and material universally used. The wire was tested before being used. It should last under ordinary circumstances for about 10 years. He had examined the wires which were hanging from the poles after the accident and they had not broken at the weakest point—the insulator. Under the conditions of the present case, taking into account the frost, snow and wind, it mattered little what wire was put up, it would break. If it did not break, the poles would go. At the time the wires were put up the tramways were not running there, and, therefore, they had no necessity to consider precautions in that respect. They intended to continue putting their wires underground until they were all so placed. It would no doubt minimise the danger of the wires falling if the standards were put nearer together. The telegraph wires were of iron. They would not coil round the trolley wire so much as the copper wire used by the Telephone Company, but would be more likely to do injury if they struck any person in the street.

Mr. T. ROWE, engineer of the Liverpool district of the National Telephone Co., produced an insulator to which one of the fallen telephone wires had been attached. It was in perfect condition. The wires crossing Pembroke-place, were erected in September, 1898, and had undergone the usual test before they were erected. The wires had broken on the night in question somewhere in the middle of the span, which was usually the strongest part. It was the opinion of the whole electrical profession that this particular wire was the best for the purpose.

ARTHUR BENFIELD, a foreman erector in the Company's service, said he superintended the putting up of the wires, and the work was done in a workmanlike manner. The morning of the accident he went up all the poles and they were in perfect condition as well as the insulators. Wires had been broken at various lengths—10, 20 and even 40 yards from the insulators. Some of the wires had become fused.

This evidence closed the proceedings on Wednesday.

At yesterday's (Thursday) proceedings the jury gave a unanimous verdict that death was caused from shock consequent upon becoming entangled in telephone wires owing to these wires breaking and coming in contact with the tramway trolley wires, the jury added a rider that, "Whilst of opinion the occurrence was due to accidental causes, they considered the accident might not have happened if the telephone standards had not been so far apart."

**London County Council.**—At Tuesday's meeting it was agreed:—That the estimates for £145,000 and £478,500 submitted by the Finance committee be approved; that the expenditure be authorised for the purposes of reconstruction for electric traction of the Council's tramways between (a) Westminster-bridge-road and Upper Tooting-road; (b) Kennington-park-road and the terminus at Blackfriars-road; (c) St. George's Circus and the terminus in Waterloo-road, of sums not exceeding these amounts respectively in respect of (1) buildings and railway sidings, and (2) lines, machinery, generating plant, rolling stock and electrical equipment.

The Parliamentary committee recommended, and the Council approved, that petitions be presented against the following railway and tramway bills:—Brompton and Piccadilly Circus (Extensions); Central London; Charing-cross, Euston and Hampstead (No. 1); Charing-cross, Euston and Hampstead (No. 2); Charing-cross, Hammersmith and District Electric; City and Brixton; City and North-East Suburban Electric; City and South London; Islington and Euston; King's-road; North-East London; Piccadilly and City; West and South London Junction; and the Bexley and the London United Tramways.

**London Post Office Telephone System.**—In the House of Commons on Tuesday Mr. Austen Chamberlain stated that he was not in a position to make any statement at present as to when the Government telephone system in London would be completed.

**Mansfield.**—The Electric Lighting committee has applied to the Board of Trade for an extension of time to carry out the terms of the Mansfield provisional order.

**Merthyr.**—The electric tramway lines will be Board of Trade inspected on 12th prox.

**Municipal Telephones.**—In the minutes of the Huddersfield Electricity committee, presented on Wednesday, appeared a scale of charges for the suggested municipal telephone exchange. For an unlimited service in the Huddersfield telephone area the charge is to be £7. 10s. per annum, and for each additional connection £7 per annum. The message rate will be £2 10s. per annum, with a fee of 1d. per call originated by the subscriber. Ald. Calvert stated that what his committee had done had been authorised by the Council. No capital had been expended nor could be expended until the committee obtained the Council's sanction and after local inquiry. The arrangements were purely preliminary, because they could not ask people to become subscribers until they had fixed a tariff, and this was all they were committed to. The minutes were adopted.

In order that the ratepayers of Brighton may thoroughly appreciate both sides of the telephone question, which at Brighton is coming to the front for general settlement, Mr. F. J. Madgen, local manager of the National Telephone Co., delivered an address on "Municipal Telephones" before the members of the Regency Ward Ratepayers' Association last week, a number of town councillors being present. It may be mentioned that the case for municipal telephones was placed before the association at its last meeting by Councillor Buckwell, chairman of the Corporation Telephone committee. Mr. Madgen reviewed the early history of the telephone in this country, referring especially to the decision of the courts as to the rights of the Postmaster-General in connection with the telephone, and pointing out that the act under which this decision was given was passed long prior to the invention of the telephone, Mr. Madgen inferring that, but for the inroads made by the telephone on the income of the telegraphs, no such claim would have been made by the Postmaster-General. The 10 per cent. royalty extracted by the Post Office from the gross receipts of telephone licensees naturally came in for severe handling.

Leaving the financial part of the question, Mr. Madgen proceeded to deal with the technical features of telephone work—with the invention of suitable telephone cables to make underground work practicable, with the difficulties the National Company had experienced from that date in obtaining municipal sanction for placing their wires underground in spite of the generally expressed view that these lines should go underground, and, finally, the evolution of the idea of establishing municipal telephone exchanges. This was followed at Brighton, Mr. Madgen pointed out, by the creation of the Telephone committee, amongst whose duties it was to obtain the sanction of the local authorities forming the area covered by the Brighton telephone licence. This area consisted of Brighton, Hove, Shoreham, Steyning, Hurstpierpoint, Burgess Hill, and Rottingdean. There was no difficulty in obtaining the consent of the smaller local authorities, because under the scheme they were to have cheap telephones—certainly at the risk and probably at the expense of the Brighton ratepayers. The adjoining district of Hove had given its consent on the distinct understanding that Brighton would not be allowed to interfere with its streets, so that the Brighton Corporation, in the Hove district, was exactly in the same position as the National Company, or, to put it in the words of an expert who had been consulted, "The existence of the independent borough of Hove complicates the working of the area by the Brighton Corporation."

Mr. MADGEN proceeded:—

The expert provided two estimates, one being for a system of 1,240 lines, or about the size of the National Company's present system, and another larger. In the former he estimated that it would cost—for 1,240 complete lines, £18. 10s. each, and for 300 partially completed lines, £8 each—£25,340. The tariff proposed worked out on an average at £5. 5s. per annum per exchange line, and presuming the whole of the lines to be completed, these items together with others would bring in a gross revenue of £6,787. From this, of course, must be deducted working expenses, which (after reducing everything all round to a minimum) was estimated at £6,441. 3s. 10d. This provides a handsome net profit amounting to £345. 16s. 2d., or a little more than 1 per cent. on the capital outlay. This report, which they might depend was put in the most favourable light, was unpromising enough in all conscience, and possibly the Brighton Telephone committee might think it sound and report accordingly. That they mistrusted many of the most important items given in the estimated expenditure was certain, as they questioned the expert's figures. The questions to be settled were in his opinion, "Would the Corporation be justified in pledging their rates by borrowing £25,000 or £43,000 to enable them to supply 1,200 cheap telephones?" The great majority of taxpayers did not want a telephone. Then should their money be put out to bring in a little over 1 per cent. per annum, when probably they could make 20 per cent. with it in their own business? This 1 per cent. was promised if all went well. He would like to remind them that Manchester was promised cheap telephones at a subscription ranging from £5 to £7, the estimated cost per line being £14. The first year's outlay amounted to £34,000, the cost per line £31. 14s. 6d. In two years more the scheme was in liquidation. The plant, costing £60,000, was found to be flimsy, worthless, and unsaleable. Sir William Preece, in a report dated Dec. 20, 1900, to a body of Portsmouth ratepayers, gave an estimate for Portsmouth at £35 per subscriber. [*The Electrician*, Jan. 11, 1901, p. 420.] Dover had been considering the question of municipal telephones, but came to the conclusion, after exhaustive consideration,

that it would be a rash speculation and probably would not pay. It had taken the National Telephone Company about 20 years to build up their present system, and this by constant hard work and thorough canvassing; yet the Corporation, with untold difficulties and expenses, were going to show a profit on the first year's working. It must not be supposed that should the municipal system become an accomplished fact the company would retire from the field. There would be two separate systems in active competition, or at least active on the part of the company, and they, with their great advantages of experience and being first in the field, would undoubtedly, he thought, more than hold their own. From a subscriber's point of view there were very grave disadvantages in two separate systems, as the experience of those towns where two systems were in operation pointed to the necessity of subscribers being connected to both.

The CHAIRMAN asked Mr. Madgen the cost per wire to the company.

Mr. MADGEN: The official figures for the company's wires in Portsmouth, where they had an underground system, was £37 per subscriber.

The CHAIRMAN said Councillor Buckwell had informed them the previous week that when the number of subscribers to the municipal telephones reached 500 there would be inter-communication between the two systems, and that the National Company would be compelled to open up its system to municipal subscribers.

Mr. MADGEN said in his opinion the statement was absolutely incorrect. According to his reading of the act, if the National Company were asked by the Corporation for such inter-communication, and they assented, then the company would have the privilege of getting its licence extended beyond 1911, when it expired.

Councillor CARDEN championed the municipal telephone scheme, and contended that municipal telephones would be more efficient than those of the company. He was convinced telephones would be used by almost every occupier of houses above the rental of £40 a year. As regarded inter-communication between various towns, they would not charge for this service but bear the costs themselves. They would retaliate by charging those in other towns communicating with Brighton. It was proposed to start with a charge of £5. 10s. If the scheme did not pay after three years they would undoubtedly raise the rentals. They put the maximum at £7. The Corporation would have a perfect right to run into Hove with overhead wires if objections were raised to their going underground. The Corporation proposed to ask for £40,000, as they were going in for a larger scheme than that originally contemplated.

Councillor HECN said it appeared to him that the Telephone committee were spending money on telephone conduits without the sanction of the council or of the Local Government Board.

Mr. Madgen received a hearty vote of thanks for his address.

**Aberdeen** Town Council will be invited at its next meeting to appoint a special committee to consider the question of laying telephone wires underground, and also as to procuring a licence for establishing and working a municipal telephone exchange.

**Newcastle-on-Tyne.**—An inquiry will be held on Tuesday into the application of the Corporation to borrow £10,000 for the electric lighting of tramways.

**New York Elevated Railway.**—The Westinghouse Company, notify that it is expected the conversion of the New York Elevated Railway from steam to electric power will be completed by June next. This undertaking will form the largest electrical system of railway working in the world. The steam-driven line on two consecutive days last year carried 1,700,000 passengers and 280 trains (12,080 cars) were run per hour. The electrical system adopted comprises 8,000 H.P. three-phase Westinghouse generators in one power station supplying energy at 11,000 volts through three cables to seven step-down transformer stations, where 1,500kw. Westinghouse rotary converter plant will receive current from the transformers at 390 volts and deliver continuous current through single-conductor cable to the third rail at 625 volts.

**Perth.**—The Council have offered to purchase the local tramway undertaking at £20,000, and should this offer not be accepted the Board of Trade will be invited to arbitrate.

**Pressure of Electricity Supply.**—In reply to a question in the House of Commons on Monday, Mr. G. Balfour said he was informed that the Chelsea Electricity Supply Co. (Ltd.) desired to change their standard pressure from 100 volts to 200 volts, and that in order to induce consumers to take current at the higher pressure, they had given notice that after July 1 next consumers taking a supply at the lowest pressure would be charged a rate higher than that to be charged for supply at the higher pressure. The higher rate was within the maximum price fixed by the company's provisional order, but whether the company were entitled to charge different rates to consumers supplied at different pressures was a legal question on which he was not prepared to express an opinion. He had no power, as President of the Board of Trade, to give or refuse sanction to the proposed charges.

**Private Bill Legislation.**—It has been decided that the Burton-on-Trent Corporation, Harrogate Corporation, Kingston-on-Hull Corporation, Manchester and Liverpool Electric Express Railway, Nottingham Corporation and Sheffield Corporation bills are to be introduced in the House of Lords, while Derby Corporation, Derbyshire and Nottinghamshire Electric Power, Mansfield Corporation, Scarborough Electric Tramways, South Yorkshire Electric Power and Yorkshire Electric Power bills will commence in the House of Commons.

The City of Birmingham Tramways Co. has deposited detailed estimates of the cost of the proposed electric extensions for which sanction is being sought. The aggregate length is over 1¼ miles, made up of five short junction lines. The total cost of construction is put at £14,172.

The Scarborough Electric Tramways Co. estimate the cost of constructing their proposed system of electric tramways at £79,545, of which £70,011 represents the cost of the tramways, and £9,534 the cost of a new street, street widening, generating station and car sheds.

**Provisional Order Transfer.**—The Prestwich Electric Lighting Order (1900) is to be transferred to the Manchester corporation, the Prestwich Council reserving the right to purchase at 21 years, or at end of any subsequent five years. The conditions of transfer stipulate that the prices for current shall be the same as in Manchester.

**Pudsey.**—The consulting engineers (Messrs. Shepherd and Watney) recommend the Council to only schedule the principal thoroughfares in their provisional order. The initial capital expenditure of plant capable of supplying current to the equivalent of 10,000 8 c p. lamps is put at £19,552.

**Rapid Cabling.**—During the illness of our late beloved Queen anxiety ran high in all parts of the world, and not the least so in far away British Guinea. At 6:45 p m. Greenwich time (2:53 p m. in the afternoon at Georgetown), the crowds round the telegraph office consisted of Europeans of various nationalities, imported East Indians, and a large group of blacks; 22 minutes later (7:7 p.m. Greenwich time) the announcement was posted outside the Georgetown office of the West India and Panama Telegraph Co. that Her Majesty had passed away, and the nondescript crowd, to whom she was only a name, were much affected. Mr. R. T. Brown, manager of the West India and Panama Company deserves the credit of organising this smart piece of work, which was cabled from Osborne to the equatorial region on the other side of the world in 22 minutes. The Government message from the Secretary of State for the Colonies was anticipated by some considerable time. When it is remembered that the news had to be conveyed from the palace at Osborne to the Isle of Wight telegraph office, across to the mainland, on to the Atlantic cables to the North American continent, thence southwards overland, and finally re-transmitted on the West India and Panama submarine system to the whole of the islands which form our colonies of this group right on to the extreme end of the company's system at Georgetown, we are shown in a striking manner how the resources placed at the disposal of the public by the British cable companies bring our colonies near to us. The coloured crowd at Georgetown were lamenting the death of Queen Victoria before the news was known in nine-tenths of the London suburban districts.

**Raub (Pahang).**—In July last an electric transmission plant, 7½ miles in length, of a total capacity of 300kw., was started to supply current to the mills of the Raub (Australian) Gold Mining Co. The consulting engineers for this installation were Messrs. Kincaid, Waller and Manville, and the plant was supplied by Messrs. Johnson and Phillips. The plant consists of high-tension generators, with low-tension distribution at a frequency of 53, a station voltage of 5,000, and voltage declared at consumers' terminals 220. Distribution is effected by bare overhead mains. Mr. John Rance, M I E E., is resident engineer for the contractors for the plant.

**Rhyl.**—Eighteen arc lamps are to be erected in the thoroughfares in the business part of the town.

**Scarborough.**—The Council have decided to apply for a provisional order to construct electric tramways.

**Sheffield.**—The Owlerton electric tramway route was officially inspected by the Board of Trade on Tuesday.

**Shoreditch (London).**—The Borough Council have appointed Mr. H. Winkler, chairman of the Lighting committee, and Mr. C. Newton Russell, chief electrical engineer, to represent them at the forthcoming Board of Trade inquiry respecting the proposed amendment of the clause relating to the change in the pressure of supply to consumers from 110 to 220 volts. The representatives will support the projected alteration.

**Swansea.**—The Corporation propose to supply the harbour trustees with electric current for harbour lighting at a price per unit equal to the present cost to the trustees, and, in the event of disagreement as to what that actual cost per unit is, to refer the matter to a third person for arbitration. A proposal to this effect was discussed at the last meeting. Mr. David Davies said on the terms proposed the Corporation would lose £300 the first year. Moreover, alterations would cost £700 or £800, and special plant from £3,000 to £4,000, though the arrangement was only for five years. After discussion the proposal was lost by 17 votes to 10.

**Taunton.**—A special meeting of the Council was held on Tuesday to consider a report of the Electric Lighting committee recommending that application be made for sanction to a loan of £17,800 for electric lighting extensions. The report was adopted on the motion of Ald. Potter, chairman of the committee.

**Uniformity of Tramway Gauge.**—In the House of Commons last night, Mr. T. M. Healy asked the President of the Board of Trade whether his department had considered the desirability of prescribing a standard gauge for electric tramways in future acts, so as to enable towns to be electrically connected in this country, as in America, without break of gauge. Mr. Gerald Balfour said the Board of Trade were fully aware of the importance of a uniform gauge, and when opportunity offered press their views on the subject upon promoters. He thought it would be a mistake, however, to insist on the adoption of the standard gauge as an absolutely invariable rule; in hilly districts and in towns with very narrow streets it was sometimes desirable to adopt a gauge less than the usual 4ft. 8½in.

**"Via Galveston."**—It is announced that the Western Union Telegraph Co.'s via Galveston route is now re-opened.

**Water Power Utilisation.**—Work has just been completed on the establishment of an electric generating station at Pinos Puente, near Granada, Spain. The plant is operated by water power, and electric energy is supplied to a number of small places in the district.

An electric tramway has been opened for traffic in Sofia—the first of the kind in Bulgaria. Electric energy is generated 9 miles from Sofia, the water power of the River Isker being utilised.

**Weston-Super-Mare.**—The question of electric lighting the marine parade is under consideration by the Baths and Lighting committee.

**Marriage.**—At St. Michael's, Bournemouth, on Feb. 9, Mr. P. J. Pringle, late of the Brush Co., and at present local representative at Wolverhampton for Messrs. Kincaid, Waller and Manville, in charge of the Midland Power Corporation's scheme, was married to Miss Beryl Olive Blyth, granddaughter of the late Sir A. Blyth, K.C.M.G.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Great Central Railway Co.* invite tenders for the supply, during the 12 months ending April 30, 1902, of various stores and materials, including electric light, telegraph and signal materials, asbestos packing, brass sheets and tubing, hardware, screws, &c. An advertisement contains further particulars, and patterns can be seen from 25th inst. to March 4 on application to the storekeeper (Mr. A. W. Longden), Junction-street Mills, off Ducie-street, London-road, Manchester. Specifications, &c., may be obtained from the secretary (Mr. Oliver S. Holt), London-road Station, Manchester, to whom tenders must be sent by 10 a.m., March 5.

*Wallasey* Urban District Council require tenders for the overhead equipment of about 10 miles of tramways, and for the supply and erection of section boxes and rail bonding. Specifications can be obtained at the offices of the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead. Tenders to Mr. H. W. Cook, clerk and solicitor to the Council, Public Offices, Egremont, Cheshire, by March 4. An advertisement gives further particulars.

*Cardiff* Corporation require tenders for steam and exhaust pipes, injection and overflow pipes, feed and drain pipes, engine house flooring, switchboard gallery and central service gangway for their tramways department. Specifications, &c., may be obtained from the engineer and manager (Mr. Arthur Ellis), Old Post Office-buildings, Cardiff. Tenders to the town clerk (Mr. J. L Wheatley) by March 18. See advertisement.

*Dundee* Gas Commissioners invite tenders for the supply of underground electric conduits and necessary jointing apparatus. Further particulars are set out in an advertisement, and specifications may be obtained from the city electrical engineer (Mr. Walter H. Tittensor), Dudhope Crescent-road, Dundee. Tenders to the clerk to the commissioners (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by Feb. 25.

*Leeds* Tramways committee invite tenders for supplying and fixing trolley wires and accessories. Specifications may be obtained at the city engineer's office, Municipal Buildings, and also at the offices of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., and 29, Princes-street, Manchester. An advertisement gives further particulars, and tenders must reach the town clerk's office by noon March 8.

*Leeds* Tramways committee also invite tenders for the supply and laying of cast-iron pipes, with the necessary drawing-in boxes and wires, and supplying insulated conductors and drawing same into the pipes. Plans may be seen and specification obtained at the city engineer's office, and also at the offices of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria street, London, S.W., and 29, Princes-street, Manchester. Tenders to the town clerk's office by noon, March 8. An advertisement gives further particulars.

The Corporation of *Worthing* (Sussex) invite offers from electric wiring contractors for fitting up premises in the borough for the electric light free of initial cost to consumers. Some particulars will be found in an advertisement, and offers have to be in to Mr. W. Verrall, town clerk, Municipal Offices, Worthing, by noon of Feb. 25.

The Council of the Metropolitan Borough of *Shoreditch* are prepared to receive proposals for the supply and construction of the articles and works set out in an advertisement elsewhere for one year and five days, from March 26, 1901, to March 31, 1902, inclusive. Forms of tender, &c., can be obtained on application to Dr. H. Mansfield Robinson, town clerk, Shoreditch Town Hall, London, N., to whom tenders must be sent before 3 p.m. of Tuesday, March 12.

*Shoreditch* (London) Borough Council require tenders for the constructional steel and iron work for the new Whiston-street generating station. Tenders by March 6.

*Middleton* Corporation invite tenders for the supply, delivery, and erection of a traction switchboard. Specifications may be obtained from the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, and 78, King street, Manchester. Tenders to town clerk (Mr. Frederick Entwistle), Town Hall, Middleton, by Feb. 28. See advertisement.

*Manchester* Tramways committee invite tenders for the electrical equipment of 87 cars. An advertisement contains some further particulars, and specifications may be obtained from the general manager (Mr. J. M. McElroy). Tenders to chairman of committee, Town Hall, Manchester, by March 4.

*Huddersfield* Corporation invite tenders for motor carts suitable for conveying about five tons of coal from the local collieries to the electricity works. Further particulars may be obtained from the borough electrical engineer (Mr. A. B. Mountain), and tenders must be delivered to the town clerk (Mr. F. C. Lloyd), Town Hall, Huddersfield, by March 5. Some further information is given in an advertisement.

*Southampton* Corporation invite tenders for the supply and laying of insulated electric cables, and frames and covers, including excavation and reinstating roadways. Specifications, &c., can be obtained from the borough accountant, and a copy may be inspected (but not obtained) at the offices of the engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, London, S.W. An advertisement contains some further particulars, and tenders have to be sent in to Mr. R. R. Linthorne, town clerk, Municipal Offices, Southampton, by noon of March 11.

*Southampton* Corporation desire to purchase three motor omnibuses. Tenders to town clerk (Mr. R. R. Linthorne), municipal offices, Southampton, by 16th prox. See advertisement.

*Farnworth* (Lancs.) District Council require tenders for tramway bonds. Tenders by March 1.

*Bray* District Council invite tenders for a Lancashire boiler and accessories, a 150kw. high-speed steam alternator, and a 25kw. rope-driven alternator and accessories. Tenders to clerk by 4 p.m. March 14.

*Stockport* Gas and Electricity committee invite tenders for condensing plant. Tenders by March 6 to chairman of committee, Portwood, Stockport.

*Clyde Navigation* Trustees invite tenders for a 3-ton electric wharf crane. Tenders to Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow, by noon March 11.

*Eastbourne* Corporation invite tenders for transformers, sub-stations and equipment, underground mains, conduits and road work, arc lamps and posts. Tenders to town clerk before noon March 4.

*Aberdeen* Electric Light committee require a fuel economiser and boilers. Tenders to city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, before noon, March 15.

*Accrington* Corporation invite tenders for two steam dynamos, jet condenser, balancer, 750-ampere-hour storage battery, steam and exhaust piping, arc lamps and pillars. Tenders by 28th inst.

*Bermondsey* Borough Council require a main switchboard and instruments and a battery of accumulators and accessories. Tenders to town clerk, Town Hall, Spa-road, London, S.E., by noon 30th inst.

*Taunton* Corporation require two 100kw. tramway generators, one engine and tramway switchboard and connections. Tenders to town clerk, by 2 p.m., Feb. 25.

*Bristol* Electrical committee require tenders for erection of superstructures of Avonbank electricity works. Tenders to secretary, Temple Back, Bristol, by March 12.

*St. Pancras* (London) Guardians invite tenders for installing an electric fire-alarm system at their infirmary. Tenders to clerk, Town Hall, Pancras-road, N.W., by 28th inst.

*Coventry* Sanitary committee require tenders for electric lighting of new buildings at Infectious Diseases Hospital. Tenders by 4 p.m. March 4.

*Belfast* Harbour Commissioners require a water-tube boiler, steam and feed-water pipes, &c. Tenders by 25th inst.

*Bradford* Corporation invite tenders for work in connection with the erection of the Valley-road electricity generating station. Tenders by March 5.

## TENDERS RECEIVED AND ACCEPTED.

Southampton Corporation have received the following tenders for the supply of car bodies and trucks, motors and equipments (per car):—

SECTION A (*Car Bodies and Trucks*).

| | With ordinary roof seats. | With Burns' auto. reversing seats. |
|---|---|---|
| * George F. Milnes & Co. | £313 0 0 | £326 10 0 |
| † British Thomson Houston Co. | 336 0 0 | 350 0 0 |
| ‡ Brush Co. | 310 10 0 | §320 10 0 |
| Ditto | — | ‖326 0 0 |

* £5 extra for Peckham trucks. † Also alternative tenders of £268, £284. 10s., and £278. 10s. ‡ Less £1 if Brush trucks substituted. § For "Challenger" seats. ‖ For "New London" seats.

SECTION B (*Motors and Electrical Equipment*).

| | |
|---|---|
| British Westinghouse Co. | £253 15 0 |
| * British Thomson-Houston Co. | 253 13 0 |
| ** Brush Co. | 253 13 0 |

* Less £18. 16s. if standard car cables were supplied. ** Also tendered at £314.

Messrs. Dick, Kerr & Co. tendered for both sections at £625 per car, and £12. 12s. extra if their standard revolving type destination boxes were used. The Tramways committee recommended the acceptance of the tender of Messrs. George F. Milnes & Co. for the supply of car bodies and trucks at £326. 10s. per car, subject to "Challenger" seats being substituted for "Burns" seats, and the tender of the British Westinghouse Co. for the supply of motors and electrical equipments at £253. 15s. per car.

Barnes District Council have received the following tenders for wiring the electricity works:—

| | Tubular draw-in system. | Wood casing. |
|---|---|---|
| Johnson and Fitzer (*accepted*) | £89 6 6 | £81 1 6 |
| National Electric Wiring Co. | 140 0 0 | — |
| Cecil Cooper & Co. | 138 15 0 | 121 7 6 |
| Rawlings Bros. | 116 10 0 | — |
| Whitehead Bros. | 104 0 0 | 98 10 0 |
| Foote and Milne | 103 0 0 | — |
| F. Troy & Co. | 98 16 8 | 96 10 0 |
| H. Beard & Co. | 98 11 6 | 86 14 0 |
| Coley Electric Works | 98 10 0 | 93 0 0 |
| W. Lowe | 94 10 0 | 85 10 0 |

The managers of the Poplar and Stepney Sick Asylum, Bromley, E., have received the following tenders for the supply and erection of an electric light installation at the asylum:—

| | | | |
|---|---|---|---|
| C. Peacock & Co. (*accepted*) | £2,039 | Roger Dawson & Co. | 2,876 |
| Cecil Cooper & Co. | 4,075 | V. G. Middleton | 2,735 |
| Speedy, Kynon & Co. | 3,494 | J. J. Roche & Co. | 2,696 |
| G. Weston & Co. | 3,488 | Frigell Bros. & Louis | 2,550 |
| John C. Christie | 3,345 | National Elec. Wiring Co. | 2,540 |
| F. A. Glover & Co. | 3,262 | Joel and Potter United | 2,439 |
| Strode & Co. | 3,193 | Young and Marten | 2,359 |
| John Bolding & Sons | 2,900 | Whittaker Bros. | 1,757 |

The following tenders were received by the management committee of the Ballinasloe (Ireland) Asylum for the electric lighting of their new asylum block:—

| | | | |
|---|---|---|---|
| Ampere Electrical Co. (*accepted*) | £1,205 0 0 | E. Hutton & Co. | £1,927 0 0 |
| Natl. Elec. Wiring Co. | 2,242 0 0 | Cummins & Son | 1,847 0 0 |
| Wm. Curtis & Son | 2,013 5 0 | W. H. Baughan & Co. | 1,790 0 0 |
| L. B. Mollan & Co. | 1,996 9 0 | Banbridge F'ndry Co. | 1,781 0 0 |
| Wm. Coates & Sons | 1,996 0 0 | Handley and Shanks | 1,737 0 0 |
| Alliance Electrical Co. | 1,940 0 0 | Egan and Tallow | 1,716 0 0 |
| | | Hobbies (Ltd.) | 1,628 10 11 |

Messrs. Davey, Paxman & Co. are supplying four boilers for the Cape Town electricity station, and the Cape Government railways with six sets of specially-designed train lighting plant for through passenger traffic, and a 120 H.P. compound engine for central station lighting. This (*Industries*, of Durban, points out) is the third engine supplied by Messrs. Davey, Paxman & Co. for this purpose.

Shoreditch (London) Borough Council have accepted the tender of Messrs. J. E. Johnson & Sons for erecting engine and boiler-houses, offices, &c., at Whiston-street, Haggerston, for the new generating station, for £16,633. This was the lowest of 13 tenders, the consulting engineer's estimate being £20,000.

West Ham Corporation have accepted the tender of Veritys Limited for electric lighting plant for the Dagenham Asylum at £1,321. Oil engines are to be used.

The contract for the electric lighting of the confectionery works of Messrs. Edward Bone & Co., Gateshead, has been placed with the Gateshead Electric and Mechanical Supply Co.

Tynemouth Town Council have accepted the tender of Messrs. Siemens Bros. & Co. for a steam dynamo at £4,832, and that of Messrs. Yates and Thom for a Lancashire boiler at £1,070.

Southampton Corporation have accepted the tender of Messrs. S. Z. de Ferranti, Ltd., for a 300kw. steam alternator at £300.

Morecambe District Council have accepted the tender of Mr. F. Moore for extending the present electricity station building at £2,040.

## BUSINESS NOTICE.

Mr. H. E. McKrell notifies that he has joined the firm lately trading as W. Hedges & Co., manufacturers of engineering and electrical fittings at 34, Barbican, London, E.C., and that the firm will in future trade as Hedges, McKrell & Co.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Cornelius Bennett Harness, late managing director of the Medical Battery Co. (Ltd.), applied on Monday at the Wandsworth County Court for his discharge in bankruptcy. The assistant official receiver (Mr. Achieson) stated that the receiving order was made on Oct. 11 last. The liabilities amounted to £8,289, there were no assets, and nothing had been realised. The application was opposed, and Mr. Achieson suspended the discharge for three years.

Claims against Paris Singer (Ltd.) must be sent by March 30 to the liquidator (Mr. S. H. Baldrey), 53, Warwick-street, London, W.

The estates of J. M. Hiley and Wm. Orchar, 21, North Tay-street, Dundee (as a firm and as individuals) have been sequestrated. Meeting to elect trustee and commissioners on 27th inst., at Lamb's Hotel, Reform-street, Dundee. Claims by June 17.

It is announced that the examination of Mr. Francis Teague, electrical engineer, Electricity Works, Blackhall, Paisley, will take place at the Sheriff Court House, Paisley, on 26th inst., at noon.

Mr. R. M. Burgess, 38, Albion-street, Leeds, has been appointed trustee in the bankruptcy of T. A. Flather, electrical engineer, lately of Park Electric Works, Speedwell-street, Leeds.

---

**Sales by Auction.**—It will be seen by an advertisement elsewhere that Messrs. Horne & Co. are instructed to sell by auction, on Tuesday next, Feb. 26, and following days, at 12 noon precisely, the remainder of the machinery and plant recently used in the construction of the Central London Railway. A large quantity of valuable plant is detailed in the advertisement, and all further information and particulars can be obtained from Messrs. Horne & Co., 8, Delahay-street, Westminster, S.W., and 85, Gresham-street, E.C., London. It will be seen that the plant includes engines, boilers, motors, cable and other plant and appliances by the leading makers.

An advertisement elsewhere gives preliminary notice of a sale by auction by Messrs. Wheatley Kirk, Price & Co., at an early date (unless previously disposed of), of a quantity of modern high-class plant, machinery, stock, and stores.

**Plant for Sale.**—Messrs. Wake and Carr, 123, Victoria-road, Darlington, have for sale four sets of vertical marine-type triple-expansion engines. An advertisement gives additional information, and further particulars can be obtained from Messrs. Wake and Carr, Darlington, or Mr. Thos. W. Ward, Sheffield.

An advertisement also contains some particulars of eight large locomotive boilers which are for sale. Applications to Messrs. Wake and Carr, Darlington, or to Mr. Thos. W. Ward, Sheffield.

Burton-on-Trent Gas and Electric Light committee have for sale a horizontal compound engine with a single-phase alternator, some particulars of which are set out in an advertisement. Offers to manager and engineer, Mr. F. L. Ramsden.

Messrs. Wheatley Kirk, Price & Co. have for disposal a high-class private electrical installation, including Crossley gas engines, Johnson and Phillips dynamo, D.P. battery, &c. See advertisement.

By order of the trustee under the deed of assignment made by G. Stegmann, the stock-in-trade and machinery of an electrical engineer, office furniture, fittings, fixtures, &c., will be sold by auction by Mr. H. W. Smith, at 45, St. John's-hill, Clapham Junction, London, on Thursday and Friday, February 28 and March 1, at 11 for 12 o'clock each day. An advertisement contains some further particulars, and catalogues may be obtained from the trustee, Mr. F. W. Davis (Messrs. Saker and Davis), chartered accountants, 95 and 97, Finsbury-pavement, E.C.; from Messrs. Stanley Evans & Co., 20, Theobald's-road, W.C., and at the Auction and Estate Offices, 7, Featherstone-buildings, Bedford-row, W.C., London.

**General Electric Co.'s Lists.**—A price list of new short-type "Solar" enclosed arc lamps is issued by the General Electric Co. We have also received a list of prices and particulars of steel interior conduit manufactured by the company.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 13 to Feb. 19, with the ports of destination:—

*Africa*—Cape Town, £1,329; Durban, £1,445. *Argentina*—Buenos Ayres, £550 (including £300 telegraph material). *Australasia*—Fremantle, £642; Melbourne, £1,819 (including £1,087 telegraph cable); Otago, £204; Sydney, £1,235. *Belgium*—Ostend, £75. *China*—Shanghai, £326. *Germany*—Hamburg, £726 (including £670 telegraph material). *Greece*—Syra, £94 (telegraph material). *Holland*—Amsterdam, £204. *Hong Kong*—£198. *India*—Bombay, £79; Calcutta, £4,806; Madras, £17. *Italy*—Genoa, £72. *Japan*—Nagasaki, £80. *Straits Settlements*—Singapore, £304. *Sweden*—Stockholm, £23. Total £14,258, against £37,999 in the corresponding week last year (Feb. 14 to Feb. 20).

# COMPANIES' MEETINGS AND REPORTS.

## National Telephone Co. (Ltd.)

The twenty-seventh ordinary general meeting of this company was held yesterday, Mr. T. STAATS FORBES presiding.

The SECRETARY (Mr. Albert Anns) having read the notice calling the meeting and the auditors' report,

The CHAIRMAN said: Ladies and gentlemen, this is an important occasion. We have to consider a new departure, and therefore I will deal with the report as affecting the half-year's working with brevity. The income of the half year has been £732,000 in round figures, an increase of £68,000 over the corresponding period last year. The working expenses for the half year have been £404,000, compared with £359,000, an increase of £45,000. At first blush that is a very disagreeable disproportion to the increase in the gross receipts, but it is attributable to one item, and that is that, in the early part of the year, we had a very heavy snowstorm, which involved us in £25,000 of expenditure. The net result of the half-year is that, after deducting the Post Office royalties, amounting to £71,000, there is a profit of £255,000, against £240,000, or an increase of £15,000. The rentals carried forward in respect of unexpired terms of contract come to the enormous sum of £696,000, this being an increase of £61,000. In fact, the business of the past year, taken as a whole, has been a record. It shows the greatest development of the undertaking in any one year, and that notwithstanding some very adverse circumstances. Out of the available balance we propose to pay the fixed interest on the various preference shares and so forth. The capital expenditure of the period under review has been £468,000, which is the price of 11,794 additional exchange and private lines and the construction of underground lines. That is a large sum, but its expenditure was inevitable. That brings us to the root of the thing, which is whether we are to go on—whether we are to cave in or fight on. I do not know whether what we have gone through on a greater scale on other occasions is an encouragement to cave in. I think we shall have to do what others who have a just cause have done, and that is fight for our own hand. But that can be done only after mature deliberation and after settling many difficult questions, and inducting the right course, if you think that you can find it. Our difficulty is the unknown. The Government have become competitors in London. They have power to license outside London, and our company have a short life—1911 is the end of our licence. What is going to arise then? The Government, under the company's licence, can every seventh year take over this concern by arbitration. Now, suppose we deal with the unknown as embraced between now and 1904. The Government then, whatever the state of things may be, may elect to take us over by arbitration; and, therefore, I think if we limit our forecast to 1904 we shall be treading much safer ground than if we attempt a forecast to 1911. With the greatest respect to the Government and the authorities, I think they will have a great deal to learn, and I think that if they persist in their objects, whatever they are, of competing with us at very low rates they will have a very sorry tale to tell in 1904. But what are we to do? Are we to fight for our own hand? Well, after much deliberation we have come to the conclusion, subject of course to your sanction, that we will go on and relax no reasonable effort to increase our subscribers and make the best of our property. I do not think we are likely to invite opposition from the Government or anybody else based upon the knocking down of rates, but we may have to "follow my leader" in that as in other things in life. We must await the result. Having all that in view it really comes to this—a new departure. Shall we draw in and make the best of what we have for the next four years or go on vigorously and make our service as efficient and as extended as possible, and get the best terms we can out of the public for doing the work efficiently? That is what we are determined to do, subject to your approval. Dealing with the year as a whole, we have had the very large addition of 23,509 exchange and private lines, and of these 16,776 have been for subscribers on the message rate system. That is to say, the payment of a low annual charge in respect of the cost of installation and the sum of 1d. per call made. That is the message-rate system, and that, I understand, is the principle which the Government intend to promote and extend. Well, I wish them joy if their result is anything like ours has been. We have spent on those subscribers half a million of money experimentally, and, in some sense, as a measure of insurance, to show that we are not behind the times; but the result has been that we have not made a farthing of interest on the money. We cannot afford to give a service of this kind for nothing, but if we are forced by competition to do it, we must take our chance. The effort to popularise may possibly justify the message rate system, supposing it develops. The theory is that the annual payment, and 1d. a message sent, will in course of time bring such an average payment as will result in a profit. Meanwhile the interest on the large capital involved accrues. If these people had come to us on the ordinary terms we should have had an additional £23,000 to the profit of the year. This is the first time we have tested and experimented with this message-rate system, and we must draw from it the lessons of experience. I now move the adoption of the report and accounts and the payment of the dividends therein recommended.

The Right Hon. Sir HENRY FOWLER, M.P., seconded the resolution.

Mr. LEE SMITH remarked that the Government might at one time have acquired the concern at a very low rate, but they had allowed this company to struggle on and make the thing a success, and now they proposed to swoop down on them. He had every confidence in the board, but felt they ought not to go on adding largely to the capital expenditure when, in 1911, the Government might take away from them their concession.

The CHAIRMAN pointed out that the company had to live with their competitors and must do their best—however much indignation they might feel against the Government—to provide an efficient and sufficient service. The hope of the board was that they would be able to beat the Post Office. They were more adaptable, and not tied up with restrictions and red tape like a Government department. They must wait for the Post Office to be found out in this matter.

The resolution was carried with one dissentient.

The CHAIRMAN next moved the resolutions set out in the directors' report, which will be found on p. 641 of our last issue. He said these propositions were based on the determination of the board, subject to the shareholders' approval, not to stop extension but to make the best of the situation. To stop their extensions meant that in every great centre of the country they must refuse applications for the telephone service. That would give an opening to those enamoured of municipal trading in the respective centres to seek for a licence to start an opposing system, and that could not be considered as desirable. The board advised the shareholders to go on developing the business till 1904, when they would know what the intentions of the Government really were. If they then gave notice to buy out the concern by arbitration, well and good. If not, his conviction was that the company would then be in a position that the Post Office would find it a particularly hard nut to crack. By the resolutions the board would be given another million of money to invest for the shareholders. That money would not be spent at once or next year, but would suffice for the discreet development of the business up to 1904.

A SHAREHOLDER inquired if the Post Office would not be in a better position than this company to compete for telephone subscribers.

The CHAIRMAN said that undoubtedly the Post Office would start with many advantages, but he had confidence in a commercial company to beat a public department, with all its advantages.

The resolutions were carried.

## W. T. Henley's Telegraph Works Co. (Ltd.).

The directors' report for the year 1900 states that of the additional capital authorised in August, the directors have issued £25,000 preference shares at par and £25,000 ordinary shares at 100 per cent. premium, enabling the reserve to be increased by £25,000. These shares were all issued to the shareholders or their nominees. The net profit for the year amounted to £62,723. 18s. 6d. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, &c., there remains £56,411. 17s. 10d., making, with £18,853. 7s. 4d. from last year, a total of £75,265. 5s. 2d available for distribution. The directors have transferred £1,000 to debenture redemption sinking fund, and £11,000 to reserve (in addition to the £25,000 above mentioned), and recommend the payment of the following dividends:—At the rate of 4½ per cent. per annum (less tax) on the preference shares, and at the rate of 20 per cent. per annum (less tax) on the ordinary shares, including the interim dividend of 4 per cent. paid on Sept. 1 last. These payments amount to £50,554. 9s. 2d., leaving £24,710. 16s. to be carried forward.

## Brompton and Kensington Electricity Supply Co. (Ltd.).

The annual report of the directors for the year to Dec. 31 states that the revenue account shows a credit balance of £21,324. 3s. 7d., which, with £229. 4s. brought forward, and £282. 13s. 5d. interest received, makes £21,836. 1s. After deducting £2,250 for interest on debenture stock, £2,100 for interim dividend on preference share, and £2,457. 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30, 1900, on the ordinary shares, the directors recommend that £6,000 be put to depreciation, £3,000 in reduction of renewals suspense, and that dividends be paid to Dec. 31 on the 7 per cent. cumulative preference shares, on the ordinary shares at 7 per cent. per annum (making 6 per cent. for the year), and that £487. 15s. be carried forward. The nominal capital of the company is now £300,000, divided into 20,000 preference and 40,000 ordinary shares of £5 each. The directors propose to issue 8,000 preference and 359 ordinary shares, bringing the ordinary and preference capital up to £100,000 each, and to redeem the existing debenture stock.

The renewal of antiquated plant has been completed during the year at a further cost of £2,992. 16s. 10d., and after appropriating £3,000 from the income of the year, the renewals suspense account stands at £14,194. 16s. 10d.

## Westminster Electric Supply Corporation (Ltd.).

The report of the directors of this corporation for the year 1900 is as follows:—The supply of current, which on Dec. 31, 1899, was provided for the equivalent of 421,445 lamps of 8 c.p., had increased by Dec. 31, 1900, to the equivalent of 469,589 lamps. At the present time there are on circuit the equivalent of 479,056, and applications have been received for a further 7,056 lamps. The length of roadway in which mains have been laid now exceeds 54 miles, making about 219 miles of ways, into which upwards of 188 miles of copper (strip and cable) have been drawn.

The directors have entered into an agreement with the Vestry of St. George, Hanover-square, for lighting the whole parish by electricity. The experimental lamps erected near Victoria Station, which have been in use for some time past, have given great satisfaction. The mains for this purpose are being laid, the lamp posts are being rapidly erected, and in a short time a considerable section of the area will be lighted by arc lamps.

The continued high price of Welsh steam coal has entailed an extra cost of about 50 per cent. for fuel, and has, of course, materially affected the profits of the past year. Since the supply of current has been given at 200 volts, the revenue has also been reduced by the allowance of 8 per cent. to consumers supplied at that pressure. All the consumers (5,661), with the exception of nine, are now on the 200-volt circuit.

During the year £148,100 ordinary share capital has been duly issued at par to the shareholders. A large proportion of this sum has been expended on the joint undertaking of the St. James' and Pall Mall Company and this corporation in the purchase of lands and erection of works at North Bank, Marylebone. This capital must necessarily, until the opening of the works, remain unremunerative.

An interim dividend at the rate of 10 per cent. per annum for the half-year ended June 30 last has been distributed, and the net balance available for dividend is £30,536. 19s. 4d., a dividend at the rate of 11 per cent. per annum, less tax, for the half-year to December is recommended, £3,860 being carried forward.

## British Insulated Wire Co. (Ltd.)

The directors' report announces that the gross profits for the year were £134,226. 0s. 11d., to which is added £6,432. 14s. 9d. brought forward, making £140,658. 15s. 8d. £66,495. 0s. 4d. is allowed for cost of administration, legal expenses, patent fees, &c., depreciation, patents, debenture interest, and interest on preference capital for the year, leaving for dividend, reserve, &c., £74,163. 15s. 4d. The interim dividend at the rate of 10 per cent. per annum already paid on the ordinary shares absorbed £12,481. 7s. 9d., and the directors have transferred to reserve £22,400, leaving £39,282. 7s. 7d., and a dividend is now proposed, making a total for the year of 15 per cent. on the ordinary shares, and carrying forward £6,763. 15s. 4d. The reserve now stands at £200,000. During the year 30,000 preference shares of £5 each have been issued at a premium of 10s. per share, and 30,000 ordinary shares of £5 each at a premium of £5 per share. The premiums thus received (£165,000), with £12,600 formerly received, make £177,600 out of the £200,000 of the reserve fund.

The new copper rolling and drawing department is now in active operation, and has fully justified the capital expenditure on these works. It will be necessary to further extend them in the near future. The company has acquired further valuable freehold property at Prescot.

The debenture issue of £50,000 matured on Dec. 31 last, but as the directors contemplate in the near future making a larger issue on more favourable terms, arrangements have been made with most of the holders to temporarily extend their bonds to June 30, 1901.

The results of the year's working have been very satisfactory, and the business of the company has considerably increased. Large additions have been made to the buildings and plant for the purpose of coping with the great increase of the company's business, and the directors have still further extensions in contemplation.

## Newcastle-upon-Tyne Electric Supply Co. (Ltd.).

The directors' report for the year ended Dec. 31 states that the total units sold amounted to 1,095,519, against 967,098 in 1899, and 803,789 in 1898. The profits, including £1,811. 1s. 6d. from 1899, amount to £10,605. 6s. 11s. Interim dividends at the rate of 5 per cent. per annum on the preference and 8 per cent. per annum on the ordinary shares were paid in July last, absorbing £3,680. 2s. 3d., and the directors now recommend further dividends at the rate of 5 per cent. per annum on the preference and 8 per cent. on the ordinary shares, absorbing £4,537. 13s. 10d., and that the balance (£2,387. 10s. 10d.) be carried forward. The high price of coal which ruled during the year has increased the cost of production by about £1,600, but at present prices the larger portion of this increased expense will be saved during the current year. The reserve and depreciation account has been increased by £20,000, the premium of £1 per share on 20,000 preference shares issued, and now stands at £40,000.

Two sets of plant, with a capacity of 500kw. each, have been erected at Pandon Dene during the year. The parliamentary bills promoted last year to give powers to the company outside the area of their original provisional order, and also for the supply of electricity in Gosforth, have been successfully carried through. The company is now in possession of an extensive central generating station at Wallsend, having taken over and enlarged a station commenced by the Walker and Wallsend Union Gas Co. A suitable riverside site at Carville has also been secured, and is available for future development. The company is now in a position to meet the present and growing demand for electricity for power and other purposes. The purchase price of the riverside site was settled at £22,500, the vendors taking preference shares for their purchase money. There now remains unissued 10,000 ordinary and 6,250 preference shares, which will be offered to the shareholders on the same terms as the last issue during the forthcoming autumn. The directors propose to create 4 per cent. mortgage debentures to the amount of £250,000, which will be issued as the extended operation of the company require, the total issue not to exceed one half of the paid-up capital. The expenditure on capital account during the year was £127,261. 2s. 9d.

## Telegraph Construction and Maintenance Co. (Ltd.).

The thirty-seventh annual report of the directors of this company states that the accounts for the past year show a net profit of £100,195. 16s. 9d., after charging interest on debentures; £53,803. 6s. 1d. was brought forward, making £153,999. 2s. 10d. From this is deducted the interim dividend of 5 per cent., paid in July, amounting to £22,410, leaving £131,589. 2s. 10d. to be now dealt with. The directors propose to distribute a dividend of £1. 4s. per share and a bonus of 6s. per share (absorbing £56,025), being at the rate of 12½ per cent., and making a total dividend for the year of £2. 2s. per share, or 17½ per cent., free of tax, leaving £75,564. 2s. 10d. to be carried forward.

The business of the company during the past year has been satisfactory, and the factories have been fully occupied in the manufacture of submarine telegraph cables and of insulated wire. The company's steamships have been employed in the laying of submarine cables, and also in the carrying out of repairing operations. The factories at Wharf-road and Greenwich and the steamships have been maintained in a thoroughly efficient condition.

The directors propose to add a further sum of £10,000 to the pension fund established in 1899 for the benefit of the company's staff.

The transfer books will be closed from 18th to 26th instant inclusive, preparatory to the payment of dividend.

**CITY OF CARLISLE ELECTRIC TRAMWAYS CO. (LTD.)**—The first half-yearly meeting was held at Carlisle on Wednesday. The chairman (Mr. G. Richardson) moved the adoption of the directors' report which stated that the lines are worked by the company under an arrangement to pay 40 per cent. of the traffic receipts to the Manchester Traction Co. in consideration of which the Manchester company pay the 4 per cent. interest on the debenture stock subscribed and paid up, and 5 per cent. interest upon the ordinary share capital to the date of taking over the tramways by the Carlisle company. The revenue account for the half-year showed a surplus of £1,523, and the balance profit, after writing off one-third preliminary expenses, was £1,669. The directors recommend that £500 be put to depreciation, and that a dividend for the half-year to Dec. 31 at the rate of 3 per cent. per annum, making 4 per cent. for the year, be declared. The car miles run had been 116,853; the number of passengers carried, 1,103,941; the traffic receipts per mile, 9·46d.; total receipts, 9·74d.; total expenses (57·52 per cent. of receipts), 5·60d. The report was adopted.

**DISTRICT MESSENGER AND THEATRE TICKET CO. (LTD.)**—At the shareholders' meeting on Monday Mr. G. E. J. Manners said that in October they heard from Lord Londonderry that, after careful consideration, he had made up his mind to renew the company's licence for five years, subject to certain conditions, and hinting at very much increased competition. The directors consulted with friendly members of Parliament, and their strong opinion was that the matter must be fought to an issue. The shareholders were now asked to sanction the bill which the directors were promoting. The directors were careful to interfere as little as possible with the monopoly of the Postmaster-General. They wanted their licence to be extended to 42 years, the period usually granted to similar companies, and suggested that, instead of the present royalty, which was very expensive for the Post Office to calculate and check, the company should pay a lump sum of £500 a year, with an extra £100 a year for every 1 per cent. per annum above 5 per cent. paid to the ordinary shareholders. If the department could afford to carry a postcard for ½d., and do all the work incidental to carrying it, he contended that if the company paid them $\frac{1}{10}$d. it would be ample, as the company had to provide the capital necessary for their electric system to catch the business. The action of the directors was approved.

**METROPOLITAN DISTRICT RAILWAY CO.**—At the general meeting of this company held on Thursday last, Mr. J. Staats Forbes (presiding) said that since their extraordinary meeting (*The Electrician*, Jan. 11) their accounts had been made up, and too sadly fulfilled the forecast which he gave them on that occasion. This serious position was traceable almost entirely to the opening of the "Twopenny Tube." They had lost in the half-year 101,000 first-class passengers, 272,000 second class, 964,000 third class, and 1,700 season ticket subscribers. Their working expenses had increased by £1,200, attributable chiefly to coal. In this condition of affairs electric traction was, of course, the saving grace, if it could be brought about, but there were other measures they must take, which will require a great deal of skill and knowledge—the question of uniform class, low fares, &c. The results of the working of the Central London Railway were not in his view so extremely brilliant to the investor as to make him (Mr. Forbes) believe that there would be a great run of money to support the designers of those railways. For engineers and electricians and professional men it was very easy to design such lines; but there would be a good many difficult questions to be got over in regard to future tube railways. The directors of the District line would have to watch and do their best to oppose and defeat schemes directly vital to the District Railway. For instance, a railway under the Strand and the City would not suit them at all. They could not allow it to go without having something to say upon it, and that would mean the necessity of appearing in opposition to the bills in Parliament—if they ever got there. On the question of provision of funds for the conversion from steam to electric traction, the directors were determined there should be electricity; but there were a great many electrical doctors in the world, and a vast number of different ideas as to the best method to be adopted. The board had before them nine proposals from different places, and one particular one was insisted upon by their technical advisers as being the best. Some outside people, however, said they did not care about technical advisers—they knew better. The company was bound, in honour to the Metropolitan Company and in justice to themselves, to determine what system was most applicable to both the lines. They were told by their experts that one system in particular was admirable for their purposes, that it was a great advance on any other system, and that the Americans were not in it. Well, the Americans thought they were in it, and there was a certain amount of conflict going on. However, the directors would have to come

to some determination; but they would not do so without obtaining in advance the consent of the very large shareholders. They would first have to settle upon the electrical system to be adopted, and then determine what was the best means of providing the funds and the least amount they could do with. The salvation of the line depended upon getting the conversion to electric traction carried out with the utmost speed.

**NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)**—According to the annual report for 1900, the equivalent of 5,399 additional 8 c.p. lamps were connected, and motive power equal to 297 lamps, together 5,696, compared with 6,702 in the previous year, bringing the total to 25,459 8 c.p. lamps. The mains have been extended about 1½ miles, making a total length of about 7½ miles. The number of consumers had been increased by 106, making 445 in all. The increase in the price of coal seriously affected the results of the year's working, and in addition there was great and unexpected delay in the delivery of machinery, upon which the change to a higher voltage was dependent. This step, which should have taken place during the summer months, was necessarily postponed until after Christmas, and can then only be satisfactorily undertaken during a few days of fine weather. Meantime the plant has been working uneconomically, with the result that no improvement can be recorded so far as net revenue is concerned. The accounts show £1,132. 18s. 1d. to credit of net revenue. It is proposed to pay dividends on the 6 per cent. (fixed) preference shares (£229), on the 5 per cent. (fixed) preference shares (£418. 3s. 8d.), and 2 per cent. on the ordinary shares (£439. 18s. 8d.), leaving £45. 15s. 9d. to be carried forward.

**SMITHFIELD MARKETS ELECTRIC SUPPLY CO. (LTD.)**—The annual meeting of this company was held on Friday. The chairman (Mr. H. S. Leon) moved the adoption of the report, which has already appeared in *The Electrician*, and said they could mildly congratulate themselves upon the result of the year's working. The number of lamps had increased by the equivalent of 6,279 8 c.p., which represented 57 new customers. About 100 new shops still remained to be lighted, and they had every reason to believe that, in course of time, all would come in. The new consumers when they come in would be profitable customers, as they were long hour consumers, and the company's plant could take them without further capital outlay. In Dec., 1900, they expended about £3,000 on a new unit of plant, which was now in operation, and they hoped to get through the summer at a decreased working cost. The necessary moneys had been raised by the issue of £3,800 second debentures, increasing the total of that issue to £8,000. The board would limit further issues of capital to works which would show a direct and immediate profit. They would maintain the plant out of revenue, and for that purpose £1,000 had been placed to depreciation account. The cost of coal had been £4,155 for the year, against £2,660 in the previous 12 months. The ordinary shareholders, although they might not receive any dividend for a few years, or only a small one, could rest satisfied that the company had been slowly but surely built up on safe and solid foundations. The directors, although entitled to a much larger sum, had only taken £500. They thought the time had come when they were entitled to a portion of their legitimate fees. For his (the chairman's) part, he was not disposed to work any longer for nothing.

**WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)**—The directors' report states that during the past year the equivalent of 3,939 8 c.p. lamps were added, bringing the total to 17,808 at the end of 1900, of which 1,063 represent motive power. The expenditure on capital account amounted to £6,764. 14s. 4d., bringing the total to £53,679. 3s. 5d. The principal expenditure was on mains, and included a new cable to Windsor Castle, where a number of additional lights have been connected, and also in St. George's Chapel. A new battery of accumulators has been provided and is now working. The net profit for the year is £4,372. 11s. 11d., and over three-fourths of the profit has been earned from the supply of electric current. The amount available for distribution, including £690. 12s. 3d. from the previous year, is £5,063. 4s. 2d., and the directors recommend a dividend at the rate of 8 per cent. for the year, tax free. An interim dividend of 3 per cent. has already been paid. A balance of £1,400. 14s. 2d. will remain, and the directors recommend that £750 be added to the depreciation, renewal, and reserve fund. £3,747. 9s. 6d. was received during the year as premium on the issue of the balance of the share capital less expenses, and the directors recommend that £1,500 of this be carried to dividend equalisation account, and the balance £2,247. 9s. 6d. to depreciation, renewal and reserve.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (Feb. 21, 1901). Price of silver 28⅜d. per oz. (Feb. 21). Consols (2¾ per cent.) 97⅛—97¼ for money, 97⅛—97¼ for account; 2½ per cent. 97—97½ (Feb. 21). Consols Pay Day March 1. Stocks and Shares Continuation Days, Feb. 26 and Mar. 12, Ticket Days, Feb. 27 and Mar. 13; Pay Days, Feb. 28 and March 14; Mining Share Carry-over Days, Feb. 25 and Mar. 11.

**BLACKPOOL AND FLEETWOOD TRAMROAD CO.**—At the meeting on Tuesday the chairman (Mr. George Richardson) said the working expenses showed an increase owing to the high price of coal. An extra receipt in this year's account was £362 for the sale of current to the Blackpool Corporation owing to a breakdown in their system. There was a decrease in the dividend of 1 per cent., bringing this down to 9 per cent. for the year.

**BRITISH ELECTRIC TRACTION CO. (LTD.)**—The subscription list closed on Wednesday in an issue of 30,000 6 per cent. cumulative preference shares of £10 each in this company issued at £11. 10s. per share by the Electric and General Investment Co. The prospectus of this issue is an interesting document and shows the progress of the British Electric Traction Co. since its formation. The share capital of the company is £2,000,000, of which, with the present subscription, £1,500,000 has been issued. The company has power to raise on debentures any sum not exceeding half the subscribed capital for the time being, and £600,000 debenture stock has been issued. 2,077 £10 ordinary shares are to be allotted as fully paid-up to certain shareholders in the Brush Electrical Engineering Co. in accordance with the agreement recently effected between the two companies.

**CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)**—At the annual meeting Mr. Munsey, who presided, referred to the company's steady progress and excellent prospects for the present year. The whole of the staff had worked well, and all had done their best to make the company a success. The Hon. C. A. Parsons said they owed a great deal to their manager (Mr. Barker), who, as some of them knew, was going shortly to Newcastle-on-Tyne to manage the works where machinery such as they had in Cambridge was made. It was a considerably larger sphere of action, and much more important, and the directors thought they could not stand in Mr. Barker's way. They had an understanding that Mr. Barker would, at any time he was called upon, give advice or assistance when the Cambridge company might wish him to do so.

**CENTRAL LONDON RAILWAY CO.**—This company are inviting applications for £876,000 4 per cent. debenture stock. The lists close to-day (Friday).

**CHELSEA ELECTRICITY SUPPLY CO. (LTD.)**—The transfer books of this company's preference and ordinary shares will be closed from Feb. 25 to March 6 inclusive.

**EDISON AND SWAN UNITED ELECTRIC LIGHT CO. (LTD.)**—A payment on account of dividend for the current year at the rate of 5 per cent. per annum (less tax) on the "A" shares for the half-year to Dec. 31 is declared. This works out at 1s. 6d. per share on the partly paid £5 shares (£3 paid), and 2s. 6d. per share on the fully-paid £5 shares (less tax).

**GENERAL ELECTROLYTIC PARENT CO. (LTD.)**—Messrs. Chalmers, Wade & Co., Liverpool, have made a thorough investigation of this company's financial position, and the directors will submit a revised balance sheet to Jan. 31 at the forthcoming meeting. The balance shown in the accounts published last year has been increased on revision by £2,835, making a total of £59,341. From this has been deducted the cash dividend of 50 per cent., free of tax, declared March 21, 1900, and the net balance to Jan. 31 is £49,536. This is represented by £62 in cash and 49,474 fully-paid up ordinary shares in the Electrolytic Alkali Co. (Ltd.). The directors recommend that 45,772 of these shares be distributed among the shareholders at the rate of eight shares in the Alkali Company for every five shares in the Parent Company, leaving 3,702 shares and £62 in cash to be carried forward. The directors consider that very satisfactory progress has been made with the construction of the works of the Electrolytic Alkali Co., at Middlewich.

**GIANT'S CAUSEWAY AND PORTRUSH ELECTRIC TRAMWAY CO. (LTD.)**—The ordinary general meeting of this company was held last week. The directors' report was adopted.

**LONDON-PLATINO-BRAZILIAN TELEGRAPH CO. (LTD.)**—The half-yearly coupons on this company's 6 per cent. debentures, due March 1, will be paid by Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, London, E.C.

### ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Feb. 9 | 536 | + 59 | 35 | 21,782 | + 3,313 |
| *Birmingham Tramways | „ 16 | 3,954 | + 332 | 6 | 23,772 | − 507 |
| *Blackburn Corporation.. | „ 16 | 393 | + 88 | 6 | 2,580 | + 89 |
| Blackpool Corporation... | „ 14 | 164 | + 65 | 46 | 29,354 | + 7,762 |
| Blackpool and Fleetwood | „ 16 | 136 | + 37 | 7 | 950 | − 20 |
| Bolton Corporation ...... | „ 17 | 1,235 | ... | 46 | 62,034 | ... |
| Bradford Corporation... | „ 17 | 771 | + 457 | 46 | 27,781 | +10,200 |
| Brisbane Trams ......... | Jan. 2 | 2,505 | + 650 | 25 | 50,649 | + 9,157 |
| *Bristol Trams & Carriage | Feb. 15 | 3,374 | +1,157 | 7 | 23,980 | + 7,034 |
| *Buenos Ayres & Belgrano | Jan. 20 | 2,333 | + 51 | 3 | 8,420 | + 1,143 |
| Carlisle Trams. Co. | ... | ... | ... | ... | ... | ... |
| Central London Railway | Feb. 16 | 6,131 | ... | 7 | 42,838 | ... |
| City & South London Ry. | „ 17 | 2,040 | + 680 | 7 | 14,039 | + 6,140 |
| Cork Elec. Trams ........ | „ 14 | 328 | + 159 | 6 | 2,171 | + 270 |
| Dover Corporation ...... | „ 16 | 111 | + 10 | 45 | 9,851 | + 624 |
| Dublin & Lucan Rly. .. | „ 16 | 71 | + 24 | 7 | 490 | + 133 |
| Dublin United ........... | „ 15 | 3,103 | + 345 | 7 | 11,997 | + 2,633 |
| Dublin Southern Dist... | „ 15 | 672 | + 143 | 7 | 5,144 | |
| *Dundee Corporation ... | „ 13 | 449 | + 106 | 39 | 17,966 | + 2,485 |
| *Glasgow Corporation ... | „ 16 | 7,801 | + 20 | 7 | 61,962 | + 2,810 |
| Halifax Corporation ..... | „ 13 | 693 | + 241 | 46 | 35,048 | + 7,502 |
| Hull Corporation ......... | „ 15 | 1,428 | + 805 | 33 | 47,397 | +25,797 |
| *Liverpool Corporation... | „ 9 | 7,599 | +1,687 | 6 | 47,058 | + 8,090 |
| Liverpool Overhead Rly | „ 17 | 1,421 | − 181 | 7 | 10,337 | + 197 |
| Portsmouth Corporation | „ 16 | 519 | − 60 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 17 | 2,793 | +1,155 | 7 | 18,103 | + 6,610 |

* Partly electrical.

**METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)**—The directors recommend a final dividend for the year ended Dec. 31 of 6s. per share on the original shares, and 9d. per share on the new shares.

**NORTHERN COUNTIES ELECTRICITY SUPPLY CO. (LTD.)**—We are informed that the recent issue of £100,000 made by this company was largely over-subscribed, and letters of allotment and regret will be posted in a day or two.

**NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)**—An extraordinary general meeting will be held at the office, 140, High-street, Notting Hill Gate, London, W., on 27th inst., to approve the bill which is being promoted for compulsory powers of purchase over two sites in the company's area of supply. A confirmatory meeting will be held on March 19, the date fixed for the annual general meeting of the company.

**SOUTH LANCASHIRE TRAMWAYS CO.**—At a special meeting of this company at Liverpool on Monday a resolution approving the company's parliamentary bill for the construction of additional electric tramways was approved.

**SOUTH LONDON TRAMWAYS CO.**—The report of the directors for the half-year ended Dec. 31, states that the London County Council have given notice to acquire the whole of the undertaking authorised by the Company's Act of 1879, embracing the section of the Battersea Park-road between Nine Elms and Plough-road, about 2¼ street miles, and negotiations thereon are pending.

**STOCK EXCHANGE NOTICE.**—The Stock Exchange Committee has ordered 20,000 £10 ordinary full-paid shares (Nos. 1 to 20,000) and £250,000 4½ per cent. first mortgage debentures of £40 each (Nos. 1 to 6,250) of the *British Columbia Electric Railway Co. (Ltd.)* to be quoted in the official list.

**WEST AFRICAN TELEGRAPH CO. (LTD.)**—The half-yearly interest on this company's £300,000 5 per cent. mortgage debentures, due March 1, will be paid by the National Bank of Scotland, 37, Nicholas-lane, London, E.C.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 13. | | Price Wednesday, Feb. 20. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Feb. 20. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 13½ | 13¾ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. x d | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 100 | 103 | 101 | 103 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 2/6 | Brompton & Kensington Electricity Supply Ord. | 7½ | 8½ | 7½ | 8½ | 3 10 7 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 7 | 6¾ | 7½ | ... | ... | ... | ... |
| 60,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 3 1 | February and August | 10½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference x d | 5½ | 5¾ | 5½ | 5¾ | 3 18 3 | " " | 5¾ | 5½ |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 7 | 6½ | 7 | 4 5 9 | March | 6½ | 6½ |
| £180,000 | Stock | 4½% | * Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,300,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,870 | 10 | 8/0 | City of London Electric Lighting Ord. | 7 | 8 | 7 | 9 | 5 0 0 | February and August | 7½ | 7½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 123 | 127 | 123 | 127 | 3 18 9 | June and December | ... | ... |
| £200,000 | Stock | | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 60,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8½ | 9½ | 6 6 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ (Deb. Stock Certs. (all pd.) red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | ... | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary x d | 11 | 12 | 11 | 12 | 4 7 6 | ... | ... | ... |
| 10,600 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6½ | 7 | 4 3 7 | January and July | ... | ... |
| £13,000 | Stock | 22/0 | Kens'n & Kn'tsbr'ch & Notting Hill Co. Jnt. Stn. (Deb. Stk (red.)) | 103 | 104 | 103 | 105 | 3 16 2 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 13 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12 | 13 | 13½ | 13½ | 4 1 6 | April and October | 13½ | 13 |
| 13,760 | 10 | ... | Do. (£5 paid) | ... | ... | 7 | 8 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £260,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 10 8 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 15½ | 15½ | 15½ | 16½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 3/0 | Oxford Electric Ordinary | 6½ | 6½ | 6½ | 6½ | 2 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 180 | 4 8 11 | April and October | ... | ... |
| £115,500 | 100 | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 105 | 103 | 105 | 4 7 5 | " " | ... | ... |
| 40,000 | 5 | 9/0 | St. James's and Pall Mall Electric Ordinary x d | 14½ | 15½ | 14 | 15 | 4 10 8 | February and August | 14½ | 11½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference x d | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 23/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 13,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 6/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 5 0 0 | March and September | 12½ | 12½ |
| 33,100 | 5 | ... | Do. Do. | 12½ | 13½ | 12 | 13 | ... | ... | 12½ | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4/0 | Blackpool and Fleetwood Tramways | 14 | 16 | 14 | 16 | 2 16 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 60,000 | 10 | 7½% | Bristol Tramways and Carriage Ordinary | 24 | 25 | 24 | 25 | 2 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 10½ | 10½ | 10½ | 3 13 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | ... | | 13½ | 14½ | ... | ... | ... | ... |
| 13,000 | 10 | 5/0 | Do. 5% Preference | ... | | 9½ | 10½ | 5 0 0 | May and November | ... | ... |
| £250,000 | 40 | ... | Do. 4½% 1st Mort. Debs. | ... | | 99½ | 100½ | ... | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 14 | 15 | 13½ | 14½ | 5 17 3 | ... | 14½ | 13½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. x d | 12½ | 13½ | 11½ | 12½ | 4 16 0 | February and August | 12½ | 12½ |
| £240,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 122 | 121½ |
| 40,000 | 5 | 2/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4½ | 5½ | 4½ | 5½ | 5 14 3 | ... | 5½ | 5¼ |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5 | ... | ... | 4½ | 4½ |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 95 | 98 | 95 | 98 | 5 2 0 | ... | 97½ | ... |
| 206,297 | 10 | 2/6 | Central London Ordinary x d | 9¼ | 9 | 9½ | 9½ | 2 16 5 | June and December | 9½ | 9 |
| £865,000 | Stock | 1½% | City and South London Railway Con. Ordinary x d | 47 | 51 | 47 | 50 | 2 10 0 | February and August | 48 | 47 |
| 37,500 | [illegible] | 1/1½ | Do. Ordinary (Nos. 22,501 to 60,000) | 4½ | 5½ | 4 | 5 | ... | " " | 4½ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) x d | 135 | 140 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) x d | 130 | 135 | 127 | 132 | 3 15 9 | ... | ... | ... |
| £244,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 115 | 120 | 115 | 120 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Tramways (1896), Ltd., Ordinary x d | 14½ | 15½ | 14 | 15 | 4 0 0 | ... | ... | ... |
| 53,987 | 10 | 6/0 | Do. 6 per Cent. Preference x d | 15½ | 16½ | 15 | 16 | 3 16 0 | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | † Imperial Tramways Ordinary | 21 | 23 | 21 | 23 | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 16 | 14½ | 15 | 3 15 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture x d | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | 9½ | 10½ | 10½ | | 4 17 7 | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary x d | 8½ | 8½ | 8¼ | 8¾ | 3 19 3 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference x d | 13½ | 18½ | 13 | 13½ | 3 15 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 16 10 | January and July | ... | ... |
| $350,000 | $1,000 | 5% | London Street Ry. (Ont.) 1st Mort. 5% Debs. (red.) | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| £325,744 | Stock | 3½ | Lond. Utd. Trams. 4% 1st Mt. Db. Stk. Prv. Certs. (all pd.) | 62 | 64 | 62 | 64 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y Sterling 5% Mort. Bonds (1908) | 104 | 105 | 104 | 105 | 4 16 0 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | 15 | 17 | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | 10½ | 10½ | ... | | 4 13 0 | " " | ... | ... |
| 15,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | 12½ | 12½ |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference x d | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 37/0 | Do. 4½ per Cent. Debenture Stock | 104 | 105 | 104 | 109 | 4 1 1 | ... | 104½ | 104½ |
| £540,000 | Stock | 1% | Waterloo and City Ordinary x d | 34 | 37 | 33 | 36 | 3 2 6 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 13. | | Price Wednesday, Feb. 20. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Feb. 20. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | £ s. d. | | Highest | Lowest |
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 19 6 | January and July | ... | ... |
| 24,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 60 | 70 | 60 | 73 | ... | ... | ... | ... |
| £[illegible],720 | Stock | 17/3 | Anglo-American | 51 | 57 | 53 | 56 | 6 11 8 | Feb., May, Aug., Nov. | 55 | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 101 | 103 | 98 | 100 | 6 0 0 | ,, ,, | 10¼ | 9½ |
| £3,088,640 | Stock | 5/0 | Do. Deferred | 9 | 9½ | 8½ | 9 | 2 15 6 | | 9 | 8½ |
| 13,333,300 | $100 | 8/4 | Commercial Cable Capital Stock | 170 | 180 | 170 | 180 | 4 9 11 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,010 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 16 11 | ,, ,, | 103½ | ... |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 8 | 9 | 8 | 9 | 6 2 3 | February and August | 8⅞ | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | ,, ,, | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | ,, ,, | ... | ... |
| £60,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 | 10½ | 10 | 10½ | 5 13 4 | Jan., Apr., July, Oct. | 10½ | 10½ |
| £138,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary ... to 1,200) (red.) | 145 | 151 | 145 | 151 | 4 11 0 | Jan., Apr., July, Oct. | 151 | 147 |
| £1,836,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 95 | 98 | 95 | 98 | 3 11 5 | ,, ,, | 97 | 95 |
| £1,482,363 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 116 | 113 | 116 | 3 9 0 | May and November | ... | ... |
| 250,000 | 10 | 2/6 | Eastern Extension | 14½ | 14¾ | 14½ | 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14⅝ | 14½ |
| 50,000 | 10 | ... | Do.(Nos. 250,001 to 300,000) £1p.1,is'd at 63pm, all pd | 13¾ | 14¼ | 13¾ | 14¼ | ... | ... | ... | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 110 | 115 | 110 | 115 | 3 9 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 | 102 | 99 | 102 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 17 8 | May and November | ... | ... |
| 193,227 | 10 | 1/0 | Globe Telegraph and Trust | 10 | 10½ | 10 | 10½ | 5 0 0 | Jan., Apr., July, Oct. | 10½ | 10⅛ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 | 15½ | 15 | 15½ | 3 17 5 | ,, ,, | 15½ | 15¼ |
| 160,000 | 10 | 6/0 | Great Northern of Copenhagen | 30 | 31 | 30 | 31 | 3 13 6 | January and July | ... | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos. | 99 | 103 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European ... 1 to 1,200) (red. | 47 | 51 | 47 | 51 | 4 11 0 | May and November | 4[illegible] | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1915 | 104 | 107 | 104 | 107 | 5 13 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 13 6 | June and December | ... | ... |
| 11,810 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | 7⅛ | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 124 | 129 | 4 16 0 | ,, ,, | 125 | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 3½ | 3¾ | 3½ | 3¾ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 | 102 | 99 | 102 | 4 19 6 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ¼ | ½ | ¼ | ½ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 15 5 | January and July | ... | ... |
| 33,321 | 10 | 6d. | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | ,, ,, | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | ,, ,, | ... | ... |
| £90,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 105 | 4 14 4 | January and July | ... | ... |
| 207,980 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 14 | 14½ | 14 | 14½ | 4 16 7 | Mar., June, Oct., Dec. | 14⅛ | 14 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. 2nd Series, 1906 | 101 | 104 | 101 | 104 | 4 15 2 | June and December | ... | ... |
| £311,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 324,8[illegible] | 10 | 3% | Consolidated Telephone Con. and Manfg. | 3/6 | 4/3 | 2/1 | 2/5 | 8 11 6 | April and October | ... | ... |
| 72,000 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | 1 | ½ | 1 | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ,, ,, | ... | ... |
| 690,000 | 5 | 3/0 | National | 4¼ | 4¾ | 3¾ | 3¾ | 7 14 10 | February and August | 4⅛ | 3⅞ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 12 | 14 | 12 | 14 | 4 5 9 | ,, ,, | 13½ | 13¼ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | ,, ,, | 11 | ... |
| 250,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | ,, ,, | 5 | ... |
| £[illegible] | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 94 | 97 | 94 | 97 | 3 13 3 | June and December | 95½ | 95 |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 | 100 | 98 | 101 | 3 19 6 | ... | 99½ | 99 |
| 171,504 | 1 | 0/6 | Oriental | ½ | 1½ | ½ | 1½ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5½ | 4½ | 5½ | 6 13 4 | July | ... | ... |
| [illegible] | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | ... |
| £178,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 11 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 3d. | Alliance Electrical Co. 5% Cum. Pref. | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 135,000 | 1 | 8½d. | Avon Electricity Motor 6% Cum. Pref. | [illegible] | [illegible] | [illegible] | [illegible] | 7 8 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 95 | 97 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 10½ | 11½ | 11 | 12 | 8 6 8 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 6¼ | 6¾ | 4 16 0 | January and July | ... | ... |
| 130,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 4¾ | 4½ | 4¾ | 6 5 4 | ... | ... | ... |
| 99,060 | 2 | 1/2½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 8 8 4 | September | ... | 1½ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2¼ | 2½ | 2¼ | 2½ | 5 9 8 | ,, | 4½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 105 | 110 | 105 | 110 | 4 3 7 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 6 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 13 | 14 | 13½ | 14½ | 6 3 4 | ,, ,, | 14¼ | 14 |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6½ | 5½ | 6 | 4 3 4 | ,, ,, | 5¾ | 5 |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 112 | 109 | 111 | 3 19 10 | November and May | ... | ... |
| 600,000 | 1 | 0/9¾ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1½ | 1 | 1½ | 6 8 0 | ... | 1¼ | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 | 97 | 94 | 97 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 51,000 | 3 | 1/[illegible] | Crompton and Co., Nos. 1 to [illegible] | 3¼ | 3½ | 3¼ | 3½ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 8 | ,, ,, | 101½ | 101 |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,251 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ | 2½ | 1½ | 2 | 9 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | ,, ,, | ... | ... |
| £344,123 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 88 | 91 | 88 | 91 | 4 8 11 | June and December | ... | ... |
| £100,000 | Stock | 2s. 4½ | Do. 3½ 2nd Deb. [illegible] (all pd.) | 98 | 100 | 98 | 100 | ... | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ | 5 | 4½ | 5 | 9 10 0 | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 102 | 105 | 103 | 106 | 4 6 1 | ... | ... | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1½ | 2½ | 1½ | 2½ | 5 13 [illegible] | January and July | 2½ | 2⅛ |
| 25,000 | 2 | 2/9 | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | 2½ | ... |
| £152,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 15 11 | January and July | ... | ... |
| [illegible] | 1 | ... | †[illegible] Electric Chemical and Power Co. Ord. | ¼ | | ⅛ | | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 14 | 15 | 15½ | 16½ | 4 10 11 | February and August | 15½ | 14¾ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | ,, ,, | ... | ... |
| £[illegible] | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 109 | 113 | 109 | 112 | 4 0 4 | ,, ,, | ... | ... |
| [illegible] | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ | 21½ | 20½ | 21½ | 4 13 0 | ,, ,, | 21½ | 20¾ |
| £[illegible] | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 [illegible] | March and September | ... | ... |
| 37,5[illegible] | 12 | 12/[illegible] | Telegraph Construction and Maintenance | 41 | 43 | 41 | 43 | 6 0 0 | March and July | ... | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 17 0 | January and July | ... | ... |
| [illegible] | 5 | 4/0 | Do. Manufacturing Ordinary | 10 | 11 | 11 | 12 | 6 [illegible] 4 | ... | 11½ | 11 |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| [illegible] | 5 | 6/0 | Willans and Robinson Ordinary | 10½ | 11½ | 10½ | 11½ | 5 1 9 | April and October | 11⅛ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 9 | ,, ,, | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 [illegible] | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,189. [No. 19. Vol. XLVI.] FRIDAY, MARCH 1, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

THE judgment of the Court of Appeal in the matter of the contracts between the Corporation of London and the City of London Electric Lighting Co. does not reduce things to a state of the most elementary simplicity. Indeed, by its reversal in a great measure of the judgment of the Court below, and in view of the fact that the City Corporation has already taken action on the assumption of the contracts being invalid, the situation grows more complicated. The view held by Mr. Justice FARWELL that the contracts were valid because they did not relate to constructive works has not been sustained by the higher Court; but, nevertheless, one of the contracts, viz., that made originally with the Laing, Wharton and Down Construction Syndicate, for the lighting of the eastern district, *is* sustained, on the ground that no shareholder in that syndicate acted in a way to render the contract void under the London Sewers Acts 1848 and 1851. Consequently, two of the contracts are held to be void, while the third is sustained. It remains to be seen what will be the tactics of attack and defence which each of the rival parties will now adopt, on the strength of the measure of victory it has gained for itself and the degree of defeat of its opponent. May we be permitted to hope, however, that open conflict will at this stage be abandoned in favour of the less costly and, in such circumstances, more satisfactory arbitration. Ratepayers' money is not to be lightly squandered on gaining Pyrrhic victories.

THE gigantic steel trust, which for some time past has been in contemplation among leading American iron and steel masters, has at length been consummated, and it involves a capital of no less than £220,000,000, distributed over the eight chief steel works in the United States, including the enormous works of the Carnegie Company at Pittsburg. Mr. PIERPONT MORGAN, the principal author of this bold "combine," anticipates that it will be able to supply the world's demand in steel, and to compete with foreign manufacturers in all markets. We are not at present concerned with the probable effect of this stupendous trust on American home markets, but British electrical and other engineers are unfortunately not in a position to ignore with impunity its influence on the British and colonial engineering markets. Should the Trust be sustained, it may be predicted that its controllers will utilise British and other outside markets as a convenient dumping ground for their surplus products, at prices which will seriously handicap local manufacturers. History, however, has shown that the artificial stability of these enormous combines is not easily nor long maintained; here, as with so much else in human affairs, "man proposes," but Providence upsets his calculations and disposes of his schemes to his complete confusion. Without, however, looking for miraculous intervention, it is not difficult to discover natural causes that tend to explode this "combine," and probably will do so effectually before it has been long in existence.

PURSUING his interesting series of researches upon the value of the electrical "blaze current" as a sign of vitality, Dr. A. D. WALLER has investigated the applicability of this test to vegetable seeds, such as beans. The results of this investigation have been embodied in a Paper which Dr. WALLER recently communicated to the Royal Society. By "blaze current," we may remark, the author denotes "the galvanometrical token of an explosive change locally excited in living matter," a definition which carries our minds back to the famous presidential address of Sir BURDON SANDERSON to the British Association at Nottingham in 1894, when the hypothesis of explosive "letting off" of electrical energy in living tissue was advanced as the explanation of vital functions. Dr. WALLER has been able to arrive at the important generalisation that "if the after-currents aroused by single induced currents of both directions are in the same direction, the object investigated is alive." Both animal and vegetable life are included in this generalisation, and the test appears conclusively to settle the question as to the vitality of any tested seed.

**Polyphase Electric Working.**—The Council of the Society of Arts has arranged for a series of special lectures on this subject by Mr. A. C. Eborall. These will be delivered on Friday evenings, April 26, May 3, 10, and 17.

**Electric Fans.**—In the *Electrical Review* of New York for Feb. 9 about 50 different electric fans are described and illustrated. We very seldom in England need these machines for ordinary cooling purposes, but there is a growing demand for them in tropical climates where their steadiness of action is greatly preferable to the glorious uncertainty of the punkah coolie.

**Personal.**—Mr. W. C. Fisher has resigned his position with Messrs. R. E. Crompton & Co. after a somewhat close connection of nearly 10 years with Col. Crompton.——Mr. W. Wood has resigned his position as engineer to the Bristol Tramways and Carriage Co. in order to take up an appointment in the traction department of the General Electric Co.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Cayenne—Pinheiro | Nov. 26, 1900 | Feb. 27, 1901 |
| Pernambuco—Ceara | Nov. 29, 1900 | — |
| Marseilles—Barcelona | Jan. 7, 1901 | — |
| Shanghai—Amoy | Jan. 17, 1901 | Feb. 25, 1901 |

**Pacific Cable.**—It is announced that Mr. Alexander Lang, manager of the Bank of Montreal in London, has been appointed a member of the Pacific Cable Board to represent the Canadian Government. —— A resolution is to come before the Canadian Parliament (proposed by Mr. Mulock, the Postmaster-General) authorising Canada to contribute $\frac{5}{18}$ths of the £2,000,000 to be advanced by the Imperial Government for the Pacific cable.

**Obituary.**—The death is announced of M. Edouard Delamare-Deboutteville, of Fontaine-le-Bourg, near Rouen. The deceased, who was only 47 years of age, was the inventor of the Simplex gas engine. In recent years he had devoted his energies to the question of the utilisation of blast furnace gases in the operation of gas engines, and his system had been taken up by some of the leading firms on the Continent, including Creusot in France and Cockerill in Belgium.

**Royal Thanks to the National Telephone Co.**—Mr. W. E. L. Gaine, the general manager of the National Telephone Co., has received from Lieut.-Col. Arthur Davidson, the King's Equerry-in-Waiting, the following letter:—"I am commanded to inform you that the telephone service at Osborne was very well and efficiently conducted last month under circumstances of exceptional pressure, and I am commanded to thank you for the arrangements which were made which secured this satisfactory result."

**Jubilee of Owens College.**—An influential committee, headed by the Duke of Devonshire, the Duke of Argyll, the Earl of Derby, and Earl Spencer, has issued an appeal with the object of raising £150,000 in celebration of the jubilee of Owens College, Manchester. £50,000 are needed to discharge debts that have been contracted and £100,000 for additional endowment. Among the objects the promoters have in view are the extinction of the debt of £22,000 on the buildings of the medical school, special endowments for existing chairs, the establishment of new chairs, the establishment of an institution for bacteriological investigation and for the study of hygiene, and of research fellowships, and the creation of a pension fund for members of the teaching staff. Owens College, the appeal says, was the first attempt outside of London to supply the great cities of England with institutions giving a high-class universal education. It is still the largest of them, whether measured by the number of its teaching staff, the number of its students, or the size and completeness of its buildings.

**Equilibrium between Self-Induction and Capacity in a Network of Concentric Cables.**—M. G. H. Julius, in the *Bulletin* of the Montefiore Electrical Society for February describes experiments made on the network of mains at St. Petersburg, where the total length of the mains is 248 kilometres, and the total capacity 87·78 mfd. The pressure employed is 2,000 volts, frequency 42·5 ~ per sec., and the capacity current works out at 46·8 amperes. With all the transformers in circuit the wattless transformer current is 270 amperes. The ideal would be to reduce the angle of lag to zero, and to do this it would in this case be necessary, the author says, to increase the capacity of the system more than five-fold. The table below gives the power-factors for various outputs at St. Petersburg, the wattless component being taken as invariable:—

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Amperes | 230 | 240 | 250 | 300 | 350 | 400 | 450 | 500 |
| Cos $\phi$ | 0·533 | 0·583 | 0·627 | 0·760 | 0·834 | 0·874 | 0·902 | 0·921 |
| Amperes | 600 | 700 | 800 | 900 | 1,000 | 1,200 | 1,500 | 1,800 |
| Cos $\phi$ | 0·946 | 0·960 | 0·970 | 0·976 | 0·981 | 0·987 | 0·991 | 0·994 |

**High-Speed Telegraphic Receiver.**—In a recent number, the *Electrotechnische Rundschau* gives a description of a new telegraphic receiving instrument by Siemens and Halske. The magnetic deflection of cathode rays by the currents from the line and the photographic registration of these deflections are the essential principles of the receiver. Several methods of carrying these principles into practice are illustrated, the methods proposed needing, as a rule, special sending apparatus. One, the most complicated, of the instruments, has, according to our contemporary, two or more electromagnets set at an angle with each other and operated by currents from separate lines. The currents are regulated at the sending end with regard to strength and direction. The thus deflected cathode stream falls on a particular one of numerous small fluorescent patches on a screen. The light from this luminous spot is gathered by a lens passed through a transparent screen bearing properly placed alphabetical characters and then reflected on to a moving strip of sensitised paper. This, when fixed, washed, and dried, gives the despatch in ordinary characters.

**An Electrically Operated Drawbridge.**—In the *Electrical World* for February 16th there is an account of the new highway bridge across the Connecticut River at Middleton, Conn. The bridge is 1,800ft. long with a 26ft. roadway and two 6ft. sidewalks, and the centre draw-span of 750ft. can be worked by electricity or hand power. The draw is operated by three 25 H.P. motors, one for turning and the others for blocking up the ends; there is a fourth motor and duplicate set of turning machinery which can be used in case of unbalanced wind pressure, or a break in the other machinery. Power is taken from the Middleton street wires and a cable is laid on the river bottom and brought up the centre pier. The blocking up of the ends is done by means of a pair of toggles, which are drawn together by two bronze nuts working in a right and left-handed screw that is turned by hand gearing from the motor. To open the bridge takes 30 seconds; takes 5 H.P. in calm weather and 30 H.P. to overcome an unbalanced wind pressure of 5lb. on one-half of the bridge. With hand-power, working with 10ft. levers, the bridge is turned by four men in 8 minutes.

**Electric Light Statistics in Canada.**—The *Electrical World* of New York publishes the following statistics, showing the progress made in electric lighting in Canada during the last 10 years:—

In 1891 the census returns gave 80 establishments selling electric light in the Dominion; in 1897 there were 187, which number increased to 297 in 1900. The electric lamps supplied by the establishments selling light numbered 443,897 in 1897 and 807,772 in 1900. The largest establishment in Canada in 1900 was the Royal Electric Light Co., of Montreal, supplying 78,762 incandescent lamps and 1,805 arc lights. The next largest is the Toronto Electric Light Co., supplying 75,000 incandescent lamps and 1,650 arc, while the Ottawa Electric Co. stands well to the front with 77,255 incandescent lamps and 621 arcs. The province of Ontario has made rapid strides in the employment of electricity for lighting purposes, using 418,573 lamps in 1900 against 201,955 in 1897. The province of Quebec increased the number from 185,892 lamps in 1897 to 235,322 lamps in 1900. The other provinces have all developed the use of electricity for lighting purposes in a very satisfactory manner. British Columbia had a couple of establishments selling electric lights in 1897, and these operating only a very small number of lamps. In 1900, however, this province had 13 electric companies, with an equipment of 52,655 lamps. The use of the arc light in Canada has increased from 9,516 lamps in 1897 to 11,917 in 1900. In gas lighting the census of 1891 gave 49 gas works in Canada; in 1900 there were 43, thus showing a decrease of six gas works.

**Works Management.**—The second lecture of the series on this subject, before the Institution of Junior Engineers, was delivered by Mr. A. H. Barker, at the Westminster Palace

Hotel, on the 20th ult. Continuing the discussion of carrying and lifting appliances introduced in the first lecture, hand-cranes, ordinary power cranes, and cranes worked electrically were considered, their relative economy in working being pointed out. Their cost was treated, as also that of radial cranes, both hydraulic and hand. Trucks and rails in the shop and railway sidings were dealt with. The lecturer then passed on to the essential features of the foundry, and considered the cost of cupolas, and foundry-lifting and conveying appliances. Moulding machines of various types were described, and the relation of number of moulders and labourers to output was entered into. The appliances of the brass foundry received attention, particular reference being made to the crucibles. General arrangements of various works were reviewed, the most advantageous positions of the different departments being shown. The systems appertaining to the tool-room and stores were touched upon, and questions with reference to heating, ventilating, and lighting discussed.

**Additions to the Theory of Cable Signalling.**—Dr. F. Breisig, a prominent engineer in the testing department of the German Government telegraphs, publishes, in a recent number of the *Elektrotechnische Zeitschrift*, an article, chiefly mathematical, on the progress of signals through long cables, the sending and receiving apparatus at the ends of the cable being taken into account. The type of signal considered is that which would be transmitted if the key at the sending end were raised and depressed alternately for intervals of nearly 3 sec. The mathematical treatment of the question resolves itself into the decomposition of the given periodic signal into a series of sine functions of the time by the Fourier process, the consideration of the properties of the cable with regard to each of these sine constituents, and, similarly, the consideration of the behaviour of the end-apparatus for each of these constituents. The ends of the cable are, throughout the investigation, supposed to be arranged for duplex signalling. From the results of the calculations the curve of received signals of the type mentioned was plotted, and this curve was compared with curves actually obtained for such signals on the Emden-Vigo cable. The comparison indicates a very fair agreement. The results of calculations based on other dispositions of the end-apparatus are also given in the Paper.

**New Turbines for the Niagara Power Plant.**—According to the *Western Electrician* of Chicago for January 26th, the Niagara Falls Power Co. has awarded the contract for six new 5,000 H.P. turbines, which are to be installed in the new wheel-pit now in course of construction. This is one of the most important contracts connected with the new installation, and as there have been rumours that the style of turbine is to be changed as compared with those at present in use, the award of the contract has been awaited with much interest. The I. P. Morris Co., of Philadelphia, Pa., which has captured the order, built the turbines now in operation in the present wheel-pit. The new water-wheels are to be built after designs made by Escher, Wyss & Co., of Zurich. The turbines in the old pit were designed by Piccard, Pictet & Co. of Geneva, and the new ones will differ from them principally by the guides and buckets being enclosed in the wheel-case and having suction tubes which will allow of the full head available. The adoption of the designs of Escher, Wyss & Co. is the result of a competition invited after the return of Dr. Coleman Sellers and Mr. Brackenridge from Europe last spring. The new turbines will be delivered in August next, and they will be used to drive the six 5,000 H.P. generators ordered in November last from the General Electric Co. of Schenectady.

**The Influence of Wave-Form on Iron Losses.**—The *Elektrotechnische Zeitschrift* of January 17th, contains a long account of an investigation by Dr. Gustav Benischke on the influence of wave-form upon the iron losses in transformers. He finds that the usual Steinmetz coefficient equation, $A = \eta n B^{1\cdot6} + \beta n^2 B^2$ ($\eta$ being the Steinmetz coefficient, $n$ the frequency, B the maximum induction, $\beta$ the eddy-current constant, and A the total loss in watts in the iron subjected to periodically alternating magnetic induction) is only an approximation, being more accurate the smaller are the eddy-current losses. The hysteresis coefficient $\eta$ does not depend merely on the magnetic induction but also on the wave-form, and is smaller the more pointed the lines-of-force curve is. From this it follows that there is a magnetic lag. In spite of the above empirical equation not being absolutely accurate, however, he considers that (at all events for 0·5mm. sheet) the wattmeter method of testing transformer iron is more reliable than the yoke method. With measurements at frequencies between 35 and 55 ∿ per sec. the errors in the wattmeter method are less than in the yoke method on account of the greater handling and accurate fitting of the iron necessary for the latter. Finally, he concludes that the eddy-current coefficient is given by the equation $\beta = 15\cdot2 d^2\sigma(1 + \alpha t)$, with the same approximation as in the formula above cited, $d$ being the thickness of the sheet, $t$ the temperature, $\alpha$ the temperature coefficient, and $\sigma$ the amplitude factor of the pressure curve.

**International Tramways Congress in London.**—As we have already announced, the Union Internationale Permanente de Tramways has accepted the invitation of the Tramways and Light Railways Association to hold its congress in London next year, from July 1st to 4th. The Association is inviting its members to join this international union. The Union Internationale Permanente de Tramways has for its object the technical and financial improvement of this means of transport. It consists of ordinary, extraordinary and honorary members. The companies of horse, steam and other tramways and local and suburban railways qualify for membership and may be represented by a delegate, and in addition, directors, managers, higher officials and engineers of these companies may also be members. Extraordinary members correspond in rank to associates, and honorary members are chosen more or less in the same way as those of our institutions. The offices of the Union and its secretary are permanently established at Brussels, but the general meetings, which take place once a year, are at a time and place fixed at the preceding meeting. At these meetings the French or German language is to be employed in preference for communications and discussions, but interpreters will be present in every case. The annual subscription for companies is 50f., and for personal members 12·50f., whether they are ordinary or extraordinary members. We are informed that arrangements are being made by the *Tramway and Railway World* for a light railway exhibition during the congress.

**Electrical Mining Dredges in California.**—According to the *Electrical World* of New York, there are an increasing number of placer mining dredges in California using electric power. These dredges are among the recent developments in placer mining methods, and they afford a means of washing over placer deposits for the extraction of gold where water under high head for hydraulic operations is not available, or where it is desired to work the river bottoms. The Ashburton Mining Co. uses heavy cast-steel buckets weighing 821b. each and forming an endless chain operated by a 150 H.P. three-phase variable speed motor. The dirt is carried up by these buckets and dumped into a revolving screen, which takes out the larger stones and lets the remainder fall into a sluice-box, where it is carried down by a stream of water over riffles, which catch the gold and lets the dirt be discharged as tailings behind the dredge. To drive the revolving screens and the pumps which furnish water to wash the dirt through the screens a 75 H.P. three-phase motor is used. To run the 26in. centrifugal pump, which furnishes a large volume of water to the sluice-boxes, another 150 H.P. three-phase motor is used. On the dredge there is also a 20 H.P. hoisting motor running winches for raising the buckets and moving the dredge, and for working two spuds, which run down into the mud under the dredge for holding it in place. As the level of the pond in which the dredge floats may be above the level of water in the river it is necessary to have a pump for keeping the pond full. This is done with a centrifugal pump run by a 40 H.P. three-phase motor.

**The Welsbach Electric Lamp.**—At a recent extraordinary general meeting of the German Incandescent Gas Light Co. Herr Scholz gave a lecture on the new osmium filament electric lamp of Dr. Auer von Welsbach. He commenced by pointing out the necessity of having a refractory material for

the filament, which could be employed at a high temperature. Osmium, he said, was the most suitable in this respect because it had the highest melting point of all the metals. However, it had only been possible recently, as a result of Dr. Auer von Welsbach's researches, to produce an osmium filament. Hitherto the metal was only known as a sponge, a fine crystalline powder, or, after melting in an electric arc, as a brittle and hard substance which could not be worked. The lecturer went on to explain that the increased efficiency owing to the increase in temperature of the filament, brought the consumption of electric power in the osmium lamp down to 1½ or 1·45 watts per Heffner candle with lifes of 700 hours upwards. In a sample of one of these lamps, tested after 1,500 hours burning, the candle-power had only gone down 12 per cent. and the watts per Heffner candle had increased from 1·45 to 1·7. A method has been devised for cleaning the bulb of the lamps without destroying the glass or the filament. An important consideration is that, owing to the conductivity of osmium being so much higher than that of carbon, the osmium lamp has to be supplied with current at a lower pressure, the voltage being from 20 to 50, so that several lamps must be employed in series on 100-volt and 200-volt circuits. In conclusion, the lecturer stated that the new lamps would be made for all candle-powers from 2 to 200.

**The Late Prof. G. F. FitzGerald.**—An appreciative article on the late Prof. FitzGerald, from the pen of one of his closest friends, will be found in another column, but, without trenching on the scope of that article, we give below some further particulars of the life of that much-lamented scientist. We will first announce that at a meeting of the Faculty of Science of the newly-constituted University of London, held on Tuesday afternoon, the following resolution was unanimously adopted :—

That this meeting of the Faculty of Science of the University of London, having heard with profound sorrow of the premature death of the late Prof. George Francis FitzGerald, desires to place on record its high appreciation of his brilliant qualities as a man, as a teacher, as an investigator, and as a leader of scientific thought, and to express to his family its mournful sympathy under the calamity which has befallen science and his many friends.

Prof. George Francis FitzGerald, Fellow of Trinity College, Dublin, died on Thursday, February 21st, at his residence, 7, Ely-place, Dublin. He was born in Dublin 50 years ago, and was the son of Dr. FitzGerald, Bishop of Cork. He was educated at Trinity College, Dublin, where he had a most distinguished career. First science scholar in 1870, in the following year he won the University Studentship with two first senior moderatorships in mathematics and experimental science. Six years later he won his Fellowship. In 1880 he was appointed registrar of the University Engineering School, and in the following year he was elected to the post of Erasmus Smith Professor of Natural and Experimental Philosophy. He took his degree of Doctor of Science in the University in the summer of 1891. Prof. FitzGerald was president of Section A of the British Association at its congress in Bath in 1888, and he held the position of examiner for London University in experimental sciences since 1888. He was elected a Fellow of the Royal Society in 1883, and he acted as hon. secretary of the Royal Dublin Society between the years 1881 and 1889. In 1888 he was appointed a member of the Board of National Education, and a great part of his time was devoted to its important work. A few months ago Dr. FitzGerald was appointed with five others to the Intermediate Education Board.

**Train Lighting.**—An axle-dynamo system of railway carriage lighting has recently been developed by Messrs. Vickers, Son and Maxim, and is briefly described in the *Engineer*. A dynamo is placed beneath each coach, and is so adjusted that at a given speed—say, 15 miles per hour—it feeds the lamps directly, the superfluous current generated charging a battery for use when the train is standing. The dynamo is driven from one of the axles by means of a short drive belt, on the inner side of which are fitted V-shaped leather blocks which correspond in section with V-grooved pulleys, so as to prevent slipping. The belt is further kept taut by means of a tension spring arranged between the two pulleys. The dynamo, an ordinary shunt-wound machine, is well protected from dust and dirt, and maintains a pressure of from 30 to 40 volts. It is automatically switched into circuit when the train has reached the pre-arranged speed, the pressure being so controlled that at all speeds the current supplied to the lamps is uniform. When the train is stationary, and the dynamo has been automatically switched out of circuit, the lights are supplied at 30 volts by the batteries. After starting, as the train gains speed the dynamo voltage increases, until a potential is reached above that of the batteries and lamps. The latter are prevented from receiving more than 30 volts by means of a resistance in the circuit. The dynamo, it should be pointed out, is controlled so that at high speeds the current remains normal. This is accomplished by the use of a small motor that works when the dynamo is generating, and with suitable mechanism throws resistances in and out of the field of the dynamo, according to the speed of the train. The lamps are specially constructed with short filaments, so that they are not affected by the vibration of the train. The Great Central Railway Co. is giving a trial to the system, and last week a first-class dining car in which the apparatus had been fitted made a trial run between Manchester and London. Although —due to a wrongly-adjusted spring in the regulating apparatus —there was a very slight diminution of light when the train was stationary, the results obtained on the run were considered highly satisfactory.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), March 1st.**

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel. Paper to be read: "Carburetted Water Gas," by S. Cutler.

POSTAL TELEGRAPH CLERKS' ASSOCIATION.

*9 p.m.* At the Holborn Town Hall Dr. J. A. Fleming, F.R.S., will give a short address on Mr. Marconi's recent improvements in wireless telegraphy, followed by a practical demonstration of the system.

**SATURDAY, March 2nd.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*2:30 p.m.* Students' visit to the generating station of the London United Tramways Co., 88, High-road, Chiswick. Nearest station: Turnham Green, on the L. and S. W. and District Railways.

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture II. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

**MONDAY, March 4th.**

SOCIETY OF ENGINEERS.

*7:30 p.m.* Ordinary Meeting at the Royal United Service Institution, Whitehall.

**TUESDAY, March 5th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*7:30 p.m.* Students' Meeting. Paper to be read: "Arc Lamps," by P. Laubach.

**THURSDAY, March 7th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*3 p.m.* Students' visit to the Thames Ironworks and Shipbuilding Co., Orchard-yard, Blackwall. Nearest station: Blackwall, on G. E. Railway.

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Extra Meeting at 25 Great George-street, Westminster. Paper to be read: "Insulation on Cables," by M. O'Gorman. Previously to this, if necessary, the conclusion of the discussion on Mr. Madgen's Paper will be taken.

INSTITUTION OF ELECTRICAL ENGINEERS—DUBLIN SECTION.

*8 p.m.* Visit to the power station of the Dublin United Tramways Co. at Ringsend, Dublin.

RÖNTGEN SOCIETY.

*8 p.m.* Exhibition Evening at 20, Hanover-square.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel, when Mr. A. H. Barker will give his third lecture on "Works Management."

**FRIDAY, March 8th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Agenda: 1. "A Theory of Colloidal Solutions," by Dr. F. G. Donnan. 2. Exhibition of apparatus by R. Appleyard. (3) "On the Production of a Bright Line Spectrum by Anomalous Dispersion and its application to the Flash Spectrum," by Prof. R. W. Wood.

**SATURDAY, March 9th.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture III. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

## THE DESIGN OF TRANSFORMERS.

BY W. B. WOODHOUSE, A.M.I.MECH.E.

(*Concluded from page 627.*)

**Pressure Drop.**—As the secondary current $C_2$ of a transformer is increased, the voltage on the terminals ($V_2$) falls when the current is in phase with, or lags behind, the E.M.F. If the current $C_2$ leads the E.M.F. by more than a certain angle the voltage will rise. This pressure drop is due to copper losses and magnetic leakage; the leakage flux cuts the windings in the opposite direction to the main flux and produces an inductive E.M.F. in quadrature with the E.M.F. in that winding. If the E.M.F. and the current in a winding are in phase, the inductive E.M.F. is in quadrature with the main E.M.F. and tends to oppose its growth; the more the current lags, the more nearly are the two E.M.F.s in direct opposition. Now, when there is a large lag of current in both primary and secondary $C_1$ and $C_2$ are practically in exact opposition of phase; so, therefore, will be the drop of voltage ($e_1$, $e_2$) due to ohmic losses in the two windings and the inductive drop of voltage ($e_p$ and $e_s$), which last will be in quadrature with $e_1$ and $e_2$. This leads to a convenient diagram for determining the pressure drop. For convenience of construction, assume that the ratio $T_1/T_2$ is unity. Any transformer may be so connected without altering the pressure drop; but if the ratio $T_1/T_2$ be not unity, we must consider that an ohmic drop of $e_1$ volts in the primary will cause a drop of pressure in the secondary $= e_1 \times T_2/T_1$; and therefore the total ohmic drop, referred to the secondary, would be

$$(e_1 \times T_2/T_1 + e_2).$$

Construct a triangle OPQ (Fig. 7) making OP = total inductive drop in the two windings referred to the secondary and PQ = total ohmic drop in the two windings; then OQ, the

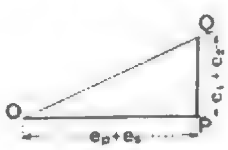


FIG. 7.

hypotenuse of the right-angled triangle, is the maximum drop or rise of the secondary voltage as the secondary current lags or leads OQ, in fact, is to scale the impedance volts. The calculation of the ohmic drop $e_1$ and $e_2$ is simple. The predetermination of OP, the sum of the inductive E.M.F.s, is more difficult; it depends on the arrangement of the windings and the length of the leakage paths. If due care be taken to sandwich the coils of large transformers, then in any case it should not exceed four times the ohmic drop.

The following expression, due to Kapp, may be used to predetermine the maximum drop due to self-induction.

Let CT = the mean of the full load ampere-turns in primary and secondary.
N = maximum flux = B × A.
$a$ = mean winding depth of primary and secondary.
$b$ = distance between primary and secondary windings, copper to copper.
$h$ = height of bobbin (length of winding space).
$l$ = perimeter of air-gap between primary and secondary.
(All measurements in inches.)

Drop of secondary voltage—

$$= K\left\{\frac{CT}{N} \times \left(\frac{b}{2} + \frac{a}{3}\right) \times \frac{l}{h}\right\} \times E_2$$

Where K = 5 for core type with a concentric primary and secondary on each limb,
= 1·25 for core type with a sandwiched secondary on each limb,
= 2·5 for shell type with one primary and one secondary,
= 1·25 for shell type with sandwiched coils.

For any phase difference between the secondary current and E.M.F. the following diagram, Fig. 8, may be used to determine the pressure drop.

Suppose $T_1 \div T_2 > 1$. Construct the triangle OPQ, making

$$PQ = (C_1 \times R_1) \times T_2/T_1 + (C_2 \times R_2) = \text{ohmic drop.}$$
$$OP = \text{inductive drop} = (e_p \times T_2/T_1) + e_s.$$

Take to the same scale radius, $= E_2$, the secondary E.M.F. at *no load* and draw two circles with centres O and Q. Draw OB perpendicular to OP, then AB to scale is the total drop of secondary pressure on a non-inductive load. If the secondary current lag by an angle $\phi$ set out OD, making the angle DOB $= \phi$, then DH is the corresponding pressure drop. It will be seen that maximum pressure drop occurs when the angle of lag is equal to OQP, and that when the current leads by an angle $\phi_2$ the pressure drop will be zero; a greater lead giving a rise of secondary pressure.

**General Method of Design.**—The labour of calculation can be much lessened by plotting the following curves: (1) Curve connecting temperature rise with watts wasted per square inch ($m$) for the particular method of cooling employed; (2) curve connecting values of B with watts wasted in hysteresis per pound of iron at a certain frequency; (3) curve connecting ($w$), the linear dimension in a core proportion (see Core Proportions), with the approximate cooling surface; and on the same sheet a curve connecting $w$ and net weight of core.

In calculating the total cooling surface of a core transformer, the whole surface of the core, the internal surface of

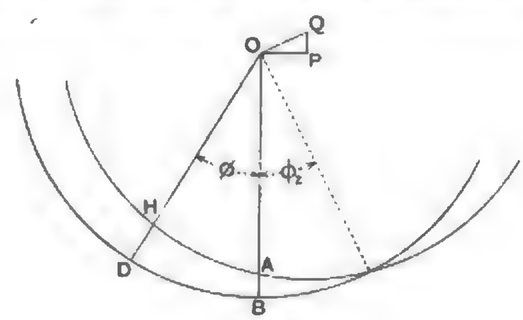


FIG. 8.

the smallest bobbin on each limb, the external surface of the largest bobbin that could be used on each limb, and the end surfaces of the bobbins may be taken as the approximate cooling surface. In a shell transformer take the total external surface of the core and that part of the surface, of the largest coil that could be used, which lies outside the core, assuming the coil to have semi-circular ends. The weight of core calculated for the above curve should be the net weight of iron; with plates 14mils. thick 10 per cent. to 15 per cent. of the volume is occupied by insulation. For example, in a core transformer with the proportions of Fig. 9 the cooling surface is approximately $145{\cdot}5w^2 + 120w$ sq. in., and the net weight of iron $2{\cdot}07w^3 + 1{\cdot}78w_{..}$ In a shell transformer with the proportions of Fig. 10—

$$\text{Cooling surface} = 72{\cdot}5w^2 \text{ sq. in.}$$

$$\text{Weight of iron} = 5{\cdot}34w^3 \text{ lb.}$$

Having drawn these curves, proceed as follows: From the specified output and efficiency find the total losses; these occur in iron and copper. For a lighting load the copper losses at full load should be greater than the iron losses; for a motor load the copper losses should be equal to or less than the iron losses. The nature of the load (or the specified efficiency at light loads) decides the proportion of total losses that are to be allowed as iron losses. The iron losses are due to hysteresis and eddy currents; as a first approximation deduct 30 per cent. or more for eddy loss, leaving the permissible hysteresis loss.

From the curve connecting rise of temperature and $m$ find the value of $m$ corresponding to the specified rise of temperature. Divide total watts lost by $m$, which gives the total cooling surface required.

Referring to the curve connecting cooling surface and size of core gives the value of $w$ corresponding to this cooling surface, and also the net weight of the core. Now the watts lost in hysteresis divided by the weight of iron gives watts lost per pound, so that a reference to the hysteresis curve gives the maximum value of B. Working values of B are from 15,000 to 40,000 lines per square inch. If the above calculation gives too low a value of B, then the cooling surface must be increased without adding to the weight of iron.

Knowing B and the dimensions of the core gives N, from which we may calculate $T_1$ and $T_2$. The number of secondary turns $T_2$ may need increasing to compensate for pressure drop, according to the size and purpose of the transformer. Take a trial current density of 500 amperes per square inch and calculate the windings, being careful to insulate the layers from one another in proportion to the voltage.

For ease of winding a number of copper strips bound together are preferable to a solid conductor; copper strip is rolled to thicknesses corresponding to the wire gauge, and can be cut to the width required.

Lastly, carefully calculate: (1) Total losses, (2) heating, (3) pressure drop. If they are within the specified figures see whether slight modifications of the design will improve it. A design is worked through below using the method indicated above; needless to say, it should be modified to see whether any improvement is made, and the final calculations as to cooling surface should be made from the drawing itself.

### Example of Design of a Core Transformer.

*Specification.*—Output 10kw., 100 amperes at 100 volts frequency, 100 cycles per sec. Oil-cooled. Maximum temperature rise not to exceed 60°F. Full-load efficiency, 97 per cent. Maximum pressure drop, 3 per cent. Power factor of primary circuit = 0·9.

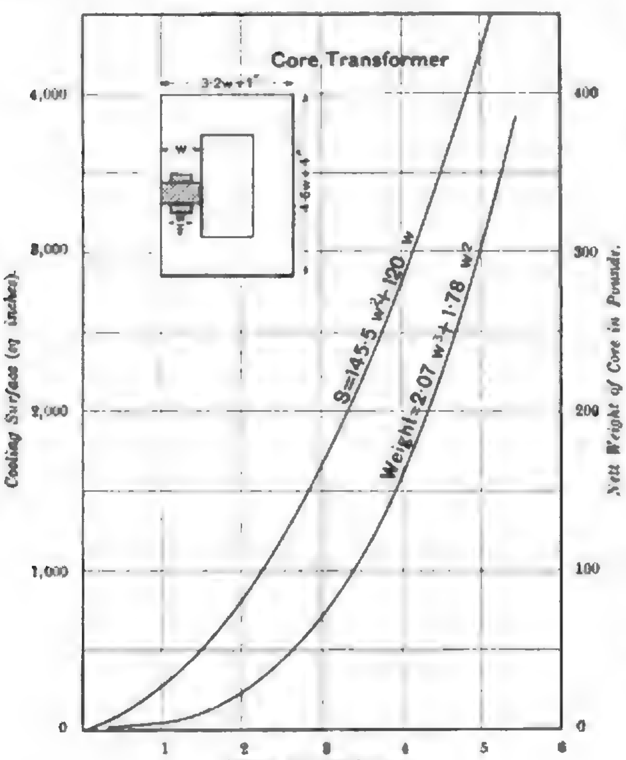


Fig. 9.

1. *Division of Losses.*—With an efficiency of 97 per cent. the total watts wasted = 300. Allow 150 watts for copper losses and 150 watts for iron losses. Assume that of the 150 watts wasted in the iron 100 are wasted in hysteresis.

2. *Size of Core.*—The value of $w$ corresponding to a temperature rise of 60deg. is, from the curve (Fig. 6), equal to 0·14. Therefore the cooling surface required = 300/0·14 = 2,140 sq. in. This corresponds to $w$ = 3·5in. (see Fig. 9), and the dimensions of the core are: Outside length = 4·6$w$ + 4in. = 20·1in. Outside breadth = 3·2$w$ + 1in. = 12·2in., and net weight of iron = 110lb.

If dimensions in eighths of an inch are preferred these proportions may be altered to the nearest eights—viz., length = 20⅛in., breadth = 12¼in.

3. *Value of B.*—The watts wasted in hysteresis per pound of iron at 100 cycles = 100/110 = 0·909, which corresponds (see Fig. 5) to a value of B equal to 38,000 lines per square inch.

The *net* area of the core section is ¾(3·5)² × 0·85 = 7·8 sq. in. and therefore the total flux N = 38,000 × 7·8.

4. *Calculation of $T_1$ and $T_2$*—

$$T_1 = \frac{E_1 \times 10^8}{4{\cdot}45 \times f \times N} = \frac{1{,}000 \times 10^8}{4{\cdot}45 \times 100 \times 7{\cdot}8 \times 38{,}000} = 758.$$

For convenience take 760 turns; then $T_2 = 100T_1/1{,}000 = 76$, but, as we wish to compensate for the drop of pressure at full load, let us add to $T_2$ making, say, 78 turns on the secondary.

5. *Calculation of $C_1$ and $C_2$*—

$$C_1 = \frac{\text{output}}{E_1 \times \eta \times \cos\phi} = \frac{10{,}000}{1{,}000 \times 0{\cdot}97 \times 0{\cdot}9} = 11{\cdot}5 \text{ amperes.}$$

$$C_2 = \frac{10{,}000}{100} = 100 \text{ amperes.}$$

6. *Design of Windings.*—Take a current density of 500 amperes per square inch; then the cross-section of the primary conductor = 0·023 sq. in. and of the secondary 0·200 sq. in. We shall find it more economical to wind the secondary inside on each limb; and to obtain equal losses in the primary and secondary windings a greater current density may be used in the secondary.

Draw out the core and measure the allowable winding space; as we have a large number of turns in the primary it is best to wind it in two sections to reduce the voltage between the layers.

Assume thickness of primary bobbin, say, 0·2in., thickness of secondary bobbin, say, 0·2in., thickness of end cheeks each 0·2in., air space between primary and secondary, say, 0·15in.

From the drawing the least diameter of secondary bobbin is 4in.; the greatest diameter of primary bobbin, allowing some clearance (say 0·1in.) will be 8·53in.

The gross winding depth = 8·53 − 4/2 = 2·26in., deducting thickness of bobbins and air-space leaves. Net winding depth = 2·26 − 0·45 = 1·81in. Gross winding length = 13in. Net winding length, primary = 12·4in; secondary = 12·6in.

*Primary winding*, 380 turns on each limb; say five layers of 76 turns, and use a rectangular conductor, double cotton-covered or taped.

Allowable width of covered wire = winding space/No. of turns + 1 = 12·4/77 = 0·161.

Deducting 30 mils. for insulation, bare width = 0·13in.; depth = 0·023/0·13 = 0·177.

Take two strips of No. 13 gauge (each 0·092in.) then primary conductor will be 0·13in. × 0·184in. bare (area 0·0239 sq. in.), covered to 0·16in. × 0·214in. Place one thickness of oiled linen between each layer (each 0·01in. thick).

$$\text{Total depth of primary winding} \begin{Bmatrix} 5 \times 0{\cdot}214\text{in.} \\ 5 \times 0{\cdot}01\text{in.} \end{Bmatrix} = 1{\cdot}12\text{in.}$$

*Secondary winding*, 39 turns on each limb, say one layer of 20 turns, and one of 19 turns. Proceeding in the same way as above we find a suitable conductor to be made up of three strips of No. 13 gauge, each 0·57in. wide. Area = 0·57 × 3 × 0·092 = 0·157 sq. in. Insulated to 0·6in. × 0·306in. Depth of secondary winding = 2 × 0·306 = 0·612. Total depth of winding = 1·12 + 0·612 = 1·732in., which is well within the allowable space.

7. *Resistance of Windings.*—From drawing. Mean length of primary turn = 7·45in. × π; secondary turn = 5·0in. × π.

$$\text{Total length of primary} = \frac{7{\cdot}45 \times \pi}{12} \times 760 = 1{,}480\text{ft.}$$

$$\text{Ditto secondary} = \frac{5 \times \pi}{12} \times 78 = 131\text{ft.}$$

Resistance may be calculated from the formula

$$R = \frac{8{\cdot}2 \times \text{length in feet}}{10^6 \times \text{area in square inches}},$$

but for the final calculations a more accurate formula, taking temperature into account, should be used.

$$\text{Resistance of primary} = \frac{8{\cdot}2 \times 1{,}480}{0{\cdot}0239 \times 10^6} = 0{\cdot}51 \text{ ohm nearly,}$$

$$\text{Ditto secondary} = \frac{8{\cdot}2 \times 131}{0{\cdot}157 \times 10^6} = 0{\cdot}007 \text{ ohm.}$$

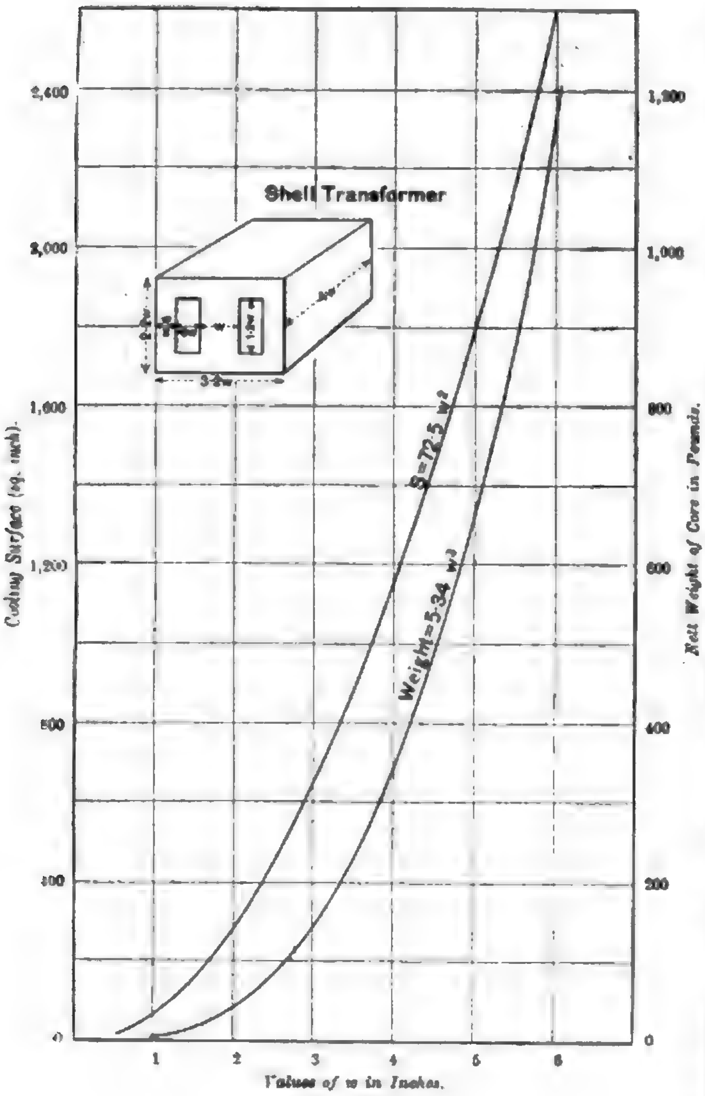


FIG. 10.

8. *Calculation of Losses. Copper losses*—

$$\begin{aligned} &\text{Primary } C^2R (11{\cdot}5)^2 \times 0{\cdot}51 &= 67{\cdot}5 \\ &\text{Secondary } 100^2 \times 0{\cdot}007 &= 70 \\ & & \overline{137{\cdot}5} \text{ watts.} \end{aligned}$$

*Iron Losses*—

$$\text{Eddy-current losses} = \text{Weight} \times 0{\cdot}0004 \left(\frac{f}{100} \times \frac{B}{1{,}000}\right)^2$$

$$= 110 \times 0{\cdot}0004 \left(\frac{100}{100} \times \frac{38{,}000}{1{,}000}\right)^2 = 63{\cdot}5 \text{ watts.}$$

Hysteresis loss = 100; total iron loss, 163·5 watts. Total losses = 137·5 + 163·5 = 301 watts.

9. *No-load Current.*—Magnetising current may be calculated from the formula already given, or from an expression involving permeability ($\mu$) obtained from a test curve of the iron used.

$$C_m = \frac{B \times l}{4{\cdot}5 \times T_1 \times \mu}$$

where $l$ = the mean length of magnetic circuit in inches, in this case equal to 50·5in. When B = 38,000, $\mu$ = 2,600 for a particular iron, and

$$C_m = \frac{38{,}000 \times 50{\cdot}5}{4{\cdot}5 \times 760 \times 2{,}600} = 0{\cdot}216 \text{ ampere,}$$

$$C_h = P_H / V = 163{\cdot}5/1{,}000 = 0.163,$$

$$\text{and} \quad C_0 = \sqrt{(0{\cdot}163)^2 + (0{\cdot}216)^2} = 0{\cdot}27 \text{ ampere.}$$

10. *Pressure drop.—Ohmic drop.* Secondary 0·007 × 100 = 0·7 volt,—primary = 0·51 × 11·5 = 5·87 volt. Referred to secondary the total ohmic drop $= 0{\cdot}7 + \frac{5{\cdot}87 \times 78}{760} = 1{\cdot}3$ volts, say 1½ volts. *Inductive drop.* Using Kapp's formula.

$$e = 5 \left\{ \frac{CT}{N} \left(\frac{b}{2} + \frac{a}{3}\right) \times \frac{l}{h} \times E_2 \right\},$$

$$CT = \frac{11{\cdot}5 \times 760 + 100 \times 78}{2} = 8270,$$

$$N = B \times A = 38{,}000 \times 7{\cdot}8,$$

$$a = 0{\cdot}866, \qquad l = \pi \times 5{\cdot}78\text{in.}$$

$$b = 0{\cdot}35, \qquad h = 12{\cdot}6,$$

$$e = \frac{5 \times 8270 \times 0{\cdot}46 \times \pi \times 5{\cdot}78 \times 100}{38{,}000 \times 7{\cdot}8 \times 12{\cdot}6} = 9 \text{ volts.}$$

Draw now the vector diagram to determine the pressure drop for different values of $\cos\phi$, taking as radius

$$E_2 = \frac{78 \times 1{,}000}{760} = 102{\cdot}5 \text{ volts.}$$

(the volts on open circuit) to some scale, say 1in. to 10 volts. With the secondary current in phase with the E.M.F., the pressure drop at full load would be 2 volts. The maximum drop on an inductive load is, however, nearly 10 volts, and the transformer would be useless for a power load. The coils should, therefore, be sandwiched.

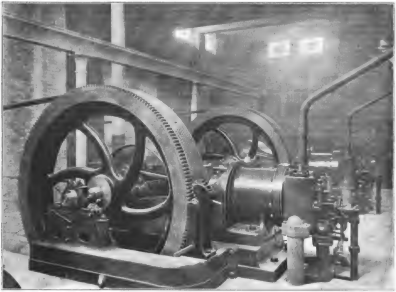
11. *Weight of Copper and Iron.*—Primary = 3·85 × 1,480 × 0·0239 = 137lb.; secondary = 3·85 × 131 × 0·157 = 79lb. Total weight of copper = 216lb.; total weight of iron = 110lb.

## THE ELECTRIC LIGHTING OF THE THAMES EMBANKMENT.

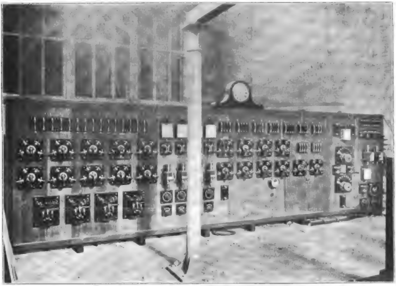
The electric lighting of the Victoria Embankment was formally brought into operation on Saturday, the 23rd inst., under the auspices of the London County Council, by Mr. W. H. Dickinson, chairman of the Council. The ceremony was performed from a small platform erected in the centre of the engine-room, in presence of members of the Council and of the Councils of the City and Westminster, some of them being in the gallery which runs round the greater part of the engine-room, the remainder standing in the body of the building.

It is interesting to recall the fact that a part of the Embankment was lighted by 20 Jablochkoff candles as long ago as December 13, 1878, the reason then given for using this system being that "no mechanical contrivance is necessary to maintain the proximity of the carbon rods through which the light is produced." One steam engine was used, and the charge of 5d. per lamp per hour was made by the pioneer company. By June, 1882, the lamps had been increased to 40 on the Embankment and 10 on Waterloo Bridge. The original charge of 5d. per hour per lamp was gradually reduced, till June, 1881, when a fresh agreement was made with the company to continue the lighting for a further period of three years at the rate of 1½d. per hour. In their report of 1883 the Metropolitan Board of Works complained of the frequent extinction of the light, and in May, 1884, tenders were invited for lighting for a further period, and in the meanwhile the lighting of the Embankment by gas was resumed.

It is needless to follow the history of the subject from that date except to notice that the London County Council decided in 1892 to light the Embankment themselves.

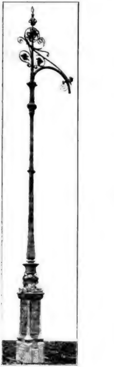


General View of Engine Room.



General View of Switchboard.

According to the descriptive account of the present generating station published by the London County Council, "at first a proposition was made that the supply of current should be obtained from the electric lighting companies. This arrangement was, however, considered inexpedient, inasmuch as parts of the Embankment were in the areas allotted to several companies, which, by the terms of their respective orders, were each precluded from supplying outside the areas scheduled thereto, and the electrical energy required for lighting the Embankment would have had to be obtained from those companies, whose systems of supply, moreover, were not uniform. The Council, therefore, after much consideration, decided to apply in the session of 1898 for powers to establish its own electric light installation, not only for the Victoria Embankment, but for the Westminster and Waterloo Bridges also; and these powers were obtained by the London Council (General Powers) Act, 1898. The act enabled the Council to erect on the plot of land on the Victoria Embankment, then used as a shrubbery but not open to the public, adjacent to the Charing Cross station of the District Railway, a generating station for the supply of electrical energy for the installation."



Arc Lamp Pillar for Kerbs.

View of Parapet Standards.

This station is the design of Mr. W. E. Riley, F.R.I.B.A., superintending architect to the Council, the contractors being Messrs. Holloway Bros., of Lambeth. It is a neat-looking building of Portland stone faced with bricks on the inside. The engine-room is in the basement, the dynamos being situated under the pavement; there are also offices, meter and lamp-testing rooms, and quarters for the resident foreman. The plant consists of four 70 B.H.P. gas engines built by Messrs. J. E. H. Andrews & Co., of Reddish, driving McClure and Whitfield dynamos by means of six cotton ropes. The engines are of the usual "Stockport" type, fitted with self-starters and duplicate ignition, they run at 210 revs. per min. with a guaranteed consumption at full load for not less than 17 cubic ft. of coal gas per B.H.P. per hour. They are governed on the hit-and-miss principle and the variation of speed is guaranteed to be not more than 1½ per cent. above or below the normal. The dynamos are of the Manchester type, having an output of 70 amperes at 500 volts when running at 500 revs. per min. For lighting the building and meter testing a battery of 56 E.P.S. cells is shortly to be fixed, and these will be charged by means of a 20-unit motor generator built by Messrs. McClure and Whitfield, who are also the contractors for the switchboard, which runs the whole length of one end of the engine-room. This board is made entirely of teak, each fuse and switch being separately mounted on enamelled slate. The instruments are of the Kelvin type, and there are single-pole switches and circuit-breakers for each dynamo. The circuits are controlled by double-pole five-way lever switches with carbon break, enabling any group of circuits to be controlled by any dynamo; each circuit is protected by a double-pole fuse, and there is the usual complement of fixtures for controlling the motor generator and cells. The cables are taken from the switchboard to teak boards near the entrance to a subway 6ft. high by 4ft. broad, which passes under the roadway to the river side of the Embankment. On these boards are fixed a number of copper links, each link being separately mounted on slate, by means of which the circuits can be disconnected for testing. The cables are composed of seven

strands of No. 16 S.W.G., insulated with paper lead-covered, served, armoured and again served. There are also several cables for common returns composed of seven strands of No. 14 S.W.G. These cables have been manufactured by the St. Helens Cable Company, of Warrington, and on the river side of the Embankment they are laid in the subway which was originally built to lighten the wall. On the land side we understand the cables are going to be laid direct in the ground.

Several suggestions were considered by the Council with regard to the positions of the lamps, but it was finally decided to light the Embankment from the footway kerbs, and utilise the old gas standards on the parapet of the Embankment and Westminster Bridge. At present only the lighting of the parapet lamps along the Embankment has been completed; the standards remain the same. New lanterns have, however, been fixed of almost exactly similar design to the old gas lantern, except that holophane glass has been used for the bottom half. Opal glass has been used for the top half, and there is an opening through which the top of the lamp projects. The appearance of the post is shown in one of the illustrations. The addition of a cap at the top of the lantern is under consideration. There are 67 of these posts along the parapet, the posts being about 22yd. apart. The lamps take 6 amperes and are run on six circuits of 10 lamps and one of seven lamps, and they are alternately on separate circuits, so that every alternate lamp can be put out after midnight. The lamps were made by the Gilbert Arc Lamp Co., and are of the open, double carbon, clutch type, and burn for 40 hours without re-trimming. The chief feature of the lamp is the arrangement of the positive carbons, which slide in brass tubes which pass right up through the mechanism of the lamp, thus enabling the lamp to be very short considering the time it will burn without attention.

One of the Dynamos.

The only difficulty encountered was in drawing in the leads from the subway into the standards, owing to the arrangements only being suitable for gas, so considerable care had to be taken. As there is no provision for placing automatic cutouts in the pillar, these are to be placed in the subway, but they have not yet been so fixed. It is hoped that in another three months the rest of the lighting will be completed, when 79 more lamps will be placed along the kerbs of the Embankment and on Westminster Bridge. The standards for the Embankment are being manufactured by Messrs. Macfarlane & Co., of Glasgow, and they will be placed alternately on either side of the street, the lamps being separated by a distance of about 90yd. The posts will stand about 32ft., the centre of the arc being about 25ft. from the ground; they will be of a handsome design, with four baby dolphins where the base and pedestal join, to harmonise with parapet standards. They will be fitted with wrought-iron brackets, with some artistic pretensions, differing from the usual cast-iron monstrosities that disfigure our metropolis. On Westminster Bridge the existing standards will be utilised, and the lamps will be fitted in the centre branch of each of the three branch standards over the piers, the branch being, of course, suitably modified, and at the foot of Northumberland-avenue three arcs will be placed in the three existing gas lanterns. The lighting of Waterloo Bridge has been undertaken by the Charing Cross and Strand Supply Corporation free of cost, in consideration of concessions made by the Council as to the company's mains being allowed to cross over the bridge. The lamps will be of the same type as those on the parapets except that they will take 12 amperes and burn for 60 hours without re-trimming, and along the Embankment lowering gear will be employed.

The lighting, as far as it is at present carried out, is an unqualified success, the ground illumination being practically uniform, and the appearance of the standards is the best we have yet seen; but it may be doubted whether the Council would not have been better advised to have procured powers to take current from one of the existing companies' stations, and even after they had settled to establish their own installation we think a compacter and more economical arrangement would have been to employ direct-driven steam dynamos. The scheme was prepared by Sir Alexander Binnie, the Council's engineer, and was carried out under the supervision of Mr. T. P. Gunyon.

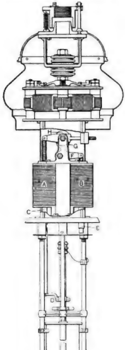
## AN ENCLOSED ALTERNATING ARC LAMP FOR SERIES CIRCUITS.

The Reason Manufacturing Co. has placed on the market a new type of enclosed arc lamp suitable for running in series on an alternate-current circuit. The lamp is of the well-known clutch type, the principal feature being the use of a subsidiary and rather powerful brake, operating on the striking lever, and taking the place of the usual dash pot. This brake comes into play on the striking of the arc, and whenever the current exceeds the normal. The lamp is shunted with a choker which takes the whole of the current should the arc break, the pressure at the terminals of the other lamps remaining fairly constant; in fact, should 80 per cent. of the lamps fail the lighting from the remainder is scarcely affected.

The action of the lamp can be followed from the accompanying illustration. The two solenoids A and B are in series with the arc. On switching on the current the core C is sucked up into the solenoid A, the arc being struck by the clutch D. At the same time the core E is pulled up into the solenoid B, raising the lever F and pressing the shoe G against the block H on the striking lever. This prevents the core C being raised too quickly and the consequent hunting, the act of striking being slow; the arc only attains its full length after about 30 seconds. When the arc is fully struck and the current normal, the core E and shoe drop, the core floating in the solenoid. The lamp is well made, the working parts being few and of good mechanical design. It is claimed that the light is of a better colour than with other makes of alternate-current lamps, owing to the small inductance and the hard gritty nature the ends of the carbons assume; it is also claimed that there is an increase of candle-power for a given consumption of energy and that the lamp is not affected by vibrations owing to the rapidity with which the braking apparatus comes into operation.

We saw twelve of these lamps at the Croydon Electricity Works running on a 1,000-volt 60 ∼ circuit. The lamps were started up in series with a resistance which was immediately cut out. When three of the arcs were broken there was no perceptible variation of the lighting of the remainder, and there was no tendency for the lamps to hunt. We are informed that the current through the arc is 7·5 amperes, the current through the choker 3 amperes, the total current

being 9 amperes. If one of the arcs is broken the pressure across the terminals rises to 160 volts, the pressure across the remaining 11 lamps remaining at 900 volts. The lamps can be run 27 in series on a 2,000-volt circuit, and we understand the Reason Manufacturing Co. is supplying lamps for two sets of 38 in series to be fixed on tramway poles at Croydon. In conclusion, we have to thank Mr. Frank Lewis, the inventor, for his courtesy in showing us the lamp, and supplying us with the above numerical data.



## A NEW RECORDING INSTRUMENT.

In view of the practice which seems now to be almost universal, of installing a number of recording instruments in central stations, the following particulars of a new series of recording ammeters and voltmeters for continuous current may be of interest. These instruments, which are being manufactured by Messrs. Everett, Edgcumbe & Co. (who are also the makers of the "Harrison recorder"), are of the permanent-magnet moving coil type, and possess several features of interest. The advantages attending the use of moving-coil instruments, both as regards accuracy and small consumption of energy, are too well known to make it necessary to dwell upon them here. For a recording instrument, however, several new requirements have to be met. Firstly, there must be ample power to overcome the friction of the pen upon the paper; secondly, the instrument must be capable of being accurately adjusted to a predetermined chart; and thirdly, the indications should not be appreciably affected if the instrument be slightly out of level.

It is claimed that all the conditions enumerated above are fulfilled by the moving-coil system employed in the instruments under consideration. To reduce the friction further, a special hinged pen arm is used. The hinged pen, as usually employed, while giving, it is true, a fairly uniform pressure upon the paper, has the disadvantage of being somewhat heavy. The instrument has consequently a tendency to hunt. To obviate this difficulty, Messrs. Everett, Edgcumbe & Co. allow the pen arm to hang from pivots fixed to the axis of the moving coil, with the result that while the pressure is perfectly even, the weight of the system is reduced to a minimum. In order to allow the pressure of the pen on the paper to be varied as may be required, a small counterweight is fixed at right angles to the pen arm, near the hinge, and can be screwed in or out until the pen rests upon the paper with the required pressure.

Fig. 1.

A fruitful source of annoyance to users of recording instruments is to be found in the pen itself. At one time the ink runs too fast and the pen soon becomes dry, at another the trace left is so faint as to be almost invisible. The Everett-Edgcumbe recorders are now all fitted with a new form of pen consisting of a small container which holds sufficient ink for a week's records. Into the container dips a narrow strip of metal, which serves at once to draw up the ink, and to trace a uniform line upon the paper. The point is so shaped that it cannot scratch the paper, whilst a very light pressure only is required to give a distinct trace, no matter how rapid may be the variations to be recorded. In order to clean the pen should it become clogged through long use, which, however, owing to the small surface of ink exposed to the air, is seldom necessary, all that has to be done is to draw a fine wire between the points.

Fig. 2.

Fig. 1 shows a recording voltmeter of the switchboard type. No external resistance is required, the whole being contained in the instrument itself. The recording ammeters are similar in external appearance to the voltmeters, and in order to simplify the connections, a separate shunt is always provided, so that the latter can be inserted in the circuit at any convenient point, whilst the instrument itself is placed in such a position on the board, as to be readily accessible. In the majority of cases a 24-hour chart is most convenient, engineers preferring as a rule to have the daily record laid before them every morning. It frequently happens, however, that a record is required in some position in which it is impossible to renew the charts more than once a week. In such cases the instru-

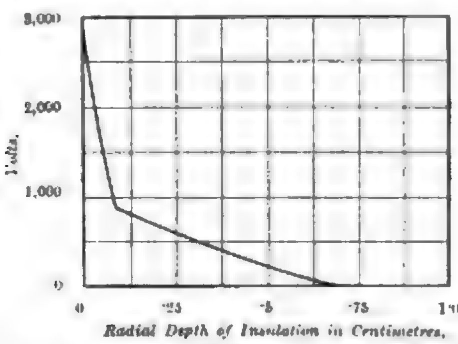
ment is provided with a continuous chart, which will last for a week, or even for a longer period if required. As the driving mechanism, which, by the way, is keyless, only requires winding once a week, whilst the pen holds a sufficient supply of ink for the same period, a recorder can be placed, say, in a sub-station, and the complete record need only be collected once in every seven or eight days, no attention being given to the instrument in the meantime. The glazed case is so hinged that, when opened, the drum is left perfectly clear for the renewal of the chart paper or the filling of the pen.

For recording the pressure on consumer's premises, or at junction boxes or the like, a portable instrument is supplied. It consists of a mahogany case with glazed door and handle for carrying, and is provided with a lock and key to prevent any possibility of the record being tampered with. Fig. 2 shows a 50-ampere shunt suitable for use with a portable ammeter. If preferred, the shunt can be fitted into the case of the instrument itself, and voltmeters are always supplied complete in themselves.

## CAPACITY IN ALTERNATE-CURRENT WORKING.

**We conclude below our abstract of the discussion on Mr. Mordey's Paper. The Paper was read at the Institution of Electrical Engineers, on January 10th, and the discussion on it was concluded on February 14th. Previous reports appeared in our issues of January 18th, 25th, and February 22nd.**

Mr. M. O'GORMAN said that whether Mr. Mordey's test or Prof. Ayrton's of the energy losses on the London and County Co.'s cable was



| | Thickness. | Capacity. | Spec. Ins. Res. |
|---|---|---|---|
| Pure Rubber............ | 0·085cm. .... | 2·3 .... | $12 \times 10^9$ |
| Separator ............ | 0·255 .... | 2·6 .... | $2 \times 10^9$ |
| Vulcanised............ | 0·34 .... | 2·9 .... | $1·5 \times 10^9$ |
| Outer Coat of Taping.... | 0·17 .... | 2·9 .... | $2 \times 10^8$ |

Conductor.—Rad., 0·64cm. Total Insulation Thickness, 0·85cm.

FIG. 1.—Curve of Potentials in 7,000-volt Cable Tested at 2,828 Volts Continuous.

the more accurate could not in any way be verified by tests on any other cable or condenser for the following reason: The work done on any commercial dielectrics upon which any published tests or experiments which he had been able to find had been made, varied as the square of the P.D. established between the two sides of the dielectric in question. These results had been endorsed and quoted by Steinmetz, and independently examined by Arno, J. Sahulka (*Wiener Sit. Ber.*, Vol. CII.), and recently

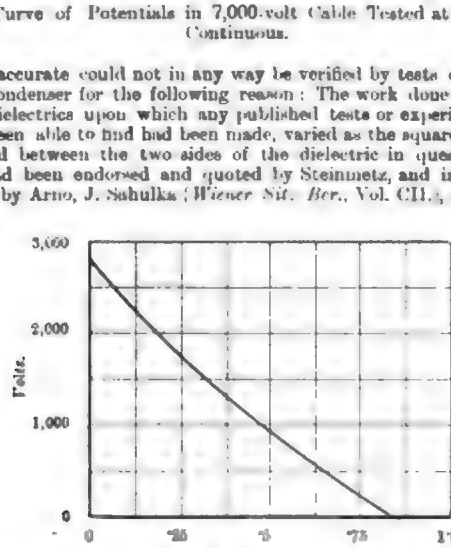
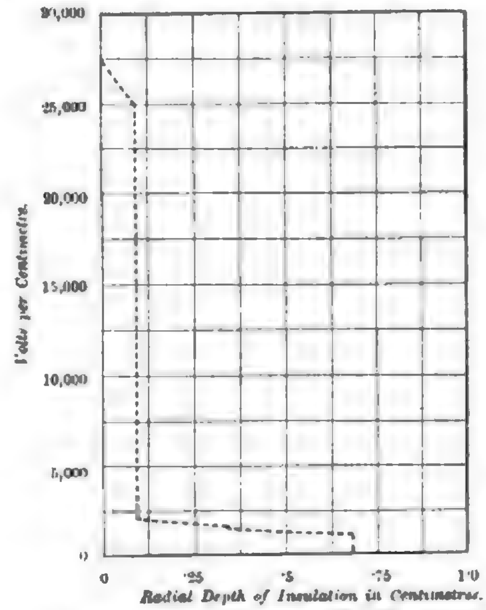


FIG. 2.—Curve of Potentials in 7,000-volt Cable Tested at 2,000 Volts, either Alternating or Continuous with Dielectric Homogeneous.

quoted by Dr. de Hoor in *The Electrician* of Feb. 8, as well as by Mr. Threlfall. If this were so, the energy lost depended upon the distribution of potential within the thickness of the insulation, and this in turn depended upon the grouping of the materials in the various layers of any individual cable. Taking a 37/15, which was the size of cable Mr. Mordey tested, and giving it, for the sake of example the subjoined arbitrarily-chosen thicknesses of dielectric (rubber) a curve of potential was obtained which was approximately according to Fig. 1, whereas if the dielectric were perfectly homogeneous the potential would be somewhat according to Fig. 2. The gradient, or slope of potential was at every point in Fig. 1



| | Thickness. | Capacity. | Spec. Ins. Res. |
|---|---|---|---|
| Pure Rubber............ | 0·085cm. .... | 2·8 .... | $12 \times 10^9$ |
| Separator ............ | 0·255 .... | 2·6 .... | $2 \times 10^9$ |
| Vulcanised............ | 0·34 .... | 2·9 .... | $1·5 \times 10^9$ |
| Outer Coat of Taping.... | 0·17 .... | 2·9 .... | $2 \times 10^8$ |

Conductor.—Rad., 0·64cm. Total Insulation Thickness, 0·85cm.

FIG. 3.—Curve of Gradient in 7,000-volt Cable Tested at 2,828 Volts Continuous.

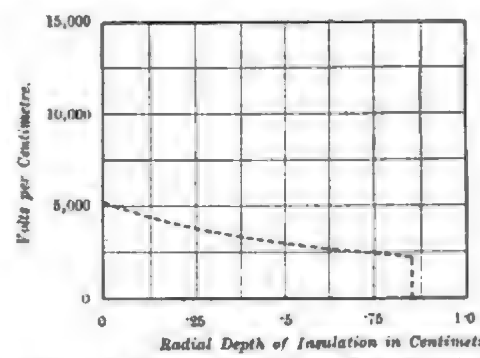
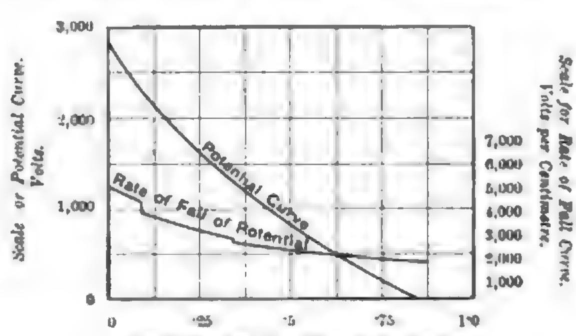


FIG. 4.—Curve of Gradient in 7,000-volt Cable Tested at 2,000 Volts Alternating or Continuous with Homogeneous Dielectric.



| | Thickness. | Capacity. | Spec. Ins. Res. |
|---|---|---|---|
| Pure Rubber............ | 0·085cm. .... | 2·3 .... | $12 \times 10^9$ |
| Separator ............ | 0·255 .... | 2·6 .... | $2 \times 10^9$ |
| Vulcanised............ | 0·34 .... | 2·9 .... | $1·5 \times 10^9$ |
| Outer Coat of Taping . | 0·17 .... | 2·9 .... | $2 \times 10^8$ |

Conductor.—Rad., 0·64cm. Total Insulation Thickness, 0·85cm.

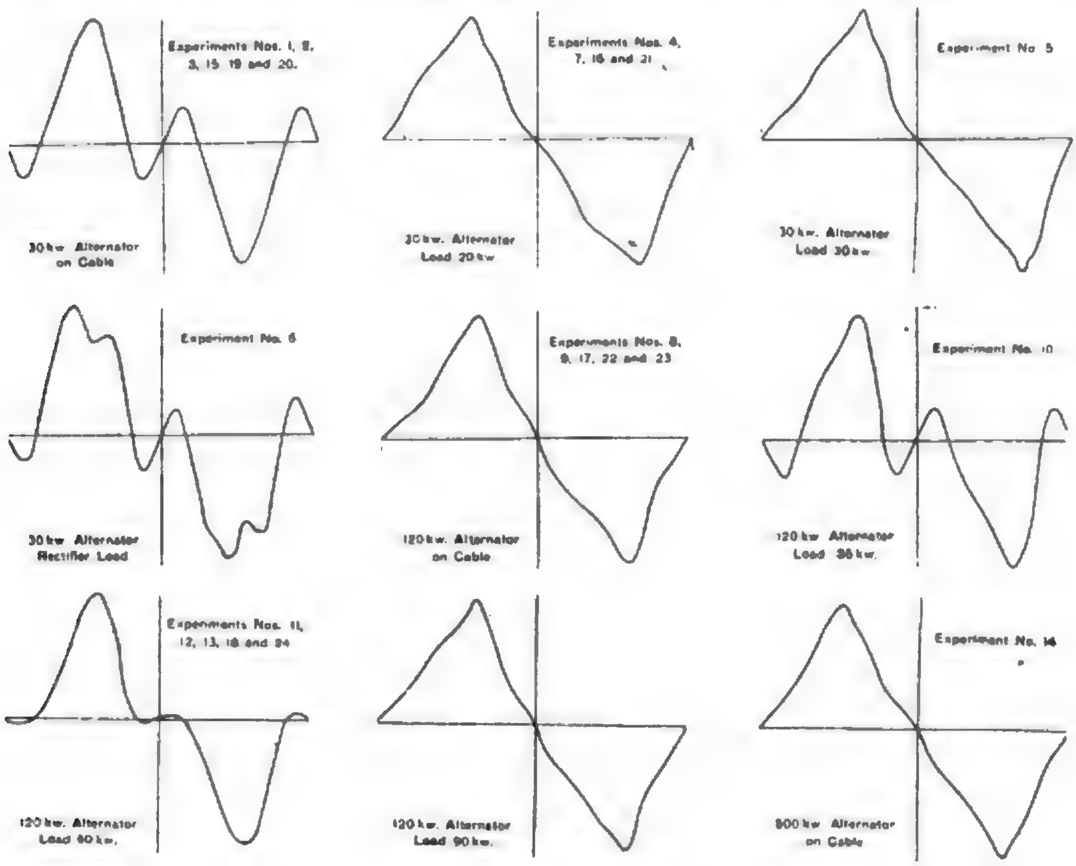
FIG. 5.—7,000-volt Cable Tested at 2,828 Volts Alternating.

indicated by the height of the ordinate of Fig. 3, whereas in a uniform dielectric the gradient at every point was approximately according to Fig. 4. If the work done on each element of thickness on a homogeneous cable were added together, and also the work done on each element on the above heterogeneous cable, it would be seen that the ratio of the energy lost might be as 26 to 1 in the above cases. These considerations explained how it was that

Prof. Ayrton found power-factors for different cables varying from 0·024 to 0·033, and there seemed no reason why the power-factor should not reach and exceed Mr. Mordey's figure in many cables which were actually in use, and where no idea of such losses was entertained by their users. These considerations also explained why the loss was greater when the curve of the alternating voltage was more "peaky" than a sine curve. There was, in fact, no reason why a cable dielectric should not, on some occasions, actually be broken down in one layer, while being perfectly sound in another. This form of breaking down would not lead to a disruptive spark right through the dielectric, but would lead to a phenomenon similar to a brush discharge for a wire in air.

Mr. W. E. GRAY differed from Mr. Mordey on the question of the concentric cable. They had heard that cable makers did not know much about designing cables, on the one side, and from the other side that dynamo makers did not know much about dynamos, and something had also been said about people not being proper engineers, so that it seemed a regular three-corner controversy. In dealing with dielectrics there were many things to be borne in mind. Paper and also rubber were called dielectrics, but it depended entirely upon the process of manufacture as to what the capacity was. He would undertake, within certain limits, to make a cable to meet any conditions as to capacity. He believed that no one could make a cable which would remain perfectly stable in capacity dielectric hysteresis in the case of a cable, where the slightest trace of air or moisture would increase the losses to an enormous extent. If they made a condenser entirely doing away with air or moisture, then it would be possible to reduce the losses to an extremely small figure. Mr. O'Gorman's reference to his work was a misrepresentation. The index was not 2, but from 1·6 to 2; but it only reached the full 2 in the case of a heterogeneous cable by mixing graphite and paraffin. In natural dielectrics, however, they did not get an index of anything like that magnitude. Cables had a real dielectric loss which was absolutely fixed and determined, but it would be impossible to get two samples of dielectric to have the same approximate loss. The only material which in any way lent itself to a determination of a fixed loss was such a thing as silver in certain states of crystallisation which, to all intents and purposes, had no loss at all.

Mr. T. H. MINSHALL described some experiments made at Croydon since the previous meeting, the results of which are given in the tables and curves below, with the object of proving that Mr. Mordey's figures were ever so much too high and all wrong. Three different sizes of machines had been experimented with. The wattmeter readings varied, and with machines of the same wave form the capacity current varied from 2·67 down as low as 1·85, the latter referring to the 500kw. machine. The figures to a certain extent, however, confirmed Mr. Mordey's, and the differences shown, he said, proved conclusively that, as had been mentioned by the



Wave-Forms applied to Cable.

independently of the insulation resistance: there would be great variations in time. But were the gentlemen who design machinery and central stations, and those who teach others to design, prepared to say really what they wanted? Apparently not. They all differed. Even Mr. Mather differed from Prof. Ayrton.

Prof. R. THRELFALL said that his experience had been that leakage losses were very subtle things. For instance, taking a film of silver, composed partly of crystals and partly of silver, it was possible to obtain any resistance within a range of 10 to 1 according to the length of time the E.M.F. was applied, the direction it took, and its magnitude. There was something which they might call dielectric resistance if they liked, but one never got the same result even on repeating the conditions exactly. There had been too much readiness to talk of hysteresis loss. In 1897 Mr. Steinmetz, by means of a wattmeter, which might or might not have been accurate, measured the losses in a condenser, and referred to them as dielectric hysteresis; and later on M. Arno referred to this matter as having been established by Steinmetz. But what had just passed that evening proved that it had not been established in any sort of way. There was generally a tendency to associate the heating losses in a condenser with what had long been known to electricians as the absorption losses. But these two cases of loss, he had been able to show during 1896-7, were not in any way associated, at all events not when using periodicities of 30 or 40. They had nothing at all to do with each other experimentally. Theoretically there might be a relation. Taking everything into account, he did not think they should speak of author, it was impossible to make a commercial test of capacity unless they had a machine which they were perfectly certain was giving a sine wave. It had been said that cables could not be got with a power-factor of 0·1, but he was inclined to think that the discrepancy of the various speakers was due to the insulation resistance not being taken into account. The cable here tested had a low insulation resistance, but Mr. Mordey had not given any figure for his cable. The wattmeter he used was specially calibrated at the Central Technical College on a power-factor of 0·1, and to test whether the readings obtained were accurate, they had been repeated with other wattmeters which were all found to agree with each other within 3 per cent. on various power-factors and wave-forms. His insulation resistance was half a megohm. Engineers were trying to keep the insulation resistances up, and the cable-makers were trying to keep them down. He had avoided a lot of trouble with his 5,000-volt cable by having a much lower insulation resistance than before, and he saw no reason to doubt the figures, especially as he had had the assistance of Mr. Duddell and others, who were all acquainted with Central Technical College methods. He had also checked them by Dr. Fleming's suggested test, and the results came out at almost the exact means of his first figures. He entirely agreed that capacity was a very good thing in power systems, and it helped to improve the power-factor of arc lamps. With certain conditions of wave-form and capacity, and an inductive load at the other end of the circuit, more amperes came out than went in. This was not perpetual motion; but it was possible, by having the capacity in the cable, actually to reduce the current entering it.

*Losses in V.B. Concentric Cable.*

Length of cable, 7,460yd. Section of conductors, 0·10 sq. in. concentric. Total insulation resistance, 0·50 megohms, including leakage over terminals. Cable only, 50 megohms.

| No. of expt. | Machine running. Kw. alt. | Input at station end of cable. C. | Watts. | P.F. | Watts wasted in cable. C²R due to cap. currnt. (approx.). | Leakage losses (approx.). | Dielc. hyst. losses. | — |
|---|---|---|---|---|---|---|---|---|
| *1 | 30 | 2·44 | 469 | 0·092 | 14 | 8 | 425 | No load on end of cable. |
| ‡2 | 30 | 2·35 | 489 | 0·101 | 13 | 8 | 468 | |
| †3 | 30 | 2·37 | 506 | 0·103 | 13 | 8 | 485 | |
| *4 | 30 | 2·18 | 459 | 0·102 | 11 | 8 | 428 | |
| †5 | 30 | 2·05 | 420 | 0·100 | 10 | 8 | 402 | |
| †6 | 30 | 2·41 | 499 | 0·101 | 14 | 8 | 477 | |
| ‡7 | 30 | 2·10 | 431 | 0·100 | 11 | 8 | 412 | |
| *8 | 120 | 2·14 | 385 | 0·088 | 11 | 8 | 354 | |
| ‡9 | 120 | 2·07 | 459 | 0·108 | 10 | 8 | 441 | |
| ‡10 | 120 | 2·67 | 561 | 0·100 | 17 | 8 | 536 | |
| *11 | 120 | 2·34 | 367 | 0·076 | 13 | 8 | 334 | |
| †12 | 120 | 2·28 | 469 | 0·100 | 13 | 8 | 451 | |
| ‡13 | 120 | 2·29 | 507 | 0·108 | 13 | 8 | 486 | |
| †14 | 500 | 1·85 | 384 | 0·101 | 9 | 8 | 367 | |

* Swinburne wattmeter (*a*) with potentiometer.

† Swinburne wattmeter (*b*) with 20,000 ω resistance direct on 2,000 volts. This instrument was specially calibrated at Central Institution on a power-factor of 0·1, and all wattmeters were found to agree with each other within 3 per cent. on various power-factors and wave-forms.

‡ Thomson wattmeter No. 9,608, with potentiometer.

| No. of expt. | Machine running. Kw. alt. | Input at station end of cable. C. | watts | P.F. | Output at far end of cable. C. | watts | P.F. | Watts wasted in cable. Tot. | C²R useful curr. | Diff. | Leakage losses. | — |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *‡15 | 30 | 3·66 | 5,250 | 0·70 | 2·22 | 4,680 | 1·03 | 570 | 18 | 552 | 8 | Non-inductive load on end of cable. |
| *‡16 | 30 | 3·52 | 5,180 | 0·72 | 2·26 | 4,660 | 1·01 | 520 | 19 | 501 | 8 | |
| *‡17 | 120 | 3·50 | 5,215 | 0·73 | 2·31 | 4,690 | 1·00 | 525 | 20 | 505 | 8 | |
| *‡18 | 120 | 3·60 | 5,110 | 0·69 | 2·26 | 4,620 | 1·01 | 490 | 19 | 471 | 8 | |
| *‡19 | 30 | 2·48 | 1,870 | 0·37 | 0·89 | 1,365 | 0·75 | 505 | 3 | 502 | 8 | Inductive load on end of cable. |
| †20 | 30 | 2·33 | 1,933 | 0·40 | 0·87 | 1,332 | 0·75 | 601 | 2 | 599 | 8 | |
| *‡21 | 30 | 2·22 | 1,852 | 0·41 | 0·89 | 1,398 | 0·77 | 454 | 3 | 451 | 8 | |
| *‡22 | 120 | 2·16 | 1,798 | 0·41 | 0·88 | 1,387 | 0·78 | 411 | 3 | 408 | 8 | |
| †23 | 120 | 2·21 | 1,902 | 0·42 | 0·86 | 1,332 | 0·77 | 570 | 3 | 567 | 8 | |
| *‡24 | 120 | 2·36 | 1,798 | 0·37 | 0·89 | 1,365 | 0·75 | 433 | 3 | 430 | 8 | |
| 25 | 30 | 6·78 | ... | ... | 7·50 | ... | ... | ... | 208 | ... | 8 | Load on cable. |
| 26 | 30 | 9·48 | ... | ... | 10·00 | ... | ... | ... | 370 | ... | 8 | |
| 27 | 120 | 8·81 | ... | ... | 9·41 | ... | ... | ... | 328 | ... | 8 | |

* Swinburne wattmeter (*a*) with potentiometer.

† Swinburne wattmeter (*b*) with 20,000 ω resistance direct on 2,000 volts.

‡ Thomson wattmeter, No. 24,425, at far end with potentiometer.

| Experiment No. | Difference between current put in, and useful current leaving. | Experiment No. | Difference between current put in, and useful current leaving. |
|---|---|---|---|
| 15 | 1·44 | 22 | 1·28 |
| 16 | 1·26 | 23 | 1·35 |
| 17 | 1·19 | 24 | 1·47 |
| 18 | 1·34 | 25 | −0·72 |
| 19 | 1·59 | 26 | −0·52 |
| 20 | 1·46 | 27 | −0·60 |
| 21 | 1·33 | | |

| Machine running. | Voltage on cable. | Exciting current for const. voltage, reduced: from | to |
|---|---|---|---|
| 30kw. alternator | 10,000 | 5·8 amperes | 2·5 amperes |
| ,, ,, | 5,000 | 5·8 ,, | 4·7 ,, |
| ,, ,, | 2,000 | 5·8 ,, | 5·4 ,, |
| 120kw. ,, | 10,000 | 17·5 ,, | 13·2 ,, |
| ,, ,, | 5,000 | 17·5 ,, | 16·0 ,, |
| ,, ,, | 2,000 | 17·5 ,, | 17·3 ,, |

Mr. W. M. MORDEY, in replying, said that he would only make a few observations. He would send his full reply to the *Journal*. He was glad that Mr. Minshall had given him a little encouragement, and had shown, at any rate, that Mr. Sparks and himself were not the only people who had found that there were appreciable losses in cables from dielectric hysteresis. If all the professors in the world stood in a row, and said there was no loss from dielectric hysteresis, he would simply smile, because he would know they were wrong. Mr. Kapp had written him from Germany to say that he agreed on the whole with the Paper, and a singular confirmation from Mr. Kapp was his statement that it had been found that the high-tension three-phase cables in Germany got appreciably warm at light load. When he explained that "appreciably warm" meant a power-factor of 0·3 or 0·4, instead of 0·1, they would agree with him that this was worth a great deal of theory. A power-factor of 0·1 on a three-phase cable was only 4 microfarads per conductor, and this would not raise the temperature of the cable 1°F. It was not possible to feel 1°F.; therefore, "appreciably warm" meant that a considerable amount of energy was being spent. Mr. Swinburne about 10 years ago said, at the Physical Society, that, from his calculation of the materials used in the Deptford paper mains, the dielectric hysteresis per main must be about 7,000 watts. Mr. Partridge, the present engineer, now assured him that the loss in these cables was quite 1,000 watts per mile, and this exactly confirmed the figure given by Mr. Swinburne 10 years ago. This was another fact which spoke for itself, whilst the figures quoted by Prof. Ayrton from Lombardi and Major Cardew really confirmed him up to a certain point. Lombardi's result from the elaborate little bit of cable he tested came out at 0·068, which was in the direction of the losses which he found. Lombardi's result was not, as Prof. Ayrton and others had tried to show, a mere fraction of his (Mr. Mordey's) figure, and it was possible with some kinds of cable that the power-factor would be that, whilst with another cable it might be more. Cable makers had told him that cables on light load and a good insulation resistance did get quite warm to the touch, and this warmth was a most warming thing to him. Although time did not permit of his dealing with all the other points, he mentioned that he had never claimed for one moment that this method of obtaining the power-factor of his was novel, although it was not of universal application. His figure had, however, been confirmed by the motor generator method, which had had the apostolic benediction of the professors. He repeatedly took steps in the Paper to guard against impressions of that sort being obtained from that one test. In conclusion, he thanked Mr. Sparks for his trouble. Mr. Sparks, when he had been told of the matter, took steps in his company's interests to make as full an investigation as he could, and personally he was very much obliged to him, and the Institution ought to be also.

---

Mr. G. L. ADDENBROOKE, in a communication, says that he has always had the capacity current in systems of mains fully in view in dealing with large power systems. Although he agrees with the letter from Dr. Hoor, in *The Electrician*, that the effect is capable of being dealt with, still Mr. Mordey has done good service in drawing attention to the fact that the effect may be large. He thinks this is most likely to be the case in the early days of power distribution, when large systems of conductors have had to be laid down and the load is comparatively light. All Mr. Mordey says under this heading is a remarkable commentary, he thinks, on the unwisdom of the Board of Trade regulations, which practically prohibit overhead wires in this country. Although power distribution on an enormous scale has been carried out on the Continent and in America, it has almost wholly been carried out by means of overhead wires, where the effects described by Mr. Mordey do not occur. The Board of Trade prohibits us adopting methods by which great industries have been safely and advantageously built up on the Continent and in America, and forces us to adopt expensive and untried methods, which, at any rate, are liable to serious inconveniences, even if by skill and care they can be got over. Mr. Addenbrooke continues that he was very much startled by Mr. Mordey's figures as to the watt loss in the dielectric, as he had no idea that its magnitude was at all comparable to these figures. Since Mr. Mordey's Paper he has been too busy to make any direct measurements on a cable itself, but has obtained the following results on condensers. The measurements were carried out entirely with electrostatic instruments, such as described in the Paper he read before the International Congress of Electricians at Paris, an abstract of which was published in *The Electrician* of Oct. 5. Some months since Dr. A. Muirhead was good enough to place at his disposal a set of condensers for experimental purposes—in fact, for investigating amongst other points, this very effect. These condensers were connected to an alternating current of 1,000 volts and about 30 periods, and careful tests, which Mr. C. W. S. Crawley confirmed with Mr. Addenbrooke afterwards showed that in these circumstances the power-factor was about 0·011 to 0·012. In fact, deducting a small fraction for loss in leads, about 1 per cent. of the apparent watts was really true work. The experiments were made on condensers of 3 microfarads and 6 microfarads capacity respectively, which were probably equal to about 7 miles to 14 miles of ordinary cable. It is perfectly true, he points out, that these condensers were made by Dr. Muirhead with great care, in order to have the absorption small; but on the other hand, he says, the dielectric is very much thinner than that of an ordinary cable, which probably would also be made of paper, and therefore the potential slope is very much greater than in a cable, which—whether rightly or wrongly—he has always taken as a serious factor. Concerning Mr. Mordey's suggestion of the use of a choking coil across the circuit, Mr. Addenbrooke may say that there has recently been completed to his specification an adjustable inductive resistance having a capacity of 170kw. on Mr. Mordey's rating. This inductive resistance is intended for putting a lag in the circuits of alternators under test. It has been wound for practical purposes with a number of circuits which have permitted a somewhat elaborate series of tests to be made on it. It is not possible to close the iron circuit of such apparatus as well as in an ordinary transformer, and therefore they take a larger wattless current than a transformer with overlapping plates, but how much he finds it difficult to say without experiment, as calculations are not of much value. At some later date he may be able to give to further data regarding the work on this resistance. Lastly, Mr. Addenbrooke refers to Mr. Mordey's wattmeter. On numberless occasions he was himself tempted to make measuring apparatus constructed with transformers for raising the voltage, but has always been deterred by the uncertainties he expected to be involved in. It might be quite possible that such an instrument, tested and calibrated by instruments which can be relied on, may be useful for approximate measurements through a moderate range and comparatively high power-factors, but he has felt that to go beyond this required great caution. Some experiments he had made months since, using electrostatic instru-

ments, confirm the view Mr. Duddell has expressed in *The Electrician* last month, that there was a certain amount of lag produced by magnetic leakage which at any considerable power-factor would entirely upset readings. His own tests were made in a way similar to Prof. Fleming's except that instead of accumulators to drive the motor transformer be used the Westminster Company's current, the voltage being kept steady by passing the current through a variable resistance and observing a voltmeter. Owing to the loading current produced by the condenser, the reactions in the generator were considerably altered when the condensers were put on, and it was necessary to observe carefully that the speed was similar when any comparative measurements were made.

*Errata.*—Prof. Fleming points out a mistake in the report of his remarks in our last issue. He did not say that Mr. Swinburne's wattmeter read correctly on his own transformer and 50 per cent. on Mr. Mordey's; but that the instrument read correctly on the Mordey transformer, and 50 per cent. too low on Mr. Swinburne's own transformer.

Dr. Sumpner writes us as follows:—There are one or two numerical errors in your report of my remarks on Mr. Mordey's Paper which I should like to rectify. I pointed out that the ratio of the dielectric losses in the cable, to the full load, could be obtained by multiplying the power-factor by the ratio of the capacity current to the full-load current. Thus, taking Mr. Mordey's power-factor as correct, the dielectric loss would be 6 per cent., or 1·2 per cent. if the current ratio were one-half or one-tenth respectively. Taking Mr. Mordey's example of a cable, and assuming a drop of voltage of 4 per cent., the current ratio is found to be one-eighth. Thus, according to Mr. Mordey's power-factor, the dielectric loss is only 1·5 per cent., while if the power-factor is only 0·02, the loss is only 0·25 per cent. Later on, the power-factors for a condenser apparently found by a wattmeter used with a transformer are stated in your report to vary between +0·04 and −0·03. The numbers I actually mentioned were +0·4 and −0·43. That some of the wattmeter measurements recently published have really been negative, and therefore worthless, seems to me to be clearly proved by a statement in the discussion made by Mr. Sparks. He distinctly says, "The meter revolved in one direction when connected with the cable, and in a reverse direction when connected with the choker."

## PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society held on February 22, Prof. S. P. THOMPSON, president, in the chair, a Paper on

**"How Air subjected to X-rays loses its Discharging Property and how it Discharges Electricity,"**

by Prof. EMILIO VILLARI (hon. fellow) was read by the chairman. Air made active by X-rays in passing through a long tube coiled in many turns loses much more of its discharging power than it does in passing through the same tube if straight. During this process the tube charges itself to a certain potential. If active air is allowed to stream on masses of wire gauze or wound up ribbons, enclosed in tubes, the metals, independent of their nature, take a positive or negative charge according to whether the active air rubs against them with force or lightly. Experiments have been performed to prove this. For instance, tubes of copper or lead, if short and straight, take negative charges, but if long and coiled they take positive charges. These phenomena cannot be attributed to chemical actions but seem to be produced by a special rubbing of the active air upon metallic surfaces, as the result of which they assume one of the charges, and the other charge ought to manifest itself in the air. This is not the case, the charge of the air being often of the same kind as that of the metals. It has previously been shown by the author that active air by streaming against an electrified body is reduced either to ordinary air or to air charged with the electricity which disappears. Hence it may be supposed that the active air in rubbing upon the metallic surfaces develops the two electricities, one of which manifests itself upon these surfaces and the other goes to reduce the active air to ordinary air, and therefore does not become manifest. The electroscope used in the experiments consisted of a fixed brass plate and a gold leaf, whose position was determined by means of a telescope with an eye-piece scale.

The CHAIRMAN said he had observed the fact that metals were charged sometimes positively and sometimes negatively by active air.

Mr. WATSON asked if any experiments had been performed on the viscosity of gases rendered active by X-rays.

A Paper on

**"The Propagation of Cusped Waves and their Relation to the Primary and Secondary Focal Lines,"**

by Prof. R. W. WOOD, was read by Mr. Watson. This Paper is a discussion of the reflection of a plane wave by a hemispherical mirror, the reflected wave being likened to a volcanic cone. The cusp of the wave, or the rim of the crater, traces the caustic and is continuously passing through a focus. This accounts for the increased illumination along the caustic. The wave fronts were drawn by constructing the orthogonal surface, which in section is an epicycloid. The evolute of this curve is the caustic, and the reflected wave fronts form a family of parallel curves which are the involutes of the caustic. The wave front between two focal lines is expanding along one meridian and contracting along a meridian at right angles to it; in other words the wave is convex along one meridian and concave along the other. The outer slope of the volcanic cone representing the reflected wave corresponds to the portion of the wave front between the focal lines. A useful piece of apparatus can be made by silvering the outside of a hemispherical glass vessel. The concave mirror thus formed should be mounted on a stand, and a small electric lamp arranged so that it can move along the axis of the mirror. A spherical wave starting at the focus of a hemispherical mirror is reflected as a saucer-shaped wave, the curved sides of the saucer coming to a focus in a ring surrounding the nearly flat circular bottom. If the lamp is placed at the focus, the luminous ring and the uniformly illuminated area within it can be shown on a ground-glass screen. If the lamp be moved to a point midway between the focus and the mirror a ring of intense brilliance, with very little light within it, is formed.

A Paper on

**"Cyanine Prisms,"**

by Prof. R. W. WOOD, was read by Mr. Watson. Prof. Wood has already described a method of making prisms of solid cyanine by pressing the fused dye between plates of glass. Until recently angles of about ½deg. were the largest that could be used with advantage on account of the small quantity of green light transmitted. A new supply of the dye has been found to transmit a large quantity of green light with an angle of over 1deg. By viewing the filament of an incandescent electric lamp through one of these prisms the anomalous spectrum is seen, the colours being arranged in the order: Green, blue, violet, red, orange. Prof. Wood has crossed one of these prisms with a photographic copy of a diffraction grating having 2,000 lines to the inch. On viewing a naked arc lamp the diffraction spectra are deviated by the prism the red ends being turned up and the blue-green ends turned down.

The CHAIRMAN said he had been trying to obtain some cyanine, but had not succeeded. Rosaniline has an anomalous dispersion but cannot be fused. The acetate of rosaniline might, however, be used.

The Society then adjourned until March 8.

## ELECTRICITY WORKS ACCOUNTS.

### Central London Railway.

Already, in our issue of Feb. 15 the accounts of this interesting undertaking have been commented on at length. Further, owing to its detailed nature, there is little if anything needed in explanation or elucidation of the analysis which we give this week. Of the total share capital of £2,850,000 received £1,969,800 was raised by £10 ordinary shares and the remainder in two amounts of £440,100 by preferred and deferred £5 half shares. Of the 2½ per cent. ordinary dividend paid as the result of this first period of working, the preferred and deferred half shares were paid on respectively at the rate of 1 and 1 per cent.

| Quantities. | City & South London Ry. Half-year to Dec. 31, 1900. | Waterloo & City Railway. Half-year to Dec. 31, 1900. | Central Lond. Railway. Half-year to Dec. 31, 1900.[a] |
|---|---|---|---|
| Train mileage | 383,670 | – | 486,004 |
| Passengers carried | 5,018,842[b] | 2,038,400[b] | 14,916,922 |
| Length of railway (double track) | 4·75 miles | 1·575 miles | 5·825 miles. |
| Capital expenditure per mile of working railway | £463,500 | £383,000 | £603,000 |
| Revenue per train mile (total) | 29·23d. | — | 59·20d. |
| Ditto (from passengers) | 27·96d. | — | 58·28d. |
| Expenditure per train mile (total) | 16·44d. | — | 34·78d. |
| Ratio of expenditure to revenue | 56·2% | 55·3% | 58·75% |
| Revenue per mile of working railway | £9,340 | £10,200 | £20,582 |
| Expenditure per mile of working railway | £5,535 | £5,645 | £12,092 |
| Revenue per passenger (total) | 2·24d.[c] | 1·89d. | 1·93d. |
| Ditto (from fares) | 2·14d.[c] | 1·84d. | 1·90d. |

(a) Working period from July 30 to December 31, 1900 (five months).
(b) Exclusive of season-ticket holders.
(c) Inclusive of season-ticket receipts, but exclusive of season-ticket passengers.

Bearing in mind the points which differentiate this line from the other two railways of its class in London—the City and South London and the Waterloo and City lines—perhaps the above table will be found interesting and convenient for purposes of comparison. In examining this table it is, of

course, necessary to remember that the working figures for the Central London line were obtained on only five months' operations, and that the price of coal and stores were, during that period, higher than in the corresponding period of 1899.

### Blackpool and Fleetwood Tramroad.

The figures in our analysis of the accounts of this trolley line for the half-year to December 31st last show that a healthy improvement has been effected on the working of the corresponding period of 1899. The increase in the passenger traffic was but slight (barely 1 per cent.), while the revenue per passenger shows an advance of about 3 per cent. It is more satisfactory to find that in spite of, perhaps, natural increases in the fuel, repairs, and stores items of power costs, the total expenditure per car mile has diminished proportionately more than the revenue, thus resulting in a distinctly improved financial return on the capital.

Since 1899 the company has started contributing towards a depreciation reserve account—a sum of £1,000 being placed aside for that purpose during the half-year being considered, and £500 in the preceding half-year. Preliminary expenses absorbed another £1,100, and interest charges £942, so that the surplus for the half-year out of the £11,133 gross profit was £8,092.

It is interesting to note the very substantial reductions of cost which have been effected in the car and electrical repairs, traffic, and management expenses.

### City and South London Railway.

Taking into due consideration the circumstances of this undertaking during the period covered by our analysis, there is reason to congratulate the company that the results of their operations are no worse than they are. Not only has idle capital been heavy, but more than one influence has tended to increased costs. Chief amongst these influences may be noted the unusually high price of coal and materials, the extra expenses arising out of the change from the use of pay-gates to tickets and, probably, the working over new lengths of line. It is very creditable that the power costs per train mile should have been diminished. Studying the effect on the expenses apart from the influence on the receipts the change to the regime of tickets appears to have had a material effect on the traffic expenses per train mile. Salaries and wages under this head have gone up by 0·85d., while the two other large contributing items of "lighting, water, and general stores" and "lift power," have doubled in actual amount, thus resulting in the total traffic expense per train mile being 1·63d. above the value at which they stood a year previously.

The increase in the average revenue per passenger from 1·92d. to 2·24d. shows that even now the use of the tickets is justified on this line.

The total number of passengers carried during the half-year was nearly 46 per cent. above the number carried in the corresponding period in 1899, while the receipts have risen from 26·3d to 29·2d. per train mile, or considerably more than the expenses.

It appears fairly certain that the past half-year and the period until the extensions are in operation will be the low-water mark of the late ebb in the fortunes of the company.

### Waterloo and City Railway.

A considerable improvement in the results of the working of this railway is shown by the accounts for the past half-year. With an increased passenger traffic of 15·2 per cent. (as compared with the latter half-year of 1899) the expenses rose no more than by 11·1 per cent., the revenue per passenger being, at 1·89d., just perceptibly higher.

The amount required, under agreement, from th London and South Western Railway to make up th guaranteed ordinary dividend of 8 per cent. was £1,732, as compared with £2,518 in the corresponding 1899 half-year.

It is interesting to notice how close are the revenue and expenditure figures per mile of railway on this line and the South London. Unfortunately neither the chief details of working expenditure nor the train mileage figures are available for the purposes of a full analysis of the accounts.

| | BLACKPOOL AND FLEETWOOD TRAMROAD. | | | |
|---|---|---|---|---|
| *Worked by* | The Blackpool and Fleetwood Tramroad Co. | | | |
| *Date of Commencement of Working* | July, 1898. | | | |
| *System* | Overhead trolley at 500 volts. | | | |
| *Tramway Manager* | John Cameron. | | | |
| *Engineer* | Joseph McMahon. | | | |
| Half-year ended | December 31, 1899. | | December 31, 1900. | |
| QUANTITIES. | | | | |
| *Car mileage* | *311,912* | | *347,577* | |
| **Passengers Carried** | 1,161,786 | | 1,171,525 | |
| Length of single track worked | 15·25 miles | | 15·25 miles | |
| **Length of Route Worked** | 7·75 miles | | 7·75 miles | |
| Rolling stock, No. of motor cars | 24 | | 30[b] | |
| " No. of trailers | 3 | | 3 | |
| CAPITAL. | Total. | Per mile of single track. | Total. | Per mile of single track. |
| **Authorised (Total)** | £240,000 | £15,730 | £240,000 | £15,730 |
| Authorised (share) | 180,000 | 11,800 | 180,000 | 11,800 |
| Authorised (loan) | 60,000 | 3,930 | 60,000 | 3,930 |
| **Received (Total)** | 189,980 | 12,450 | 190,000 | 12,450 |
| Received (share) | 149,980 | 9,840 | 150,000 | 9,830 |
| Received (loan) | 40,000 | 2,620 | 40,000 | 2,620 |
| **Capital Expended (Total)** | 192,892 | 12,650 | 195,584 | 12,820 |
| On permanent way, lands, buildings, working stock, &c. | 192,892 | 12,650 | 195,584 | 12,820 |
| **Balance of Capital Account** | – 2,912[c] | – 191 | – 5,584[c] | – 366 |
| REVENUE. | Total. | Per car mile. | Total. | Per car mile. |
| **Total** | £20,400 | 15·70d. | £21,100 | 14·56d. |
| Traffic receipts | 20,297 | 15·62d. | 20,482 | 14·14d. |
| Transfer fees and sundry receipts | 103 | 0·079d. | 618[d] | 0·426d. |
| EXPENDITURE. | | | | |
| **Total** | £9,840 | 7·579d. | £9,967 | 6·880d. |
| *Maintenance of way and works* | *505* | *0·389d.* | *538* | *0·371d.* |
| Salaries, wages, &c. | 413 | 0·318d. | 292 | 0·202d. |
| Materials | 91 | 0·070d. | 246 | 0·170d. |
| *Engine Power* | *1,977* | *1·521d.* | *2,579* | *1·780d.* |
| Coal | 1,017 | 0·783d. | 1,203 | 0·830d. |
| Salaries and wages | 642[a] | 0·494d. | 671[e] | 0·463d. |
| Oil, tallow, waste and water | 200 | 0·154d. | 251[f] | 0·173d. |
| Repairs and renewals | 118 | 0·091d. | 454 | 0·313d. |
| *Repairs to cars and electrical repairs* | *565* | *0·435d.* | *369* | *0·255d.* |
| Wages | 90 | 0·069d. | 146 | 0·101d. |
| Fittings and materials | 475 | 0·365d. | 223 | 0·154d. |
| *Traffic expenses* | *3,078* | *2·369d.* | *2,951* | *2·038d.* |
| Salaries and wages | 2,576 | 1·982d. | 2,423 | 1·672d. |
| Printing and stationery | 119 | 0·092d. | 148[g] | 0·102d. |
| Other charges | 383 | 0·295d. | 380[h] | 0·262d. |
| *General charges* | *1,739* | *1·339d.* | *1,452* | *1·003d.* |
| Directors' fees | 800 | 0·616d. | 800 | 0·552d. |
| Salaries of sec., manager, clerks, &c. | 573 | 0·441d. | 398 | 0·275d. |
| Other charges | 366 | 0·282d. | 254[i] | 0·175d. |
| *Rents, rates, taxes and insurance* | 1,506 | 1·159d. | 1,110 | 0·767d. |
| *Compensation* | 471 | 0·362d. | 427 | 0·295d. |
| FINANCIAL RESULTS. | Total. | Per cent. to mean capital expended. | Total. | Per cent. to mean capital expended. |
| **Working Profit** | £10,560 | 5·59% | £11,133 | 5·70% |
| Sum carried to depreciation fund | nil | — | 1,000 | 0·512% |
| Net interest on loans | 924 | 0·490% | 942 | 0·482% |
| Balance from last half year's account | 392 | 0·208% | 495 | 0·254% |
| **Balance Available for Dividend** | 10,028 | 5·31% | 8,587[j] | 4·395% |
| **Ord. Div. paid at per cent. per annum** | 10% | — | 9% | — |
| Percentage of total expenditure to rev. | 48·2 | — | 47·2 | — |
| **Revenue per Mile of Single Track** | £1,338 | — | £1,383 | — |
| Expenditure per mile of single track | £645 | — | £653 | — |
| **Revenue per Mile of Route** | £2,634 | — | £2,723 | — |
| Expenditure per mile of route | £1,270 | — | £1,285 | — |
| **Revenue per Passenger (Total)** | 4·21d. | — | 4·33d. | — |
| Revenue per passenger from fares | 4·19d. | — | 4·20d. | — |

**BLACKPOOL AND FLEETWOOD TRAMROAD.**—REMARKS.—*a* Includes wages under "Running expenses" £520, and "Salaries, office expenses and general superintendence" £121. *b* Including 19 open motors and 11 closed. *c* Over expended. *d* Includes £366 from sale of current and £234 from advertising. *e* Inclusive of £534 wages under "Running expenses" and £137 under "Salaries, office expenses and general superintendence." *f* Water being £98. *g* Inclusive of tickets, £35. *h* Inclusive of uniforms £118, advertising £97, and lubricating and cleaning materials £63. *i* Includes auditing £51, office expenses £87, and legal expenses £44. *j* After deducting £1,100 written off preliminary expenses.

| | CENTRAL LONDON RY. | | CITY AND SOUTH LONDON RAILWAY. | | | | WATERLOO AND CITY RAILWAY. | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Worked by* | Central London Railw'y Co. | | The City and South London Railway Co. | | | | The Waterloo and City Railway Co. | | | |
| *Date of Commencement of Working* | July 30, 1900. | | December 20, 1890. | | | | August 8. 1898. | | | |
| *System* | Third rail with trans. sub-[stations] | | Third-rail surface conductor at 500 volts. | | | | Third rail surface conductor at 500 volts. | | | |
| *Chief Engineer* | Sir Benjamin Baker. | | P. V. M'Mahon. | | | | W. R. Galbraith and A. B. W. Kennedy. | | | |
| Half-year ended | Dec. 31, 1900. | | Dec. 31, 1899. | | Dec. 31, 1900. | | Dec. 31, 1899. | | Dec. 31, 1900. | |
| QUANTITIES. | | | | | | | | | | |
| *Train mileage* | *486,004* | | *251,973* | | *[illegible]* | | — | | — | |
| **Passengers Carried** | **14,916.922** | | **3.442 942**[d] | | **5.018.812**[d] | | **1 769.731**[a] | | **2.038.400**[a] | |
| Length of railway authorised | 6 miles 34·7 chains | | 6 miles 64·5 chains | | 6 miles 64·5 chains | | 1 mile 46 chains | | 1 mile 46 chains | |
| Length of railway constructed | 6 miles 34·7 chains | | 3 miles 12 chains | | 5 miles 42 chains | | 1 mile 46 chains | | 1 mile 46 chains | |
| **Length of Railway Worked** | **5 miles 66 chains** | | **3 miles 12 chains** | | **4 miles 60 chains** | | **1 mile 46 chains** | | **1 mile 46 chains** | |
| Length of railway under construction | nil | | 3 miles 52·5 chains | | 1 mile 22·5 chains | | nil | | nil | |
| Rolling stock, number of cars | 150 | | 84 | | 84 | | 22[c] | | 27[b] | |
| " number of locos. | 23 electric, 2 steam | | 28 | | 32 | | 1 | | 2 | |
| CAPITAL. | | | | | | | | | | |
| **Authorised (Total)** | **£3,726,000** | | **£2.198.000** | | **£2.198.000** | | **£720.000** | | **£720.000** | |
| Authorised (share) | 2,850,000 | | 1,680 000 | | 1,680 000 | | 540 000 | | 540,000 | |
| Authorised (loan) | 876,000 | | 518,000 | | 518,000 | | 180 000 | | 180,000 | |
| **Received (Total)** | 3.463.665[a] | | 1.748 549 | | 2.117.878[c] | | 580.333 | | 603.833 | |
| Received (share) | 2,850,000 | | 1,500,772 | | 1,666,510 | | 540,000 | | 540,000 | |
| Received (loan) | 613,665[a] | | 244,315 | | 413,913 | | 40,333[d] | | 63 833[d] | |
| | Total. | Per mile of working railway. | Total | Per mile of working railway. | Total. | Per mile of working railway. | Total. | Per mile of working railway. | Total. | Per mile of working railway. |
| **Expended (Total)** | £3,512,013 | £603,000 | £1.884.067[a] | £598.300 | £2.201.870[f] | £463.500 | £581,989 | £369.500 | £603.125 | £383,000 |
| On line open for traffic | — | — | 841.877 | 267,000 | 841.877 | 17.710 | 581,989 | 369,500 | 603,125[c] | 383,000 |
| On line in course of construction | — | — | 966,653 | 304,000 | 1.210,035 | 254,700 | | | | |
| On worki'g stock, incl'd'g power stat'n | — | — | 74,992 | 23,790 | 81,518 | 17,160 | | | | |
| **Balance of Capital Account** | 48.348 | 8.300 | −135 518[f] | −43,030 | −83.993[h] | −17,670 | −1.656 | −1,051 | 708 | 449 |
| **Renewal Fund** | — | — | — | — | — | — | — | — | — | — |
| **Contingent Fund** | — | — | — | — | — | — | — | — | — | — |
| REVENUE. | Total. | Per train mile. | Total. | Per train mile. | Total. | Per train mile. | Total. | Per train mile. | Total. | Per train mile. |
| **Total** | £119.890 | 59 205d. | £27.506 | 26·30d. | £46.740 | 29 23d. | £13.892 | — | £16.066 | — |
| Passenger traffic | 118,008 | 58·280d. | 26 198 | 25 00d. | 44,716 | 27·96d. | 13,484 | — | 15,616 | — |
| Parcels, rents, transfer fees, &c. | 1,682[b] | 0·930d. | 1,308 | 1·299d. | 2,024 | 1·266d. | 408 | — | 450 | — |
| EXPENDITURE. | | | | | | | | | | |
| **Total** | £70.434 | 34·783d. | £15.968 | 15·84d. | £26.281 | 16·44d. | £8.003[g] | — | £8.891[i] | — |
| *Maintenance of way, works, and stations* | *2,076* | *[illegible]* | *676* | *0·671d.* | *[illegible]* | *[illegible]* | — | — | — | — |
| Maintenance of way { Wages | 1,208 | 0 597d. | 261 | 0 259d. | 470 | 0·294d. | — | — | — | — |
| Maintenance of way { Materials | 188 | 0·093d. | 147 | 0·146d. | 112 | 0·070d. | — | — | — | — |
| Repairs of structure, stations, &c. | 580[c] | 0·286d. | 223 | 0·221d. | 298 | 0·186d. | — | — | — | — |
| Salaries, office expenses, and general superintendence | 100 | 0·049d. | 45 | 0 045d. | 58 | 0·036d. | — | — | — | — |
| *Locomotive and generating power* | *26,184* | *12·931d.* | *5,899* | *[illegible]* | *8,800* | *[illegible]* | — | — | — | — |
| Coal and coke | 11,094 | 5·479d. | 1,675 | 1·661d. | 2,696 | 1·686d. | — | — | — | — |
| Wages | 7.717[d] | 3·811d. | 2,385 | 2·366d. | 3.711 | 2·320d. | — | — | — | — |
| Oil, water, gas and stores | 1,913[e] | 0·945d. | 432 | 0·429d. | 678 | 0·424d. | — | — | — | — |
| Repairs and renewals { Wages | 3,460 | 1·708d. | 618 | 0·613d. | 773 | 0·483d. | — | — | — | — |
| Repairs and renewals { Materials | 765 | 0·378d. | 711 | 0·706d. | 649 | 0·406d. | | | | |
| Salaries, office expenses, and general superintendence | 1,235 | 0·610d. | 78 | 0·077d. | 294 | 0·184d. | — | — | — | — |
| *Repairs and renewals of cars* | *2,336* | *1·154d.* | *[illegible]* | *[illegible]* | *836* | *[illegible]* | — | — | — | — |
| Cars { Salaries, office expenses and general superintendence | 20 | 0·010d. | 40 | 0·040d. | 60 | 0·038d. | — | — | — | — |
| Cars { Wages | 829 | 0·410d. | 358 | 0·355d. | 594 | 0·371d. | — | — | — | — |
| Cars { Materials | 491 | 0·245d. | 90 | 0·089d. | 182 | 0·114d. | — | — | — | — |
| Lifts | 956 | 0·472d. | — | — | — | — | — | — | — | — |
| *Traffic expenses* | *30,478* | *15·051d.* | *6 138* | *6 088d.* | *12,339* | *7·718d.* | — | — | — | — |
| Salaries & wages—stations & service | 16.106 | 7·955d. | 3 961 | 3 930d. | 7,642 | 4·780d. | — | — | — | — |
| Fuel, light'g, water & general stores | 5,446 | 2·690d. | — | — | — | — | — | — | — | — |
| Electric lifts—wages and materials | 5,059 | 2·498d. | — | — | — | — | — | — | — | — |
| Miscellaneous expenses | 3,867[f] | 1·910d. | 2,177[i] | 2·160d. | 4,697[j] | 2·937d. | — | — | — | — |
| *General charges* | *5,076* | *2·507d.* | *1,877* | *[illegible]* | *2,280* | *[illegible]* | *391* | — | *260* | — |
| Directors | 1,250 | 0·617d. | 650 | 0·645d. | 650 | 0·406d. | 270 | — | 165 | — |
| Salaries of sec., gen. man. & clerks, &c. | 1,947 | 0·961d. | 498 | 0·494d. | 590 | 0·369d. | 70[f] | — | 45[f] | — |
| Other charges | 1,879[g] | 0·928d. | 729 | 0·723d. | 1,040 | 0 650d. | 51 | — | 49 | — |
| *Rent, rates, taxes, &c.* | *[illegible]*[h] | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | *[illegible]* | — | — | — | — |
| *Miscellaneous items* | *480*[i] | *[illegible]* | *[illegible]* | *[illegible]* | *117* | *[illegible]* | — | — | — | — |
| FINANCIAL RESULTS. | Total. | % to mean cap. exp'nd'd | Total. | % to mean cap. exp'nd'd | Total. | % to mean cap. exp'nd'd | Total. | % to mean cap. exp'nd'd | Total. | % to mean cap. exp'nd'd |
| **Working Profit for Half year** | £49.456 | 1·44 | £11.538 | 0·643 | £20.460 | 0·962 | £5.889 | 1·02 | £7.172 | 1 19 |
| Sum carried to depreciation fund | — | — | — | — | — | — | — | — | — | — |
| Net interest on loans | 10,303 | 0·300 | 1,215 | 0 068 | 5,906 | 0·278 | 425 | 0·074 | 792 | 0 132 |
| Balance from last half year's account | — | | 1,106 | 0·062 | 788 | 0·037 | 273 | 0·047 | 65 | 0 011 |
| **Balance Available for Dividend** | 39.152 | 1·14 | 11.430 | 0·637 | 15.342 | 0·722 | 8.255[k] | 1·43 | 8.177[i] | 1·35 |
| **Ord. Dividend paid at per cent per ann.** | 2 | — | 1½ | — | 1½ | | 3 | | 3 | — |
| Percentage of total expenditure to rev. | 58·75 | — | 58·1 | — | 56·2 | — | 57·6 | — | 55·3 | — |
| **Revenue per Mile of Working Railway** | £20.582 | — | £8.730 | — | £9 840 | — | £8 820 | | £10 200 | — |
| Expenditure per mile of work'g railway | £12,092 | — | £5,070 | — | £5,535 | — | £5,080 | | £5,645 | — |
| **Revenue per Passenger Total** | 1·93d. | — | 1 92d. | — | 2 24d. | — | 1 88d. | | 1·89d. | — |
| **Revenue per Passenger from Fares** | | | 1·83d. | — | 2 14d. | — | 1 83d. | — | 1·84d. | — |

CENTRAL LONDON RAILWAY.—REMARKS.—*a* The loan capital included here as received, viz. £613,665, is the amount of debenture stock due to contractors for construction of railway to Dec. 31, 1900. *b* Includes transfer fees £166. *c* Includes repairs of signals £304, and of stations and buildings £276. *d* Being wages connected with working of generating and locomotive engines. *e* Includes water and gas £[illegible], and oil, tallow and other stores £1,065. *f* Includes cleaning of carriages £1,655, printing, stationery, &c., £1,[illegible], and clothing £477. *g* Includes office expenses £1,[illegible] and insurance £358. *h* Includes Gov. duty £[illegible], rates and taxes being estimated in official accounts at £[illegible]. *i* Includes law charges £331, & compensation for accidents & losses £158.

CITY & SOUTH LONDON RAILWAY.—REMARKS.—*a* Inclusive of £[illegible] dividend to June 30, 1899, on £200,000 preference stock, and £[illegible] interest on [illegible] ordinary shares at [illegible] per annum. *b* Over expended. *c* Includes passenger duty £[illegible] and law £4. *d* Exclusive of [illegible] season ticket holders in 1899 and [illegible] in 1900. *e* Includes £[illegible] from premiums. *f* Includes £[illegible] dividend to Feb. 28, 1900, on £[illegible] pref. stock (1896) also £[illegible] interest on £[illegible] ord. shares at [illegible] per annum and £[illegible] discount, brokerage and commission on [illegible] shares issued Nov. 1900. *g* Includes passenger duty £[illegible] and law £11. *h* Includes wages £[illegible] and materials £[illegible]. *i* Includes hydraulic and electric lift power £[illegible], and lighting, water and general stores £[illegible]. *j* Includes hydraulic and electric lift power £2,[illegible] and lighting, water and general stores £1,418.

WATERLOO AND CITY RAILWAY.—REMARKS.—*a* Exclusive of season ticket holders. *b* Of which 17 are motor carriages and 10 are "trailers." *c* Of which 12 are motor carriages and 10 are "trailers." *d* Inclusive of £[illegible] interest paid during construction. *e* Includes £[illegible] interest during construction, £[illegible] on way and stations, and £[illegible] on electrical equipment. *f* Salaries of secretary and clerks. *g* Includes Government duty £270 in 1899 half-year and £[illegible] in 1900 half year. *h* After adding £[illegible] amount allowed by L. & S. W. Ry. Co. under agreement to provide dividend of [illegible] on ord. and borrowed capital. *i* After adding £1,7[illegible] from L. & S. W. Ry. Co., see note *h*.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday. Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON

*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*ll Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed* "*Coutts and Co.*"

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN' are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## CAPACITY IN ALTERNATING-CURRENT WORKING.

"Every schoolboy knows who imprisoned Montezuma and who strangled Atahualpa. But we doubt whether one in ten, even among English gentlemen of highly-cultivated minds, can tell who won the battle of Buxar, who perpetrated the massacre of Patna, whether Sujah Dowlah ruled in Oude or Travancore, or whether Holkar was a Hindoo or a Musselman . . ." So wrote MACAULAY in his essay on CLIVE. In the same strain we might say, every schoolboy (or, at any rate, each one of Prof. AYRTON's third-year students) knows that the charging current of a cable is $2\pi$ times the product of the impressed sine-wave voltage, the capacity, and the frequency, that this current may be diminished by an inductance in parallel with the capacity, and that a certain amount of energy must necessarily be wasted in the dielectric of the cable. But we doubt whether one in ten, even among English professors of highly-cutivated minds, could have told —before the discussion on Mr. MORDEY's Paper—what would be the nature and magnitude of the effect of varying the sine law of the alternating impressed voltage, what was the commercial importance of the capacity current, and what was the magnitude of the loss in the dielectric of an actual cable. It has been even argued that Mr. MORDEY's Paper is one that should never have been accepted by the Institution owing to its being partly ancient history and partly based on what appear to have been inaccurate measurements; but no one can deny that the net result of the Paper and the discussion on it has been to bring out some interesting new facts, and to fix our ideas generally on the part played by the capacity of cables in alternate-current working.

Coming, first, to the vexed question of dielectric hysteresis loss. The weight of the evidence put forward tends to show that the loss by dielectric hysteresis has been computed by Mr. MORDEY at from four to six times its probable value. Testing one rubber-insulated cable, he came to the conclusion that its power-factor, or the ratio of the real power spent in the cable to the product of the volts and amperes which it carried, was 0·124. Subsequent experiments have shown this ratio to be more in the order of 0·2 or 0·3; and of course, the cables now generally employed for high voltage being

insulated with oiled paper, bitumen, or impregnated fibre, their capacity is lower and the volt-amperes therefore less, so that for the same power-factor the waste watts are again diminished. Thus, instead of a loss of 1,200 watts per mile with a 6,000-volt 37/15 cable at a frequency of 50 ∼ per sec., we may reckon about 200 watts. Taking a light and power distribution system with this size of cable as an average and, say, 50 miles of it constantly charged, we have a waste of 10kw., or 240 Board of Trade units during the day. If the alternating current were not employed for lighting purposes the frequency would, no doubt, be considerably diminished, and this loss lessened in proportion. Of course 240 Board of Trade units *per diem*, or less than 100,000 *per annum*, is a very small proportion of the output of a large works. If, therefore, cables with still lower capacity and still lower dielectric hysteresis loss would cost appreciably more than the present ones, it would not pay to employ them. But this need not be the case. Now that the cable manufacturers' attention has been drawn to the matter, a slight modification in one of the processes of manufacture might very possibly be found to eliminate this dielectric hysteresis almost entirely. It is to be regretted that the meeting did not hear the opinions of cable makers on this point. In using the term "dielectric hysteresis" we include, as Mr. MORDEY has done, all the dielectric losses. Whether these are chiefly due to an actual hysteresis effect in the dielectric, whether the absorption and polarising effects are of some account, and whether the insulation resistance itself is actually less for charges of brief duration are questions of molecular physics and hardly affect the engineering side of the question.

The capacity current is the next consideration. If the load is sufficiently non-inductive, a fairly large "wattless current" will go out from the generator to charge the cables, and although this current is out of phase with the voltage, there will yet be a certain $C^2R$ loss both in the cable and alternator. In practice, however, the inductance is more often of greater account than the capacity, and the resultant current is lagging and not leading. Cases do occur, as Mr. MORDEY pointed out, in which there is not sufficient inductance to counterbalance the capacity effect, and for this case he revives the proposition of employing an inductive leak across the cable. It must be pointed out, however, that the effect of this inductance, unless it be a number of coils distributed along the cable, will only be to diminish or eliminate the capacity current from the dynamo, and the $C^2R$ loss in the cable due to the capacity current remains. The light load losses of the alternator which might thus be saved were, in Mr. SPARKS' opinion, unimportant.

Peculiarly enough, the method of measuring capacity, to which Mr. MORDEY invited the station engineer's consideration attracted a vast deal of attention in the discussion, in spite of its antiquity, and, moreover, brought to light some most interesting and useful phenomena. The outcome was that this method is unreliable in most cases without the employment of elaborate corrections to the simple formula enunciated. For the formula to be applicable, a true sine-wave curve is necessary, and experiments made subsequently to the reading of the Paper show that this form of curve cannot safely be assumed. Mr. MORDEY pointed out in his supplementary remarks that the current might vary 200 or 300 per cent. for a given capacity, depending on the form of wave, and this was fully borne out by other speakers. The vagaries of meters and wattmeters when traversed by currents with small power factors, were also interesting, and in this connection Dr. SUMPNER's remarks are instructive.

In conclusion, therefore, it must be admitted that, so far as direct engineering utility is concerned, Mr. MORDEY's Paper has been a disappointment. The net result is that perhaps cable manufacturers will pay more attention than hitherto to diminishing the capacity of electric light and power cables, and to the elimination of dielectric losses—the latter may possibly be achieved by a reduction of the effect known as "electrification" in the cable-testing room. But the educational value of the Paper, taken in conjunction with the correcting coefficient supplied by the discussion, is not inconsiderable. Many points have been threshed out on which erroneous views existed hitherto, and even professors must allow that the publication and subsequent explosion of fallacies should not be discouraged any more than the publication of experimental researches leading to negative results. Had Mr. MORDEY, for instance, not called attention to the method of measuring capacities with alternating currents, Prof. AYRTON's Physical Society Paper of 1891 might have remained forgotten; and if the bugbear of dielectric hysteresis had not been set up, perhaps the inapplicability for practical work of this method—whoever its originator—might not have been pointed out.

## OBITUARY.

### GEORGE FRANCIS FITZGERALD.

At the same age as Clerk Maxwell, FitzGerald has gone from us: there has been no equal blow to Physical Science between the two events, in this country, possibly not in the world: for the untimely death of Hertz himself was no greater blow. Old men pass in the course of nature, and we mourn them; but the departure of a bright genius full of power and originality, trained by years of effort and self-denial to do work which no one else can do, strikes one with a chill feeling of calamity.

Why do they die so young? They are overworked, undoubtedly they are overworked. The problems of highest physics are too appallingly difficult, ordinary humanity knows nothing of them, it does not realise the burden of thought which weighs on the shoulders of the few who can solve them: it cannot realise the mental strain, the continued weeks of thought which must go to the highest achievements in physics. Such men should live apart and be preserved from the every day struggle of common life; but that is not our system. Nature is prodigal, and we imitate her wastefulness in dealing with genius. Let any Dublin man bear testimony, let us be told how many committees and boards and meetings FitzGerald attended; let us hear how constantly he was used by societies as scientific referee, how many proof sheets of others he had to read when they were writing books, how he was appealed to in all cases of difficulty not only by his colleagues and disciples and pupils in Ireland, but by the whole physical and chemical English speaking world.

Was it a waste of time, this help freely given to others, this self-forgetful energy in the public service? Who is to say? It was waste of health, but it stored up in the minds of many a mighty affection for their helper. No it was not waste of time.

A good man he was if ever there was one: devoting himself to public work, free from all petty ambition, caring nothing for himself: throwing out his ideas right and left with splendid prodigality, rejoiced if they were absorbed and utilised by others. How quick he was to seize a point, how keen to criticise, to extend, to illuminate, a subject. Put near his elbow an abstruse Paper, he would take it up casually, as another might a newspaper, and soon he would be absorbed and begin pencilling out calculations indicative of luminous ideas.

See him at a British Association meeting of Section A, he was the life and soul of debate, he was always ready with some

semiparadoxical but wholly suggestive and stimulating idea. See him at that memorable meeting at Bath, when he brought forward and made known to the world the brilliant experimental discoveries of Hertz, discoveries which verified FitzGerald's own suggestions and surmises. Hear him at that same meeting when he was discussing with Lord Kelvin and others about Ψ and J and the propagation of electrostatic potential in time, and the other outstanding difficulties in Maxwell's splendid work. Turn back to *The Electrician*, for 1888, Vol. XXI., pp. 624, 660, and read it again.

There did not exist a brain quicker to seize a point, fuller of ripe learning, readier to apply it in any direction, less absorbed in itself, and more willing to enter into the work and the difficulties of others; nor was any mind keener to apprehend rightly the real difficulties of physics, or more fruitful of verifying suggestions. Let Larmor tell us of his help in mathematics, let Ramsay tell us of his help in chemistry, let Perry tell us of his help in problems applied to engineering, but let me bear testimony to his simple human unselfish public spirited hard working college and family life. Aye he was a man worth knowing. His memory will not fade. Long life could not have bettered it. He has lived his life, and has left an influence on his generation as potent as his influence on the progress of physical science.

It has been a great epoch this latter half of the nineteenth century, a period with which his life was conterminous; but it seems closing in. Yet no, there are a few men left, and discoveries are in the air. We must close up the ranks and proceed; thankful that we have known him, and not disheartened or dismayed.

His powers blossomed early, and he had a good education. He did not go to school, but absorbed mathematics at home under tutors who must have known and loved their subject, and from them he did not learn the inattention and listlessness which seem inseparable from class work under average teachers.

He possessed extraordinary versatility, and could turn his mind almost instantly to anything, but the instant it was so turned it went deep into the subject, to the exclusion of other things for the moment; and in the deepest subjects he was more at home than in the trivial and superficial. But he was never a recluse; had he been more of a recluse perhaps his great power of intimate brooding and absorption, combined with his wide mathematical knowledge and preparedness, might have led him to some epoch-making discovery.

But if so he did not give himself the chance, his place was with the captains and the shouting, and the intervals of leisure for real continuous work were few and far between; hence he leaves no book and few papers. Not so few as people think however; many were published by the Royal Dublin Society, and these may be collected and made more accessible in future; but very few indeed compared with his powers and the fertility of his brain.

Had he lived on into the more serene atmosphere of a senior fellowship of Trinity College, Dublin, he might have put all his work together and brought out a suitable treatise which would serve as a memorial, a landmark for later time; but he lived a hard and strenuous life, and the era of peace was still in the future when he died.

I saw much of him at Bradford last September, and he spoke of indigestion and of needful care and caution with food; it did not seem to me serious, but a few weeks later he wrote to say that problems stayed on his mind more than they used, and interfered with him and could not be shaken off, and that he was not allowed to think continuously. He feared that he might be permanently debarred from thinking if he were not careful. The letter frightened me, and I wrote round to several who were likely to correspond with him, and to some in Dublin, warning them of danger and begging them to be careful.

Then the indigestion grew worse, and he had to have complete rest and isolation from letters: but the internal trouble continued, and suddenly intensified; then an operation, and the peaceful rapid end.

The electricians of the world will not resent these details: surely they regarded him as a friend. They will wish to know the cause and the manner of the end. Into many parts of the earth, wherever cables are laid and wherever man talks Morse, the death of Fitzgerald has already gone: it is fitting that these unknown friends of his should hear the few details which we in England know.

It is right that such a man should be honoured for his great learning, high powers, and bright achievements, on which many from various points of view can speak; but it is right also that he should be lamented on his human side by one who loved him as a brother.

OLIVER LODGE.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Thermo-Luminescence due to Radium Rays.*—The fluorescence produced by radium rays is, generally speaking, feeble, and can only be perceived in a completely darkened room with thoroughly rested eyes. But E. Wiedemann has found that an intense thermo-luminescence can be produced comparatively easily. He used the radium preparation by Rousseau & Co., Paris. The preparation was contained in a hole 8mm. wide sunk into a glass plate 3mm. thick. A piece of aluminium foil was stuck over the hole, thus keeping the substance safe from moisture. The detective substance employed for thermo-luminescence was the solid solution of manganese sulphate in calcium sulphate. This was spread in a thin layer on a piece of aluminium foil 6 cm. square, and covered with a sheet of mica. The radium preparation was laid upon it, and left so for several hours. The aluminium foil was then placed upon a heated copper plate. At the place where the radium preparation had lain a green circle shone out, visible at some distance. That the solid solution named is only feebly incited to phosphorescence, but strongly to thermo-luminescence, by radium rays, is paralleled by its behaviour under the influence of discharge rays, and shows that both kinds of rays exert an influence upon the structure of the substance.

[E. WIEDEMANN, *Phys. Zeitschr.*, February 2, 1901.]

*The Electro-Radiophone.*—T. Tommasina describes an interesting new instrument for detecting and studying distant thunderstorms, and gives some graphic details of its use on some special occasions. The apparatus consists essentially of a self-decohering carbon coherer, placed in circuit with a dry cell and an ordinary telephone receiver. The carbon is in grains, prepared from arc carbons thoroughly dried by heat, and sealed up hermetically in a glass tube attached to the telephone magnet, so as to lie horizontally when the telephone is put to the ear. With this arrangement, the author discovered that certain definite sounds corresponded to every indication of Lera's electro-radiagraph as installed at Catania. The impression produced upon the observer was that of being transported into the neighbourhood of the thunderstorm which might yet be hidden below the horizon. To strengthen the effect the author used three copper "antennæ," each 30m. long, taking due precautions against shock. In this manner it was found possible to observe the development of a violent thunderstorm at a distance for 12 hours before it broke loose at the observing station, which was situated on the Lago Maggiore. A distant rain is indicated by a rattling sound before a cloud is visible. The author believes that his apparatus, simple as it is, will be of important service to navigation in the matter of weather forecasts.

[T. TOMMASINA, *Phys. Zeitschr.*, February 9, 1901.]

*Bare Telephone Wires on Snow.*—In a letter to M. Janssen, A. Ricco announces that he has solved the problem of maintaining communication between the Etna Observatory and Nicolosi by the expedient, suggested by Janssen, of laying the bare wire over the frozen snow. The experiment has been perfectly successful.

[RICCO and JANSSEN, *Comptes Rendus*, February 11, 1901.]

*Current Intensity of Lightning Flashes.*—F. Pockels succeeded in showing some time ago that the remanent magnetism produced in basalt by a magnetic field only depends upon the

maximum intensity of the latter, however short the time during which that maximum intensity might prevail. This fact may be used to determine the current intensity of lightning flashes. For this purpose a rod of basalt would be placed near a lightning conductor in such a position that the circular lines of magnetic force produced by a discharge would approximately pass through the length of the rod. The maximum intensity of the discharge current would then be calculated by the formula

$$i = \frac{5L}{2\tan^{-1}\frac{L}{2a}}\,\mathsf{H} \text{ (amperes).}$$

H would have to be found in terms of the remanent magnetism of the basalt by previous experiments. Such experiments, when made by the author, gave for $\mathsf{H}=100$, $m_r=0{\cdot}1484$, and for $\mathsf{H}=310$, $m_r=0{\cdot}5246$. Some basalt rods were thus successfully exposed by Chistoni in the Monte Cimone observatory in the Apennines, and the resulting magnetisations indicated currents of 10,000 to 20,000 amperes. Another rod showed a feeble magnetisation, probably due to the prevalent "St. Elmo's Fire."

[F. Pockels, *Phys. Zeitschr.*, February 16, 1901.]

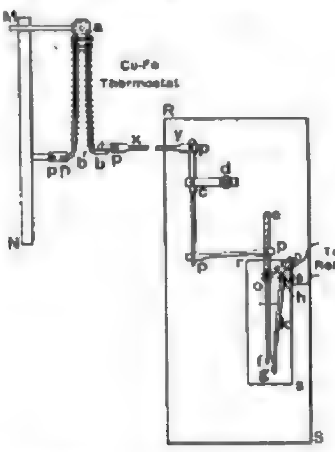
---

*Dielectrics in a Magnetic Field.*—The experiments of Faraday and Kerr on the behaviour of polarised light in passing through various media, when these are in a magnetic field, or subject to dielectric strain, make it seem possible that the presence of a magnetic field may have some effect on the specific inductive capacity of a dielectric. The following experiments were undertaken by E. C. Roberts in order to discover if possible whether such an effect exists. Although the method of attacking the problem was varied, the whole procedure was based on the fact that if a condenser be charged and insulated, any change in the specific inductive capacity will manifest itself as a change in the P.D. between the coatings. The dielectrics studied (glass, hard rubber, and vulcanite) were used in the form of small condensers. Sheets of tinfoil 5·8cm.² were fastened on opposite sides of a plate of the dielectric, which was in each case about 20 × 25cm., thus making the leakage path rather long. In the case of glass the whole condenser was covered with shellac to further decrease the leakage. The direction of the electric strain was parallel to the lines of magnetic force in nearly all cases. The magnetic field was one of 1,500 lines per square centimetre across an air-gap of 3·5cm. Three different methods were used, but in none of them was any magnetic effect upon the specific inductive capacity observed. The limit of observation was such that if the effect had been $\frac{1}{3500}$th of the whole it could still have been observed.

[E. C. Roberts, *Phys. Review*, January, 1901.]

---

*Automatic Temperature Regulator.*—C. T. Knipp has devised an electric temperature regulator which enables one to keep a



temperature up to 380deg. within a fraction of a degree. The arrangement is shown in the diagram, where *ab*, *ab'* are two Cu-Fe thermostats clamped with their backs to each other. MN, the main support, carried at its upper end an arm M*a*, from which at *a* the thermostat was supended by pivots. The lower end of the arm *ab'* was fastened by pivoted connections directly to the support MN, thus leaving the lower end of *ab* free to move in the plane of the paper, its motion being that due to both branches of the thermostat. This motion communicated by an aluminium rod *xy* to a system of pivoted aluminium levers mounted on a vertical board RS. The first lever had its fulcrum on a movable support at *c* which was capable of adjustment up and down by means of a thumbscrew at *d*. The motion of the lower end of this lever was communicated to another lever *ef*. This lever was mounted on a separate board *rs*, and both lever and board were pivoted concentrically at *o* to RS. The lower end of *ef* terminated in a platinum ring. Another lever supported on *rs* and pivoted at *h* was held lightly against a stop *g* by a delicate spring at *k*. The lever *hg* was flattened at its lower end and carried a platinum surface on which *f* played. All of the joints *p* were delicately pivoted needle points. The amount of motion at *f* could be varied through a considerable range by adjusting the length of the levers *op* and *ep*. Wires led from *o* and *h* to a relay which in turn operated an ordinary sounder that controlled a part of the heating current. A great deal of the success of the regulator depends upon the delicacy of the needle-point bearings.

[C. T. Knipp, *Phys. Review*, January, 1901.]

---

## THE ELECTRICAL POWER BILLS OF 1900: BEFORE AND AFTER.*

BY WM. L. MADGEN.

The difficulty of selecting a title to describe suitably a statement dealing with many considerations is a familiar one, and as I should wish to deflect discussion to more important questions, I will by way of preamble more particularly describe the scope and intention of this Paper. The intention, then, is to consider those conditions of our electrical industry which led up to the electrical power bills of the past session, to describe briefly some of the main features of the bills themselves, and to urge the Institution to determine what its attitude should be in face of the charges of backwardness continually being made in regard to the applications of electrical energy in this country.

To present a connected case it may be necessary to traverse a certain amount of ground well known to many of us; but it is in the hope that we shall be more firmly united in our struggle against the continuing legislative and other difficulties by which our path is sorely beset, that I ask you to review the situation this evening. The new century has been acclaimed on all hands as the age of electricity, but every article on the subject in the magazines and daily press, and they have been many, appears to bewail the backwardness of this country in electrical enterprise.

The *Daily News*, in a leading article devoted to the recent visit of Mr. C. T. Yerkes, the American tramway magnate, suggests that now Mr. Yerkes is about to have his hand in on this side he might proceed to think out some magnificent scheme for enabling the people of England to, among other things, work their factories and workshops by electricity!

The *Daily Graphic*, in an illustrated article describing electrical developments in northern Italy, notes that

"... in one enormous industry there can be no doubt that we are far behind nearly every important country in the world. That industry is, in broad terms, the adaptation of electrical energy to the needs of man."

The *Daily Mail*, in a leader headed "Our Start in the Electrical Age," says:—

"In the twentieth century we find that our competitors are ahead of us in the utilisation and application of electricity. It is not to England that the foreigner comes for dynamos or electric tools or electric lifts or electric railway and tramway fittings. .... Our streets are rarely lighted by electricity. As a motive power on our railways and tramways this new force has been as yet only occasionally employed, and the two or three electric railways of London are still a source of wonder to the inhabitants of our islands. All this is greatly changed from the day when we led the world. And whereas in the past we built the foreigners' steam railways, to-day the American is building, or proposing to build, our electric lines."

This article goes on to say that "it would be interesting to investigate the causes of our backwardness." The matter is, however, something more than "interesting"—it is one that demands our most active concern.

Some of the indictments are more sweeping. It appears we are not all alone unhappy; the *Pall Mall* considers that

"in every department of public life our methods are out of date. We feast on words and trade upon tradition. ... We forget that, though the camel may exist for a period upon its own hump, the process cannot last for ever. We have been like Brahmins in our pride and Mandarins in our methods, and that is a bad combination."

* Paper read before the Institution of Electrical Engineers, Feb. 21.

*Fielden's Magazine*, the militantly British, finds space for Sir W. H. Preece to say, *à propos* of the dangers of foreign competition, that "we are a foolish and conceited nation, and blind to our own deficiencies."

The above are a few examples of the reproach which has become familiar to most of us. It may be the habit of the British, "in the intervals of blowing our own trumpets, to rush to the other extreme, and to needlessly belittle ourselves." It may be that "prophets of ill are for ever telling us of the decadence of our industries and of the rapid progress of our rivals," but there is no comfort for the electrical engineer in any such commonplace.

After the events of the past year there is little need to urge that the national sentiment is as sound among members of this Institution as in any part of the community, and the conclusion which has been forced upon us from all sides that the extent of our department of industrial work is far behind that of nearly every other important nation in the world, is sufficiently mortifying.

There may be some of us who find amusement in the comments of the daily papers on technical subjects, but it should be remembered that the articles we scoff at are read by thousands of those of our fellow countrymen who make up those sentiments and influences which affect us seriously, and it seems full time that steps should be taken to place the responsibility for our backwardness where it belongs. We shall have to take our own part, or we shall find the public ordering German plant with the same complacency as they purchase German pianos. It has become the custom with some of us to devote occasionally a few weeks to the visiting of other countries to benefit by the experience gained there in the developments of electrical work, and thanks principally to the energy of our secretary this practice has become organised, and a largely increasing number now have opportunities of taking part in these expeditions. The reflections ensuing upon these visits have no doubt varied in depth, and in character, with the individual and the nature of his occupations.

One of our greatest science teachers, in his presidential address which lives in our memory, referred in inspiring terms to the visit to Switzerland and the revelation it was to us. We were, he said, very much like what engineers of 1870 would have been if brought suddenly into a generating station, and attributed much, if not most, of our backwardness to our knowing too little theory. I am inclined to the view that this lack of theoretical knowledge is an effect rather than a cause of our troubles. In Germany and Switzerland particularly we see a systematic devotion to technical and scientific training, but the Americans have applied themselves rather less to the principles than to the applications of science, and it is the latter country which is probably the most in advance of us in electrical engineering. It is unnecessary, however, to give occasion for a discussion on theory *versus* practice. I am sure we take it to heart that we have too little theory, and will loyally support those who are endeavouring to apply more scientific methods to our manufactures. I am more apprehensive just now concerning the scope for the employment of the young electrical engineer when he has been prepared by the most approved methods.

We have no feeling but cordial goodwill for those friends abroad who have made our visits so pleasant and instructive; but the reflections of many of us on our return have been those of indignation at the obstacles set in the path of our industry by the governing bodies of this country, and of resentment at the wretched waste of energy and enterprise which they have occasioned. The electrical engineers of the United Kingdom are not to blame, and there is no occasion for any apology on their behalf. I am aware there may be those who are interested in the maintenance of old methods of working, and we have internal complaints now and again for which the observatory at Kew may for the moment be taken as a symbol. But we can put such issues past us for the present, and consider whether it is not our duty to make a united effort to secure liberal measures of enfranchisement.

The position cannot be attributed to lack of ability or inventiveness on the part of British engineers. Some of the most important improvements have been worked out in this country, but our environment has been too much for them, and they have found their fullest practical application abroad. One of the first electric tramways on a practical scale was put down in the North of Ireland by Lord Kelvin, Mr. Traill, and others, but the effect of the Act of 1870, which had been humorously entitled "An Act to Facilitate the Construction and to Regulate the Working of Tramways," has been disastrous to tramway enterprise in this country. The principles of dynamo construction were worked out at an early stage by the late Dr. John Hopkinson, whose share in the evolution of the three-wire system is also well known to us. To Swan, as much as to any other, the world is indebted for the incandescent lamp. In the early eighties work of the utmost value was done by Ferranti and others on the details of alternating-current transmission.

It is unnecessary for me here to dwell upon the abundant evidence in support of this. It is registered for the most part in the *Journal* of the Institution, and much of it is recorded in the work of others on every continent. What is the reason, then, that our electrical industry is behind that of nearly every important country in the world? It is due in the first place to silly legislation by Parliament and to obstruction by the numerous local authorities entrusted with arbitrary powers. In the second place, it is due to a class of quasi-officials and their associates, to whose direct monetary advantage it is that an opposition should be entered to every project in which they are not employed. There may be contributory causes; but to these, and others that flow from them, our chief difficulties may be assigned.

Ere this Institution was founded an obstacle had been prepared for us. In 1870 was passed the Tramways Act to which I have referred, and these are some of its leading provisions. A tramway cannot be authorised by provisional order without the consent of the local authority of the district. If the proposed tramway is to run through two or more districts, and consents have been obtained in respect of two-thirds of the length, the Board of Trade may, upon inquiry, dispense with consents for the remainder. When the procedure is by provisional order the construction of the line can be absolutely blocked by notice given in the prescribed manner by one-third of the owners, or of the occupiers, of the premises abutting upon the road where for so short a distance as 30ft. or upwards there would be less than 9ft. 6in. between the outside of the footpath on either side of the road and the nearest rail of the tramway. The most onerous condition is provided in the notorious section 43, by virtue of which the local authority can purchase a tramway at the expiration of 21 years from the date of the order, or of any subsequent period of seven years, on the terms of paying the then value of the tramway, exclusive of any allowance for past or future profits of the undertaking, or any compensation for compulsory sale, or other consideration whatsoever.

We shall agree with Mr. Granville C. Cunningham, general manager of the Central London Railway, that—

> "there is perhaps nothing that has done so much to prevent the relief of overcrowding and congestion as the Tramways Act of 1870. Its provisions in rigidly limiting the term of the concession to 21 years, and practically fixing the price at which the municipality may take over the undertaking at something far below its value, have effectually checked the growth of electric systems."

If procedure by special act is resorted to the standing orders of the two Houses require in like manner the consent of the local authority, so that the undertaking is not furthered in that respect and is equally liable to be bled for the purpose. The frontagers are given a locus to oppose, so that a small number of them are not so well able, through caprice or other motive, to prevent the construction of an important line; but the expense and risk of procedure by special act have been sufficiently serious deterrents.

I think the net results will justify us in agreeing with Mr. Balfour Browne that this same Tramways Act was "a very silly contrivance indeed." Consider the waste of energy and of enterprise in battling against such conditions, and whether it is any wonder our countrymen have to complain that we are lamentably behind the rest of the world in the cheap and rapid transport facilities afforded by electric traction. We have* pleaded that there is no country in the world which would benefit more than our own by the provision of comprehensive electric tramway systems, or that stands more in need of them to relieve overcrowding, yet their introduction has been slow and halting, and carried out in the face of bitter opposition. Instead of lending a helping hand governing bodies seem to have thought they were doing the public a service by narrowing enterprise down to the scantiest possible outlets, and in some cases by establishing an effective blockade against it.

Twenty-six years elapsed—near upon a generation—and it was not until 1895 that the repose of the Board of Trade was disturbed—a body curiously constituted and still more curiously named—and it was found that something really must be done. A commission was then appointed to consider the question of tramways and light railways, and as a result of their report the Light Railways Act was passed in 1896, only four years ago. But this was only a tentative provision; it expires this year, and unless some measure of enfranchisement is passed we shall be thrown back upon the Act of 1870, which remains effective upon the Statute Book.

The other great department of our domain, the general supply of electrical energy for industrial and domestic purposes, is even yet almost entirely governed by the Act of 1882, which was passed at a time when "the state of the art" was such that electrical energy could only be supplied economically for a distance of 1 mile to $1\frac{1}{2}$ miles from the generating station. In effect the legislation was made to match the fact that at least one separate station was then required for each town, and the town council was constituted the authority which could either undertake the work itself, or consent to the acquirement of the necessary powers by a company.

In either case the act contemplated the local authority being the ultimate owner of the local undertaking. The clauses as to consent, the period and the terms of purchase, were inspired by the spirit of the Tramways Act of 1870, and the effect upon electrical engineering

* See particularly Paper by Mr. Granville C. Cunningham in the *Tramway and Railway World*, December 1899.

as a national industry has been equally disastrous. The result was a fiasco. What did Parliament then do? Nothing until 1888, when it climbed down in a half-hearted way—analogous to its performance in connection with the Light Railways Act—and passed another measure extending the purchase from 21 to 42 years, but leaving the onerous consent clause and the ridiculous terms of purchase as they were. Until after the Act of 1888 we could do practically nothing in the way of establishing electrical supply undertakings.

Circumstances were more favourable in America and Germany during those six valuable years, and, encouraged by the home demand, which is an essential condition of enterprise abroad, the manufacturing trades of those countries laid the foundations of their great export business in electrical plant and accessories, the consequences of which we are feeling to-day. America and Germany now hold the great bulk of the export trade of this character, not only to the countries of Europe and to South America, where this country has heavy financial interests, but also to our own colonies and the United Kingdom itself. You will remember that the whole of the steam engines, dynamos, electric lifts, &c., for the Central London Railway were supplied from America, and many other examples will occur to you.

As I have said, the legislation was in effect made to match the fact that in 1883 it was necessary to put down at least one generating station for each town, and the conception of the situation by many local authorities is shown by their persistent endeavours to wall themselves in, so to speak, against the improvements by means of which the area of economic supply has vastly outgrown such limits. The Acts of 1882-88 and their administration have proved entirely congenial to the narrow exclusiveness of these bodies, who are endeavouring even now in their opposition to the power bills, to insure themselves against the developments of science and a cheap supply rather than impair the prospect of their being able to have an isolated municipal plant all to themselves some day or other. The statistics available afford us the following figures:—

| — | Electricity works in operation. | | Undertakings for which orders have been obtained, but works not yet carried out. | |
|---|---|---|---|---|
| | Local authority. | Company. | Local authority. | Company. |
| 1901... | 130 | 68 | 212 | 55 |

Of the 55 undertakings which have not yet been carried out by companies, only three of the provisional orders (not taken by transfer from the local authority) are two years old yet, and 32 of the remainder only date from last session. Many of the works are now in course of construction, and very few are being hung up in any way that I am aware of. Of the 212 orders not yet carried out by local authorities, the works in 89 cases are, I believe, in course of construction or have been more or less decided upon, leaving a balance undecided of no less than 123. Under a provisional order, the time within which a supply should be available is two years from the date of the order, but of the 212 towns referred to, a large proportion have exceeded that period, some of the dates tailing back so far as 1891, 1892, and 1893.

The figures do not really show the full extent to which business is retarded, because no one has tabulated the local authorities, who not only have not applied for a provisional order, but of whom it is known that they would have blocked any application; but the state of affairs is sufficiently shown by the fact that throughout the whole of the United Kingdom electricity supply under the acts is only available to the public in some 250 districts.

Now we know that the consumer can procure his electrical energy on a more favourable basis for all concerned from an undertaking dealing with a comprehensive area and varied classes of demand, than he can get it from a relatively small local station. This being the case, it may be supposed that it could only be a question of time when the obstacles, obstinate though they have been, to the cheap supply and to a large extension of the industry, must give way somewhere.

The first break in the clouds was observed in 1898, when a Joint Select Committee of the two Houses was appointed (at the instance of the Lords) to consider and report upon a reference in regard to "Electrical Energy—Generating Stations and Supply." Time does not serve to detail the circumstances which led up to the appointment of this Committee, to describe the bills then pending in Parliament in which it was proposed to give effect to the developments of electrical science, nor can I read you the full terms of the reference or of the report,* but I extract the following paragraphs from the latter.

"Where sufficient public advantage is shown, powers may be given for the supply of electrical energy over an area including districts of numerous local authorities, and involving plant of exceptional dimensions and high voltage. The Committee further think that undertakings of this character may properly be authorised on conditions differing in some respects from those imposed by and under the existing acts.

"The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a provisional order, should be amended. In their opinion the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade."

It was the feeling of electrical engineers that the report was too moderate, considering the attitude maintained by the local authorities and their notorious misuse of the powers conferred upon them by the acts, but this feeling is turning to one of dismay at finding that during the two or three years which have ensued nothing whatever has been done to carry out the recommendation last mentioned—which is a full justification of much that I have urged—and that their exertions continue to be very largely wasted.

It might be gathered from the continued lamentations of the press that the electrical engineers of this country were likely to be put upon their defence, and this might indeed be a consistent involution of the legislation which has already tried us very severely in another sense, but it cannot be said that we have been slow to act upon any measure of encouragement available to us. This was true of the Act of 1888, so far as its provisions would allow, and there has been absolutely no hesitation or delay in turning to practical account the paragraph in the report from which I have just read, with reference to the supply of electrical energy over extensive areas, by means of plant of exceptional dimensions and high voltage. I have referred to the bills pending in Parliament at the time of the report, and we must acknowledge the valuable pioneer work of some of our members in connection with them.

The bill which affected our prospects most strongly, although it did not pass, was promoted by the General Power Distributing Co. in 1898-99, and was familiarly known as the Warsop scheme, the project being to distribute electrical energy over an area comprised within a radius of 26 miles from Warsop in Nottinghamshire. This district includes such populous centres as Sheffield, Rotherham, Nottingham, Lincoln, Doncaster, Derby, and Chesterfield. The powers sought were to lay trunk mains throughout the area, to give a supply of electrical energy except where the local authority was itself empowered to supply under an order or act and agreed to take a supply in bulk from the company on arbitration terms. To supply direct in all cases to consumers taking 10,000 units per annum and upwards. The conditions in regard to district, &c., were favourable, and large quantities of coal slack were available at 2s. per ton in the neighbourhood of the proposed power-station. The bill, as we know, did not then pass, but the powers which it sought to obtain have a considerable interest from the point of view of to-day, as in varying degrees they are reflected in the four power bills which were passed last session.

Before summarising the considerations relating to the supply of electrical energy over extensive areas, it will be convenient to follow the course of events. Public opinion became gradually informed on the subject, and it is to be hoped a little moved at the sense of national backwardness, and in the session of 1900 four electric power bills, each for supply over important English areas, passed through Parliament. These were:—

*The County of Durham Electric Power Supply.*—This area, about 250 sq. miles in extent, comprises the main portion of the Durham coal fields and one of the leading manufacturing and shipbuilding districts of the north-east coast. Provisional orders had been obtained authorising the retail supply to consumers in the chief towns, viz., Gateshead, Jarrow, and Durham City. The British Electric Traction Co. had undertaken an extensive system of electric tramways in Gateshead and district, and have since obtained powers for lines in the Jarrow and Durham City districts. The power act authorises the laying of trunk mains throughout the area, and the supply of electrical energy in bulk to undertakers authorised to supply, and also to undertakers authorised to use it for prescribed purposes.

Thus the supply may be given at once for general use in Gateshead, Jarrow, and Durham City, and for electric tramways and light railways in Gateshead, Jarrow, and other parts of the county.

The first portion of the main power station on the River Tyne at Gateshead is rapidly approaching completion, and will be available this spring for a comprehensive system of supply which is being prepared in readiness for it.

*The North Metropolitan Electric Power Supply.*—This area, about 325 sq. miles, includes the great suburbs to the north of London from Tottenham on the east to Harrow on the west, and the growing manufacturing districts along the River Lea. It covers the area within which the extensive North Metropolitan electric light railway has been carried through by interests friendly to those of the act. The provisions and general considerations are the same as in the County of Durham bill, and the same general policy was followed.

*The Lancashire Electric Power.*—This act takes in the whole of Lancashire south of the River Ribble (except Manchester, Salford, Bootle, and Stockport), an area of about 1,000 sq. miles. The district may appear

* In the House of Commons, July, 1898, Mr. Ritchie, replying to Mr Kimber, said that the report of the Joint Committee would be carefully considered by the Board of Trade, but legislation would be required to give effect to some of the Committee's recommendations, and he was afraid that the prospect of passing a bill through that session was very small. The prospect must have been small indeed, for the process of official consideration has extended not only over 1898, but also beyond 1899 and 1900.

somewhat large, but a great part of it is undoubtedly very suitable, since it comprises a large number of collieries, engineering works, cotton mills, and a variety of other industries. The act contains powers to lay trunk mains throughout the area, and to furnish electrical energy in bulk to undertakers authorised to supply, the promoters having relied upon the cheapness of production at large generating stations as sufficient to secure holders of electric lighting provisional orders as customers for bulk supply.

*The South Wales Electric Power Distribution.*—This includes the whole of the county of Glamorgan and extends into Monmouth as far as the River Usk (also including Newport), an area of about 1,050 square miles. The principal towns are Cardiff, Swansea, Newport, Barry, Merthyr, Pontypridd, and Neath, and the district thus comprises the great colliery, shipping, and manufacturing districts of South Wales. The provisions of this act are similar to those of the Lancashire Act, with one important difference. The South Wales Company were given powers to supply direct to *any* person for power purposes, and for lighting any premises on some part of which the power is utilised, provided only that in a local area where an electric lighting provisional order exists, the consent of the authorised distributor in such area is first obtained. If such consent is withheld the Board of Trade may dispense with it, if in the opinion of that body the authorised distributor under the provisional order is not willing and in a position to give the requisite supply to the power user upon reasonable terms and within a reasonable time.

All these acts contain a sliding scale clause as regards prices and dividends, also powers for the revision of the scale every 10 years by the Board of Trade, 8 per cent. being taken as the normal maximum dividend. The general clauses follow pretty closely the usual electric supply practice; for details reference should be made to the acts themselves.

*(To be concluded.)*

## M. GUARINI'S WIRELESS TELEGRAPH EXPERIMENTS IN BELGIUM.

M. Guarini is still carrying out miscellaneous experiments between Brussels and Malines (13½ miles), and Malines and Antwerp (11 miles). On February 8th he made some tests between the Colonne du Congrès, at Brussels, and the cathedral of St. Rombaut, Malines, as before, but on this occasion he took the latter point as a transmitting station. He used the same apparatus as before, but his air-wires were different. Since his last experiment storms have broken these, and he now profited by this circumstance to make experiments with a different type of air-wire.

At the transmitting station (Malines) he used the ordinary air-wire with a single cable, but at the receiving point the cylinder of 50 metallic wires of 1mm. diameter which formerly constituted the upper part of the air-wire was replaced by a cone whose apex was turned towards the ground and connected to earth by a single cable. The cone was formed by 50 wires 0·4mm. diameter. The single cable leading from the ground to the apex of the cone extended right through the cone axially to the top of the air-wire. This arrangement is sketched in Fig. 1. At first communication was bad, M. Guariani only receiving at Brussels a very small part of the signals transmitted from Malines, while communicating in the inverse direction he received at Malines all the signals transmitted at Brussels. An analogous effect, he says, had already been observed last year in Paris when telegraphing without wires between the Eiffel Tower and the Panthéon, when it was found that the tower acted very well as a transmitter but gave no results as a receiver. He attributes this to the presence of metallic masses on the monument—the bronze statue of Leopold I. at the top, the metal balustrade round the platform, the bannister of the staircase in the interior of the column, the statues at the base, &c. Only on doubling the source of electrical energy at Malines and employing an extra sensitive Blondel coherer at Brussels could he obtain irreproachable transmission. He also found that, other things being equal, the maximum effect was obtained if the air-wires were so placed that the vertical plane connecting them or its prolongation did not meet the column and spire to which the wires were attached (see Fig. 4). Other experiments show that the sensitiveness of a coherer for a particular wave increases on diminishing the local current in its circuit by using appropriate resistances.

Finally he made experiments to determine the importance of the earth connection. As might be expected, if neither of the stations were connected to earth, or if the receiving station only was connected to earth, no good signals could be transmitted, but with the ordinary earth connection at the transmitting station he found the results better when the receiving wire was not connected to earth than when it was. M. Guarini thinks the explanation of this is that earthing one of the balls of the oscillator increases the potential of the ball connected to the air-wire, and determines the position of a point of maximum vibration at the summit of the transmitting wire—*i.e.*, at the part most in sight of the receiving wire, while, on the other hand, by insulating the coherer one forms a maximum vibration at the point of the receiving air-wire where the coherer is inserted. He concludes that the earth acts as a large capacity and not as a conductor, this large capacity being advantageous to the transmitter, but harmful in the case of the receiver.

On February 12, M. Guarini experimented between Malines and Antwerp. The transmitting station at Malines was at the Cathedral of St. Rombaut, as before, and at Antwerp the tower of the church of Notre Dame was employed. The same apparatus was used as in the previous experiments. Simple air-wires were adopted, without capacity at their upper ends.

Fig. 1.—Brussels.

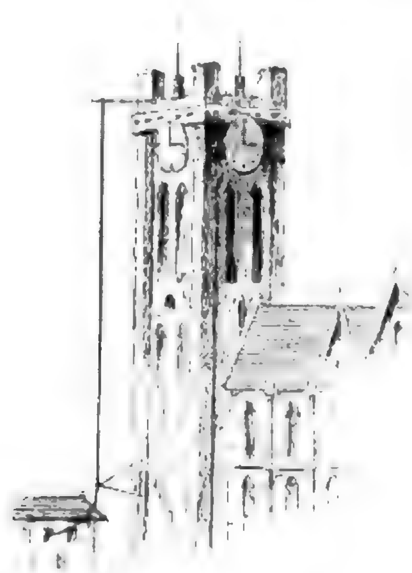


Fig. 2.—Malines.

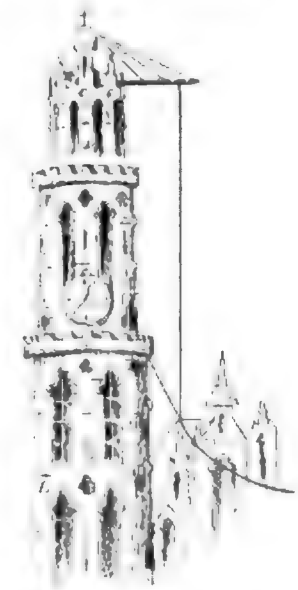


Fig. 3.—Antwerp.

Figs. 2 and 3 show the air-wires at Malines and Antwerp respectively. In the latter case certain difficulties were encountered, owing to the more or less pyramidal shape of the tower of Notre Dame. M. Guarini made up a sort of fishing rod, composed of three pieces of bamboo cane, jointed with metal rings, and fastened this securely on the third gallery. At the extremity of this rod a ring of 7 wires 0·9mm. diameter was fixed, which descended in as nearly a vertical direction as possible to the height of the roof, *i.e.*, about

1—Saint Rombaut Cathedral; 2 and 3—Air Wires; 4—Colonne du Congrès
FIG. 4.

40 metres from the ground (the third gallery is 106 metres above the ground, or 112 metres above sea level). From this point the wire was slanting to the receiving apparatus, which was placed in a neighbouring house. The coherer was of the Blondel pattern, and the earth-wire was formed by three metallic wires connected to a street lamp post.

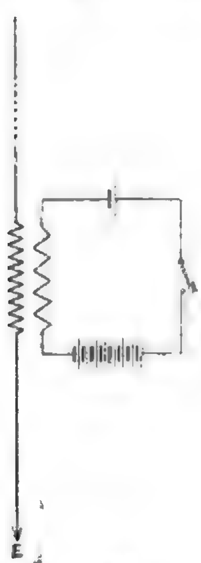


FIG. 5

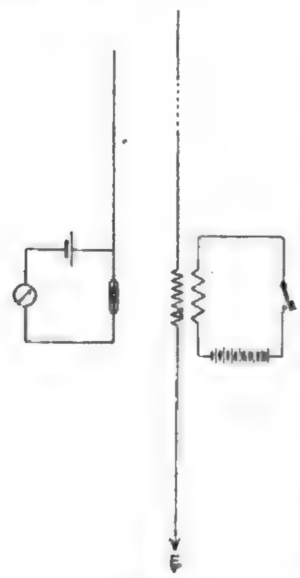
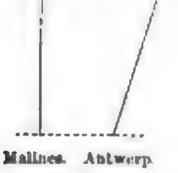


FIG. 6.

Between the two air-wires were the groups of houses in Malines and Antwerp, some villages and castles, and undulations from 5 metres to 30 metres in height. With current from 2 to 2½ amperes at the transmitting station, good results were obtained.

On removing the earth connection from the receiver, however, the results were not so good as those between Brussels and Malines. M. Guarini attributes this to the absence of the capacity in the upper part of the receiving air-wire in the present case.



Malines. Antwerp.
FIG. 7.

Malines. Antwerp.
FIG. 8.

Another interesting observation is worth recording. The oscillator at Malines was removed and the air-wire connected to one terminal of the secondary of the induction coil, the other terminal of the secondary being earthed. With these connections (Fig. 5) 12 signals were transmitted, three of which were clearly received at Antwerp. This, M. Guarini points out, constitutes wireless telegraphy in accordance with Edison's American patent 465,971 of 1891, with the difference that the receiving apparatus included a coherer. On removing the earth connection from the coherer (Fig. 6) in this case also signals were still received.

In experiments in the inverse direction, from Antwerp to Malines, communication was, in general, less good. M. Guarini attributes this to two causes. First, a violent wind which deflected the transmitting air-wire at Antwerp to such an extent that parallelism between the two wires was quite destroyed, and, secondly, the enormous metallic masses about the Antwerp cathedral. With regard to the first cause, in the Malines-Antwerp experiments, the relative positions of the air-wire were as in Fig. 7, that is to say, the receiving air-wire at Antwerp was entirely included between the two planes normal to the wire at Malines, and passing through its extremities; whilst from Antwerp to Malines the planes normal to the Antwerp wire only cut part of the Malines wire (Fig. 8). Signals could also be received with the transmitter connection of Fig. 5. In this case it was an advantage to add a capacity at the top of the air-wire.

## CORRESPONDENCE.

### POWER LOSS IN CHOKING COILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with Mr. Mordey's recent Paper on "Losses in Cables" it is mentioned by Mr. Mather and others that the calculation of the loss in an ironless choking coil can be determined by $C^2R$. I think this statement must be accepted with caution. If the coil be wound with a fairly small wire, the amount of the loss with an alternating current will be not very different from that on direct current, but if the wire be, say, $\frac{1}{10}$in. or more in diameter, a very considerable discrepancy may exist between the loss measured with an alternating current at a commercial frequency and that calculated from the resistance.

In January, 1899, I made some tests, the results of which I venture to think may be interesting in this connection. A coil was taken consisting of about 200 turns of wire 0·162in. diameter wound in the shape of a rectangle 14in. by 11in. Its resistance was about 0·3 ohm. A continuous current of 10 amperes was passed through the coil, and the watts measured by a portable Weston wattmeter. Reversed readings were taken and showed 30 watts. With the same instruments a measurement was made on alternating current at 100 cycles, and showed 41 watts as the loss for 10 amperes —an increase of 37 per cent. The power factor was 0·085.

In order to find whether the error was in the wattmeter or not, a test was made with two of the above coils placed one opposing the other to increase the power-factor. The result was :—

| | |
|---|---|
| Loss with continuous current ............ | 62 watts. |
| Ditto alternating do. ............... | 80 do. |

showing still an increase of 30 per cent., the power-factor being 0·068, or nearly double that with the single coil.

Another test was made on an odd hank with 200 turns of wire 0·072in. diameter. The result was :—

| | |
|---|---|
| Loss at 7 amperes, continuous current......... | 66 watts. |
| Ditto alternating do. ........ | 66 do. |

the power-factor being 0·14.

Another test on a third coil composed of wire 0·018in. diameter, also gave practically identical values for the continuous and alternating measurements.

It is evident from these figures that it is not safe to calculate the $C^2R$ loss from the measured resistance, except in the case of a small conductor where the eddy currents are negligible. In the case also of transformers with very thick conductors, it is well-known that a wattmeter measurement of the $C^2R$ loss greatly exceeds that calculated from the resistances of the winding. Especially is this the case if the transformer have a large magnetic leakage.—Yours, &c.,

London, Feb. 27. R. C. CLINKER.

# LEGAL INTELLIGENCE.

## City of London Electric Lighting Co. v. Corporation of the City of London.

Lords Justices Rigby, Vaughan Williams, and Stirling on Friday last, in the Court of Appeal, delivered judgment in this case on defendants' appeal against a declaration made by Mr. Justice Farwell in May last that the electric lighting contracts entered into between the defendant Corporation and the plaintiffs' predecessors in title, and of which the plaintiff company were assignees, were binding upon the defendants. Particulars of these contracts have been given in *The Electrician* from time to time. At the time the contracts were made certain aldermen and common councillors of the City of London were also shareholders in the Brush Electrical Engineering Co., who were the other parties to two of the contracts. The contracts were for lighting the City by electricity. The City had been lighted under these contracts since 1891, but in 1898 defendants repudiated the contracts, and the plaintiffs commenced this action. The question wholly depended upon the construction of the City of London Sewers Acts, 1848 and 1851. The Commissioners of Sewers Act of 1848 provided that, "No person, being a commissioner, or a member of the Court of Aldermen or of the Common Council of the City of London, shall be directly or indirectly interested or concerned in any contract which shall be made or entered into by or on behalf of the commissioners for the execution of any works by this act directed or authorised to be done or executed, or for furnishing materials or labour, or for any other matter or thing whatsoever, upon pain that every such contract shall be null and void, and that the person who, being a commissioner, or a member of the said Court of Aldermen or of the Common Council, shall be so interested or concerned therein shall for every such offence forfeit and pay the sum of £100 to any person who shall sue for the same, to be recovered in any of the superior Courts by action of debt or on the case." The case for the defendants (appellants) was that under that provision the two contracts with the Brush Company were invalid *ab initio*. The third contract was entered into when no member of the Commissioners of Sewers or alderman or common councillor was a member of the contracting syndicate or company, but at some time subsequently certain shares were taken by members of the Corporation in the plaintiff company, to whom the contracts had been transferred, and the suggestion was that that was sufficient to annul the contracts. Mr. Justice Farwell held that the Act of 1848 contemplated that the commissioners would enter into contracts of two sorts—(1) For the construction of works or supply of materials to the City which would become their own property, and which he called "construction contracts"; and (2) for the supply of water for cleansing or of gas or other illuminant for lighting the City by companies or persons owning waterworks or gasworks or the like; that the contracts in question in this case fell under the second head; that secs. 33 to 42 dealt with construction contracts; and that notwithstanding the generality of the language of sec. 42 that section applied to construction contracts only, and ought to be read with sec. 53 of the continuing Act of 1851. He held that it would be idle to enact that a commissioner who was a shareholder in any contracting company should not be eligible to vote on the contract if the mere fact of his being a shareholder rendered it impossible that any contract could be entered into, and if sec. 42 of the 1848 Act was ambiguous, then the more reasonable construction should be preferred.

Lord Justice VAUGHAN WILLIAMS delivered the considered judgment of the Court of Appeal, and said:—I am quite unable to concur in the construction put upon the Act of 1848 by Mr. Justice Farwell, who appears to have held that sec. 42 of that act dealt only with "construction" contracts, leaving all other contracts, such as lighting contracts, outside the provisions of the act, with the result that, notwithstanding the provisions of sec. 42, there is nothing to prevent any commissioner, alderman, or common councillor from having the largest interest in any contract with the commissioners that is not a construction contract. On the contrary, I hold that secs. 33 to 42 of the act deal with every possible contract that the commissioners can enter into by virtue of the act, and that the proviso contained in sec. 42, whatever its effect, is to be applied to every such contract. All contracts dealt with in sec. 33 of the act are also referred to and dealt with in sec. 42, and it is almost impossible to suppose such one-sided legislation as would apply the stringent provisions of the latter section to construction contracts only. As to the meaning of sec. 42, the important point for their decision was whether a corporator or shareholder of an incorporated company is or is not directly or indirectly interested in any contract entered into with a company. It was admitted on behalf of plaintiffs in this action that as a general rule he is so interested. But, beyond what I regard as the main contention (that only construction contracts are within sec. 42), plaintiffs have contended, and Mr. Justice Farwell has held, that the Act of 1851, and particularly sec. 53 of that act, proves that under the special legislation affecting the Commissioners of Sewers a shareholder is not considered as being interested in a contract made by his company, though he must necessarily share in any profits or loss that might result therefrom. If there were words in the Act of 1851 involving that conclusion, then effect must be given to them, but no mere conjecture based on probable grounds would be sufficient for the purpose. Sec. 53 of the 1851 Act was obviously intended to extend still further the disabilities of commissioners, and there is nothing to indicate that any relaxation of the provisions of the earlier statute was intended. But, whilst providing that no commissioner being a surveyor, solicitor, or agent of a company with whom it is intended to enter into a contract shall sit or vote, it applies naturally the same provision to a shareholder of the company. It would be singular indeed if, while a surveyor, solicitor, or agent were prevented from sitting or voting, a shareholder was permitted to do both. It would be unnecessary, it is urged, to prevent him from sitting and voting, if the fact of his holding shares would of itself avoid the contract. Such an argument loses sight of the fact that a shareholder-commissioner might, by taking part in and voting as to the expediency and policy of a contract with his company, exercise perhaps a decisive influence on the entering into such contract and yet might not, when the contract was signed, be any longer a shareholder or any longer a commissioner, in either of which cases the contract would be unaffected by sec. 42 of the 1848 Act. The conclusion I arrive at therefore, is that a shareholder-commissioner, alderman or common councilman is interested within the sec. 42, and that the existence of his interest is sufficient to render a contract with his company null and void. The fact that express provision has been made by Parliament that a member of an ordinary municipal council shall not be precluded, by being interested only as a shareholder of an incorporated company, from taking part in making a contract between his company and the corporation of which he is a member does but emphasise the distinction in this respect between ordinary municipal corporations and the City of London Corporation, as to which no similar parliamentary provision exists, or apparently ever has existed. The Anglo-American Brush Electric Lighting Co. entered into contracts with the Commissioners of Sewers as to the lighting of the central district of the City of London on May 19, 1890, and, as to the western district, on Feb. 5, 1891. At each of those dates a common councilman was a shareholder in the company, and each of the two contracts was consequently null and void *ab initio*. Notwithstanding this, on Aug. 21, 1891, the Brush Company affected to convey the contracts to plaintiff company, but this assignment could not render valid contracts which were already null and void. And now with regard to the contract as to the lighting of the eastern district, which is dated May 28, 1890, it appears that the Laing, Wharton, and Down Construction Syndicate (Ltd.), one of the contracting parties, had no shareholder whose position would render this contract null and void; and, although it appears that the Board of Trade might have revoked the provisional order but for the assurance of the Commissioners of Sewers that the syndicate would be financed and the contract taken over by the Pioneer City of London Company and the City of London Company respectively, and that both those companies were disabled from entering into any valid contract with the Commissioners of Sewers, yet, on the assumption, which I see no reason to doubt, that the contract as to the eastern district was originally entered into in good faith, I can find no provision in either the Act of 1848 or that of 1851 entitling us to set it aside. The Court declared that the first two contracts were invalid, but did not interfere with the third; and, on the ground that each party had in part succeeded and in part failed, no costs were given in either Court. As each party had had substantial success, the Court held that there should be no costs either of this appeal or of the hearing in the Court below.

## Attorney-General v. London County Council.

This case came before the Court of Appeal, composed of Lords Justices Rigby, Vaughan Williams, and Romer, this week, and was an appeal from an order made by Mr. Justice Cozens-Hardy. The question involved was whether it was within the powers of the London County Council to take over and work the service of omnibuses running from the tramways south of the Thames over Blackfriars, Waterloo, and Westminster Bridges. The action was by the Attorney-General on the relation of a large number of omnibus proprietors of London, who succeeded in the Court below in obtaining a declaration that it was beyond the powers of the Council to carry on the business of omnibus proprietors in connection with their tramways, or to apply the county fund for the purpose of maintaining and working omnibuses, and defendants were ordered to pay the costs.

Mr. HALDANE, K.C., said the Council was not claiming to run omnibuses generally, but only to run them as part of the undertaking of the business which they took over in 1898 from the London Tramways Co. The tramways ran to Blackfriars and Westminster Bridges and to Waterloo station, and the company had started omnibuses from Blackfriars to Farringdon, from Waterloo to the Strand and from Westminster Bridge to Trafalgar-square. The County Council when they took over the tramways also purchased the omnibuses and afterwards extended the journey from Westminster along the Strand and over Waterloo Bridge so as to provide a stream of omnibuses from the south side of Westminster Bridge to Waterloo Station and back. There was a large profit from the working of the tramways, and there was no evidence that the County Council were doing anything which involved any risk of a charge falling upon the ratepayers. Even assuming that the running of the omnibuses by the County Council was *ultra vires*, the Attorney-General could not, if the rates were not affected, interfere at the instance of rival carriers. Counsel further contended that the Council must be treated as being in the position of a municipal corporation, and, therefore, not restricted to that for which it had express statutory authority.

Mr. MACNAGHTEN contended that no ground had been shown for reversing the judgment of the Court below. All that the County Council were entitled to take over were the tramways. They were in the position, not of an old municipal corporation, but of an ordinary corporation created by statute, and could only do what Parliament had permitted them to do. They had no fund except the rates out of which they could run the omnibuses, and he submitted that the case was clearly one in which the Attorney-General was entitled to interfere, particularly as the relators were ratepayers of the City of London.

Lord JUSTICE RIGBY in his judgment said the case raised the question of the power of the London County Council to act as omnibus proprietors, not in general, but in respect to a particular line of omnibuses which in great part was used by the London Tramways Co., who were their predecessors in title of the tramways. The London Tramways

Co. when they wanted to run omnibuses as feeders to their tramways got power to amend their memorandum of association for that purpose: but the act which authorised the Council to take over the tramways did not empower them to take over the omnibuses also, therefore the appeal failed.

Lord Justices Vaughan Williams and Stirling gave judgment to the same effect, and the appeal was dismissed with costs.

An injunction was thereupon granted, but its operation was suspended on Mr. HALDANE stating that he would intimate within a month whether the Council intended to appeal to the House of Lords before seeking further powers.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Manchester Tramways committee invite applications for the position of electrical engineer, to take charge of the electrical and mechanical work in connection with the department, and also an engineer to take charge of the permanent way work. Particulars may be obtained from the general manager (Mr. J. M. Mc'Elroy), Town Hall, Manchester, and applications (addressed to chairman) must be in by March 9. See advertisement.

West Bromwich Corporation require an accountant-clerk for their electricity department. Applications to town clerk (Mr. Alfred Caddick), Town Hall, West Bromwich, by March 13. See advertisement.

The Council of the Institution of Electrical Engineers require an accountant-clerk. An advertisement gives further particulars, and applications must be sent to the secretary (Mr. W. G. McMillan), 28, Victoria-street, London, S.W., by March 9.

Morecambe District Council invite applications for the position of resident electrical engineer. An advertisement contains additional information, and applications must be sent in to the clerk (Mr. Wm Tilly), 5, Morecambe-street, Morecambe, by noon, March 5.

Lambeth (London) Borough Council require the services of a chief engineer for their baths and washhouses, Kennington-road, S.E. An advertisement contains some further particulars, and applications must be sent in to Mr. H. J. Smith, town clerk, by 12 noon of March 20.

A motor inspector is wanted by the Bradford Corporation. Applications to city electrical engineer (Mr. R. A. Chattock, M.I.E.E.), Town Hall, Bradford. See advertisement.

An assistant engineer is required by the Guardians of St. Mary, Islington, London, for their new infirmary at Upper Holloway. See advertisement.

The British Electric Traction Co. are prepared to admit a limited number of qualified students as pupils. See advertisement.

Lincoln Corporation require an engineer and manager for their electricity works. Applications to deputy town clerk, 5 and 6, Bank-street, Lincoln, by March 11.

Manchester Electricity committee require a shift engineer. Applications to chairman by March 4.

Mr. Reginald S. Downe, second engineer-in-charge at Liverpool, has been appointed borough electrical engineer at Southport at a commencing salary of £350 per annum.

Mr. W. S. Ross, assistant engineer at Hampstead, has been appointed resident electrical engineer at the Reigate electricity works.

Mr. E. Rowley Hill, assistant engineer to the Bromley (Kent) Electric Light and Power Co. (Ltd.), has been appointed engineer and manager of the Harrow Electric Light Co. (Ltd.).

**Aldershot.**—An inquiry was held last week into the application of the Council to borrow moneys for the erection of electricity works. The application was supported by the chairman of the Council (Mr. J. May) and the clerk (Mr. W. E. Foster), and there were also present Mr. Iles, representing Messrs. Thomas Parker (Ltd.), who have entered into a conditional contract for the erection and equipment of the works, and Mr. Beeston, on behalf of the Callender Company, contractors for the cables. There was no opposition.

**Bedford.**—From March 31 the charge for electric current for lighting will be 5½d. per unit, less a discount of ½d. per unit for prompt payment.

**Berwick.**—Edmundson's Electricity Corporation are negotiating with the Harbour Commissioners for a site for a generating station.

**Birmingham.**—The reconstruction of the Bristol-road tramways route on the overhead trolley system is approaching completion. The power station is well advanced; 25 cars are on order and it is anticipated that they will be delivered early this month. The route will be opened for traffic about the end of March.

**Bradford.**—The Bradford *Observer* of Feb. 23 contains an account of an inspection made of the National Company's new premises in Union-street, Bradford, at the invitation of Mr. H. B. Sutcliffe, the district manager of the company. Most of the members of council of the Bradford Chamber of Commerce, including the Mayor of Bradford and many influential citizens, were included in the deputation. The Union-street exchange deals with over 2,000 subscribers and the number of daily calls is about 40,000.

**Bridgwater.**—The Local Government Board have intimated that unless the council pass a resolution renewing their application for a loan of £20,000 for electric lighting, the Board will regard the original application as withdrawn.

**Canterbury.**—The receipts of the Electricity department for the December quarter were £1,347. 11s. 11d., and the expenses, including interest and sinking fund, £1,076. 8s. 7d.

**Carnarvon.**—An inquiry was held on Tuesday by Mr. A. P. Trotter into the application of Mr. E. J. Peterson for a provisional electric lighting order. For the applicant, Mr. W. L. Williams said the present system of gas lighting was generally considered unsatisfactory. Mr. Peterson originally proposed to construct a light (electric) railway to Dinas Dinlle, and if the negotiations for the acquisition of land were successful he would carry out that portion of the scheme. Carnarvon Corporation wished to treat the two schemes as one. The Corporation, however, then stated that they intended to apply for a light railway order, and, therefore, he maintained that the Corporation were not acting bona-fide in the matter. If the Corporation were prepared, within three months of the approval of the order, to buy it on such terms as might be fixed by the Board of Trade, his client agreed they should have the order on condition that the Corporation kept faith with the outside district, and if they did not carry out the scheme within a certain period, then Mr. Peterson asked that he should be entitled to carry it out.

**Chislehurst Trials of Electric Cars.**—Messrs. Shippey Bros. write in reference to the report of the judges of these trials, which appeared in our last issue (page 669), that with regard to the "Still" electromobile car entered by them, as British agents of the Canadian Electric Vehicle Co., "as it was found impossible to finish the special car that was being prepared in time for the trials, it was decided at the last moment to enter the No. 12 car 'Oxford' type, specially built to carry four persons, and this was the only car which carried four persons daily throughout the trials, and this with a set of batteries already used to propel the car for over 1,000 miles in and around London." Messrs. Shippey state that the car since these trials has run another 1,000 miles, and, with a new set of tyres, will, Mr. Still considers, be good for another 7,000 to 8,000 miles. Messrs. Shippey conclude:—

> We quite agree with the judges that units used per ton-mile is not so fair a basis of comparison as units per car-mile, and it occurs to us that this idea might be carried still further, and that the proper comparison should be units per load-mile, or in tests of the Chislehurst class per passenger-mile. On this basis the units used by the leading cars would be as follows:—Say for Wednesday's test: Car No. 1 took 1·49, No. 11, 0·617; No. 12, 0·133; No. 13, 0·378; whereas on Thursday's run car No. 1 took 1·02; No. 11, 0·341; No. 12, only 0·077; and No. 13, 1·241. Thus the mean average of watts consumed for, say, 12 days' work of 30 miles per day would give valuable data as to the efficiency of any particular system.

**City of London.**—At yesterday's meeting of the Court of Common Council the Streets committee reported that they had decided to lodge petitions against the following bills in Parliament:—City and North-East Suburban Electric Railway, Central London Railway, Piccadilly and City Railway, and City and Brixton Railway (extension of time).

The Charing Cross and Strand Electricity Supply Corporation has given notice of intention to open all the principal streets in the eastern portion of the City for the purpose of laying cables, &c.

The Police committee have entered into a contract with the National Telephone Co. to place the City police stations on the company's service.

**Coventry.**—The question of electric lighting extensions was again under discussion by the City Council on Tuesday, when the report of the Electric Light committee, recommending a further expenditure of £23,200, was adopted.

At a special meeting of the Electric Lighting committee on Wednesday a communication was read from Mr. Gilbert S. Ram, engineer and manager of the electricity works, resigning his position consequent upon his having accepted an appointment in London. Mr. Ram's resignation was accepted with regret, and the committee decided to advertise for a successor.

**Croydon.**—At the meeting of the Electricity committee last week the borough electrical engineer (Mr. Minshall) reported that the extra high-pressure main to Upper Norwood, laid in the autumn of 1899, specified to work at a pressure of 5,000 volts, notwithstanding its having successfully withstood this test at the works, did not now, as laid, meet the requirements of the specification, the failure not being due to deterioration but to the fact that such a long length of cable required larger margins of insulation to withstand the current generated by their machines than the makers had given it. He further reported that he had been in communication with the contractors with regard to the cable, and that the contractors had

expressed their willingness to lay a new cable, in accordance with the specification, from the Central Station to Upper Norwood, via Thornton Heath, free of cost, the Corporation to pay for the excavation only, the old cable being left in the ground, the property of the Corporation. The committee recommended that this offer be accepted, and that the corporate seal be affixed to a contract embodying this arrangement, and the Corporation have adopted this proposal.

**Cutting Telephone Wires.**—At the Stratford (Essex) Police Court on Feb. 17 John Nolan was charged with maliciously cutting telephone wires belonging to the National Telephone Co. at Barking on Jan. 17. Mr. Arthur Newton, for the company, said that during the last 12 months £90 worth of wire had been cut in the Barking district, and as defendant had been in the company's service he must have known the consequences of the act alleged against him. The defendant reserved his defence, and was committed for trial, bail being allowed.

**Electric Traction in Spain.**—The National Tramways Co. has been granted a concession for an electric tramway in the province of Barcelona from Los Jusepte to Casa Gomes and a branch line to La Bonanova.

**Evesham.**—A report has been presented by the Gas committee on the results of the inquiries made in regard to electric lighting in other towns, but the Council were recommended not to undertake electric lighting at present. Mr. G. New, however, has induced the Council to refer the matter to the General Purposes committee for further consideration, on the ground that a company can easily be found who will carry out the work.

**Exhibitions.**—The Pan-American Exhibition to be held at Buffalo, N.Y., from May 1, is to have a tower for electric display and observation 375ft. high. On the base of this there will be a cascade, 70ft. high, of coloured electric lights. Electric motive-power will be utilised throughout the extensive range of buildings, current being generated at Niagara. It is stated that a quarter of a million electric lamps will be scattered throughout the exhibition grounds.

Official intimation has been given that His Majesty will be unable, owing to State mourning, to fulfil his engagement to open the Glasgow International Exhibition in May. The duty will be performed by the Duchess of Fife. Glasgow is hopeful, however, that the King's decision may be altered.

**For the Front.**—Mr. E. Vernon Flamank Shaw, son of Rev. John Shaw, rector of Southhill, of the Plymouth Corporation electricity works, starts for South Africa in a few days as a member of the corps of Royal Engineers.

**Gillingham.**—The Council decided last week to purchase so much of the undertaking of the Chatham, Rochester, and District Electric Lighting Co. as lies within the Gillingham district.

**Leeds.**—The Lighting committee decided on Wednesday to purchase plant for electric lighting extensions, at an estimated cost of £24,135.

**Leicester.**—Mr. E. Manville (Messrs. Kincaid, Waller and Manville) has been appointed consulting electric tramway engineer to the Corporation.

**Light Railways.** The Board of Trade have, after modification, confirmed the Ormskirk and Southport Light Railways Order, 1901, and the West Hartlepool Light Railways (Deviation, &c.) Order, 1901.

The Light Railway Commissioners held an inquiry last week at Stoke-on-Trent into the application of the Potteries Electric Traction Co. for an order authorising various extensions of their light (electric) railways. Mr. Sydney Morse briefly sketched the history of tramway and light railway construction in the Potteries, and said that the real objection raised by the Stoke Corporation was as to the power of purchase. The North Staffordshire Railway Co. also objected to the lines from Stoke to Newcastle, through Hartshill, and from Trent Vale to Newcastle; but he submitted that the lines would not compete with the railway. The Commissioners decided that the opposition of the North Staffordshire Company was not sufficient to justify them in withdrawing the case from the consideration of the Board of Trade. With regard to the period of purchase, they thought Stoke should be put on the same footing as the other boroughs, viz , 31 years.

**Liverpool Tramway Accident.**—In our last issue we gave the verdict of the jury in the inquest on the bodies of Thomas Hankey and David Singleton, killed by the electric cable accident at Liverpool on Feb. 4.

At the adjourned inquest on Thursday last, the CORONER announced that he had received a letter stating that the writer saw immediately after the accident a number of broken insulators lying at the end of Pembroke street. If that was so, and the insulators were proved to be imperfect, that would open up a new phase of the inquiry—as to whether all care had been exercised with regard to the insulators.

Mr. MATTINSON (for the National Telephone Co. stated that his information was that there was no ground for saying the insulators were imperfect. Out of many hundreds of insulators, an odd one or two might have been broken, but his information was that there was not one.

Mr. BENFIELD, recalled, stated that the insulators connected with the pole in Pembroke place were intact on the morning after the accident. He had never heard of any broken insulators being found in Pembroke-street, and he thought it impossible for them to get there. On the morning after the accident the insulators on the Pembroke place pole were still in position.

Mr. S. W. DRUMMOND, inspector of the National Company, said he inspected the Pembroke-street pole on the evening of the accident; there were no insulators on the ground, and those on the pole were in good condition.

Mr. DANE SINCLAIR said he inspected both the Pembroke-street and Pembroke court poles. All the insulators on the pole before the accident were there after the accident. Every precaution was taken that only the best material was used for both insulators and wires, and he had never known an insulator to come down, although the wires did so under certain conditions. They never renewed the insulators in towns. If they had come down there would be no object in denying the fact.

Mr. W. A. LATHAM deposed that he saw a collection of damaged insulators lying in a court close to Pembroke-street the morning after the accident. Some of the insulators looked as though they had had pieces knocked off for some time He thought there were over a dozen insulators there. He did not infer that they had given way. They might have been there for a long time before the accident. He did not notice them before the accident, however. He was of opinion that if the wooden guards had been perfectly in order the wire would not have come into contact with the trolley wire.

Mr. BENFIELD said that on the day of the accident he took some old insulators from poles in Burlington-street. On the morning of the accident he was told to go to Pembroke-place to repair wire and put the old insulators, which were still on his cart, down by the pole, and, no doubt, Mr. Latham saw these.

Mr. C. E. SPAGNOLETTI said he had examined the standard insulators and wires at the site of the accident. There was every indication that there had been thorough and satisfactory work in the erection of the telephones. The wire was of the universal standard. It was 40lb. phosphor-bronze wire, which was more suitable and stronger for telephone purposes than copper wire. The insulators were in good condition. He had tested some of the wire that came down in the accident. It was good wire, and quite up to gauge. The life of a good wire in a large city was from eight to 10 years. The atmospherical conditions on the day of the accident were of a dangerous kind to wire, and were abnormal, especially on account of the half-frozen snow falling on the wire, freezing into ice, and adhering to the wire until it became several times its normal thickness. A span of 120yds. of wire was not a particularly long span. Assuming the company could get the necessary wayleave, it would be better to have a shorter span. The company would, in fact, be glad to put up shorter spans.

Mr. W. E. LANGDON, electrical engineer to the Midland Railway Co., agreed with Mr. Spagnoletti's evidence.

Mr. C. R. BELLAMY, manager of the Liverpool Corporation tramways, said that since the opening of the electric routes the trams had carried 100,000,000 passengers, and there had been no previous accident through electricity. The route on which the accident happened was opened on Jan. 21. Regarding facilities for cutting off current, they had half-mile sections, and assistants were provided with keys, which they could use on short notice. The wooden guards on the trolley wires had acted effectively when other telephone wires had fallen. The tramway track had been salted on the night of the accident.

Mr. A. BROMLEY HOLMES, electrical engineer to the Corporation, stated there were two well-known means for the protection of trolley wires from falling telephone or telegraph wires—the earth guard wires and the guard strips. With regard to catching falling wires, there was not much to choose between the two systems, but with regard to the safety of the system, the wood strip had great advantages, because it was obviously dangerous to put a metal conductor over the trolley wires. The late Dr. John Hopkinson approved of the guard strip. Of course no form of protector was completely satisfactory, and the only safe principle was to put all telephone wires underground, and the Telephone Company were proceeding with this work. 500 volts, at which the tramways were worked, would not give a fatal or dangerous shock if the recipient was standing on dry material. The fatal results of this accident were due to the exceptional conditions that prevailed on the night in question. The people were standing in snow and slush, and even then several people received shocks which were not fatal. Had the accident happened in dry weather, he thought it was most unlikely that fatal consequences would have ensued. He did not see that protection would be afforded by soaking the guard strip in paraffin, nor that any other form of protector could be adopted having regard to the working of the trolley. A larger guard would mean more weight, and so difficulty after difficulty would be caused. The strip guard dealt satisfactorily with the ordinary falling wire, but not with tangled wire.

Mr. H. WARREN, electrical expert, said it was his view that the accident was caused entirely through insufficient insulation of the trolley wires. The guards, if they might be so called, were worse than no insulator at all. It would be a simple matter not only to arrange a perfect insulator against falling wire, but also to readily attach the same. He would have been much surprised at any novice, not to say a practical engineer, proposing to solder an attachment to a wire carrying 500 volts. If the guard were soaked in paraffin it would improve it as an insulator. He suggested that the strip of wood should be carried over each side of the wire, so as to form a sort of shed. He had had no practical experience of tramway or telephone construction. He had not considered that the additions to the guard, as suggested, would increase the weight from 3oz. per foot to 4lb. per foot. It depended upon the material used. Paraffin was supposed to be the best thing for insulating a high potential.

Major CARDEW (Messrs. Preece and Cardew) said there was much differ-

ence of opinion as to the merits of the two kinds of kinds of guards—the woolen strip and the wire. Neither was thoroughly satisfactory, and it would be very satisfactory if something better could be found. In his opinion, whatever the state of insulation on this occasion it would have been of no value, in view of the metal contact which took place. In the case of electric shocks, it was entirely a question of length and duration of contact. It would be possible to kill a man with even 100 volts if proper preparations were made to kill him. It was hopeless to pretend to work tramways with a voltage which would be absolutely safe. If the person who came into contact with a wire could make it touch the earth by falling upon it he would be relieved from the shock.

Mr. PHILIP DAWSON said he had superintended the construction of the Wavertree route, the work of which was thoroughly done. As to protectors, the guard-strip was the better of two imperfect systems. Both had grave faults. He had tried experiments, from the result of which he felt convinced that when a telephone wire fell upon a guard wire under conditions which prevailed on the night of the accident, the telephone wire would cut through the guard wire and probably through the trolley wire. He had received several shocks of 500 volts. They were disagreeable and burned him. Mr. Warren's suggestions as to the improvement of the protector were impracticable.

Mr. S. B. COTTRELL, general manager and engineer of the Liverpool Overhead Railway, stated that for their railway they used a voltage of 500. He agreed that the guard slip was the best known form of practical protector for trolley wires. He had had shocks at 500 volts. One of the employés of the Overhead Company was on one occasion in contact with the middle rail for about 20 minutes. A hole was burnt in his leg, but he was a man of good physique and used to electricity, and, therefore, was not dangerously injured. He was working for the railway company at the present time.

This concluded the evidence, and after the Coroner's summing up, the jury returned the verdict recorded in our last issue.

**London County Council.**—At Tuesday's meeting it was agreed to loan £10,600 to Battersea for electric lighting.

The Finance committee presented a statement regarding a matter which had been placed before the committee by the Electrical Trades' Union on the subject of rate of pay to workmen in the Council's electrical department, and asking for an increase from 8½d.—9d. to 9½d.—10d. per hour for wiremen, and for chargemen 10½d. per hour, and their assistants 7½d. per hour. The committee recommended that the wages of wiremen be fixed from 9d. to 10d. per hour, and chargemen from 10d. to 10½d. They further recommended that no class of assistants be created. The consideration of the subject was postponed.

It was decided to refuse the Council's consent to the construction by the London United Tramways (Ltd.) of the proposed lines within the County of London set out in the company's bill before Parliament.

**Municipal Telephony.**—The question of Municipal versus National telephones in Hull is becoming an acute one. It would appear that circular has been sent out to the ratepayers of the borough calling in question the estimates prepared by Mr. A. R. Bennett for the Hull Corporation in connection with the establishment of a municipal telephone service. To many of the statements in the circular Mr. Bennett takes exception, and in a long letter to the *Eastern Morning News* of the 25th ult. deals somewhat fully with the vexed question of the cost per subscriber of installing the telephone. The circular and Mr. Bennett's reply may be left to speak for themselves, but it is certainly time that the question of the cost of installing the telephone should be definitely settled.

**Newcastle-upon-Tyne.**—An inquiry was held last week into the application of the Council to borrow £10,000 for electric lighting of tramways.

**Oldham.**—Last week an inquiry was held respecting an application by the Corporation to borrow £157,000 for electric lighting and traction. The town clerk (Mr. A. Nicholson) said this was the fifth application the Corporation had made for borrowing powers for electric lighting, the total amount being £88,000. The present station was full of machinery, and there was no room on the present site for extensions of the building; it was therefore necessary to acquire a new site. The demand for current was greater than could be supplied, and was constantly increasing. The first year's working resulted in a loss of £152 8s. 5d., but in each of the subsequent years there had been a profit. In 1896, the net profit was £847; in 1897, £1,043; in 1898, £1,350; and this year (ending March), £18. 17s. 2d. Last year a great difference was made in the profit owing to the advance in the price of coal. The Corporation had been empowered to construct electric tramways in the borough of a total length of about 25 miles. The consulting engineer (Prof. Kennedy) gave technical details, and the architect (Mr. Peach) described the plans for the new station. There was no opposition.

**Presentation.**—On Thursday evening last the employés of the Cambridge Electric Supply Co. presented the late engineer and manager of the company (Mr. J. H. Barker) with a piece of silver plate on his leaving to take up an appointment with Messrs. C. A. Parsons & Co. The presentation was made by the secretary (Mr. A. A. W. Wynne) at a farewell supper given to the members and friends of the staff by Mr. and Mrs. Barker prior to their departure. The directors of the company have also made a presentation of a silver tea service and a set of silver candlesticks.

**Private Bill Legislation.**—The following bills were read a first time in the House of Commons on Friday last:—Eccles Corporation Tramways, Blackpool Tramways, West Cumberland Electric Tramways, Derbyshire and Nottinghamshire Electric Power Co., and Bury Corporation Tramways.

The London County Council will oppose the Metropolitan District Railway and British Westinghouse Electric Manufacturing Companies' bills, as well as that of the London United Tramways (Ltd.), referred to elsewhere. The engineer's estimate in connection with the London United Tramways bill puts the total cost of the proposed extensions at £665,943.

**Provisional Order Transfer.**—The Llanelly District Council give notice of intention to transfer their electric lighting order to the Llanelly and District Electric Lighting and Traction Co. (Ltd.). The company are to erect and equip a generating station within 12 months, and the Council reserve the right to re-purchase at the end of periods of seven years.

**Rochester.**—Negotiations are still proceeding between the Council and the Chatham, Rochester and District Electric Lighting Co. for the acquisition of the company's undertaking in the district. As soon as the General Purposes committee received the report of their consulting engineer (Mr. F. C. Raphael), who was recently appointed to value the company's distributing system within the city, an offer was made for the purchase, and on Feb. 6 a deputation from the company attended a committee meeting to discuss the matter. Eventually it was arranged that the company should name a figure for consideration by the committee. It will be seen that the company's Gillingham area has been taken over by the Gillingham Council.

**St. Pancras (London).**—On the presentation of the financial statement at Wednesday's meeting of the Borough Council, Mr. J. Thornley, J.P., drew attention to the banker's overdraft on account of the electricity works amounting to £74,000, and said they were told that application had been made some time ago to the London County Council for a large loan. It was not a wise policy to pay 4 or 4½ per cent. when money could be obtained at 3½ per cent., and he considered the County Council should be asked to complete the loans without delay. Mr. C. H. F. Barrett, town clerk, said he had written the County Council three times during the past month in reference to the matter, and a reply had been received two days previously stating that information was required from the electricity department in relation to the expenditure. Mr. Cox Sinclair said the loans had been applied for 18 months ago, and the clerk said the amount still outstanding from the County Council was £77,000.

The Electricity committee submitted a long report by Mr. Baynes, embodying a comprehensive scheme for extending the arc lighting system in addition to the proposed outlay of £29,000 which was recently sanctioned for laying additional feeders for private supply. There are at present 418 public arcs, and it was proposed to similarly light other thoroughfares by erecting 567 additional arcs, making 985; 10-ampere open arc lamps are recommended, similar to those erected in recent extensions in St. Pancras, to be connected nine in series, and fed from the low-tension plant. Mr. Baynes suggested that orders be placed forthwith for the larger portion of the materials. It would take some two years to carry out the scheme even with an increased outdoor staff, as it was only during summer that street work of the kind could be carried out reliably and economically. The Council decided to adopt the scheme at an estimated expenditure of £69,112.

The Parliamentary committee reported upon the County Council's letter in relation to the conference on the supply of electricity in bulk, and on the advice of the chief electrical engineer (Mr. S. W. Baynes) it was decided that the St. Pancras Council was not prepared to take any action in regard to another conference.

**Scarborough.**—The Scarborough Electric Tramways Co. offer to hand over the Tramway bill to the Corporation, if the latter will pay the expenses incurred to date.

**Southport.**—The Board of Trade have sanctioned a loan of £75,000 for reconstructing and electrically equipping the lines leased to the Southport Tramways Co.

**Sunderland.**—An inquiry was held last week into the application of the Corporation to borrow £73,035 for electric lighting. The town clerk (Mr. F. M. Bowey) said that, with the exception of £18,615, the loan was required for the erection and equipment of a power station at Hylton-road. The Dunning-street station could not accommodate any further machinery, and the Corporation had had to refuse applications for current. The loan would be used as follows: Buildings, &c., £20,950; boilers, economisers, pumps, stokers and elevators, £9,260; two 200 H.P. and three 450 H.P. dynamos, £23,010; switchboard, &c., £1,200; new feeders, &c., £18,615. Technical details were supplied by the borough electrical engineer (Mr. J. F. C. Snell) who also gave particulars as to the progress of the electricity undertaking. In 1895 they started with 83 consumers and now they had 611 connected and 60 awaiting connection. During the half-year to Sept. 30, 1899, the Corporation sold 197,000 units, and in the corresponding period last year 289,000 units. Since

September the sale had been 630,000 units, and when the year was completed it would probably amount to 1,200,000. There was no opposition.

The official inspection of the Southwick, Tatham-street and Hylton-road tramways will take place on Wednesday. The Southwick, Hendon, and Hylton-road sections were opened for traffic last week without the sanction of the Board of Trade, but ceased working on Wednesday pending official inspection.

**Telegraphic Communication between England and Germany.** A deputation of German commercial men recently informed Gen. von Podbielski, the German Postmaster-General, that, owing to interruptions in telegraphic communication between England and Germany, merchants preferred to send their telegraphic communications to England via New York rather than direct to London, as by that means they reached their destination earlier. Gen. von Podbielski promised to do his utmost to obviate the interruptions in future.

**Train Lighting.**—The boat train service between Dieppe and Paris (in connection with the London-Paris 10 a.m. service) is now composed exclusively of corridor carriages, and these are fitted throughout with the electric light.

**Water Power Utilisation in Spain.**—A company has been formed to establish an electricity generating station near Zarogoza, to utilise the waters of the Galvez canal to supply current for lighting and power to the small towns of Almunia, Epla, Rueda, and Lucena.

**Wolverhampton.**—An inquiry was held last week into the application of the Council to borrow £58,912 for electric lighting extensions. The town clerk (Mr. Horatio Brevitt) said the loan would be employed as follows: Buildings and foundations, £4,620; boiler-house equipment, £18,140; engine-house equipment, £19,580; feeders, distributors and pilot mains, £15,000; and £1,602 overspent on previous loan. The demand for current for lighting was increasing at rate of 33 per cent. per annum. During the year ended March 31, 1895, the total units sold amounted to 23,372, and in the year ended March, 1900, 482,277. The Corporation had under consideration the question of electric traction on the tramways, and were compelled to make provision for the necessary supply of electric energy. The total amount of loans authorised was £87,669. 18s. 9d., and in respect of the loan now asked for the Corporation asked that 25 years be allowed for repayment. A ratepayer protested against the insertion of the fair wages' clause in contracts, as it appeared to be an extravagant method of carrying out work according to the action of the trades unions, and which the Corporation seemed inclined to favour. The cost of all undertakings of the kind, he urged, was increased from 20 to 30 per cent. The borough electrical engineer (Mr. Shawfield) gave technical evidence in support of the application, which was unopposed.

**Wrexham.**—The municipal electricity works will supply electric current in a few days.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Cardiff* Corporation require tenders for steam and exhaust pipes, injection and overflow pipes, feed and drain pipes, engine house flooring, switchboard gallery and central service gangway for their tramways department. Specifications, &c., may be obtained from the engineer and manager (Mr. Arthur Ellis), Old Post Office-buildings, Cardiff. Tenders to the town clerk (Mr. J. L. Wheatley) by March 18. See advertisement.

*Leeds* Tramways committee invite tenders for the supply and laying of cast-iron pipes, with the necessary drawing-in boxes and wires, and supplying insulated conductors and drawing same into the pipes. Plans may be seen and specification obtained at the city engineer's office, and also at the offices of the consulting engineers (Messrs. Hopkinsons and Talbot), 26, Victoria-street, London, S.W., and 29, Princes-street, Manchester. Tenders to the town clerk's office by noon, March 8. An advertisement gives further particulars.

*Leeds* Tramways committee also invite tenders for supplying and fixing trolley wires and accessories. Tenders to town clerk's office by noon March 8.

*Huddersfield* Corporation invite tenders for motor carts suitable for conveying about five tons of coal from the local collieries to the electricity works. Further particulars may be obtained from the borough electrical engineer (Mr. A. B. Mountain), and tenders must be delivered to the town clerk (Mr. F. C. Lloyd), Town Hall, Huddersfield, by March 5. Some further information is given in an advertisement.

*Warrington* Corporation invite tenders for the supply, delivery and laying of steel rails, paving, &c., and for the supply, delivery and erection of steel poles, brackets, trolley wire, insulators, &c., and for electric tramcars. An advertisement contains further particulars, and specifications may be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Tenders to town clerk (Mr. J. Lyon Whittle), Town Hall, Warrington, by noon 27th inst.

*Sunderland* Corporation invite tenders for indiarubber-covered cables, stoneware casing, wrought-iron piping, cast-iron piping and cast-iron box frames and covers. Specification may be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, Sunderland, and tenders (addressed chairman of Lighting committee) must be delivered at the office of the town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon of 29th inst. An advertisement gives some particulars.

*Newport* Corporation invite tenders for the supply and erection of constructional steel-work, bunkers, &c., steel flue, coal and ash conveyor, overhead travelling crane, steam boilers, mechanical stokers, fuel economiser, water storage tanks, compound condensing vertical engines, electric generators, condensing plant with cooling towers, and feed pumps. Specifications from the consulting engineer (Mr. H. F. Parshall), 8, Princes-street, Bank, London, E.C., and tenders to the town clerk (Mr. Albert A. Newman), Town Hall, Newport, Mon., by 5 p.m. March 25. An advertisement contains further particulars.

The General committee of management of the District Asylum, *Mullingar* (Ireland), invite tenders for the supply and erection of tell-tale clock and indicator, also tell-tale keys, and connecting up same, &c., throughout the old asylum; also for electrical bells in doctor's house at the new asylum. Specifications from the electrical engineer (Mr. Joshua W. Edmundson), 35, Capel-street, Dublin, and tenders care of resident medical superintendent, District Asylum, Mullingar, by March 8. Further particulars are contained in an advertisement.

The *British Electric Traction Co.*, on behalf of the Gravesend and Northfleet Electric Tramways Co., invite tenders for the construction of new and re-construction of existing tramways in Gravesend, for supply and construction of electrical equipment, and for supplying and laying cables, &c. An advertisement gives further particulars, and tenders must be in by March 7.

*Buxton* District Council invite tenders for a 250kw. steam dynamo and a Belliss engine coupled to two 43kw. dynamos. An advertisement contains further particulars, and specifications, &c., may be obtained from the chief electrical engineer (Mr. Edward Calvert), electricity works, Buxton. Tenders by noon of March 12.

*Shipley* District Council invite tenders for house terminals, boxes and switch-gear, motors and switch-gear, meters, wiring, cables, wires, switches, fuses, fittings, &c. Specifications can be obtained at the Council Offices, Manor House, Shipley, and tenders must be in by March 19 to the clerk (Mr. Jno. S. Rhodes). See advertisement.

*Brighton* Corporation invite tenders for the supply and erection of the steel and ironwork required in the construction of an electric power house at Southwick. Further particulars are given in an advertisement, and specifications, &c., can be obtained at the offices of the town clerk (Mr. F. J. Tillstone), Town Hall, Brighton. Tenders to Mr. Tillstone's office by 10 a.m. April 26.

*Great Central Railway Co.* invite tenders for the supply, during the 12 months ending April 30, 1902, of various stores and materials, including electric light, telegraph and signal materials, asbestos packing, brass sheets and tubing, hardware, screws, &c. Specifications, &c., of the secretary (Mr. Oliver S. Holt), London-road Station, Manchester, to whom tenders by 10 a.m. March 5.

*Shoreditch* Borough Council invite tenders for supply and construction of various stores and works for one year and five days, from March 26, 1901, to March 31, 1902, inclusive. Tenders to Dr. H. Mansfield Robinson, town clerk, Shoreditch Town Hall, Old-street, London, E.C., before 3 p.m. March 12.

*Shoreditch* (London) Borough Council also require tenders for the constructional steel and iron work for the new Whiston-street generating station. Tenders by March 6.

The *Commissioners of H.M. Works and Public Buildings*, 12, Storey's-gate, London, S.W., require tenders for the erection of a building in Bushey Park for the National Physical Laboratory. Tenders by noon March 12.

*Wimbledon* District Council invite tenders for various stores and materials for their electric lighting department for 12 months. Tenders by March 15.

*Southampton* Corporation invite tenders for insulated electric cables, and frames and covers, including excavation and reinstating roadways. Tenders to town clerk by noon March 11.

*Southampton* Corporation also desire to purchase three motor omnibuses. Tenders to town clerk by 16th prox.

*Bray* District Council invite tenders for a Lancashire boiler and accessories, a 150kw. high-speed steam alternator, and a 25kw. rope-driven alternator and accessories. Tenders by 4 p.m. March 14.

*Clyde Navigation* Trustees invite tenders for a 3-ton electric wharf crane. Tenders to Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow, by noon March 11.

*Aberdeen* Electric Light committee require a fuel economiser and boilers. Tenders to city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, before noon March 15.

*Bristol* Electrical committee require tenders for erection of superstructures of Avonbank electricity works. Tenders to secretary, Temple Back, Bristol, by March 12.

Tenders are invited for the electric lighting of St. John's Church, *Cheltenham*. Tenders to Mr. Weaver, Carlton-place, Hewlett-street, Cheltenham, by March 25.

*Whitehaven* Electricity committee require tenders for erecting a chimney shaft and flues. Tenders by March 5.

*Stockport* Gas and Electricity committee invite tenders for condensing plant. Tenders by March 6.

*Barnsley* Guardians require tenders for the electric lighting of the workhouse. Tenders by March 6.

## TENDERS RECEIVED AND ACCEPTED.

Brighton Corporation have received the following tenders for overhead trolley construction and equipment on the whole of the tramways, and for feeder, distributing, test and telephone cables :—

| | £ | s. | d. |
|---|---|---|---|
| *Overhead Trolley Construction and Equipment.* | | | |
| Robert W. Blackwell & Co. (*accepted*) | £11,073 | 14 | 7 |
| G. Hill & Co. | 13,656 | 11 | 4 |
| Lowdon Bros. & Co. | 11,854 | 0 | 0 |
| Macartney, McElroy & Co. | 11,218 | 8 | 10½ |
| National Electric Wiring Co. | 11,189 | 10 | 0 |
| *Feeder, Distributing, Test, and Telephone Cables.* | | | |
| St. Helens Cable Co. (*accepted*) | £4,045 | 3 | 3 |
| Land und Seekabelwerke | 4,853 | 17 | 7 |
| Société Industrielle des Téléphones | 4,332 | 4 | 10½ |
| W. F. Dennis & Co. | 4,225 | 3 | 9 |

Brighton Corporation have accepted the tender of Messrs. Pedrette & Co. for concrete foundations for the Southwick electricity station, wharf, timber piling, dam, and concrete weir for £35,760.

The London County Council on Tuesday approved the recommendation of the Highways committee for the acceptance of the tender of the Stirling Boiler Co., for the supply of boilers for the Council's power station in connection with the conversion of the tramway system on the south side of the Thames to electric traction. The amount of the accepted tender was for 16 boilers £17,953, with the addition of £3,034 for Proctor's type of stoker, or alternatively, £4,829 for chain-grate type, of improved and extra-strong pattern. The time for completion of contract is 35 weeks from date of order. The following firms also tendered :—B. R. Rowland & Co. (nine boilers and stokers, £26,646), R. Hornsby & Son (alternative tenders for boilers and stokers, ranging from £26,293 to £30,985), Babcock and Wilcox (alternative tenders of £30,820 and £33,418), W. R. Renshaw & Co. (12 boilers, £26,995), and Edwin Danks & Co. (18 boilers, £37,500). It will be seen that the accepted tender of the Stirling Co. was the lowest sent in.

Messrs. C. A. Parsons & Co. have secured an order from the Newcastle-on-Tyne Electric Supply Co. for a steam turbine alternator. The plant is to be three-phase and for an output of 1,500kw. at 5,750 volts, with a periodicity of 40 complete cycles per second. The machine is to be complete with surface condenser and air pumps driven by electric motor.

Aberdeen Corporation have let the contract for the electrical equipment of the Bathing Station tramway route to the British Insulated Wire Co.

The Kalgoorlie Electric Power and Lighting Co. (Ltd.) have placed a contract with a London firm for the supply and erection of a complete generating plant of 2,400 H.P.

Swansea Corporation have placed an order with Messrs. Crompton & Co. for 2,000 pairs of arc lamp carbons at £10 8s. per 1,000 pairs.

Messrs. Escher, Wyss & Co., Zurich, have received from Niagara an order for six turbines, each of 5,500 H.P.

## BUSINESS NOTICES.

Messrs. Pritchetts and Gold inform us that, in order to devote the whole of their attention to the increasing demand for the type of storage battery manufactured at the company's works at Feltham, Middlesex, the business of electrical engineers and contractors, lately carried on at 15, Hart-street, London, W.C., has been transferred to Messrs. Braby and Tomlinson (Ltd.) at the same address. Messrs. Pritchetts and Gold's only address is at Feltham.

The offices of the Electric Welding Co. have been removed to 28, Basinghall-street, London, E.C. The department for jobbing work has been transferred to Messrs. Smith, Parfrey & Co., 141, Buckingham Palace-road, S.W.

After to-day the address of the Schattner Electricity Meter Co. (Ltd.) will be Tyndale Works, Upper-street, Islington, London, N.

The Sturtevant Engineering Co. have removed to 147, Queen Victoria-street, London, E.C.

Messrs. W. A. Baxter and G. D. Impey, electrical engineers, trading as Baxter, Impey & Co., have dissolved partnership. Debts by Mr. Baxter, who continues.

Mr. W. E. Gilmore and Mr. W. Little, electrical engineers, Fountain-street, Belfast, have dissolved partnership. Mr. Gilmore continues.

## BANKRUPTCIES, LIQUIDATIONS, &c.

The first meeting of creditors of Lewis Benjamin and Ernest Benjamin, wire manufacturers, &c., trading as Johnstone, Benjamin & Co., 10, Ascham-street, Kentish Town, London, N.W., took place recently, when Messrs. B. T. Norton and F. S. Salamon were appointed joint trustees with a committee of inspection. Debtors attributed failure to pressure by creditors. The business was started in 1890, and was continued until Dec. 20 last, when debtors converted it into a limited liability undertaking, receiving £500 cash, and £8,700 in shares and appointment as managing directors. Liabilities £7,480, assets estimated £5,912.

The public examination of Tom Arthur Flather, electrical engineer, lately carrying on business at the Park Electrical Works, Speedwell-street, Leeds, took place at Leeds on Tuesday. Liabilities £357. 3s. 4d., assets £31. 13s. 7d., deficiency £325. 9s. 9d. Bankrupt commenced business six years ago with £600, and attributed his failure to excessive rent charged for hire of machinery. The business was now being carried on by his brother-in-law and by Mrs. Flather as Flather & Co. Examination adjourned.

F. A. Butler, mica merchant and manufacturer, 6, Comly Bank-road, Walthamstow, has been adjudicated bankrupt. The first meeting of creditors takes place on March 7, and the public examination on April 3, at Bankruptcy-buildings, London, W.C.

The discharge in bankruptcy of A. G. Inrig, electrical engineer, 46, White Post-lane, London, E. (trading as the Globe Electrical Co.), is suspended for two years, as the assets are not equal to 10s. in the £, and debtor had not kept proper books.

The estates of P. Sinclair, electrical engineer, &c., Port Ellen, Isle of Islay, N.B. (as a firm and as an individual), have been sequestrated.

The liquidator of the Phaeton Electrical Co. (Ltd.) (Mr. W. J. Ogden, 6A, Austin Friars, London, E.C.) announces a first and final dividend of 6s. in the £, payable on March 13 and 14, and on any succeeding Wednesday, between 10 a.m. and 12 a.m.

The Electro-Chemical Co. (1900), Ltd., is to be wound-up voluntarily, Mr. R. Shaw acting as liquidator.

---

**Plant for Sale.**—Messrs. Wake and Carr, 123, Victoria-road, Darlington, have for sale four sets of vertical marine-type triple-expansion engines. An advertisement gives additional information, and further particulars can be obtained from Messrs. Wake and Carr, Darlington, or Mr. Thos. W. Ward, Sheffield.

An advertisement also contains some particulars of eight large locomotive boilers which are for sale. Applications to Messrs. Wake and Carr, Darlington, or to Mr. Thos. W. Ward, Sheffield.

Hull Electric Lighting committee invite offers for four Willans-Siemens direct-coupled steam dynamos, together with spare armature and other parts, switchboards and accessories. The plant is in excellent working order, and may be seen at work by appointment. The sale is due to the change to the high-voltage system, and tenders (addressed Chairman of committee) must be delivered at town clerk's office, Town Hall, Hull, by noon March 21. Further particulars may be obtained from the city electrical engineer (Mr. A. S. Barnard), Sculcoates-lane, Hull. See advertisement.

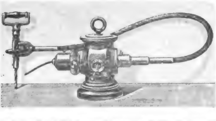
Burton-on-Trent Gas and Electric Light committee have for sale a horizontal compound engine with a single-phase alternator, some particulars of which are set out in an advertisement. Offers to manager and engineer, Mr. F. L. Ramsden.

**Sale by Auction.**—By order of the trustee under the deed of assignment made by G. Stegmann, the stock-in-trade and machinery of an electrical engineer, office furniture, fittings, fixtures, &c., will be sold by auction by Mr. H. W. Smith, at 45, St. John's-hill, Clapham Junction, London, this day, Friday, March 1, at 12 o'clock precisely. An advertisement contains some further particulars, and catalogues may be obtained from the auctioneer, at the auction and estate offices, 7, Featherstone-buildings, Bedford-row, London, W.C.

**Electrical Co.'s Specialities.**—Lists Nos. 10 and 15 of the Electrical Co.'s main catalogue are now available, and deal respectively with lampholders and measuring instruments. In the former list an infinite variety of holders for all purposes are illustrated and described. A section of the list deals with lampholders for electric signs and illuminations, and another with lampholders used in stage lighting. The measuring instrument list includes instruments for direct and alternating-current phase meters, dynamometric wattmeters, instruments for testing insulation, phase adjusters, &c., and on page 35 is an illustration showing a cable-testing van

fitted complete. The particulars include prices for complete travelling testing equipments.

**Electric Drilling Machines.**—We illustrate below a stationary type of drilling machine with flexible shaft, supplied by the General Electric Co., which comprises a small electric motor of the ironclad type specially designed for this class of work. The motor is made in sizes from a small fraction of a horse-power upwards, and these diminutive machines can be worked from an ordinary 16 c.p. lamp connection. Other than stationary types of these machines can, for ease in working, be suspended from above by means of pulleys and counter-weights, each of the machines having a breast rest. Owing to the small size of the motor a low voltage is advisable—usually 65 volts to 110 volts—but the design is suitable for voltages up to 500. The number of parts of the machines has been reduced to a minimum, and these are interchangeable for the respective sizes, so that repairs can be effected with ease and without delay. In order to secure comparatively light weight the parts are mostly of aluminium.



**"E.L.B." System.**—We are informed that a demonstration of the system of electric lighting boards and strips owned by Electric Lighting Boards (Ltd.) was made recently before the Czar of Russia, the Grand Dukes Waldemar, Alexis, and Sergius, and others. A careful examination was made by the Czar, and considerable interest was shown in the company's system and its various applications.

**"A.B.C." Mechanical Draught System.**—The American Blower Co., of 70, Gracechurch-street, London, E.C., have prepared a pamphlet on their "A.B.C." fan system of mechanical draught for steam boilers, and copies can be obtained on application. The system is diagrammatically illustrated, and a view shows an installation of an induced draught system with duplicate fans and engines and short iron chimney applied to a battery of six large Lancashire boilers, with a fuel economisers combined.

**Electric Generating Plant.**—A circular relating to electric generating plant manufactured by Messrs. Mather and Platt has just been issued.

Messrs. Ernest Scott and Mountain have issued some interesting particulars of a large installation recently completed for the Broughton and Plas Power Coal Co., Wrexham. This is described as the largest electric plant in the United Kingdom for endless rope haulage and pumping, the total power of the plant being 600 H.P.

**"London Manual," 1901**.—Edited by Robert Donald. (London: Edward Lloyd (Ltd.). 1s. 6d.) This is the fifth annual publication of a useful manual of information concerning metropolitan public bodies, obtained from official sources or officially revised. The editor is closely connected with the literature of London municipal life, and is consequently in a position to acquire a mass of information and statistics relating to municipal London. The numerous changes brought about by the passing of the London Government Act, including the establishment of borough councils in place of the old vestries, and the widening of the sphere of municipal operations in many directions, are fully recorded in the "Manual," which may be consulted upon all matters relating to the constitution of the numerous public bodies responsible for the government of London and Greater London. A few—very few—of what may be termed the municipal landmarks of the great city are illustrated, and if we have a suggestion to make it is that the number of these illustrations should be greatly increased in future issues and their quality somewhat improved. The price of the "Manual" should be increased to meet this added cost. London and its many disappearing points of interest are of more than local concern, and the title of the work under review justifies the hope that more attention may be given to these interesting points than is now the case. The portraits of the mayors of the new boroughs are interesting, and much of the information given is useful, but the title seems to demand that something more than municipal information should be included within the covers of such a work. We have already the "Municipal Year Book," of which Mr. Donald is editor. The "London Manual" is much too unimposing a work for its excellent title.

**"Power and Lighting Economist."**—This is the title of a quarterly magazine published in New York, which is established to deal with the "economic laws and experiences in the fields of power and lighting, and to give a general view and review of the whole field, especially of new ideas." The first issue of the magazine is not a striking one, consisting mainly of extracts from the electrical journals. These extracts have, for the most part, little bearing upon the advertised programme of the new publication.

**Brevets d'Invention.**—Señor Henri Hauser, 38, Zorrilla, Madrid, Spain, has issued a pamphlet entitled "Bases Fondamentales d'une Loi Universelle sur les Brevets d'Invention," in which he calls the attention of all concerned to his proposal that when new laws are being made for the regulation of matters relating to patents and trade marks, the inventor should be heard, and not only lawyers and patent agents. Señor Hauser puts forward a strong case on the inventor's behalf temperately, and the pamphlet is otherwise interesting reading. The right of translation is given, and copies of the pamphlet can be obtained for 50c. (5d.).

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 20 to Feb. 27, with the ports of destination:—

*Africa*—Alexandria, £30; Cape Town, £488; Durban, £863; East London, £15; Suez, £12,500 (telegraph cable). *Argentina*—Buenos Ayres, £490 (telegraph wire). *Australasia*—Auckland, £49; Lyttleton, £203; Melbourne, £242; Perth, £559; Port Chalmers, £53; Sydney, £1,763; Wellington, £221. *Brazil*—Rio Janeiro, £89. *Ceylon*—Colombo, £70. *Chili*—Valparaiso, £66. *China*—Shanghai, £48,000 (telegraph cable). *Denmark*—Copenhagen, £14. *Germany*—Hamburg, £643 (including £600 telegraph material). *Gibraltar*—£80. *Holland*—Amsterdam, £25; Rotterdam, £19. *Hong Kong*—£1,175 (telegraph apparatus). *India*—Bombay, £420; Calcutta, £137. *Japan*—Kobe, £1,412 (telegraph cable). *Malta*—£30. *Mexico*—Coatzacoalcos, £75 (telegraph material). *Roumania*—Braila, £190 (telegraph cable). *Russia*—Kure, £6,532 (telegraph cable). *Siam*—Bangkok, £29. *Spain*—Barcelona, £83 (telegraph material); Grenada, £75 (telegraph material). *Straits Settlements*—Singapore, £11,148 (including £11,000 telegraph cable). *West Indies*—Trinidad, £14. Total £87,857, against £10,647 in the corresponding week last year (Feb. 21 to Feb. 27).

## COMPANIES' MEETINGS AND REPORTS.

◆

### Telegraph Construction and Maintenance Co. (Ltd.).

The thirty-seventh ordinary general meeting of the members of this company was held at the offices, 38, Old Broad-street, London, E.C., on Tuesday, under the presidency of Sir ROBERT G. W. HERBERT, G.C.B.

The SECRETARY (Mr. E. Dickens) read the notice calling the meeting and the auditors' report, as appended to the balance-sheet.

The CHAIRMAN said: I conclude, gentlemen, you will take the report as read, as you generally do; and I hope that it is a report that has given you full satisfaction. We have for many years past been able to present you with a very satisfactory statement of the condition of the company, showing it to be thoroughly sound and capable of providing the proprietors with a good dividend; but on this occasion it is our great pleasure to be able to place before you an account of a very much extended sphere of operations, resulting in very much larger figures than have appeared in any of our balance-sheets for a great many years. The net profit for the year was £100,195, as compared with £82,828 last year; and after paying an interim dividend of 5 per cent., there remains—including the amount brought forward—£131,589 to be dealt with, out of which it is proposed to distribute a dividend of £1. 4s. per share, together with a bonus of 6s. per share, absorbing £56,025, or at the rate of 12½ per cent., and making, with the amount already paid, 17½ per cent., including the bonus of 2½ per cent., tax free, leaving the substantial sum of £75,564 to be carried forward. The balance-sheet totals, as you see, have at last reached a sum of above £2,000,000 on each side. We have been very actively at work during the past year. We have done a great deal of work in every way, laying some considerable cables, performing repairs for foreign Governments and companies, and providing store cable for companies to keep in stock for their requirements: and our factories have been fully occupied. They are in excellent condition. The Wharf-road factory has been somewhat further extended and furnished with fresh machinery; and they have both been fully occupied with work during the greater part of the year under consideration. The debts owing by the company are of the usual character; they are all of a limited kind, and are what occur in the current transactions of our business. The reserves are considerably increased, and this you will at once understand to be desirable when you bear in mind that we have been able to obtain the execution of the great Pacific cable, which will undoubtedly entail upon us a heavy outlay before we can receive a corresponding amount of pay for the work. The cable, as you know, has to be completed by the end of 1902—the

smaller portions of it by the middle of 1902—so that we have got a long period of work and expenditure to get through before we receive the full remuneration which that work will bring in when it is completed. I think you will all understand that for that reason it is desirable that we should have our pockets full of money placed in reserve to meet all the expenses of that somewhat trying period. The pension fund, you will observe, we have increased by a further £10,000. We have now, therefore, in hand £20,000 towards the organisation of this pension fund for our officers. I think it is the opinion of the proprietors, as well as of the directors, that this is the best way in which we can give some special remuneration to our staff, which has worked so very industriously and effectively during the past few years. The sum we had already accumulated of £10,000 was not sufficient to start the pension fund on a strong footing, because, although the scheme is a simple one, and does not involve any large actual payments from the junior members of the staff, yet it is necessary that their payments should be subsidised and assisted by contributions from the company in order to make them such as the staff could be fairly called upon to pay. The scheme, as I told you on a former occasion, is generally of this nature—that a junior clerk coming in, receiving at the rate, say, of £100 a year, should pay £10 in his first year, which would entitle him to a pension of £5 on his retirement at the age of 65, and that each year he should pay an increased rate of contribution and that a corresponding increase should be made to his pension at the end of the time. I think we shall be able to start that if you approve, as no doubt you will, our strengthening the pension fund. The ships are in excellent condition, and have all been actively employed in various directions. All our ships have done good work, and the "Anglia" has almost exceeded her previous work, and is almost always doing record work. The officers in charge of the ships, as well as the officials at both our factories, have merited the very high approval of the directors, and I am quite sure you will feel, as we do, that their energies have contributed very largely to the success of the company. I do not know that I have anything very special to say to you unless any question should be asked; but if you should wish for any further explanations we shall be happy to give them to you. I now propose—

"*Resolved that the report and accounts of the directors to Dec.* 31, 1900, *submitted to this meeting, be and the same are hereby received and adopted, and that a dividend of* 24*s. per share, together with a bonus of* 6*s. per share, making a total of* 30*s. per share (in addition to the* 12*s. per share interest or interim dividend paid to June* 30, 1900), *be paid upon all shares of the company for the year ending Dec.* 31, 1900, *and that such dividend and bonus be paid free of income tax.*"

Sir JAMES PENDER, Bart., seconded the resolution, which was carried unanimously.

On the motion of Sir J. PENDER, seconded by the CHAIRMAN, the retiring directors, Admiral Sir Anthony H. Hoskins and Mr. Colin F. Campbell, were re-elected; and the auditors, Mr. John Gane and Mr. Patrick A. Glegg, were afterwards re-appointed.

Mr. GIBSON then proposed a cordial vote of thanks to the chairman, directors, secretary, and staff for their management of the company's affairs and for the good report which had been placed before the shareholders. Their company enjoyed no privileges in connection with the work they undertook to carry out, but were open to competition, and therefore the shareholders must assume that the extended business announced to them that day was attributable to the skill, industry, and constant perseverance of those who managed the affairs of the company. He had been a shareholder for a great many years—from nearly the beginning of the company—and he greatly appreciated the services of all who were connected with the conduct of the business.

Mr. BARNES seconded the motion, which was carried unanimously.

The CHAIRMAN: On behalf of my brother directors and myself, and also on behalf of the staff, I thank you very cordially for the generous expressions which Mr. Gibson has used, and for the manner in which you have received his proposal to thank us. We have had a hard time, particularly the officers and the employés, who are working sometimes night and day at our factories. It does require constant watchfulness to get work and to carry it out, and we hope not to diminish our energies in any way, knowing that we have your kind approval.

The proceedings then terminated.

## W. T. Henley's Telegraph Works Co. (Ltd.).

The twenty second ordinary general meeting of this Company was held yesterday (Thursday) at the Cannon street Hotel, under the presidency of Mr. SYDNEY GEDGE.

The SECRETARY (Mr. A. E. Salmon) having read the notice calling the meeting,

The CHAIRMAN said: Gentlemen, a perusal of the balance-sheet will show you that it requires no large amount of courage on the part of your Directors to meet you to-day. We have to put before you a balance-sheet which, I think, has had no rival among the balance sheets of similar companies in the course of this year, and we feel that we may look you in the face with a little courage, perhaps, and not be afraid of the comments you will make upon it. There is nothing new in it; it follows the old lines. It mentions the facts in the plainest and clearest way, so that "he who runs may read" and know the position of the company. At the foot of the balance-sheet you will find an excellent certificate from the chartered accountants who act as your auditors, who have borne in mind the new and somewhat stringent Act of Parliament passed last session with respect to companies. You will find that everything required by the act has been done by the Board, and is certified to by the auditors as being correct. Very great pains have been taken by the Directors in preparing the accounts, and in taking care that the profit and loss account, especially, shall not overstate the doings of the Company. I may say that in arriving at the gross profit of £99,001, we set aside more than sufficient to cover all risks of every kind with respect to contracts in existence. No profit is taken into account which has not been actually earned, and every possible liability has been considered, and amply sufficient reserve made out of our receipts to meet those liabilities; I mean such liabilities as we incur in the shape of guaranteeing cables laid for the betterment, the improvement, or the lighting—or, I should say, in introducing the electric light, or telephones, and things of that kind. Where we have any liability in the shape of guaranteeing the good working for a time—for a limited time—the amplest provision has been made before we arrived at the gross profit. I may say that we have resisted the temptation, at the commencement of the new century, of putting down those profits at £100,000. I think that we could have done so with a good conscience, but we have left it at £99,001—£99,000 for the old century and £1 with which to start the new century; and I hope that those who survive and see the end of the new century will have equally good results to congratulate themselves upon as we have to congratulate ourselves upon the position which the Company has attained in this first year of the twentieth century. There is really nothing else, I think, to state with respect to the report. We have come, as you see, to the melancholy fact that we are going to pay 20 per cent.; but do not let our rivals suppose that, because that 20 per cent. is paid on the small nominal capital of £175,000 that that is all our capital. There is more—considerably more—capital invested in the business. There is £175,000 of preference shares, and there is also the considerable premium which has been obtained by the issue of ordinary shares from time to time as required. Looking back, and comparing the accounts this year with those which we submitted last year, you will see that there is an improvement in every particular. On the debit side of the balance sheet you will see that the ordinary capital has increased by £25,000; but that £25,000 produced £50,000 for the coffers of the society. The whole of the new capital of £25,000 was taken up by the shareholders at 100 per cent. premium, and therefore that £25,000 produced £50,000. The preference shares have been increased from £150,000 to £175,000 at par, and the capital again was placed among the shareholders or their friends or nominees. There is nothing at all, I think, to observe with respect to the creditors; but when we come to the reserve account you will find that the amount as per last balance-sheet was £42,500. We are adding to it the £25,000 received by the issue of the new ordinary capital, and we are proposing to transfer to it from profit and loss account £11,000. Last year we transferred only £10,000 to the reserve account out of profits. As to the next item of £1,000 for sinking fund, it is the first year in which such an item has appeared. You know that we have £50,000 of debenture stock to be repaid by degrees, a sum of £1,000 a year being set aside from the profits, and also the interest payable on all that has already been redeemed. That is to say, the £50,000 of debenture stock is nominally kept alive, but year by year so much as has been redeemed is taken as belonging to the trustees for the debenture-holders, to whom the interest is paid; and that interest, in turn, will go at the end of the year towards redeeming the amount. The reserve under the cable-repairing contract (that is, the Bahamas cable) increases every year. In former years it has increased by £700 a year and accumulations. This year it is but £350 and accumulations, because, as the stock exceeds in value £6,000, half of the annual sum of £700 paid by the Government of the Bahamas is now paid to us in cash, and forms part of our profits; and so long as the amount is over £6,000, that will continue to be done. If there should be any call on that repairing fund for repairs, and it should be reduced below the £6,000, the whole £700 will again go to the capital of the fund for investment, until it again arrives at a sum exceeding £6,000; but if the cable goes on as well as it has done during the whole course of its existence, there will be no demand on the fund which can by any possibility so reduce the amount, because hitherto nothing has had to be spent on anything connected with the submarine cables. A few pounds have had to be spent every year on some little matters connected with the landline or the huts, but is a mere bagatelle, and scarcely worth talking about. We show at the end of this side of the balance-sheet the balance at credit of profit and loss general account; and as against £37,440 shown last year, we have now £53,890. If we turn to the other side you will see that our freehold land, buildings, &c., after writing off depreciation, is valued at £21,700 more than it was last year; and as we have spent £25,000 odd hundreds in addition, you will see clearly that we have not over-estimated the value. The stock-in-trade, including expenditure on orders in hand—taken, as I have already said, without estimating any profit—is £30,000 more than it was last year. The debtors are about £10,000 more, and the bills receivable are rather less. Cash at bankers, owing to our having issued new capital, is £22,000 more. All that, I think, shows a very healthy balance-sheet. We then come to the profit and loss account, and there you find that the gross profit has risen from £76,000 to £99,000; and the net profit—the balance carried to profit and loss general account—is £56,411 this year as against £40,311 last year. In everything you see a decided improvement; and I think that, without troubling you any more with details, we can come to the very excellent and admirable result—namely, that last year we paid 15 per cent., which took £16,500, and this year we pay 20 per cent., dividing £25,467 among the ordinary shareholders, and £5,712, as against £2,086, among the preference shareholders—a result on which we may mutually congratulate each other. I ought only to add one word. We could not have presented this agreeable result but for the unremitting attention and skill and energy of Mr. Sutton and Mr. Hatton, and but for the manner in which they have been cordially supported by the staff who work under them and under the Board. I now move the adoption of the report and accounts.

The EARL OF GALLOWAY seconded, and the motion was carried unanimously.

A resolution that the dividends recommended by the directors be approved was also carried unanimously.

The retiring Directors, the Earl of Galloway and Sir Henry M. Stanley and the retiring auditors, Messrs. Ball, Baker, Deed, Cornish, & Co., were afterwards re-elected.

On the motion of Mr. LAMONT a sum of £500 was next voted to the Directors beyond their fixed remuneration.

The CHAIRMAN, in acknowledging the vote, stated that he had omitted to mention one point. Last year the Directors spoke of the possibility of their having to raise further capital, for which the shareholders had already given them powers. They thought at the time that they might have to raise capital, particularly as they had hoped to get a share of the Pacific cable. That work had, however, been obtained by their great rival, and this Company had no share in it. That occasion for raising capital had, therefore, not arisen, and there was no desire on the part of the Directors to "water" the capital in any way by issuing more than they thought necessary. They raised their first additional capital of £30,000 at par, for the next issue they got 60 per cent. premium, the following £25,000 was raised at 80 per cent. premium, and for the last issue they got 100 per cent. premium. If the Board should have occasion to raise the £25,000 of ordinary capital which they had the power to raise, they hoped that they might get even more than 100 per cent. premium.

Mr. LAMONT afterwards proposed a hearty vote of thanks to the managing director, the secretary, and staff in London and at the branches at home and abroad, and also to the chief engineer and his staff at the works for their services in the past year.

Mr. COOPER, in seconding the motion, expressed a hope that the Directors would at their next meeting take into consideration the question of voting some increased remuneration to the staff for their successful services.

The motion was carried unanimously.

The MANAGING DIRECTOR (Mr. George Sutton), in acknowledging the vote, said that with respect to Mr. Cooper's remark as to the payment of the staff, it had been the custom of the Board for many years—even in the bad times when no dividend was paid—to consider the whole list of the Company's servants, and, where it was considered that they deserved it, to increase their salary or in some cases to grant small bonuses. The shareholders might depend upon it that the staff were well looked after. It was well known that the success of a company must largely depend on the loyalty and the services of its permanent staff, and he was glad to say that the Company had such a staff. As regarded the work done by the Company, he believed that, so far as submarine work was concerned, last year was the best the Company had ever had. This was a class of work which had less risk than the laying work, and it was the kind of work they liked best. He might take that opportunity of saying—and he was confident that the shareholders would like to be assured of the fact—that the production of the balance-sheet and the splendid accounts submitted were not due to any abnormal conditions. Their business was done on the merit of the work they turned out, and he therefore thought that they might hope that the present position of the business would be maintained. This year the Company had attained its majority; it was 21 years old this month, and on its 21st birthday they had paid their first golden dividend—one sovereign on every ordinary share.

A vote of thanks to the Chairman brought the meeting to a close.

## Westminster Electric Supply Corporation (Ltd.).

The ordinary general meeting of the shareholders of this corporation was held on Wednesday, under the presidency of the Right Hon. Lord SUFFIELD, K.C.B.

The SECRETARY (Mr. Frank Lago) read the notice calling the meeting, and the report of the directors was taken as read.

The CHAIRMAN said: I regret that there is a reduced dividend on this occasion, for although we have added to our circuits over 48,000 lamps during the 12 months, we have, like all other users of Welsh steam coal, been very hard hit by the great rise in price. Our profits are also affected by the rebate made to consumers taking their supply at 200 volts, and by a considerable increase in rates and taxes. During the year ordinary share capital to the amount of £148,100 has been issued at par to the shareholders. A large proportion of this sum has been expended on the joint undertaking of the St. James' and Pall Mall Company and this corporation in the purchase of lands and erection of works at North Bank, Marylebone. This capital must necessarily, until the opening of the works for supply purposes, remain unremunerative. You will have been pleased to learn that the Directors have at last come to an agreement for lighting the whole of St. George's parish. The question of provision of further capital as it becomes necessary will be considered by the Board in due course. I do not think there are any other matters to which I have to draw your attention and I therefore now move—

"*That the report and accounts for the past year be received and adopted.*"

Mr. BOULNOIS, M.P., seconded the motion.

Mr. E. P. S. REED: Can you give us some information as to the date when the Board expect the works now being promoted by this Company and the St. James' Company to be ready?

The CHAIRMAN: I will ask Prof. Kennedy to answer your question.

Prof. A. B. W. KENNEDY, LL.D., F.R.S., M.Inst.C.E. (engineer-in-chief): The plant for the central station is on order, and a great deal of it is actually completed, or very nearly so. The section that is absolutely necessary for our working has been arranged to be put up in our station here, and we shall get the benefit of that next winter. The building at North Bank will not be ready in time; it is expected to be ready about August twelvemonths, so as to meet the demand in the winter after next. The plans are prepared, the excavations are being made, and the work is going on to that extent, but the building will take a long time. The directors thought it better to take the plant and put it here in our own building, and it can be removed afterwards. With regard to the effect of the increase in the cost of coal on our accounts, the total difference in cost has been 0·28d. per unit, but our actual increased cost is only 0·23d., so that we have saved in other matters.

The motion was then carried unanimously. A resolution approving the dividend at the rate of 11 per cent. per annum for the past half-year was then passed.

Lord Suffield and Mr. R. W. Wallace, K.C., were unanimously re-elected directors, and a hearty vote of thanks to the chairman, directors, and staff concluded the proceedings.

## Electric Resistance and Heating Co. (Ltd.).

An extraordinary meeting was held on Tuesday to consider a resolution to the effect that, it having been proved to the satisfaction of the meeting that the company could not, by reason of its liabilities, continue its business, it was advisable to wind-up the same voluntarily.

The SECRETARY (Mr. W. Chaplin) having read the notice calling the meeting,

The CHAIRMAN (Mr. Cyril Wanklyn) said the board felt as deeply disappointed as any shareholder at the necessity of having to take the step now proposed, but by continuing the business with little or no capital they were incurring a heavy moral, and perhaps also, a legal responsibility. The liabilities at present amounted to between £1,500 and £2,000, and it was doubtful if the assets, apart from the patents, by which he meant such assets as could be immediately realised—plant, tools, and small movable property of that sort—would cover the amount of the liabilities. The company's working capital should have been in cash £17,500. Of this £5,500 had gone principally in patent fees, law expenses, and plant, without which it was impossible to start manufacturing their patent material. They then had another £5,500 left, and that was the only sum that they had had to spend on the actual manufacture of the processes and the development of them to the particular objects for which they had been invented. This shortness of working capital was the principal reason why the position of the company was what it was to-day. Another important reason was one which the board had realised only after a certain amount of experience of working the patents, and that was that the process was undoubtedly represented to them to be in a more advanced stage than they found to be actually the case when they came to test it by putting it into actual practice. He would mention only two or three respects in which they had been disappointed with the invention. The first was the question of sparking. The board were given to understand by experts' reports that this resistance would work, as it was called, sparkless—that there would be no danger from sparking. When they tested the first of their ring resistance they found that far from being the case. They now had a ring which had been tested within the last few days, and which showed that the defect of sparking had been entirely overcome. Another defect from which they might fairly have expected that the invention would have been free, was that of jumping. One of the reports which were published contained the following statement with regard to this point:—"With the patent resistance there will be not only an absolutely imperceptible gradation of the resistance, but it will be possible to regulate to a much greater nicety." When the board came to put the first ring resistance under the test they found that that was not the case. They found, in fact, that the instrument with which they were tested as a sliding contact moved round the ring, giving jumps the whole way round, and on inquiry the directors found that this was not due to any inherent defect in the material, but simply because their manager, for some reason or other, had not built the ring as a continuous whole, but had built it in sections. The ring appeared to be a continuous solid body, but it was not so. That also had now been got over. The very ring to which he had just referred showed no defect of that kind, but was one continuous homogeneous whole from start to finish. The third and last defect to which he wished to call attention was that of heating. Here, again, they were told "it was proved that the strength of this material (this company's material) could not be influenced by the repeated application of red heat," and, finally, "that the constant subjection to current producing very high temperatures for several days could not deteriorate it." As regarded deterioration generally from the application of red heat, he could not express an opinion, because they had not been in a position to put rings under sufficiently lengthy tests, but he could say emphatically, that not the ring to which he had referred as having been recently tested, but two previous ones, got red hot under a not particularly lengthy trial. This was especially the case with arc-lamp resistance, thereby rendering them not only dangerous but liable to speedy deterioration when used for a length of time. These were three points out of many, all of which had had to be dealt with, and the overcoming of these defects had meant the expenditure of a considerable sum. He did not regard the present position of the undertaking as hopeless. In fact, since the production of the company's last ring the prospects appeared to be infinitely better than they were some months ago. It was possible the shareholders might reproach the directors for an error of judgment in having launched this thing before the time when it was a commercial success. He was afraid that they did so, but if the board made a mistake it was in excellent company, because a firm of such standing as Ganz & Co., of Buda Pesth, were led away by the reports submitted to them and the test they made for themselves. If the resolution were passed he hoped that it would be possible to make arrangements whereby the business could still be carried on, and if such arrangements were made he felt sure—although he did not wish to be understood as giving any guarantee in the matter—that every possible means would be taken to preserve the interest of every shareholder in this company represented by a cash payment. The vendors, who were largely foreigners, received a large sum in cash, but they had never come forward to assist the company with a single penny.

Capt. BAX said he had shown the company's material to a great number of engineers, all of whom had been taken with it. He believed that if the company had been provided with sufficient working capital they would by this time have come very near to a great success, and he believed still that there was a great success in store for the process. Some friends of his, whom he had approached with a view to their providing further capital in order to put the thing on a proper basis, said that they could not be loaded up with a lot of foreign shareholders holding vendors' shares. Therefore, though in the first instance it might have seemed more desirable not to wind-up with reconstructing, the board had after mature consideration, come to see that it would be better to wind-up the whole thing and start *de novo*.

The resolution was carried.

On the motion of the chairman, seconded by Mr. Guedella, a resolution was afterwards passed appointing Mr. Chaplin (secretary) as liquidator.

## British Insulated Wire Co. (Ltd.).

The ordinary general meeting was held at Liverpool on Monday, the chairman (Mr. W. MARRINER BRIGG) presiding.

In moving the adoption of the report, which appeared in our last issue, the CHAIRMAN said the gross profit for the year had been a pleasant surprise to the directors. In view of the development during the last two years of electrical undertakings, which, of course, meant increased competition, which in its turn usually represented a larger turnover and less profit, he was glad to say that in the case of that company the profits had been fully maintained, and, indeed, increased. Last year a bonus of 5 per cent. had been paid, in addition to the dividend, but that was under exceptional circumstances: large profits had been made, and it had been decided to make a further issue of capital, but the shareholders at that time had preferred that the profits should be fully divided amongst the existing shareholders, and should not be left for division amongst those who might subsequently come in; therefore it was that the bonus of the previous year had not been repeated on the present occasion. The company required all the strength it could possibly get, for they had a great amount of work in hand and in prospect; further, the directors deemed it very desirable to establish a strong reserve, which now amounted to £200,000, this having been created to the extent of £177,000 by the premiums of the new shares issued last year, and by the sum of £22,400 now proposed to be transferred. Referring to the investments, these had been most carefully considered in the best interests of the company, and had been the means, as it was intended they should be, of obtaining for the company valuable contracts. The investments were now worth much more than were given for them.

Ald. SNAPE, J.P., seconded the motion, and said the past year had brought to the company a larger amount of business than they had known in any previous year, and also the largest amount of profit. In both respects they had broken the record; he must congratulate the shareholders upon the astounding growth of business which had characterised the progress of the company. Looking at present conditions and bearing in mind that on every hand electrical enterprises were increasing to an enormous extent, he thought there was every reason to anticipate that the company would get as fair a share of work in the future as they had enjoyed in the past. One notable feature of the company's working was that it made practically no bad debts. The work of the company was likely to increase because not only was the Government extending its trunk telephone service by means of underground cables, but municipalities were following suit; and in Liverpool, owing to recent accidents, the National Telephone Co. were actively engaged in transforming their overhead into an underground system. The company had also valuable connections with Australia and other colonies, and from a recent visit he had paid to Australia he could testify to the rapid growth of certain cities and the widespread development of electrical tramways and other organisations offering a market for the products of the company. Some of their investments had been, for business reasons, placed in these colonial undertakings, and he, for one, anticipated that the result would ultimately be a very considerable profit to the company.

The motion was carried unanimously.

Mr. Ald. SMITH moved that the dividends set out in the report be declared, and said that business men would approve the policy of the directors in strengthening the reserve, which would permanently increase the value of the shareholders' investments.

The retiring directors, Messrs. Marriner Brigg and S. Z. de Ferranti, were re-elected, and the auditors re-appointed, after which a cordial vote of thanks to the chairman and directors was passed unanimously.

Mr. J. B. ATHERTON, in responding to the resolution, reviewed the history of the company and referred to the time in its early days when, having started with a capital of only £20,000, it was very near expiring. It had, however, pulled through, and its present important position was a source of great gratification to the directors.

## Chelsea Electricity Supply Co. (Ltd.)

The directors' report for the year ended Dec. 31 last states that in consequence of the high price of coal there has been a considerable increase in the cost beyond the provision made in 1899 to meet the expected extra outlay. An appreciable diminution in the revenue per unit sold has also been caused by the reduction in the price to consumers on the 200-volt supply, which it was deemed advisable to make in the latter part of 1899. This reduction has, however, been gradual, as it depended on the change by consumers to the higher pressure; it has resulted in bringing increased custom and inducing a somewhat freer use of the current. The number of lamps connected on Dec. 31 was 145,277, an addition of 16,410 during the year.

In October an allotment of 14,000 ordinary shares, at £6 per share, was made pro rata to the shareholders, and at Dec. 31 allotments of 9,805 shares had been taken up. The balance of premium received in 1900, after deducting cost of issue and certain exceptional expenses, has been carried to reserve, which now stands at £56,622. 13s. 5d.

£3,000 had been added to renewals and depreciation fund out of the net revenue. After deducting this and interest on debenture stock (£6,750) there remains a balance of £11,370. 17s., which is to be applied as under:—Interim dividends on preference and ordinary shares to June 30 last (£5,150); dividends on 6 per cent. preference shares, and of 6 per cent. per annum on the old ordinary shares (making 5½ per cent. for the year), and of 5½ per cent. per annum on the 9,805 new ordinary shares from due dates of instalments to Dec. 31 (£6,099), leaving £121. 17s. to be carried forward.

## Metropolitan Electric Supply Co. (Ltd.).

The report of the directors of this company for the year ended Dec. 31, shows the capital expenditure to have reached £1,417,805. 8s. 11d., an increase during the year of £173,551. 7s. 5d. The principal items of expenditure were for the works at Willesden, and for the extension of the low-tension system. During the year the capital has been increased by the issue of £125,000, balance of 3½ per cent. mortgage debenture stock, and of 15,000 ordinary shares of £10 each to the shareholders at par, this being the balance of the company's authorised share capital.

The gross revenue amounted to £209,420. 6s. 1d., compared with £179,190. 1s. 10d. in 1899, an increase of £30,230. 4s. 3d. The cost of generation, which in 1899 was £90,419. 7s. 1d. amounted in 1900 to £106,009. 4s. 9d., an increase of £15,589. 17s. 8d.

To meet the rapidly increasing demands for current a fourth steam generator of 1,500kw. capacity is in course of erection at Willesden, and a fifth machine of similar size has been ordered and will be erected in the course of the coming summer.

During the year negotiations took place with the Marylebone vestry for the sale to them of the company's West London (Marylebone) undertaking. A provisional agreement, subject to approval of the vestry and shareholders respectively, was entered into on fair and reasonable terms. The agreement was approved by the vestry in August, but in October the vestry decided that the resolution approving the agreement should not be confirmed.

The balance to credit of revenue, before providing for depreciation, is £78,500. 10s. 5d. The directors have set aside £14,000 as an addition to depreciation and reserve, which now amounts to £78,422. 5s. 10d., carrying to credit of net revenue £64,500. 10s. 5d. which, with the balance brought forward and other receipts, makes a total of £71,840. 18s. 9d. After deducting debenture and share interest and other charges, there remains a balance of £27,841. 1s. 3d. An interim dividend of 6s. per share on the ordinary shares was paid on August 11 (absorbing £25,500), and the directors recommend a further dividend of 6s. per share be now paid, making the distribution for the year at the rate of 6 per cent., together with the proportionate payment of 9d. per share on the new shares. This will absorb a further £26,016. 6s. 9d., and leave £1,824. 14s. 6d. to be carried forward. The directors consider this result satisfactory, having regard to the high price of coal generally, especially during the last three months of the year.

The number of 8 c.p. lamps supplied by the company increased during the year from 500,000 to 570,000. The number of lamps now connected is 578,000, and the applications show no signs of decrease.

The company's engineer reports that the stations, machinery and plant have been maintained in a satisfactory condition.

## Charing Cross and Strand Electricity Supply Corporation (Ltd.).

The directors' report for the year to Dec. 31, states that the working of the company has been satisfactory.

*West End Areas.*—Building extensions at Lambeth station have been completed, and the entire site is occupied by the fully-equipped generating station. The sub-station buildings at Short's-gardens have been completed and partially equipped: 1,500kw. in motor generators and 400kw. in batteries have been installed. The plant and machinery at all the stations have been maintained in a high state of efficiency. The increased business has necessitated the erection of a further sub-station for the West-end areas, and a site has been acquired in St. Martin's-lane for this purpose, while offices are being built to accommodate the staff necessary to carry on the general business of the corporation.

*City Area.*—An act empowering the corporation to acquire land and erect generating stations at Marsh Gate-lane, Bow, has been passed. This act empowered the corporation to supply electric energy in bulk to certain local authorities in the East-end. The site acquired under this act consists of 7½ acres of freehold land. Sites for sub-stations have been secured at Fenchurch-street and Ludgate-hill. Building operations are in progress on these sites, and negotiations are proceeding for other sites. Motor generators and batteries are being installed at Ludgate-hill sub-station, and supply is already given from that station to part of the City area.

The growth of the corporation's business in all its areas has been satisfactory. The equivalent of 39,431 additional 8 c.p. lamps (36,003 in the western areas, 3,427 in the City area) have been connected, making 222,120 lamps now connected, while negotiations are proceeding in the several areas for a supply to nearly 50,000 additional 8 c.p. lamps, of which a large proportion are in the City area. There have been 22 miles added to the mains in the West-end areas, and 27 miles in the City area, making the total mains laid 174 miles. The units sold during the year show an increase of 995,132 over those sold during 1899.

The increase of gross revenue from sales of current in 1900 over 1899 was £15,962, compared with an increase of £10,715 in 1899 over 1898, i.e., an increase of nearly 50 per cent. This satisfactory result of the year's trading would have been even more satisfactory but for the price of coal (an increased expenditure of nearly 30 per cent. over 1899), the serious loss of income due to the fire at Maiden-lane station in March, and the further consequent heavy distribution losses pending the reinstatement of damaged plant and machinery. The fire loss on capital account is being written off share premium.

£73,670. 16s. 10d. has been lent to the Charing Cross and City Electric Co. on account of £200,000 authorised.

The net earnings have amounted to £29,517. 1s. 3d., £2,182. 2s. 9d. has been paid as interest on debentures and temporary loans up to Dec. 31, and £10,625 was distributed as interim dividend (at the rate of 8½ per cent. per annum) for the half-year to June 30. There remains £16,709. 18s. 6d., which, with £4,541. 13s. 10d. from last account and £1,161. 4s. 7d. received for interest on advances, makes £22,412. 16s. 11d. The directors recommend the payment of the dividend on the 4½ per cent. preference shares (£7,052. 1s.), and a dividend at the rate of 9½ per cent. for the half-year to Dec. 31 on the ordinary shares (making 9 per cent. for the year) (£11,875), leaving to be carried forward £3,485. 15s. 11d.

---

**BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)**—A shareholders' meeting was held yesterday, under the presidency of Mr. H. R. Beeton, who said there had been a growth of the business, with an all-round increase in the expenditure, although had it not been for the higher price of fuel, the works cost would have been the lowest they had yet achieved. As it was, however, it compared favourably with that of any similar station with the same output. During the past year the renovation of their station had been completed by disposing of the last instalment of their antiquated plant. To do this nearly £27,000 had had to be written off capital account from first to last, but the company now had practically a brand new engine-house, which was equipped with the most modern plant, and for many years they would reap the fruit of this in economy of production. By substituting vertical for horizontal plant so much addition had been made to the floor space of the engine room as to postpone for a long time the necessity for building a new station. It was proposed to increase the ordinary and preference capital to £100,000 each. The object of the issue was not only to provide for immediate capital requirements, but also to redeem the debenture stock, which in the present circumstances of the company was carrying too high a rate of interest. The directors' report was adopted.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ARON ELECTRICITY METER (LTD.)**—The annual return to Dec. 27 gives the capital as £250,000, in £1 shares (125,000 preference), of which 125,000 ordinary and 124,896 preference have been taken up. £1 per share has been called up on the preference shares, and the ordinary shares are considered as fully paid.

**BULLERS LIMITED**—The annual return to Dec. 7 has been filed. The capital is £400,000 in 20,000 preference and 20,000 ordinary shares of £10 each, of which 15,000 preference and 15,000 ordinary shares have been taken up. £10 has been called up on each of 15,000 preference and 7 ordinary, and £150,070 has been received; 14,993 ordinary shares are considered as fully paid.

**CENTRAL ELECTRIC SUPPLY CO. (LTD.)**—The annual return to Jan. 1 has been filed. The capital is £100,000 in 20,000 shares of £5 each, all taken up. £3. 2s. 6d. has been called up on each of 19,692, £1 on each of 300, and £5 on each of 8 shares. £61,877. 10s. has been received. No mortgages or charges.

**DIRECT UNITED STATES CABLE CO. (LTD.)**—The annual return to Feb. 12 gives the capital as £1,300,000, in 65,000 shares of £20 each, 60,710 of which have been taken up. £1,214,200 is considered as paid. No mortgages or charges.

**ELECTRIC RESISTANCE AND HEATING CO. (LTD.)**—In the annual return to Jan. 1 the capital is given as £120,000, in £1 shares, 103,950 of which have been taken up. £1 has been called up on each of 41,450, and £43,587. 10s. has been received, including £2,137. 10s. paid on 8,550 forfeited shares. 62,500 shares are considered as fully paid. No mortgages or charges. (See report of shareholders' meeting on another page.)

**GENERAL ELECTRIC CO. (1900) (LTD.)**—The annual return to Jan. 31 gives the capital as £800,000 in £10 shares, 50,007 of which have been taken up. £7. 10s. per share has been called up on 18,000 and £10 per share on 7 shares, and £160,177. 10s. has been received, leaving £11,892. 10s. uncalled. 32,000 shares are considered as fully paid. Mortgages and charges £200,000.

**KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION (LTD.)**—The annual return to Dec. 24 gives the capital as £225,000, in £1 shares, 175,000 of which have been taken up. 10s. per share has been called up on 150,000 and £57,305. 0s. 9d. has been received, leaving £17,694. 19s. 3d. in arrears. 23,000 shares are considered as fully paid. No mortgages or charges.

**NERNST ELECTRIC LIGHT (LTD.)**—From the annual return to Jan. 2 it appears that the capital is £320,000, in £1 shares (140,000 preference), all of which have been taken up. £1 per share has been called up on 115,000 and £114,711. 5s. has been received, leaving £288. 15s. in arrears. £235,000 is considered as paid on 180,000 ordinary and 25,000 preference shares. £231. 5s. has been paid on 520 forfeited shares. No mortgages or charges.

**PEARSON FIRE ALARM SYSTEM (LTD.)**—The annual return to Jan. 11 has been filed. The capital is £150,000, in £1 shares, all of which have been taken up. £1 per share has been called up on 24,307, and 1s. per share on 5,700 shares, and £24,592 has been received. 119,993 shares are considered as fully paid. No mortgages or charges.

**PACIFIC AND EUROPEAN TELEGRAPH CO. (LTD.)**—The annual return to Dec. 19 gives the capital as £100,000 in £10 shares, all of which have been taken up. £4 has been called and paid on each share.

**PERTH ELECTRIC LIGHTING CO. (LTD.)**—According to the annual return to Dec. 30 the capital is £1,000, in £1 shares, seven of which have been taken up. No calls.

**PERU TELEPHONE CO. (LTD.)**—According to the annual return to Jan. 14 the capital is £100,000 in £5 shares, seven of which have been taken up. No calls have been made.

---

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 28 1/16d. per oz. (Feb. 28). Consols (2¾ per cent.) 97 3/16—97 1/4 for money, 97 5/16—97 3/8 for account; 2½ per cent. 96½—97½ (Feb. 28). Consols Pay Day March 1. Stocks and Shares Continuation Days, Mar. 12 and 26, Ticket Days, Mar. 13 and 27; Pay Day, March 14; Mining Share Carry-over Days, Mar. 11 and 25.

---

**CAVERHILL AND WHITEWELL TRAMWAY CO.**—At the annual meeting last week, a resolution that the agreement between the company and the British Electric Traction Co., Ltd., dealing with the proposed adoption of electric traction for the Caverhill and Whitewell tramways, be approved was agreed to. The capital of the company is to be increased, and powers are being sought to authorise the equipment of the tramways for electric working and for their extension.

**CENTRAL LONDON RAILWAY CO.**—Letters of allotment in the recent issue of £876,000 4 per cent. debenture stock have been posted.

**CHARING CROSS, EUSTON, AND HAMPSTEAD RAILWAY CO.**—A special meeting will be held on March 4, to consider the company's bills now before Parliament.

**CLARKE, CHAPMAN & CO. (LTD.)**—Mr. William I. Taylor, M.I.Mech.E., 50, Fenchurch-street, E.C., London representative for Messrs. Clarke, Chapman & Co. (Ltd.), Gateshead, has been elected a director of the company.

**ENGINE BOILER AND EMPLOYERS' LIABILITY INSURANCE CO.**—At the annual meeting Mr. R. B. Longridge, who presided, said that during the past year there had been a larger amount than usual paid for damage to boilers from the collapse of furnace crowns owing to the deficiency of water or the accumulation of deposit. There had been a considerable increase also paid for breakdown of steam and gas engines, dynamos, and motors. The timely discovery of defects of material and workmanship in this and other machinery by the company's inspectors had been the means of preventing numerous mishaps. A dividend of 3s. per share was declared.

**GROSSE BERLINER STRASSENBAHN GESELLSCHAFT.**—This company has paid a dividend of 11 per cent. for 1900, compared with 10½ per cent. in 1899. The number of passengers carried was 236,000,000 compared with 188,000,000. There are three systems of traction on the lines—overhead trolley (453 cars), storage battery (420 cars), and horses (1,371 cars).

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Feb. 16 | 520 | + 5 | 37 | 25,303 | + 3,318 |
| *Birmingham Tramways. | „ 23 | 4,085 | − 43 | 7 | 27,857 | + 464 |
| *Blackburn Corporation.. | „ 22 | 400 | + 41 | 8 | 2,980 | + 130 |
| Blackpool Corporation... | „ 21 | 166 | + 33 | 47 | 29,620 | + 7,795 |
| Blackpool and Fleetwood | „ 23 | 139 | − 4 | 8 | 1,089 | − 23 |
| Bolton Corporation ...... | „ 24 | 1,224 | ... | 47 | 74,258 | ... |
| Bradford Corporation... | „ 24 | 780 | + 408 | 47 | 28,562 | + 10,608 |
| Brisbane Trams ......... | Jan. 9 | 1,895 | + 183 | 1 | 1,895 | + 183 |
| *Bristol Trams & Carriage | Feb. 23 | 3,462 | + 814 | 8 | 28,442 | + 7,848 |
| *Buenos Ayres & Belgrano | Jan. 27 | 2,628 | + 411 | 4 | 11,048 | + 1,559 |
| Carlisle Trams. Co. ...... | ... | ... | ... | ... | ... | ... |
| Central London Railway | Feb. 23 | 5,941 | | 8 | 48,779 | ... |
| City & South London Ry | „ 24 | 2,048 | + 933 | 8 | 16,088 | + 7,074 |
| Cork Elec. Trams ......... | „ 21 | 327 | + 19 | 7 | 2,498 | + 289 |
| Dover Corporation ...... | „ 23 | 145 | + 4 | 47 | 9,997 | + 628 |
| Dublin & Lucan Rly. .. | „ 23 | 71 | + 16 | 8 | 561 | + 148 |
| Dublin United ............ | „ 22 | 2,932 | + 1 | 8 | 14,929 | + 2,670 |
| Dublin Southern Dist.... | „ 22 | 642 | + 23 | 8 | 5,785 | |
| *Dundee Corporation ... | „ 20 | 444 | + 74 | 40 | 18,400 | + 2,459 |
| *Glasgow Corporation ... | „ 23 | 8,035 | 236 | 8 | 69,997 | + 2,574 |
| Halifax Corporation .... | „ 24 | 683 | + 122 | 47 | 35,736 | + 7,624 |
| Hull Corporation......... | „ 23 | 1,445 | + 725 | 31 | 48,843 | + 26,523 |
| *Liverpool Corporation... | „ 16 | 7,576 | + 1,335 | 7 | 54,442 | + 8,754 |
| Liverpool Overhead Rly. | „ 24 | 1,420 | + 60 | 8 | 11,757 | + 257 |
| Portsmouth Corporation | „ 23 | 505 | − 40 | ... | ... | ... |
| *Sheffield Tramways ...... | „ 24 | 2,617 | + 912 | 8 | 21,810 | + 7,522 |

* Partly electrical.

but it is proposed to adopt the overhead trolley throughout the entire system. The working expenses absorbed 59·65 per cent. of the receipts and £89,440 was paid to local authorities for wayleaves, &c.

**NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)**—An extraordinary general meeting of the shareholders was held on Wednesday, when it was decided to approve the bill which is being promoted for compulsory powers of purchase over two sites in the company's area of supply. The confirmatory meeting will be held on March 19.

**RUSTON, PROCTOR & CO. (LTD.)**—The directors have elected Mr. J. S. Ruston chairman, in place of the late Col. G. M. Hutton, C.B., and Mr. A. E. Tylor deputy-chairman.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed March 6 as a special settling day in 75,000 ordinary £5 fully-paid shares (Nos. 1 to 75,000), 75,000 5 per cent. cumulative £5 fully-paid preference shares (Nos. 1 to 75,000) and fully and partly paid provisional certificates for £400,000 4½ per cent. first debenture stock of the *Brisbane Electric Tramways Investment Co. (Ltd.)*, and has ordered the same to be quoted in the official list. The committee has also been asked to allow the further issue of 30,000 ordinary £5 fully-paid shares (Nos. 40,001 to 70,000) and 30,000 6 per cent. cumulative £5 fully-paid preference shares (Nos. 40,001 to 70,000) of the *British Insulated Wire Co. (Ltd.)*, the further issue of 5,000 ordinary £5 fully-paid shares and 5,000 4½ per cent. cumulative £5 fully-paid preference shares of *W. T. Henley's Telegraph Works Co. (Ltd.)*, and 115,000 7 per cent. £1 fully-paid preference shares (Nos. 1 to 115,000) of the *Nernst Electric Light (Ltd.)* to be quoted in the official list. The latter is a renewed application.

**WESTERN TELEGRAPH CO. (LTD.)**—The tranfer books will be closed from March 18 to 23 inclusive preparatory to the payment on March 25 of an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended Dec. 31 last.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 20. | | Price Wednesday, Feb. 27. | | Rate per Cent. Yielded. | Dividends Due. | Business Done During Week Ending Feb. 27. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'okh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd. | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £100,000 | Stock | .. | Do. 4½ 1st Deb. Stock Prov. Certs. (red.) and [illegible] | 70 | 75 | 71 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10·0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4·6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,861 | 5 | 2·6 | Brompton & Kensington Electricity Supply Ord. | 7½ | 8½ | 7½ | 8½ | 3 10 7 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8¾ | 9¾ | 8¾ | 9¾ | 3 13 6 | March and September | ... | ... |
| 20,000 | 5 | 1·6 | Calcutta Elec. Supply Ordinary (fully paid) | 6¾ | 7¼ | 6¾ | 7¼ | ... | ... | ... | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9¾ | 10¼ | 9¾ | 10¼ | 4 8 1 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¾ | 5¾ | 5¾ | 5¾ | 3 18 3 | " " | ... | ... |
| 34,000 | 5 | 2·6 | Chelsea Electricity Supply Ordinary | 6¾ | 7 | 6¾ | 6¾ | 4 6 11 | March | [illegible] | 6½ |
| £180,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30-yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,879 | 10 | 8·0 | City of London Electric Lighting Ord. | 7 | 8 | 7 | 8 | 5 0 0 | February and August | 7½ | 7½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 18 9 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | 103 | 102½ |
| 40,000 | 10 | 4·0 | County of London and Brush Prov. Ordinary | 8½ | 9½ | 8 | 9 | 6 13 4 | ... | ... | ... |
| 30,000 | 10 | 6·0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 18 0 | March and September | 11½ | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 106 | 108 | 106 | 108 | 4 2 7 | ... | 107½ | 107 |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7¾ | 8¼ | 7¾ | 8¼ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11 | 12 | 10¾ | 11¾ | 4 11 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. (Deb. Stk. (red.) | 6¾ | 7 | 6¾ | 7 | 4 2 7 | January and July | ... | ... |
| £73,000 | Stock | 22/0 | Kensington & Notting Hill Co. (Int. Stk.) | 103 | 105 | 103 | 105 | 3 16 2 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 99 | 101 | 99 | 101 | 3 19 3 | Mar., June, Sept., Dec. | 99½ | 99 |
| 55,000 | 10 | 6·0 | Metropolitan Elec. Supply Ord. | 12½ | 13½ | 13 | 14 | 3 18 6 | April and October | 13 3/16 | 13½ |
| 13,760 | 10 | ... | Do. ([illegible]) | 7 | 8 | 7 | 8 | ... | ... | 7½ | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 5 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 96 | 99 | 3 10 8 | ... | 99 | ... |
| 6,452 | 10 | 6·0 | Notting Hill Electric Ordinary | 15½ | 16½ | 15½ | 16½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 5·0 | Oxford Electric Ordinary | 6¾ | 6¾ | 6¾ | 6¾ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1·6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | 180 | 170 | 190 | 4 8 11 | April and October | ... | ... |
| £115,600 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 105 | 103 | 105 | 4 7 5 | " " | ... | ... |
| 40,000 | 5 | 3·6 | St. James's and Pall Mall Electric Ordinary | 11 | 12 | 11 | 12 | 4 16 9 | February and August | 11½ | 11½ |
| 20,000 | 5 | 3·6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 23·0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | 100 | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 88 | 90 | 88 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5·0 | Westminster Electric Supply Ordinary | 12 | 14 | 12 | 13 | 5 0 0 | March and September | 12¾ | 12 7/16 |
| 30,100 | 5 | ... | Do. Do. | 12 | 13 | 12 | 13 | ... | ... | ... | .. |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 4·0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 16 | 3 15 0 | ... | ... | ... |
| £167,900 | 100 | 5% | Brisbane Tramway 5 per Cent. Debentures | 104 | 106 | 104 | 106 | 4 15 0 | ... | ... | ... |
| 50,000 | 10 | 7½% | Brixton Tramways and Carriage Ordinary | 24 | 25 | 24 | 24½ | 3 7 7 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 50,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 13,610 | 10 | 7/0 | Do. 5% Preference | 9½ | 10½ | 9½ | 10½ | 4 17 7 | May and November | ... | ... |
| £200,000 | 40 | ... | Do. 4½% 1st Mort. Debs. | 93½ | 100½ | [illegible] | [illegible] | ... | ... | ... | ... |
| 60,000 | 10 | 6·0 | British Elec. Tram. Ord. | 10½ | 11½ | 11½ | 12½ | 5 9 7 | ... | [illegible] | 11½ |
| 60,000 | 10 | 6·0 | Do. 6% Cum. Pref. | 11½ | 12½ | 11½ | 12½ | 4 18 0 | February and August | 12½ | 12½ |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 124 | 121 | 123 | 4 1 4 | ... | 121½ | 121½ |
| 40,000 | 5 | 3·0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 4¾ | 5½ | 5 | 5½ | 5 14 3 | ... | 5 1/16 | 5½ |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5 | ... | ... | 4½ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stock Prov. Certs. (all pd.) | 95 | 98 | 95 | 98 | 5 1 8 | ... | 97½ | 97 |
| 206,307 | 10 | 2·6 | Central London Ordinary | 9½ | 9¾ | 9 | 9½ | 2 17 10 | June and December | 9½ | 9½ |
| £856,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 41 | 43 | 43 | 45 | 2 10 0 | February and August | 43½ | ... |
| 37,500 | 10 | 1½ | Do. Ordinary (Nos. 22,5[illegible]) | 4 | 5 | 4 | 5 | ... | " " | 4½ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1898) | 127 | 132 | 127 | 132 | 3 15 9 | ... | ... | ... |
| £344,215 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 115 | 120 | 115 | 120 | 3 16 11 | May and November | 116 | 115½ |
| 60,000 | 10 | 6·0 | Dublin United Tramways (1896), Ordinary | 14 | 15 | 14 | 15 | 4 0 0 | ... | ... | ... |
| 50,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. [illegible] Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 25,000 | 10 | 7½% | Imperial Tramways Ordinary | 22 | 23 | 22 | 23 | 3 12 9 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 18 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debentures | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1·3 | Kidderminster & District E. L. & Traction Pref. | 10½ | | ... | | ... | May and November | ... | ... |
| 31,800 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 9½ | 9½ | 9 | 9½ | 3 19 5 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 14 | 13 | 13½ | 3 15 8 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 17 2 | January and July | ... | ... |
| $150,000 | $1,000 | 5% | London Street Ry. (Ont.) [illegible] | 102 | 104 | 102 | 104 | 4 17 7 | ... | ... | ... |
| £12[illegible],744 | Stock | [illegible] | Lon. Utd. Trams. [illegible] Pref. [illegible] | 62 | 64 | 62 | 64 | ... | ... | ... | ... |
| £80,000 | 100 | 5% | Montreal Street Railway [illegible] | 101 | 105 | 101 | 105 | 4 15 [illegible] | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. [illegible] 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 14,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 80,000 | 5 | 6·0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | " " | ... | ... |
| 12,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | 12½ | ... |
| 10,000 | 10 | 6·0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 37·0 | Do. 4½ per Cent. Debenture Stock | 101 | 104 | 103 | 105 | 4 1 1 | ... | 103 | ... |
| £140,000 | Stock | 1% | Waterloo and City Ordinary | 28 | 30 | [illegible] | [illegible] | 3 2 8 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 20. | Price Wednesday, Feb. 27. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Feb. 27. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 – 102 | 99 – 102 | 3 11 5 | January and July | ... | ... |
| 38,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 60 – 70 | 55 – 65 | ... | ... | ... | ... |
| £827,720 | Stock | 17/6 | Anglo-American | 53 – 56 | 53 – 55 | 5 13 4 | Feb., May, Aug., Nov. | 53½ | 51 |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 98 – 100 | 97 – 98 | 6 1 10 | " " | 98½ | 97 |
| £3,088,640 | Stock | 5/0 | Do. Deferred | 8½ – 9 | 9 – 9½ | 2 14 6 | " " | 9½ | 8½ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 170 – 180 | 175 – 175 | 4 11 3 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,030 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 – 104 | 103 – 105 | 3 16 11 | " " | 103½ | ... |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 8 – 9 | 7½ – 8½ | 6 9 5 | February and August | ... | ... |
| 8,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 – 17 | 16 – 17 | 5 17 8 | " " | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ – 4½ | 3½ – 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 – 10 | 9 – 10 | 5 0 0 | " " | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% – 104% | 100% – 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 – 10½ | 10 – 10½ | 6 13 4 | Jan., Apr., July, Oct. | 10 | ... |
| £109,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 to 1,200) (red.) | 98 – 102 | 98 – 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 146 – 151 | 145 – 150 | 4 13 9 | Jan., Apr., July, Oct. | 147½ | 147 |
| £1,826,888 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 – 95 | 95 – 98 | 3 11 5 | " " | 95½ | 95 |
| £1,432,360 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 – 117 | 113 – 117 | 3 9 6 | May and November | 113 | ... |
| 150,000 | 10 | 7/6 | Eastern Extension | 14½ – 14½ | 14½ – 14½ | 4 16 11 | Jan., Apr., July, Oct. | 14½ | 13½ |
| 50,000 | 10 | ... | Do. (Nos. 240,001 to 300,000) £5 pd., is'd at £3 pm, all pd | 13½ – 14½ | 13½ – 14½ | ... | ... | ... | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 110 – 116 | 110 – 115 | 3 9 7 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 – 102 | 99 – 102 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% – 104% | 101% – 104% | 3 17 8 | May and November | ... | ... |
| 180,237 | 10 | 1/9 | Globe Telegraph and Trust | 10 – 10½ | 9½ – 10½ | 5 2 5 | Jan., Apr., July, Oct. | 9½ | 9½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 15 – 15½ | 14½ – 15½ | 3 18 8 | " " | 15½ | 15½ |
| 180,000 | 10 | 5/0 | Great Northern of Copenhagen | 33 – 34 | 33 – 34 | [illegible] 6 | January and July | 33½ | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos 1 to 1,200) (red. | 90 – 103 | 90 – 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 47 – 51 | 47 – 51 | 4 14 0 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 104 – 107 | 104 – 107 | 5 19 1 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 – 102 | 99 – 102 | 3 19 5 | June and December | ... | ... |
| 11,239 | 8 | 4/0 | Reuter's | 7½ – 8½ | 7½ – 8½ | 4 14 1 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 – 127 | 124 – 127 | 4 16 0 | " " | ... | ... |
| 16,000 | 10/0 | ... | West African Telegraph | 3½ – 3½ | 3½ – 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 99 – 102 | 99 – 102 | 4 19 6 | March and September | ... | ... |
| 30,000 | 3½ | ... | West Coast of America | ½ – ½ | ½ – ½ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 97 – 102 | 97 – 102 | 3 14 5 | January and July | 101 | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ – 1 | ½ – 1 | ... | May and November | 6½ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 – 7 | 6 – 7 | 3 11 6 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 – 7 | 5 – 7 | 3 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 – 106 | 103 – 106 | 4 11 4 | January and July | 103 | ... |
| 207,980 | 10 | 3/0 | Western Telegraph (late Brazil'n S'bm'rine) | 14 – 14½ | 14½ – 14½ | 4 13 3 | Mar., June, Oct., Dec. | 14½ | 14½ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 – 104 | 101 – 104 | 4 16 2 | June and December | ... | ... |
| £348,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 – 105 | 102 – 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 64,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 – 3½ | 3 – 3½ | 5 14 4 | August | ... | ... |
| 234,850 | 10 | 3% | Consolidated Telephone Con. and Maint. | 2/1 – 3/3 | 2/6 – 3/3 | 3 11 6 | April and October | ... | ... |
| 72,000 | 1 | 2½% | Monte Video Telephone Ordinary | ½ – ½ | ½ – ½ | 6 0 0 | November | ... | ... |
| 36,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ½ – 1 | ½ – 1 | 5 0 0 | " | ... | ... |
| 690,000 | 5 | 2/0 | National | 3½ – 3½ | 3½ – 3½ | 6 0 0 | February and August | 3½ | 3½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 13 – 14 | 13 – 14 | 4 5 9 | " " | 14 | 13½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 – 13 | 11 – 13 | 4 12 4 | " " | 13 | ... |
| 750,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ – 5½ | 4½ – 5 | 5 0 0 | " " | 4½ | 4½ |
| £3,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 95 – 97 | 95 – 97 | 3 13 3 | June and December | 95½ | 95 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 98 – 10[illegible] | 98 – 101 | 3 19 6 | ... | 10[illegible] | 98 |
| 171,504 | 1 | 0/6 | Oriental | ½ – 1½ | ½ – 1½ | 5 3 9 | April and October | ½ | ... |
| 68,000 | 5 | 2/6 | United River Plate | 4½ – 5½ | 4½ – 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ – 5½ | 4½ – 5½ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 – 108 | 103 – 108 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 9d. | Alliance Electrical Co. 5% Cum. Pref. | ½ – 1 | ½ – 1 | 5 0 0 | ... | ... | ... |
| 124,000 | 1 | 1/1½ | Aron Electricity Meter 6% Cum. Pref. | 1½ – 1½ | 1½ – 1½ | 7 8 3 | March and September | ... | ... |
| 65,000 | 1 | ... | British Electric Works Co. Ordinary | ... | ... | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ... | ... | ... | ... | ... | ... |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 – 90 | 85 – 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 5/0 | British Insulated Wire Ordinary | 11 – 12 | 11 – 12 | 8 6 8 | July and February | 11½ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6½ – 6½ | 6½ – 6½ | 4 18 0 | January and July | 6 | ... |
| 100,000 | 5 | 2/0 | British Westinghouse 6% Preference | 4½ – 4½ | 4½ – 4½ | 6 6 4 | ... | ... | ... |
| 90,060 | 2 | 1/2½ | Brush Electrical Engineering | 1½ – 1½ | 1½ – 1½ | 6 8 4 | September | 1½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 80,000 | 2 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2½ – 2½ | 2½ – 2½ | 5 9 8 | " | 2½ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 105 – 110 | 105 – 110 | 4 3 7 | March and September | 10[illegible] | 103 |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 – 103 | 101 – 103 | 4 7 5 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 13½ – 14½ | 15½ – 16½ | 4 10 11 | " " | 16½ | 13½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ – 6 | 5½ – 6 | 4 3 4 | " " | 5½ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 – 113 | 109 – 113 | 3 19 11 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 – 1½ | 1 – 1½ | 6 8 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 – 97 | 95 – 97 | 4 12 [illegible] | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ½ – 1 | ½ – 1 | 6 10 [illegible] | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ½ – 1½ | ½ – 1½ | 5 6 [illegible] | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3½ – 3½ | 3½ – 3½ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 – 103 | 100 – 103 | 4 17 6 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ½ – 1 | ½ – 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/9½ | Edison and Swan United ("A" Shares) (£3 paid) | 1½ – 2 | 1½ – 2 | 9 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/9½ | Do. (£5 paid) | 3½ – 4½ | 3½ – 4½ | 6 13 4 | " " | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 85 – 90 | 88 – 90 | 4 6 11 | June and December | ... | ... |
| £100,090 | Stock | 2½/4½ | Do. 5% 2nd Deb. Standing Prov. Certs. (all pd) | 95 – 100 | 95 – 100 | ... | ... | ... | ... |
| 35,100 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ – 5 | 4½ – 5½ | 6 1 10 | Half-yearly | 4½ | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 – 106 | 103 – 105 | 4 5 1 | ... | 105½ | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1½ – 2½ | 1½ – 2½ | 5 13 9 | January and July | 2 | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ – 3 | 2½ – 3 | 4 13 4 | July | ... | ... |
| £152,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 – 104 | 101 – 104 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | ... | Giffre Electro Chemical and Power Co. Ord. | ½ | ½ | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 16½ – 16½ | 16 – 17 | 4 6 8 | February and August | 16½ | 16½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ – 6 | 5½ – 6 | 3 15 0 | " " | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 108 – 112 | 108 – 110 | 4 1 3 | " " | 112 | 110 |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ – 21½ | 20½ – 21½ | 4 13 0 | " " | 20½ | ... |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 – 104 | 101 – 104 | 3 17 8 | March and September | ... | ... |
| 37,350 | 12 | 12/9 | Telegraph Construction and Maintenance | 41 – 45 | 41 – 45 | 4 0 0 | March and July | 41½ | 41 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 – 104 | 101 – 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 – 12 | 11 – 12 | 6 9 4 | ... | 11½ | 11 |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ – 6 | 5½ – 6 | 4 3 4 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 10½ – 11½ | 11 – 11½ | 4 3 4 | April and October | 11½ | 11 |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ – 7½ | 6½ – 7½ | 4 2 9 | " " | 7½ | 6½ |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 – 107 | 103 – 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote them.

# WITTING BROS., Ltd.

(Electricite & Hydraulique),

## Electric Power & Traction Engineers,

***Head Office: 49, Cannon Street, LONDON, E.C.***

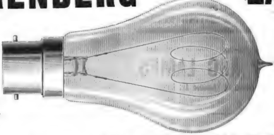
Telegrams: WITTING LONDON. Telephone: 5795 Bank

STANDARD CRANE CONTROLLER.

---

# BERRENBERG LAMPS.

Lamps of the
**HIGHEST EFFICIENCY**
on the market
combined
with **LONG LIFE.**



Testimonials from
consumers state
that they have
**Saved 50 per cent.**
**in Current**
over other makes
by using the
**BERRENBERG.**

*Write for particulars*
*and Price List to—*

**The BERRENBERG ELECTRIC LAMP SYNDICATE, Ltd.,** Standen Rd., Southfields, LONDON, S.W.

---

# CHEMICALS

ALL KINDS for ELECTRICAL WORK, and also for INDIA RUBBER & GUTTA-PERCHA MANUFACTURERS: BICHROMATES and BICHROMATE SALT for EXPORT.

**G. BOOR & CO.** 1 & 2, Artillery Lane, Bishopsgate, **LONDON, E.C.**

CONTRACTORS TO THE POST OFFICE, WAR OFFICE, ADMIRALTY, INDIA AND NEW ZEALAND OFFICES AND LEADING TELEGRAPH COMPANIES.

***Over 19,000 in Everyday Use in the United Kingdom alone.***

# JANDUS

## The 20th CENTURY ARC LAMP.

WILL BURN ANY NUMBER IN SERIES.
ON ANY CIRCUIT.
UNDER ANY CIRCUMSTANCES.

**STANDARD PATTERN.**
Nickel or Japanned Cases.

## LONG BURNING HOURS

The only Lamp that can be Trimmed Without Removing the Outer Globe.

Steady, White and Diffused Light.

The Most Economical Lamp to maintain.

The Stoutest Case on the Market, and yet—

The Most Artistic.

**POWER-CIRCUIT LAMP.**
Complete, with Internal Cut-out and Resistances.

## WILL OUT-LIVE ALL THE CHEAPER IMITATIONS.

The Simplest Lamp on the Market.

The Smallest Number of Moving Parts.

The Easiest Cleaned.

NO Flexible Cords to PERISH
NO Solder or Lead to MELT
NO Gear Wheels to STICK
NO Carbon Guides to CLEAN
NO Tin Cases to RUST
NO Brakes to SLIP

**SPHERICAL GLOBE.**
Complete, with Internal Resistance.

SOLE AGENTS for the

**JANDUS ARC LAMP & ELECTRIC CO., Ltd.,**

**DRAKE & GORHAM,**

***66, Victoria Street, Westminster.***
Telegrams: "ACCUMULATOR LONDON." Telephone: 393 and 71 Westminster.

**Also 100, King Street, MANCHESTER;**
**Baltic Chambers, 50, Wellington Street, GLASGOW; and**
**Westminster Chambers, East Parade, LEEDS.**

*SUB-AGENTS FOR THE NORTH:*
ROBERT BOWRAN & CO.,
3, St. Nicholas Buildings,
NEWCASTLE-ON-TYNE.
Telegrams: "BOWRAN NEWCASTLE."

*SUB-AGENTS FOR THE MIDLANDS:*
THE ELECTRICAL TRADES' SUPPLY, Ltd.,
Cornwall Buildings, Cornwall Street,
BIRMINGHAM.
Telegrams: "MOTORS BIRMINGHAM."

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,190. [No. 20. Vol. XLVI.] FRIDAY, MARCH 8, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

# NOTES.

The latest stage in the progress of the singularly unfortunate arrangements for the erection of a large electricity station for the supply of Dublin is not such as can afford any satisfaction to the advocates of the Pigeon House Fort scheme, nor is it a matter upon which the Dublin Corporation's consulting engineer is to be congratulated. It will be remembered that the employment of the Pigeon House Fort as a municipal electricity works was emphatically condemned by Prof. A. B. W. Kennedy in the early stages of this unhappy venture. But the Corporation, having bought that white elephant for an absurdly high figure, were desirous of turning it to some account; and, in spite of Prof. Kennedy's advice, and upon the recommendation of Mr. Robert Hammond, they decided to erect their electricity works on that site.

Our readers will also recall that last summer the Dublin Corporation were offered an electricity supply from a company associated with the existing tramways company, who already owned a large central power station that might well have served the double purpose of running the tramway system and of supplying light and power to the town. Instead, however, of accepting this offer, the Corporation opposed and succeeded in obtaining the rejection of the bill promoted by the Dublin Electric Lighting Co., the principal ground of their opposition being that they themselves were promoting a scheme drawn up by Mr. Hammond which would give their ratepayers a cheaper and better electricity supply.

Mr. Hammond's scheme involved, as we have stated, the erection of an electricity station at the Pigeon House Fort; and the figure which that expert gave in his estimates as the cost of the buildings was £20,000. In the ordinary course of events tenders to Mr. Hammond's scheme were invited, duly received and opened, when, behold, not one of the firms tendering offered to do the work for less than double Mr. Hammond's figure. In this predicament there was no alternative but to pay the much larger sum or else to cut down Mr. Hammond's specification. The latter alternative was foolishly adopted, but even after that the lowest of the revised tenders is for more than £9,000 in excess of Mr. Hammond's original figure. Only those who consider that the erection of substantial buildings upon suitable foundations is not of prime importance to the satisfactory working and lasting durability of a power-station can treat this matter lightly. All competent engineers must agree that it is emphatically a matter of supreme importance; and it is greatly to be regretted that Mr. Hammond should have allowed himself to be persuaded into such a serious departure from his original specification upon so vital an element of his scheme. Especially is this so if, as we understand, a portion of the alteration in the plans involves a reduction in the depth of the concrete foundations, for the Pigeon House Fort is by no means the most rigid and substantial site available for the erection of machinery.

We report at considerable length this week the meeting of the shareholders of the Metropolitan Electric Supply Co., on Tuesday, at which several matters of more than usual interest were brought forward. With regard to financial matters, there has been a capital expenditure of £173,000 during the year, chiefly on additional plant at Willesden; and as a result of this increase of plant, the amount paid for current purchased from outside has decreased from £2,000 to the small sum of £20. We invite the careful attention of certain local authorities to the exemplary action of the company in setting aside no less than £14,000 against depreciation. The lamp connections have increased by 70,000 during the year, and there is plenty of spare plant to meet further increase in this direction. The complaint of

the chairman (Mr. W. Harrison Cripps) with regard to the action of the Marylebone Vestry is worth perusal, more especially where he deals with the power of the local authority to send their inspector into the company's works to "pry into their trade secrets" and, in the event of the vestry entering into competition, possibly to use the information to their own advantage.

We referred a few weeks ago to the action which the Board of Trade was taking with regard to a reduction of the maximum charge per unit for electric supply inserted in all new provisional orders. From the report, in another column, of the conference that took place on this question on Wednesday, it is seen that this proposal has met with considerable opposition—opposition which appears to have been needless, as in the Electric Lighting Acts it is perfectly clear that the fixed maximum charge is always liable to modification in any particular instance if the Board of Trade considers that this is justified by the circumstances of the case. It is also to be remembered that the proposed change would have only applied to new provisional orders and would have been in no way retrospective. The result of the conference, however, is one satisfactory to all parties. Sir Courtenay Boyle informed those present that he expects that a maximum of 7d. will be adopted in general; in very populous places a maximum of 6d.; and in special cases 8d. may be allowed if sufficient cause is shown, the onus of showing cause to rest with the undertakers.

Like an erratic block in a geological formation, a complete and self-contained discussion on the politics of the telephone question intruded itself upon the debate on Mr. Madgen's Paper. What on earth the telephone can have to do with the power bills of 1900, either "before" or "after," passes comprehension; but the President ruled the subject to be in order, and he not only allowed Mr. C. B. Clay, of the National Telephone Co., to make a lengthy protest against the policy of the Post Office, but also permitted Mr. Gavey to reply and Major-Gen. Webber to interfere. We report very briefly the speeches in this tiresome digression; but we protest that it is unfair to many members present at the meetings to allow such digressions to occur. On this particular occasion the result was that a large number of members who had intended to speak on the subject of the Paper were requested to send in their remarks to the *Journal*. Beside this, there are few meetings, and certainly no important debates, at which members are not present who have travelled from distant parts of the country for the express purpose of hearing the discussion. Is it fair that when these hard workers ask for bread they should be given material for which they have neither appetite nor digestive power?

Various devices have been suggested, and even used, for signalling when a bearing gets dangerously hot. Thus it has been proposed to paint the outside of the bearing with iodide of mercury or some other compound which changes colour when it becomes warm. A German firm is putting on the market a formidable-looking thermostat which is to be erected on the bearing. On the latter becoming heated a fusible metal runs, and closes an electric circuit. In this circuit is either a lamp or bell, so that the fact is signalled. In practice, however, such labour-saving expedients are not to be recommended. A greaser has to be on duty in any case, and such automatic apparatus merely encourage him to slackness in his observation of the running machinery.

The American scheme for an extra fast, extra cheap, extra electric railway from London to Brighton, about which there was so much talk in the lay papers several months ago, has, it appears, been resuscitated. The *Daily Express* is informed, apparently on the authority of Mr. T. L. Johnson, who is said to be at the head of a syndicate for the construction of this line, that parliamentary powers are to be sought for next session. As at this rate a year at least must elapse before a bill can be brought in and passed, it is rather premature to forecast the details of the scheme, especially as it seems to be a *sine quâ non* that they should be of a sensational order.

Prof. Ayrton, whose skill and originality in the invention of new scientific terms have long been famous in electrical circles, has added, in a letter we publish this week, one more to his long list. He creates the "accuracy factor" which he defines to be the ratio of "what it truly is" to "what it apparently is," in any particular statement. We have sometimes met with the reciprocal of this ratio as "the coefficient of mendacity"; and a function of Prof. Ayrton's new ratio is well known to the world at large as "*cum grano salis*." But the chief difficulty in the case of Prof. Ayrton's factor is to discover a unit; for he would not be a true professor who denied the need for a unit of measurement in the case of any new scientific quantity. In this particular ratio the numerator is philosophically indeterminate. The historic question "What is truth?" has never been answered by Philosophy, nor even, as regards absolute truth, by Science. After all, human intelligence can never comprehend more than the "what it apparently is"—of the "what it truly is" humanity must ever remain in ignorance.

Personal.—Mr. Gilbert S. Ram is resigning his position as engineer to the Coventry Corporation to take up an appointment with the Nernst Electric Light (Ltd.).

Royal Society.—A Paper by Mr. J. E. Petavel, "On the Heat Dissipated by a Platinum Surface at High Temperatures. IV.—High Pressure Gases," was down for reading yesterday, "in title only."

Wireless Telegraphy in the Congo.—The *Westminster Gazette* states that wireless telegraphy is to be established by the Congo Government in substitution for the ordinary posts and wires, which the elephants tear down and destroy.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Pernambuco—Ceara | Nov. 29, 1900 |
| Marseilles—Barcelona | Jan. 7, 1901 |

The German Emperor.—The Kaiser's carriage narrowly escaped a collision with an electric tramcar in Unter den Linden, Berlin, on Thursday last week. We congratulate his Imperial Majesty and also the electric traction industry on their escape.

Municipal Time.—According to the *Elektrotechnischer Anzeiger*, the local authority at Baden-Baden is about to hire out a few electric clocks to private customers. Presumably the scheme is only to be proceeded with tentatively, as an outlay of but £15 is at present estimated.

**The Institution of Civil Engineers.**—At the ordinary meeting on the 5th inst. the monthly ballot resulted in the election of three honorary members, viz., the Right Hon. Lord Alverstone of Alverstone, G.C.M.G., Admiral of the Fleet Sir Frederick W. Richards, G.C.B., and Sir William C. Roberts-Austen, K.C.B.

**Damage by Lightning.**—During the thunderstorm which passed over London on Wednesday the German church in Dalston was struck by lightning and the organ loft took fire. The flames were soon extinguished with the aid of a couple of hydrants, but the organ was destroyed, and other damage was done, chiefly from water.

**General Electric Co. (1900) (Ltd.).**—The eleventh annual dinner of the directors and staff of this company took place on Saturday evening last in the Grand Hall of the Hotel Cecil. An enjoyable evening, during which numerous friends shared the hospitality of the company, maintained the good record of these annual functions.

**Institution of Electrical Engineers Benevolent Fund.**—The third annual general meeting of contributors to this fund will be held at the offices of the institution on Thursday, March 14th, at 2 p.m. The statement of accounts to December 31st last shows a credit balance for the year of £65. 11s. 3d., making the total funds in hand and invested £1,616. 6s. 9d.

**Electrical Equipment of a New York Suburban Railway.**—It is announced that electric traction will be adopted on the New York Central and Hudson River Railroad. Part of this steam railway runs through tunnels, and is somewhat similar in point of bad ventilation, it is stated, to the old London "Underground," which is soon to enjoy a similar transformation.

**Cable Communications Committee.**—A meeting of this committee was held on Tuesday, under the presidency of Lord Balfour. Evidence was given by Sir John Wolfe Barry, K.C.B., chairman, and Mr. J. Denison-Pender, vice-chairman, of the Eastern Telegraph Co.; by Mr. F. E. Hesse, manager of the Eastern Extension Telegraph Co.; and by Mr. W. Hibberdine, traffic accountant of the Eastern and Eastern Extension Telegraph Companies.

**An Electric Lighting Station on the Congo.**—The *Church Weekly* states that the first electricity station on the Congo West Africa is to be erected by the Roman Catholic mission at Luluabourg, which is a settlement on River Lubia, a tributary of the Koasas River, flowing into the Congo. A waterfall, 28ft. high, will actuate a turbine, which will run a dynamo supplying current to 100 incandescent lamps and three arc lamps. All the machinery is, it is said, to be of French construction.

**Röntgen Society.**—The Council announce that the following gentlemen nominated as the jury to award the president's gold medal for the best tube for general X-ray purposes have agreed to act in that capacity:—Sir William Crookes, J. Mackenzie Davidson, J. H. Gardiner, Herbert Jackson, C. W. Mansell-Moullin, Wilson Noble, Chas. E. S. Phillips, Prof. Silvanus P. Thompson, Prof. Dawson Turner, H. Snowden Ward, J. J. Vezey (hon. treasurer), and F. Harrison Low (hon. secretary).

**The Pacific Cable.**—The Canadian Parliament has adopted the resolution authorising the payment of Canada's share of $\frac{5}{18}$ths of the £2,000,000 to be allocated to the cost of the Pacific cable. On the subject of the arrangements entered into by the New South Wales and other Australian States with the Eastern Extension Telegraph Co., Mr. Mulock, the Canadian Postmaster-General, said it was too late now for Canada to recede from the undertaking, as the contract was signed and the cable under construction.

**Annual Report of the Commissioner of U.S. Patents.**—In the United States during the year 1900 there were 39,673 applications for patents, 2,225 applications for designs, and 82 applications for re-issues. Including designs 26,418 patents were granted and 81 patents were re-issued. With regard to patentees out of the United States the greatest number of patents was granted Great Britain, who received 1,088, then came Germany with 1,070, Canada 867, France 341, Austria-Hungary 117, and Switzerland 79.

**Cantor Lectures on Electric Railways.**—The first of three Cantor lectures on "Electric Railways" will be delivered by Major Cardew, at the Society of Arts, on Monday. The following is a synopsis of this lecture:

Historical summary and recent advances. Advantages of electric traction—Class of railway to which the method is most applicable. Details of equipment—Motors and dynamos identical in principle—Continuous-current motor—Counter E.M.F.—Efficiency—Magnetic field—Waste of power at start—Ward Leonard system—Series parallel control—Gearing—Polyphase current traction—Induction motor—Torque diagram—Comparison with continuous-current motor—Cascade connection—Return of energy—Frequency.

**The Berlin Elektrotechnischer Verein.**—The Secretary of State for the German Post Office, Lieut.-Gen. Von Podbielski, has been nominated honorary president of this society. He has filled the office of president for two years. The following council has been elected on the recommendation of the retiring council:—

*President*: Prof. Dr. A. Slaby. *Vice-President*: Herr Naglo. *Secretaries*: Prof. Dr. Strecker and Herr Nobel. *Other Members of the Council*: Herrn Aschenborn, Conrad, and von Dolivo-Dobrowolsky.

This introduces new and younger blood into the council, and it is hoped that the result will be that the society will become still more energetic than hitherto.

**Opening of the Accrington Electricity Works.**—The Accrington Corporation electricity works were formally opened on Monday. The Corporation has held its provisional order since 1890, and the works finally erected under the advice of Mr. J. N. Shoolbred, the consulting engineer, are on the two-wire system. The capacity of the plant is 170kw., and the generating units are Willans-Johnson & Phillips combination, a battery of 134 Chloride cells with 750 ampere-hours' capacity being provided for regulating and storage purposes. Energy for lighting will be charged at 5d., and for power at 1½d., gas costing 2s. 6½d. and 2s. 9d. in the district. At present there are 71 consumers, representing a total lamp connection equivalent to 4,900 8 c.p. lamps. A refuse destructor is combined with the electricity works. The sum authorised to be borrowed for the scheme was £36,350, of which £26,850 has been raised and £27,935 expended. Mr. Harold Gray, the resident electrical engineer, informs us that the works have been running successfully with temporary arrangements since early in November last

**Phosphorescence as a Source of Illumination in Photography.**—Mr. F. Jervis-Smith contributes an interesting letter to *Nature* of the 28th ult. on this subject. In certain libraries there exists a fixed rule that no books may be removed. This being so, all extracts and copies of plates and engravings have to be made in the libraries. Reproduction by the methods of ordinary photography is most inconvenient, since the employment of artificial light is strictly prohibited; also the introduction of a camera, and its manipulation in a library, are surrounded by many difficulties. These circumstances led him to devise the following method for obtaining copies of plates, engravings, printing, and writing. A piece of cardboard is coated with a phosphorescent substance, and after sufficient exposure to the light of the sun or of an arc lamp, it is placed at the back of the engraving or writing to be copied; on the face of the engraving or writing a dry photographic plate is placed, and then the book is closed for a certain time, depending on the nature and thickness of the paper used in the book. He finds that the period of time lies between 18 and 60 minutes. The plate is then withdrawn and stored in a dark box for development. The dry plate is easily manipulated under a cloth, which shuts off all light and covers the book during the operation. The results are sufficiently good for most purposes—in the case of some papers the fibrous structure is shown; this very slightly detracts from the clearness of the copies made by this process. Neither the luminous substance nor the dry plate injure the book in any way, so that the method may be employed in the case of valuable prints and engravings. If films be used instead of plates, a large number of copies of different engravings in the same book may be made at the same time. The time of exposure to the phosphorescent backing is shortened considerably by placing the phosphorescent card

on a warm surface, such as that of a metal vessel heated to about 20°C. with hot water; when films are employed this temperature should not be exceeded. In an experiment made in the laboratory Mr. Jervis Smith found that the phosphorescent substance under normal barometric pressure became brightly luminous when subjected to the brush discharge of a Tesla inductor; but the discharge from an ordinary induction coil fails to produce the same effects.

**Application for the Extension of a Ferranti Patent.**—Notice has been given of the intention of Mr. S. Z. de Ferranti to present a petition for the extension of Patent No. 12,419 of 1887 for an invention "Improvements in Electric Railways." The patent is dated September 13, 1887. The hearing of the petition is fixed for April 15, or such subsequent date as the Judicial Committee shall appoint. Opposition to this petition must be filed on or before April 15. The patent may be roughly divided into three parts: First, an alternating current electric traction system is described, in which the car is supplied by current through converters, each of which feeds its own section of the line, and is switched on or off as the car enters or leaves the section. Next, some systems of motor suspension are described for direct-driving, and lastly, it is pointed out how a battery may be employed on the car for the purpose of exciting the field magnets of the motor, and for driving the car for a short time in case of failure of supply. The claims are as follows:—

1. An electric railway, with conductors for conveying current to the motor locomotives in short sections, fed with current of comparatively low tension from a high-tension alternating circuit, through converters or induction coils which are only brought into action at the time when a motor locomotive is on the section of line which they have to feed.

2. An electric railway with conductors for conveying current to the motor locomotives in short sections each fed with current of comparatively low tension from a high-tension alternating circuit through two or more converters, one, a small one, constantly acting to maintain the required tension in the conductor, the other, or others, of large dimensions, brought into action by the increase of current passing through the small one when a locomotive comes on to that section of the line.

3. An electric locomotive engine with the dynamo-electric machine placed between the driving wheels of the locomotive, and with the armature concentric with the axle, or axles, of the wheels and coupled to them by a connection which allows the body of the locomotive, together with the dynamo which it carries and which are supported on springs, to play up and down freely.

4. An electric locomotive engine, with the dynamo-electric machine placed between the driving wheels of the locomotive and with the driving wheels on short axles, each driven from the armature axis by couplings, which allow of a certain amount of movement of the axles out of line with the armature axis.

5. An electric locomotive engine, with the dynamo-electric machine placed between the driving wheels of the locomotive and with the driving wheels on an axle, which passes through a hollow formed through the centre of the armature, and driven from it by couplings, which allow of a certain amount of movement of the axle away from the central line of the hollow armature axis.

6. An electric locomotive engine, with the dynamo-electric machine placed between the driving wheels of the locomotive, and formed with a hollow cylindrical armature supported on anti-friction rollers.

7. In electric locomotives worked with alternating currents, the employment of secondary batteries to magnetise the field magnets of the motor engine, and to drive the engine for a short time when it cannot be supplied with alternating current.

**A 25,000-volt Power Transmission.**—There is an interesting description in *Cassier's Magazine* for February of the plant transmitting power from the Apple River to St. Paul, U.S.A. The fall available is 82ft., the flume is 1,550ft. long, and was designed to carry 670 cubic ft. of water per second, sufficient to give an output of about 5,000 H.P. The turbines are of the Victor type, each set consisting of two 36in. special wheels with bronze runners, mounted horizontally in a cylindrical wheel-chest, 9ft. in diameter by 12ft. long. Both wheels run on the same shaft, which is directly connected to one of the 750kw. alternators. In each of the four branch feeders is placed a 56in. gate valve, operated independently from a shaft by a 7½ H.P. electric motor provided for the purpose. The four alternators are three-phase, 800-volt, 60-cycle machines, with armatures revolving at 300 revs. per min. The air-blast step-up transformers are six in number, and they each have an output of 500kw. at 25,000 volts, and are connected in two sets of three with Y connections. Six No. 3 B.W.G. medium-drawn copper wires are employed for the line, in two circuits of three wires each, one circuit being supported on each side of the poles in the form of an equilateral triangle with 24in. sides. One of these circuits runs straight through without transposition, while the other is spiraled twice at equal intervals. The joints are made by giving each wire six turns about the other, the whole being soldered by dipping. The poles are of cedar with 8in. tops and spaced at a maximum distance of 110ft. The insulators are glass 7in. in diameter. The resistance of each conductor between the generating station and St. Paul is 22·85 ohms, and the drop in voltage for 3,000kw. with a 90 per cent. power factor, is 7·7 per cent., the initial voltage being 25,000, and both lines being operated in parallel. At the substation at St. Pauls there are 10 oil-cooled step-down transformers, which are arranged in banks of twos and threes. Some of the transformers supply directly to a distributing network and others through rotatory converters to a continuous-current network. These rotatory converters are operated in pairs and supply current for the Edison three-wire system throughout the city. The potential of 78 volts given may be be varied 7 volts up or down by a series of inductor regulators. The secondary windings of the 200kw. transformers are divided, and leads are taken from each section to a quick-break multipoint switch on the outside of the case. By advancing this switch from point to point the secondary is thrown into circuit a section at a time, and the potential is correspondingly increased, in steps of 21 volts, from 2,100 to 2,700. In operating the station, the potential on the high-voltage 'bus bars is maintained at 22,500 volts, and the voltage of the distributing circuits is adjusted by the devices above described.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), March 8th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) "A Theory of Colloidal Solutions," by Dr. F. G. Donnan. (2) Exhibition of apparatus by R. Appleyard. (3) "On the Production of a Bright Line Spectrum by Anomalous Dispersion and its Application to the Flash Spectrum," by Prof. R. W. Wood.

**SATURDAY, March 9th.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture III. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

**MONDAY, March 11th.**

INSTITUTION OF ELECTRICAL ENGINEERS—NEWCASTLE LOCAL SECTION.

Ordinary Meeting at the College of Science, Newcastle-on-Tyne.

SOCIETY OF ARTS.

*8 p.m.* First Cantor Lecture on Electric Railways, by Major Phillip Cardew.

**TUESDAY, March 12th.**

INSTITUTION OF ELECTRICAL ENGINEERS—MANCHESTER LOCAL SECTION.

*7.30 p.m.* Ordinary Meeting at Owens College, Manchester. Paper to be read: "The Adaptation of the Steam Engine to the Generation of Electrical Energy," by J. S. Raworth.

**WEDNESDAY, March 13th.**

INSTITUTION OF ELECTRICAL ENGINEERS.

*7.30 p.m.* Extra Students' Meeting. Paper to be read: "Distribution of Energy in Coal Mines," by F. E. Pring.

INSTITUTION OF ELECTRICAL ENGINEERS—GLASGOW LOCAL SECTION.

*8 p.m.* Ordinary Meeting at the Institution of Engineers and Shipbuilders, 207, Bath-street, Glasgow.

**THURSDAY, March 14th.**

ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary Meeting. The following Paper will be read: "Some Notes on Polyphase Substation Working," by A. C. Eborall, and if necessary the discussion on Mr. O'Gorman's Paper concluded The Students' visit to the works of the Incandescent Electric Lamp Co. announced for to-day will not take place.

**FRIDAY, March 15th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary Meeting. Paper to be read: "Combined Trolley and Conduit Tramway Systems," by A. W. Connell.

**SATURDAY, March 16th.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture IV. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Condenser with Adjustable Capacity.*—Brigg's adjustable condenser, made of flexible mica plates subjected to varying pressures, gives a wide range of capacities, but is open to the objection that the variation of capacity with pressure follows an unknown law, and is not always a certainty. G. Ercolini has, therefore, improved upon it by substituting glass plates for the flexible plates. The glass plates are mounted one above the other on metallic rails laid into an ebonite scaffolding. The scaffolding can be sheared like a parallel ruler, so that the glass plates can be made to approach each other to any extent desired. Sheets of tinfoil stuck on both surfaces serve as the metal plates. The capacity varies with the cosine of the angle of inclination of the guiding rod. The condenser can, of course, be used as an air-condenser, or immersed in a liquid.

[G. Ercolini, *Nuovo Cimento*, November-December, 1900.]

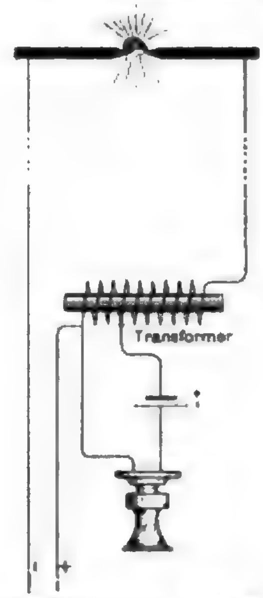
*Transparency of Bodies for X-Rays.*—It has long been known that the absorption of X-rays by matter is proportional to its density, therein resembling the force of gravitational attraction. L. Benoist has endeavoured to impart a greater precision to this rough generalisation. He defines the X-ray transparency of a body as the mass in grammes of a prism of the body 1 sq. cm. in base, which produces upon X-rays passing along its axis an absorption equal to that produced by a layer of paraffin 7·5 cm. thick. From a large number of measurements he concludes that the specific transparency of a body is independent of its physical state. Thus water and ice of equal density would show the same X-ray transparency. It is also independent of chemical combination, the atom exerting the same absorption whatever its grouping with other atoms. A more or less strict proportionality between atomic weight and absorptivity is only observed when the X-rays are of the most penetrating kind. Otherwise the curve of absorption resembles an equilateral hyperbola. On entering the atomic weights as abscissæ and transparencies as ordinates, a curve is obtained which fairly follows the hyperbola laid through lithium, but shows a maximum divergence for the atomic weights between 40 and 50.

[L. Benoist, *Comptes Rendus*, February 11, 1901.]

*Magnetic Effect of Electric Charge.*—V. Crémieu has repeated his own experiments on the magnetic effect of a moving electric charge, with a view to meeting the objections raised by Rowland, Himstedt, and Fitzgerald. He acknowledges that the action of the armatures which are used to discover the magnetic effect looked for is difficult to determine. He therefore devised a new experiment in which no metallic layer was interposed between the needle and the turning disc. But as before, the revolving charged disc produced no magnetic effect whatever. It was easy, however, to obtain an effect showing the same reversibility as the magnetic effect looked for, and even agreeing with it in order of magnitude. This pseudo-magnetic effect of electric convection is due to sparks or brushes, and is in any case of electrostatic origin. It is always observed when the suspended system has not been very carefully dis-electrified, or when it is not protected by a good conductor. A tube of paper covered with graphite, which constitutes a perfect electric screen for bodies at rest, ceases to be so when they are in motion. The conditions of experiment are generally so difficult that it is impossible to take a satisfactory set of readings. The author considers himself, however, still justified in denying the existence of a magnetic effect of electric convection.

[V. Crémieu, *Comptes Rendus*, February 11, 1901.]

*Photophones.*—E. Ruhmer has found that an electric arc is not absolutely essential for the transmission of speech by light. It can be accomplished by means of a simple Bunsen flame surmounted by a piece of platinum foil serving as an electrode, while the burner itself serves as the other. The flame is inserted in the secondary circuit of a transformer, and a battery and microphone receiver in the primary circuit. The effect is, however, much feebler than in the case of the arc. In using the arc care must be taken to have the proper transforming ratio. The best ratio—*i.e.*, that with which the loudest rendering of the original sound is obtained—is that in which the numbers of turns in the two coils are in the proportion of the square roots of the resistances of the microphone and the arc respectively. The ratio comes out as something like 1 to 2·2. To attain this ratio empirically, and to vary it in accordance with the pitch of the note transmitted (as is often desirable), the author proposes to employ a single-coil transformer with variable contact (see diagram). At the



receiving station low-resistance selenium cells should be employed. Under favourable conditions they may be made to work the recording magnet of a Poulsen telegraphone.

[E. Ruhmer, *Phys. Zeitschr.*, February 23, 1901.]

*Electric Anemometer.*—E. Legrand describes a simple device which surmounts all the difficulties experienced in transmitting the indications of an ordinary centrifugal anemometer to a distance. The shaft of the cup anemometer carries a small Gramme ring, which revolves between the pole-pieces of a strong permanent magnet. The E.M.F. produced in the ring is proportional to the speed of rotation. The apparatus is connected with a voltmeter formed by adapting a Deprez galvanometer, with a suitable damping device and a low resistance. To avoid errors due to temperature, the circuit is made of manganin wire. The apparatus is graduated empirically.

[E. Legrand, *Comptes Rendus*, February 11, 1901.]

*Solar Activity and Magnetic Variation.*—A. Angot claims to have discovered the precise value of the term due to the sun's influence in the equation representing the course of magnetic declination. The term has been calculated from the records of Parc Saint Maur and of Greenwich, and the two results show a remarkable agreement. The 17 equations of condition which determine each group of unknowns present in general only slight residual errors, and the influence of sun spots is very clear and precise. A slight lack of correspondence may be attributed to the fact that the sun's activity is not strictly measured by the number of sun spots visible. The diurnal term of the disturbing wave has a phase $\phi$ which, when referred to the true time, may be taken as constant for the whole year. It is 211·2deg. for Saint Maur, and 210·2deg. for Greenwich. Its amplitude in terms of the longitude $l$ of the sun is:—

Saint Maur........ $1{\cdot}37' + 0{\cdot}17' \sin l + 0{\cdot}22' \cos 2l$
Greenwich ......... $1{\cdot}48' + 0{\cdot}15' \sin l + 0{\cdot}24' \cos 2l$

The semi-diurnal term is:—

Saint Maur......... $0{\cdot}82' + 0{\cdot}30 \sin l + 0{\cdot}20 \cos 2l$
Greenwich ......... $0{\cdot}83' + 0{\cdot}35 \sin l + 0{\cdot}18 \cos 2l$

The Batavia observations give formulæ of the same form, but with somewhat different coefficients.

[A. Angot, *Comptes Rendus*, February 4, 1901.]

D

## THE FIRST ELECTRIC TRAMWAY IN NEW ZEALAND.

To the city of Dunedin belongs the honour of being the first to instal and operate an electric tramway in New Zealand. This line is operated on a stretch of track about 1½ miles long, running through the picturesque suburb of Roslyn to Maori Hill, a route formerly traversed by horse-drawn cars. It forms a branch of the rather extensive and mixed tramway system belonging to the Roslyn Tramway Co. The complete equipment of the system, including the rolling stock, track and line work, and generating station, has been carried out by Messrs. Noyes Brothers, the sole agents in Australia and New Zealand of the British Westinghouse Electric and Manufacturing Co. The overhead trolley system has been adopted. The trolley wire, which is of the somewhat unusual 8 section, is suspended either on side brackets or by span wires. The trolley poles are of Australian iron-bark wood, and the side brackets of iron having a light and neat appearance. The return circuit consists of the track with Edison-Brown plastic rail bonds. The steepest gradient on the line is 1 in 12, which the cars have no difficulty in negotiating at a speed of 8 miles an hour.

Electric, Cable and Horse Traction at Dunedin, N.Z.

The power-house is situated in the Kaikorai Valley, about three-quarters of a mile from the centre of the electric line. It is here that the cable machines for the operation of the cable-driven tramways are also installed, the electric generator being driven by counter-shafting from the same steam engine. Westinghouse standard plant has been installed, including a 75kw. railway-type generator, and a white marble switchboard bearing the usual main switches, automatic cutouts, rheostats, instruments, &c.

The cars are of the ordinary box type: inside dimensions 14ft. by 7ft. 3in. by 8ft. 8in. high; total length outside, 25ft.; and 6½ tons weight each. Each has a seating capacity for 20 persons. The inside finish is of cherry with a three-ply veneer ceiling of birch. The cars are well equipped with electric light, there being two three-light electroliers inside, and one lamp under each canopy and a head light. A gong is also arranged so that passengers may communicate with the conductor if they wish. Two Westinghouse tramway motors, type 49 B., rated at 25 H.P. each, operate each car, a motor being coupled to each axle through a single reduction gearing. The Westinghouse No. 90 type of car controller is used, one being fitted on each end platform so that cars can be run with equal facility in either direction.

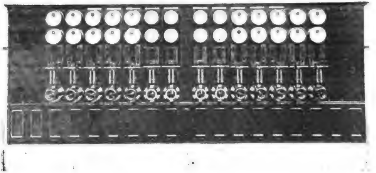
The cars commenced running for public service on October 28 last, but the formal opening by the Mayor of Dunedin did not take place until December 4.

At a meeting of the Dunedin City Council, held last December 12, Mr. W. G. T. Goodman, B.Sc., representing Messrs. Noyes Bros., presented a report on the Dunedin tramways, and it was resolved to borrow £46,128 for the purpose of purchasing and acquiring all the tramways, plant, &c., of the Dunedin City and Suburban Tramways Co. (Ltd.), also to borrow a further sum of £200,000 for improving, converting to electric power, and extending these tramways. The schemes submitted embraced both gas and steam power generation and also two water-power schemes. Of the latter the Taieri River and Lee Stream scheme meant securing 4,822 available H.P. from the river at a distance of about 12 miles from the centre of Dunedin. The Waipori River scheme meant securing 5,700 available H.P. at a distance of about 26 miles from Dunedin. The Council were in favour of adopting the former water-power scheme. The car mileage per annum under the present system of horse-drawn cars is 450,000, operated by 35 cars. Under the proposed new system, with electric trolley cars, the mileage will be raised to 1,040,800, operated by 26 motor cars.

## A NEW FEEDER SWITCHBOARD AT NEWINGTON.

A feeder switchboard has just been supplied and erected at the Newington (London) electricity supply works by the General Electric Co. (1900) Ld. Since the time when it was first opened, in 1899, this station has had some new plant added, and certain extensions have been made in the private lighting, necessitating three new feeders. When these matters were considered it was recognised that the large station switchboard standing in the gallery (and described in our article on the Newington station in Vol. XLIII., p. 224) was not capable of accommodating all the necessary new panels, owing to the fact that it already nearly filled the gallery. It was, therefore, decided to remove the five positive and negative feeder panels to the floor at the other end of the engine-house, and to erect in their place the panels for the new plant. This work was carried out by the General Electric Co., who were also makers of the original switchboard, and it comprised the supplying of (1) one positive and one negative panel for a 400kw. generating set, containing one B.T.H.

maximum automatic cut-out, one ammeter, one single-pole switch, and one minimum automatic cut-out, one single-pole fuse, and one double-shunt rheostat respectively ; (2) one balancer panel, containing two fuses, two centre-zero Weston ammeters, one starting rheostat, two knife switches, two shunt rheostats, and two field switches ; and (3) one booster panel, containing two double-pole fuses, one Weston ammeter, one centre-zero Weston ammeter, one Weston voltmeter, two double-pole switches, one starting rheostat, two shunt rheostats, and two field switches. The shunt rheostat on the large machine panel is deserving of special notice, in that it comprises one large-step and one small-step regulator on the potentiometer principle.



Front of Switchboard.

Back of Switchboard.

In addition, one spare 400kw. panel was supplied, and the old knife switches were replaced by the new and improved "Peel" spring knife switches, and minimum automatic cut-outs were added to all the old machine panels. The solid 'bus bars at the back of the board were replaced by new ones, consisting of three copper strips, each taped together, and these have been extended to the end of the gallery, where the middle wire bar drops straight down, whilst the positive and negative, after traversing the station wattmeters, are carried bare on insulators to the end of the engine house—some 60ft. Here they drop down to the new feeder board, to which they are connected by bare copper arches.

The new board comprises the five old positive and negative feeder panels arranged from the centre outwards, three additional panels on each side and one spare panel on each side. Each panel contains one feeder ammeter, with a scale of volts added, which shows the voltage at the feeding points, one voltmeter indicating station volts, one plug fuse-block with two fuses, one knife switch, and one regulator for the back E.M.F. cells, with which it is proposed eventually to regulate the pressure on the individual feeders. The instruments on the new panels are of the Weston type. The new panels also have screw plugs instead of fitted plugs, and the fuses are covered with micanite shields instead of mica shields. All the switches on the old panels have been replaced by "Peel" switches to match those on the new panels, and these are similar in pattern to those on the station switchboard, having double contacts and carbon breaks.

The accompanying views, showing the front and end of the board, will give an idea of the way in which the framework is built up. In devising this design the object aimed at by the General Electric Co. was to have a standard series of parts which could be put together with a minimum of labour, and combine strength, flexibility and facility for extension. The parts are all of cast-iron, and comprise for one panel a base, two side web brackets, two side frames, one apron, and one top frame. Of course the number of brackets and side frames are always one more than the number of panels. The base is cast with a long hole in the centre for entering cables, and five bosses with holes for coach screws for screwing to the floor. The brackets are bolted to the base through their flanges and support the apron in like manner; the side frames, which have a flange top and bottom, are bolted at the bottom to the top of the bracket, and at the top to the top frame, which they support. The side frames have also bosses with holes half way up and at the top, for bolting up to the next one, and so on. The top frame is cast with three rectangular holes for lightness, separated by two webs. It is in section somewhat like a T, into one angle of which the top of the panel fits, whilst the bottom rests in an angle or ledge cast in the apron. The panels are bolted top and bottom against these angles. With various standard heights of panels the number of panels of any width and height which can be erected is unlimited, and after they are bolted on, the edges are finished off with amoulding, and the whole painted. We are informed by the General Electric Co. that all the alterations were accomplished without shutting down the station or depriving anyone of the light.

## ELECTRICAL OSCILLATIONS AND ELECTRIC WAVES.*

BY DR. J. A. FLEMING, M.A., F.R.S.

(*Continued from page 691.*)

It becomes, therefore, important to consider how we can accumulate large stores of energy in a vibrator, which can be released as electrical oscillations. The energy stored up in any condenser is proportional to the capacity and to the square of the voltage or P.D. of the conductors. If we attempt to obtain large storage by using large capacity, we can only do so by increasing the wave length, and it is not always desirable to unduly enlarge the wave length. Hence it is best to gain energy storage by employing high-charging voltage. Here, however, we meet with a difficulty. The voltage, to which we can charge when using an oscillator of the Hertz type, is determined by the length of the spark-gap in the oscillator. It is found by experience that if we make this gap larger than 1cm. or at most 2cm., the spark is generally non-oscillatory—that is, the spark-gap when the spark is passing does not become conductive enough or remain conductive long enough to permit electrical oscillations to take place through it. Therefore, when using the Hertz radiator with spark balls of about a centimetre in diameter, we are limited in practice to a voltage difference between the two sides of about 30,000 volts. If we attempt to increase the capacity, when using an ordinary induction coil as the source of E.M.F., we find ourselves in another difficulty. Owing to the high resistance of the secondary circuit of the coil the whole electrical system has a very large time-constant; in other words, the coil cannot supply electricity fast enough to charge more than a small capacity up to the full voltage during the time the voltage exists. To overcome this latter difficulty, it is necessary to employ a transformer with a secondary circuit of not very great resistance and yet capable of giving the required voltage. When this is done we find we have quelled one obstacle to success and created another. The attempt to charge and discharge a condenser connected to spark balls joined across the terminals of the secondary circuit of the transformer results in the production of an alternating-current arc or flame discharge which stops all alternations. It is necessary to get rid of this arc without interfering with the oscillatory discharge of the condenser. Many methods have been proposed for doing this; one, due to Mr. Tesla, is to place the spark balls in a strong magnetic field, so that as soon as the arc is formed it is blown out magnetically. Mr. Tesla has also described and patented a number of devices in which revolving contact breakers of various kinds extinguish the arc intermittently. In one of these a jet of mercury is made to effect the contacts by being discharged against a revolving metal disc carrying contact blades. (See *Electrical Engineer*, New York, XXVI., p. 477, 1899.)

Another and more effective method is to employ an air blast to blow out the arc intermittently. To achieve this result, the air blast must be vigorous and then the arc discharge is destroyed, but the condenser disruptive discharge remains. With a jet of carbonic acid at a pressure of 3kg. per square centimetre (about 40lb. per square inch), it has been found that more than 100,000 sparks per second were obtained; with air at 3lb. per square inch, about 10,000 per second. (See H. Abraham, Soc. Franc. Phys. Seances 2, p. 70, 1899; also *Comptes Rendus*, 128, p. 991, 1899.) The use of an air blast to destroy the continuous current arc was suggested by Prof. Elihu Thomson. A third plan which is satisfactory, at least for small transformers, and has been adopted by Mr. Leslie Miller, is to construct a closed magnetic circuit transformer having great magnetic leakage. In other words, to put all the secondary winding on one side of the iron ring, and all the primary on the other. Hence the moment the arc is started the transformer attempts to send a large current, but then magnetic leakage causes the secondary voltage to drop and the arc is extinguished. A fourth plan, devised by M. d'Arsonval (*Comptes Rendus*, 130, p. 1,049, April, 1900), is to employ a spark-ball arrangement in which the spark balls are periodically pulled apart by being carried on revolving arms. By this plan the arc is broken mechanically and by the air vortex produced. I have devised and put into practice a more elaborate arrangement which is capable of creating very powerful and sustained oscillations. Using a glass plate condenser having a total capacity of about 1 microfarad, charging it to a voltage of 20,000 volts by means of a step-up transformer, and discharging it from 10 to 20 times a second by means of a rotating discharger as above described, it is possible to produce persistent electrical oscillations of very considerable energy, each group of which is composed of at least 1,000, or possibly several thousand individual oscillations.

Prof. Elihu Thomson has described (see *The Electrician*, Vol. XLIV., p. 40, 1899) an apparatus which is likely to be of great use in converting the energy of a continuous current into high frequency and high-potential oscillations. His apparatus consists of a continuous-current motor which has on its shaft a pair of insulated rings connected to two opposite ends of a diameter of the armature circuit. From these rings can be drawn off an alternating current having a frequency of 25 periods per second. This is passed through a transformer and raised in pressure to 20,000 volts. This high pressure is employed to charge a series of mica plate condensers in parallel, the connection of the transformer to the condensers being made just when the E.M.F. is a maximum. The contact maker which does this is driven by the shaft of the motor, and this shaft also drives a commutator which causes all the condensers to be charged in parallel and then discharged in series. Hence we get an enormous multiplication of potential, and can discharge a condenser charged say to 200,000 volts through a low resistance circuit. In this manner he creates an oscillatory spark discharge of considerable length, and representing a very high voltage combined with high frequency.

Returning then to the consideration of electric resonance, I may exhibit here an experiment to illustrate the exact "tuning" of two circuits together and a method of indicating it. On a wooden frame

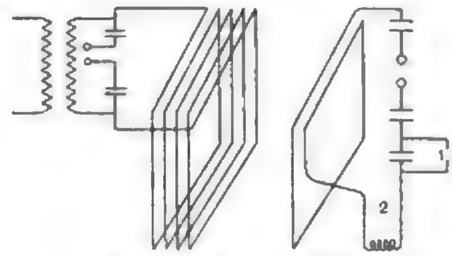


FIG. 6.—Co-Resonant Circuits.

is wound 12 turns of insulated wire, and this circuit joins the outsides of two Leyden jars (see Fig. 6). The insides of the jars are connected to a pair of spark balls, and these to the secondary circuit of an induction coil. When the coil is set in action electrical oscillations are excited in the circuit. At a distance is placed a similar coil of wire and a pair of jars, the coil connecting the outsides and the insides of the jars being nearly closed by a small spark-gap. If the circuits are arranged as shown, then oscillations in one circuit set up sympathetic oscillations by resonance in the other. If in the second circuit we decrease the capacity by adding a third jar in series with one of the others, then the sparking in the receiving circuit stops. It can, however, be restored by increasing the inductance of the circuit; hence we see that decreasing capacity can be compensated for by increasing inductance. This is in accordance with theory, for the "note" or "tune" of the system depends upon the product of its inductance and capacity, and therefore remains the same when one quantity is made to vary inversely as the other.

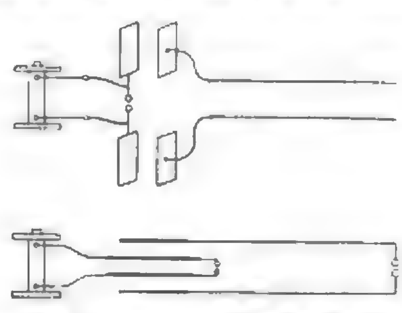


FIG. 7.—Arrangement of Lecher Circuit.

Thus, if we have two electrical systems, each consisting of a capacity and an inductance in series denoted by C, L, and $C^1$, and $L^1$, then these systems will be in resonance or in sympathy or tune if the product CL is equal to the product $C^1L^1$. It is extraordinary how little variation of capacity will in some cases upset the "tuning." A striking experiment in electric resonance has been described by G. le Bon ("Revue Scientifique," 11, p. 513, 1899; or "Science Abstracts," 1899, Vol. II., p. 671). By means of an induction coil, spark-gap, two Leyden jars, and connecting coil of wire, oscillations are set up in the coil as already shown. From the end of the solenoid or coil two wires are led, one of which is connected to the bottom end of a second special coil, and the other to some point in the coil found by trial. The upper free end of this second coil is furnished with a sharp point. When the proper points of attachment have been found it is seen that a vigorous "electric brush" starts from the sharp point. This is due to sympathetic oscillations set up in the second coil by properly adjusting its length, so as to tune it to the primary coil.

* Cantor lecture delivered before the Society of Arts, December 4, 1900.

Another interesting phenomenon in which electric resonance or tuning plays an important part is that of the establishment of stationary electrical oscillations in open wire circuits. Let a double condenser be formed by placing four sheets of tinfoil between sheets of glass or ebonite (see Fig. 7). Suppose the two inner plates connected to a pair of spark balls and to the secondary circuit of an induction coil, and the outer plates connected to two long insulated wires placed, say, 6in. apart. When the induction coil is set in action the inner plates form a condenser which discharges with oscillations. The potentials of the two outer plates are, therefore, raised and lowered with great frequency; hence the wires connected to them are subjected at one end to very rapidly-varying E.M.F., and if they are properly adjusted as to length and distance apart, we have set up in them stationary electrical oscillations. These consist of high-frequency currents in the wires, but determined by the condition that at the open or free end of the wires the currents must be zero, but the potential variation may be a maximum. The peculiarity of these stationary oscillations is that we may have a current in one part of the wire which is in the opposite direction to that in another part, and in between we may have a place where there is no current at all. This can be detected by encircling the wire with a small insulated coil of very fine platinum wire which forms part of one arm of a Wheatstone's bridge. Any heating of this platinum wire upsets the balance of the bridge and creates a deflection of the bridge galvanometer. The platinum wire becomes heated when in such a position on the long wire that at that point current oscillations exist. This bolometer arrangement is a means of detecting a localised current in a wire by the heat it there creates. This method of detecting stationary current oscillations in a wire has been put into practice by Rubens, Paalzow, Ritter, Arons, and others, and is described at length by Prof. J. J. Thomson in his book, "Recent Researches in Electricity and Magnetism," p. 461 See also *Wied. Ann.*, 1899, Vol. XXXVII, p. 529; 1890, Vol. XL, p. 55; 1891, Vol. XLII., pp. 154, 581.

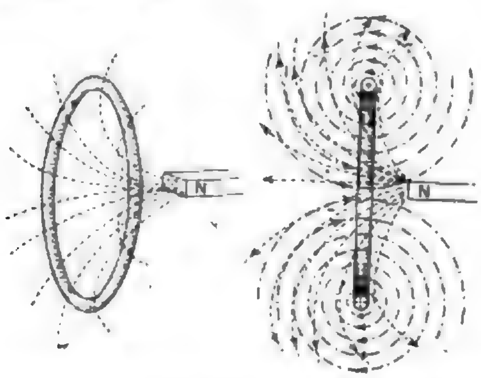


FIG. 8.—Induced and Inducing Magnetic Fields in case of a Magnet and Circular Circuit.

Measurements made with the bolometer in the above manner show that the electric impulses applied to the end of the wires excite the free vibrations of the wire in such fashion that the length of the wire is either equal to one complete wave length of current or to an odd integer multiple of the wave length. If the circuits are arranged as shown in the upper of the two diagrams in Fig. 7, which is commonly known as the Lecher arrangement, and if the two wires attached to the secondary plates have a vacuum tube joined across their open ends, we can show a pretty resonance experiment as follows: Place a metallic wire as a bridge across the two parallel wires, and move it about. We can find a position in which the vacuum tube is alight even when the long wires are thus short-circuited. This happens when the two separate circuits so formed are in resonance with each other. It is impossible to leave the subject of electric resonance without making reference to one important region of fact in which electric resonance is possibly the key to the physical explanation. In the next and last lecture your attention will be directed to some of the evidence that what we call light consists in the propagation through space of electric and magnetic force, and that along the path of a ray of light there is a distribution of electric force periodic and cyclic in space as well as in time.

One of the most familiar optical phenomenon is that of "absorption." A substance may be very transparent to rays of one frequency, but perfectly opaque to those of another. Consider now an electric circuit tuned to one particular frequency. Let us suppose that it is subjected to inductive impulses of very various frequencies, all acting upon it at once. From what has already been explained it will be clear that the receiving circuit will pick out and respond to the particular frequency of oscillation to which it is tuned. It can also be shown that such a system must be opaque to the impulses to which it responds. Imagine a single resonator consisting of a circular wire suspended in space; let magnetic flux be inserted into this circuit so as to create in it an E.M.F. and an electric current (see Fig. 8). A little consideration will show that the direction of the magnetic force due to the current set up in the resonator is such as to tend to annul or destroy the magnetic force which gave rise to it by its insertion into the circuit. If, then, we imagine a wall composed of such circular resonators, all placed with their planes perpendicular to the wall, and if we furthermore imagine a period magnetic force parallel to the plane of the wall and perpendicular to the plane of each resonator, to operate on the resonators, it will be evident that each resonator will have induced in it a current which will produce a magnetic force exactly annulling at the centre of the resonator the external magnetic force which gave rise to it. It is then possible to show that if this impressed magnetic force is rapidly periodic, and due to an electric wave impinging on the wall of resonators, then the resonators will themselves emit electromagnetic waves which will, at all places beyond the wall, neutralise the action of the incident wave.

In this way we can produce an electro-magnetic model of a wall which is opaque to waves of a particular frequency. If, then, for a moment we anticipate matters to be considered in the last lecture, and take it as highly probable that what we call a ray of light is a periodic change in space and time of magnetic and electric force along the line of ray, and if we may assume that atoms or molecules are, for present purposes, equivalent to receiving and resonant circuits, it is clear that the phenomena of absorption—whether general, as in opacity, or special and limited, as in the absorption bands in the spectra of certain solids, liquids and gases—may be an instance of electric resonance. Any electrical theory which is to explain absorption must, however, deal with the connected phenomena of abnormal dispersion and that variation of the refractive index on either side of an absorption band which is characteristic of optical absorption. An attempt to base a theory of optical absorption on electric resonance has been made by G. Sagnac (see Soc. Franc. Phys. 141, p. 3, 1900; or "Science Abstracts," Vol. III., p. 527), and any complete electromagnetic theory of light must include as part of it a consideration of that limited opacity of bodies to certain luminous radiations, which is such an important department of optics.

*(To be continued.)*

## A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.*

BY MICHAEL B. FIELD, A.M.INST.C.E.

*(Concluded from page 659.)*

In Heap's patent 8,348 of 1898, instruments of the Weston type are described for use in three-wire circuits, where the moving member has two distinct coils and four terminals as shown in Fig. 8. The great disadvantage of this arrangement is, of course, the difficulty of insulating the coils on the movable member from each other, the difference of potential being the full voltage between outer and neutral wire.

A further device is described, as shown in Fig. 9, with reference to instruments depending on the attraction of a small piece of iron. If these instruments be used at all, they may quite as readily be compounded with a few turns in series with the outer and neutral mains in accordance with the original scheme of Dr. Hopkinson. In any case, the device described above of Heap possesses the disadvantage that unless a large drop be allowed in the inserted resistances in the mains, the available voltage across the terminals of the voltmeter is altogether insufficient. For example, on a 250-volt circuit, if the series resistance caused an added drop of, say, 2 per cent. of the feeder drop, the available difference of potential for working the voltmeter would be only about 2·5 volts. With an instrument of the above type to be actuated by only 2·5 volts, a comparatively large current would be necessary, causing a relatively large watt-loss in the whole arrangement.

*Case C.*—This case—viz., the compensation for the ohmic and inductive drop in long alternate-current transmission lines has been very ingeniously handled by Mershon. As already intimated, Fig. 3 gives the pith of Mershon's arrangement, but in his American patents a considerable number of very pretty modifications are shown; but all of these, as he is careful to point out, depend upon the employment of potential or current transformers, or both. The following method, therefore, which is quite independent of all transformers, not even necessitating one for the voltmeter, may be of interest. In this instance, not only must an extra resistance be inserted in the line, but similarly an extra self-induction, unless indeed a portion, say a $\frac{1}{100}$th part of resistance and self-induction of the line itself, be employed for the purpose by running back a pilot-wire to the station from a point on the line situated at a distance from the power-station equal to ($\frac{1}{100}$th) part of the whole length of the line.

* Paper read at a meeting of the Glasgow Local Section of the Institution of Electrical Engineers, February 13.

To fix our ideas, let us consider a specific case where the line voltage is 30,000 volts, the line being 50 miles from end to end. At the station a 100-volt multicellular electrostatic voltmeter of the Kelvin type is employed, and connected as shown in Fig. 10. It would, of course, have to be thoroughly insulated from earth. $k_1$ and $k_2$ are condensers replacing the resistances $r_1$ and $r_2$ shown in Fig. 1. The condenser $k_2$ has a capacity approximately equal to the maximum capacity of the voltmeter—*i.e.*, the capacity between the fixed and movable vanes, the latter being in the position they normally

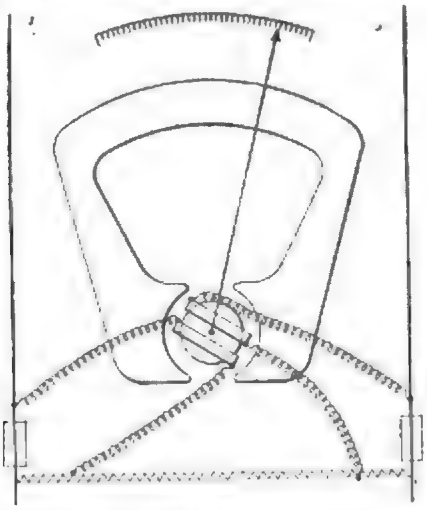


Fig. 8.

occupy when the voltmeter is indicating its maximum voltage. The capacity of the condenser $k_2$ is accordingly very small; it must, however, be capable of withstanding practically the full line voltage of 30,000 volts. The writer therefore proposes to employ for this condenser a slab of glass with pieces of tinfoil pasted on the two opposite surfaces, the slab being sufficiently thick to withstand the voltage, and the area of the tinfoil coatings being chosen to give a capacity approximately equal to the maximum capacity of the voltmeter. To prevent leakage and condensation on the edges of

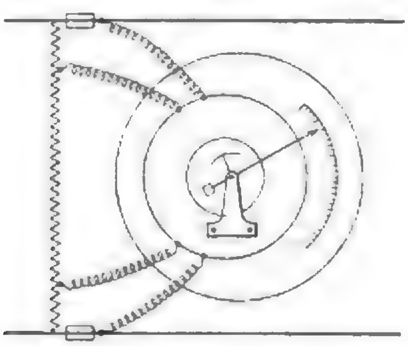


Fig. 9.

the slab the whole might advantageously be immersed in a bath of special oil, or be imbedded in a block of paraffin wax or other suitable dielectric.

The condenser $k_1$ must have a capacity nearly 300 times as great as that of $k_2$; since, however, the voltage across the former will be of the order of 100 volts, it can readily be constructed in the usual way of sheets of tinfoil and mica, and will not be an expensive matter. It is important that the ratio of the capacities of $k_1 : k_2$ be

Fig. 10.

maintained exactly, but it is not of any importance that the capacity of $k_2$ shall bear any very exact ratio to that of the voltmeter. Thus the voltmeter, if deranged, might be replaced by another of the same pattern, and the latter would indicate correctly. If a portion of the line itself be utilised, instead of inserting extra resistance and inductance a pilot-wire must be run back from a point one-third of a mile distant from the power house. This wire must be protected, of course, from the inductive action of the current in the line in a manner explained later on. One advantage in utilising a portion of the feeder itself instead of inserting extra resistances, &c., which may, of course, be done in this or any of the foregoing cases, is that no error is produced by a change of resistance of the line due to changes o; atmospheric temperature.

We thus have a simple and inexpensive arrangement whereby a 100-volt electrostatic voltmeter may be arranged to measure directly the potential at the far end of a 30,000-volt line, the voltmeter being compensated for both ohmic and inductive effects of the line itself. It is obvious that similar arrangements may be applied to many such useful purposes—*e.g.*, in the last case the voltmeter might be arranged to compensate not only for the line drop, but also for the drop due to both copper resistance and magnetic leakage in the transformer at the far end, and thus indicate the voltage at the low-tension terminals of the transformer irrespective of what kind of load may be connected to the same, *i.e.*, one possessing self-induction capacity or anything else. The drop in the transformer might be exactly imitated by inserting in series in the circuit (now containing a perfect transformer with no drop) a definite self-induction and resistance. These might then be considered as forming part of the transmission line, and therefore, by adjusting $k_1$, $k_2$, and the inserted resistance and self-induction, or possibly the position at which the pilot-wire is connected, the drop due to the extra resistance and self-induction—*i.e.*, the drop in the transformer at the far end of the line, may also be compensated for.

### Analytical Investigation.

A simple and straightforward, though possibly a somewhat lengthy, method of dealing with this subject is to consider $n$ feeder circuits (Fig. 11), where $F_1$, $F_2$, $F_n$, &c., represent the total (go and return) feeder resistances of the various circuits. At the station end the positive and negative feeders of each circuit are bridged over by

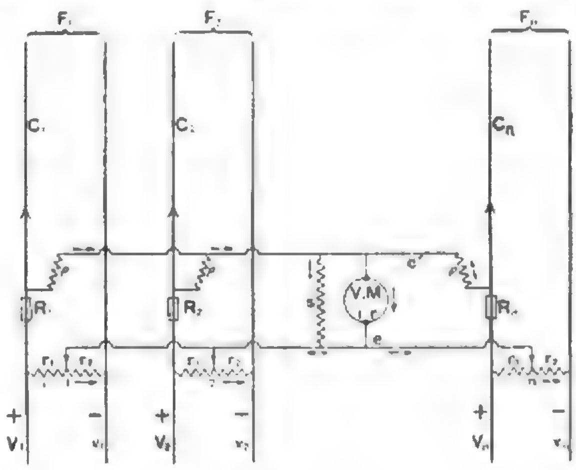


Fig. 11.

resistances $r_1 + r_2$, and all the points, 1, 2, 3, &c., of these resistances are connected together and to one terminal of the voltmeter. The potential of this terminal is $e$. The resistance of the voltmeter is $r$, and the current flowing through it $i$. It is further shunted by a resistance $s$.

Let $V_1 v_1$, $V_2 v_2$, &c., be the potentials of the positive and negative feeders of the different circuits respectively, then it is easy to show that

$$e = \frac{r_2}{r_1 + r_2} \cdot \frac{\Sigma(V_1 + V_2 + \ldots V_n)}{n}$$
$$+ \frac{r_1}{r_1 + r_2} \cdot \frac{\Sigma(v_1 + v_2 + \ldots v_n)}{n}$$
$$+ \frac{r_1 r_2}{r_1 + r_2} \cdot \frac{s + r}{s} \cdot \frac{i}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let $R_1$, $R_2$,...$R_n$ be the series resistances inserted in the feeder circuits, and let the far end of each of these be connected by a wire whose resistance is $\rho$ to the second terminal of the voltmeter. Calling the potential of this terminal $e'$, we may write

$$e' = \frac{\Sigma(V_1 + V_2 \ldots V_n)}{n} - \frac{\Sigma(C_1 R_1 + C_2 R_2 \ldots C_n R_n)}{n} - \rho \cdot \frac{s + r}{s} \cdot \frac{i}{n}, \quad (2)$$

where $C_1$, $C_2$...$C_n$ are the various feeder currents, which may be taken as identical with the currents flowing through $R_1$, $R_2$, &c., provided $\rho$ be sufficiently large to prevent any appreciable interchange of current between the various feeders.

We have further

$$\epsilon' - \epsilon = ir. \quad . \quad . \quad . \quad . \quad (3)$$

Hence, eliminating $\epsilon$ and $\epsilon'$ we have

$$i = \frac{\frac{1}{n}\Sigma\left(V_\kappa - v_\kappa - \frac{r_1+r_2}{r_1} \cdot C_\kappa R_\kappa\right)}{\left(\rho \cdot \frac{r_1+r_2}{r_1} + r_2\right)\frac{s+r}{sn} + r\left(\frac{r_1+r_2}{r_1}\right)} \quad . \quad . \quad . \quad (4)$$

If $$\frac{r_1+r_2}{r_1} = \frac{R_1+F_1}{R_1} = \frac{R_2+F_2}{R_2} = \&c.,$$

the numerator of the above expression is merely the average voltage existing at the far ends of all the feeder circuits. We will call this $V_a$. It is then clear that the current flowing through the voltmeter is proportional to $V_a$ if any given number of feeder circuits be connected. The constant of the instrument, however, involves $n$; in order therefore to make the same calibration serve for all values of $n$, and to obtain the most sensitive arrangement, we must keep $s+r/sn$ equal to unity, in other words $s$ must always equal $r/n-1$. This, therefore, is the function of the shunt $s$ in Fig. 2, and if by means of the multiple contact switch, $s$ be made to depend on $n$ in the above manner, we have

$$i = \frac{V_a}{r_2 + \frac{(\rho+r)(r_1+r_2)}{r_1}}.$$

If $n=1$ we may make $\rho=o$ and $s=\infty$, *i.e.*, no shunt is required. This is the arrangement of Crompton and Ashley, and also of Heap.

The equation holding for the device represented in Fig 1 is slightly different from the foregoing,

We must insert in equation (1)

$$n=1,\ V = \frac{1}{n}\Sigma\left(V_1+V_2 \ldots V_n\right),\ v = \frac{1}{n}\Sigma\left(v_1+v_2+\ldots v_n\right),$$

and in equation (2) merely

$$V = \frac{1}{n}\Sigma(V_1+V_2 \ldots V_n).$$

Combining (1) and (2), we have

$$i = \frac{V_a}{\left(\frac{\rho}{n} \cdot \frac{r_1+r_2}{r_1} + r_2\right)\frac{s+r}{s} + \frac{r(r_1+r_2)}{r_1}}.$$

Now, in this case, if $\rho$ be very small compared with $r$, we may say that $i$ does not depend on $n$, hence $s$ may be made $\infty$—*i.e.*, no shunt is required, and we have

$$i = \frac{V_a}{r_2 + \frac{r(r_1+r_2)}{r_1}}.$$

Applying the above results to an actual case, let $V=200$, and let the current required by the voltmeter for maximum scale deflection, corresponding to, say, 220 volts, be 0·01 ampere, the resistance of the voltmeter being 60 ohms.

Let, further, $$\frac{F_1}{R_1} = \frac{F_2}{R_2} = \&c. = 90,$$

then we have $$r_2 = 16{,}000 \text{ ohms.}$$

$$r_1 = 161{\cdot}6 \text{ ohms.}$$

We may take it that the maximum feeder drop will not exceed 10 per cent., hence the maximum volt drop along $R_1$, $R_2$, &c., cannot be greater than 0·2 volt. If, therefore, $\rho=0{\cdot}75$ ohm, we may say that the interchange of current between any two feeders cannot be more than 0·13 ampere, or an amount which is quite inappreciable, and at the same time the maximum error introduced by the variation of the value of $\rho/n$ as $n$ is varied cannot exceed one-fifth of 1 per cent.

With the arrangement shown in Fig. 2, $\rho$ must be much greater than heretofore assumed, for if one set of feeders be switched out, the voltage at the near end of the positive of the same might differ by as much as 20 volts from that of neighbouring positive feeders, and a serious interchange of current between them would occur if $\rho$ were not of considerable magnitude. Since, however, from equation 4 it appears that no error whatever is produced by the variation of $n$, provided $s$ is always equal to $r/n-1$, we may, if we like, take $\rho=100$ ohms. In this case, taking the same constants for the voltmeter as before, $r_2$ will come out 6,000 ohms and $r_1$ 60·6 ohms.

It has been assumed throughout the foregoing that the same current returns by the negative feeder as goes by the positive feeder of the same circuit; this will generally be true, unless indeed the resistances of the positive and negative feeders are different, or the problem is complicated by the fact that there are faults at different parts of the system. In such cases, however, where the outgoing current is of *different magnitude* from the return current, the following arrangement might be employed, which, moreover, is particularly applicable to three-wire systems and such like.

To derive an expression for $i$ in case ($b$), see Fig. 5, we have from equation (1)

$$\epsilon = \frac{r_2}{r_1+r_2} \cdot \frac{\Sigma V_\kappa}{n} + \frac{r_1}{r_1+r_2} \cdot \frac{\Sigma v_\kappa \pm C'_\kappa R'_\kappa}{n}$$
$$+ \frac{r_1 r_2}{r_1+r_2} \cdot \frac{s+r}{s} \cdot \frac{i}{n} \quad . \quad . \quad . \quad . \quad (5)$$

To obtain $\epsilon'$ we must substitute in this same equation

| | | |
|---|---|---|
| $\epsilon'$ for $\epsilon$ | $V_\kappa - C_\kappa R_\kappa$ for $V_\kappa$ | |
| $r_4$ „ $r_1$ | $v_\kappa$ | „ $v_\kappa \pm C'_\kappa R'_\kappa$ |
| $r_3$ „ $r_2$ | $-i$ | „ $i$ |

and we may further write $r_1+r_2=r_3+r_4$,

hence $$\epsilon' = \frac{r_3}{r_1+r_2} \cdot \frac{\Sigma V_\kappa - C_\kappa R_\kappa}{n} + \frac{r_4}{r_1+r_2} \cdot \frac{\Sigma v_\kappa}{n}$$
$$- \frac{r_3 r_4}{r_1+r_2} \cdot \frac{s+r}{s} \cdot \frac{i}{n} \quad . \quad . \quad . \quad . \quad (6)$$

Combining (3), (5), and (6) we get

$$i = \frac{\frac{1}{n}\Sigma\left(V_\kappa - v_\kappa - C_\kappa(R_\kappa+F_\kappa) \mp C'_\kappa(R'_\kappa+F'_\kappa)\right)}{(pr_4+qr_2)\frac{s+r}{sn} + \frac{r(r_1+r_2)}{r_1-r_3}}, \quad . \quad (7)$$

where $$\frac{r_1}{r_1-r_3} = 1 + \frac{F_1}{R_1} = 1 + \frac{F_2}{R_2} = \&c. = p,$$

and $$\frac{r_2}{r_1-r_3} = 1 + \frac{F_1'}{R_1'} + 1\frac{F_2'}{R_2'} = \&c. = q.$$

Now the numerator in (7) is the average voltage obtaining at all the far ends of the feeder circuits between the outers $F_1$, $F_2$, &c., and the neutrals $F_1'$, $F_2'$, &c. Call this average voltage, as before, $V_a$.

If, then, we again, by means of the multiple contact switch, keep $s+r/sn$ equal to unity, we have for case ($b$)

$$i = \frac{V_a}{pr_4 + qr_2 + \frac{r(r_1+r_2)}{r_1-r_3}},$$

from which the necessary values for $r_1$, $r_2$, $r_3$, and $r_4$ are calculable for any given instance.

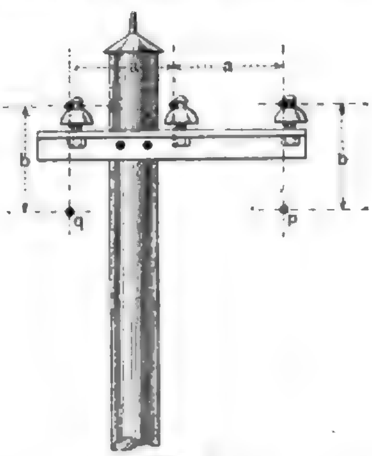


Fig. 12.

The last case is that of ($c$), Fig. 10. We can readily derive the equation for the voltage existing across the voltmeter (which may be designated $\epsilon'$) from equation (4), by writing

| | | |
|---|---|---|
| $n=1$ | $R+l\theta$ for $R_1$ | $\frac{1}{k_2\theta}$ for $r_2$ |
| $s=\infty$ | | |
| $\rho=0$ | $\frac{1}{k_1\theta}$ „ $r_1$ | $\frac{1}{\kappa\theta}$ „ $r$; |
| $v=0$ | | |

where R and $l$ are the resistance and self-induction respectively of that portion of the line spanned by the pilot-wire, $\kappa$ is the capacity of the voltmeter, this being a function of the position of the movable vanes, and $\theta$ represents the operator $d/dt$.

We have then

$$\epsilon' = \frac{i}{\kappa\theta} = \frac{V - \frac{k_1+k_2}{k_2} \cdot (R+l\theta)C}{\frac{\kappa+k_1+k_2}{k_2}}.$$

If $$\frac{k_1+k_2}{k_2} = \frac{F}{R} = \frac{L}{l},$$

the numerator of the above expression represents the voltage obtaining at the end of the line. Call this $V_a$.

As already explained, $k_2$ may advantageously be made about equal to the maximum value of $\kappa$, in which case, owing to the comparatively large value of $k_1$, we may write with great accuracy,

$$v' = \frac{k_1}{k_1 + k_2} \cdot V_c.$$

It has been pointed out in the previous part of this Paper that it is necessary to shield the pilot-wire from the inductive action of the line. If the line be a single-phase one carried overhead, it will be simple to place the pilot-wire symmetrically with regard to the two-line wires, in which case all inductive effects will be obviated. If the line be an overhead three-phase one, it is not always possible to place the pilot-wire in a symmetrical position with regard to all three-line wires. The inductive action may, however, be neutralised by running the pilot-wire for *part* of the distance nearer the one or other of the lines. Thus, if the three-line wires be carried in a row (see Fig. 12) and a pilot-wire be run for a total distance of 500yd. from the station, it might be located for 250yd. in position $p$, and for the remaining 250yd. in position $q$. The inductive action of each line wire on the pilot-wire depends on the logarithm of the reciprocal of the distance between them plus a constant, which latter is the same for all the line wires.

If, therefore, we adjust matters so that

$$\tfrac{1}{2}\log\left(\frac{1}{b}\right) + \tfrac{1}{2}\log\left(\frac{1}{\sqrt{4a^2+b^2}}\right) = \log\left(\frac{1}{\sqrt{a^2+b^2}}\right),$$

or

$$b = \frac{1}{\sqrt{2}}a,$$

the inductive action of each line wire on the pilot-wire will be the same, and since the total current flowing in the three-line wires at every instant is zero, the total inductive effect will likewise be zero.

With other arrangements of the line wires, corresponding modifications of the positions of the pilot-wire will be requisite.

## ELECTRICITY WORKS ACCOUNTS.

### St. James' and Pall Mall Electric Light Co. (Ltd.).

The steady and unbroken progress of this undertaking has now become its chief characteristic. Although, in common with other concerns, vitally influenced by the abnormal prices of fuel during the past year, the results of the working fully maintain the company's splendid record. Reference to our analysis shows that the output sold, with a rise like that in 1899 of 22 per cent., now exceeds five million units in the year. The new lamp connections were not so many as in the preceding year, the total being increased by 10 per cent.

The whole of the authorised share and loan capital has now been taken up, and the expended capital amounts to £390,231, representing £100. 12s. per kilowatt of plant installed. From our 1899 analysis it will be seen that the net interest charges on the gross profit were reduced by interest received for advances by the company. This interest (of £1,582 from the Central Electric Supply Co.) has, at the instance of the auditor of the Board of Trade, been placed to a special interest suspense account instead of to the credit of the net revenue account.

To the large extensions of the Carnaby-street station and the meanwhile unproductive capital involved therein may be traced the slight decline of the ratio of working profit to capital. We learn that these extensions will be completed in time to deal with next winter's demand, while that of the succeeding winter and afterwards will be provided for by the Grove-road works of the Central Electric Supply Co.

Turning now to the costs, it will be noticed that the only item which has increased is that of fuel. The very low value of 0·18d. per unit for repairs at the station in 1899 shows a distinct diminution. Another of the generating items showing a very low figure is that of wages, as in our table for both years the wages at distributing stations as well as at the generating stations are included in the 0·066d. given under generating costs.

It is to the great reduction in the management and property charges that the improvement in the aggregate costs is due. All the various items of cost and the total revenue per unit now present figures which, even taking into account the nature of the output and the high load-factor of 16·2 per cent., are below the average for company stations in 1899.

The following table affords an idea of the growth of the concern:—

| Year. | Lamp connections. | Output, units sold. | Plant capacity, kw. | Total cost per unit sold. | Ord. div. per cent. |
|---|---|---|---|---|---|
| 1890 | ... | ... | ... | ... | 5 |
| 1891 | 38,500 | 1,067,996 | 820 | ... | 8½ |
| 1892 | 47,900 | 1,186,826 | 1,060 | .. | 7½ |
| 1893 | 60,000 | 1,211,451 | 1,300 | ... | 4½ |
| 1894 | 75,200 | 1,569,884 | ... | ... | 6½ |
| 1895 | 91,800 | 1,848,064 | 2,100 | 2·83d. | 7½ |
| 1896 | 108,000 | 2,4[illegible]1,431 | 2,750 | 2·29d. | 10½ |
| 1897 | 123,000 | 3,028,242 | 3,880 | 2·23d. | 14½ |
| 1898 | 142,788 | 3,448,858 | 3,880 | 1·98d. | 14½ |
| 1899 | 169,400 | 4,201,104 | 3,880 | 1·98d. | 14½ |
| 1900 | 186,347 | 5,127,775 | 3,880 | 1·92d. | 14½ |

### Smithfield Markets Electric Supply Co. (Ltd.).

The second of our analyses is that of the accounts for 1899 and 1900 of the Smithfield Markets Supply Company.

Although under this company supply was started in 1897, the old company from which the concern was purchased, started supply in August, 1894. Inclusive of the purchase price of £100,000 paid for the property, including buildings, plant, mains, markets installations, &c., the capital expenditure to December 31 last was £114,857, or at the rate of £144 per kilowatt of plant capacity, which is now 800kw.

During the period of 15 months ended at December 31, 1899, the output was 646,133 units, and secured a return of £10,999, or an average total revenue of a little over 4d. per unit, to which the costs bore the ratio of 69·8 per cent., resulting in the reduction of the standing deficit from £775 to £210.

Comparing the operations of 1900 to those of the preceding period pro rata it will be seen that the output made the splendid advance of nearly 75 per cent. with a load factor of no less than 18·9 per cent. The costs are, perhaps, hardly comparable with those of ordinary electricity supply concerns, but we should have thought that they might yet be reduced considerably, even to values below what might be expected of ordinary stations under similar conditions of load.

Last year's results not only wiped out the remaining deficit, but left a surplus of £675, after placing £1,000 to depreciation.

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | June 22, 1900 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 23, 1900 | Notting Hill (Company) | Mar. 16, 1900 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 13, 1900 |
| Cambridge (Company) | April 13, 1900 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 9, 1900 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 23, 1900 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Feb. 16, 1900 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southport (Municipal) | July 7, 1899 |
| Eastbourne (Company) | May 4, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Edinburgh (Municipal) | Dec. 7, 1900 | Stafford (Municipal) | Aug. 17, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Sunderland (Municipal) | Nov. 9, 1900 |
| Folkestone (Company) | April 27, 1900 | Taunton (Municipal) | June 16, 1899 |
| Glasgow (Municipal) | Sept. 14, 1900 | Tunbridge Wells (Mun.) | Jan 18, 1901 |
| Guildford (Company) | Oct. 19, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Halifax (Municipal) | Sept. 21, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Wandsworth (Company) | May 18, 1900 |
| Hampstead (Vestry) | Oct. 19, 1900 | Westminster (Company) | Mar. 9, 1900 |
| Hanley (Municipal) | July 27, 1900 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Winchester (Company) | Oct. 26, 1900 |
| Harrow (Company) | Dec. 21, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Woking (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Woolwich (Company) | Jan. 13, 1899 |
| Islington (Vestry) | Nov. 23, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kensi'gton & Knightsbr' (Co.) | Mar. 16, 1900 | Great Yarmouth (Mun.) | Dec. 23, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | | |

| | ST. JAMES', LONDON. | SMITHFIELD MARKETS, LONDON. |
|---|---|---|
| *Undertaking Worked by* | The St. James' and Pall Mall Electric Light [Co., Ltd. | The Smithfield Markets Electric Supply Co., Ld. |
| *Date of Commencement of Supply* | April, 1889. | October, 1897. |
| *System of Supply* | Three wire continuous-current. | 3-wire continuous-current at 100 & 200 volts. |
| *Chief Engineer* | Sydney T. Dobson. | Eustace Ridley. |

| YEAR ENDED | DEC. 31, 1899. | DEC. 31, 1900. | DEC. 31, 1899.[a] | DEC. 31, 1900. |
|---|---|---|---|---|
| **QUANTITIES—** | | | | |
| Units generated | 4,686 192 | 5,740,634 | 780,801 | 1,091,647 |
| „ SOLD (TOTAL) | 4,201 104 | 5,127,775 | 646,133 | 903,795 |
| „ sold to consumers | 4,063,274 | 4,984,748 | 577,757 | 808,494 |
| „ sold for public lighting, &c. | 137,830 | 143,027 | 68,376 | 94,001 |
| „ used on works | 68,798 | 79,501 | 33,734 | 27,086 |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 35·0 | 42·4 | 34·5 | 36·1 |
| Maximum supply demanded | — | 3,624 kilowatts | 385 | 646 |
| Number of public lamps | 60 arc | 60 arc | — | — |
| Number of consumers | 1.500 | 1,821 | 266 | 323 |
| Connections to mains in 8-c.p. lamps | 169,400 | 186,347 | 16,960 | 23,239 |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 120,000 | 121,000 | 18,740 | 25.000 |
| CAPACITY OF PLANT IN KILOWATTS | 3.880 | 3,880 | 609 | 800 |

| | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| **CAPITAL—** | | | | | | | | |
| AUTHORISED (TOTAL) | £450.000 | £116 | £450,000 | £116 | — | — | — | — |
| Share | 300 000 | 77·3 | 300,000 | 77·3 | £100,000 | £167 | £100,000 | £125 |
| Loan (including Debenture charges) | 150,000 | 38·7 | 150,000 | 38·7 | — | — | — | — |
| RECEIVED (TOTAL) | 283 935 | 73·2 | 450.000 | 116 | 112.328 | 187 | 113,990 | 142 |
| Share | 283.935 | 73·2 | 300,000 | 77·3 | 60,000 | 100 | 60,000 | 75·0 |
| Loan (including Debenture charges) | nil | — | 150,000 | 38·7 | 52,328 | 87·1 | 53,990 | 67·5 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | 16 065 | 4·14 | nil | — | — | — | — | — |
| Share (unissued) | nil | | nil | — | 40,000 | 66·7 | 40,000 | 50·0 |
| Share (uncalled) | 16,065 | 4·14 | nil | — | nil | — | nil | — |
| Loan (including Debentures) | — | — | nil | — | — | — | — | — |
| REPAID (TOTAL) | — | — | — | — | — | — | — | — |
| RESERVE OR SINKING FUND | 49.523[a] | 12·7 | 66.529[a] | 17·1 | — | — | — | — |
| DEPRECIATION FUND | — | — | — | — | — | — | — | — |
| EXPENDED (TOTAL) | 317,283 | 81·8 | 390 231 | 100·6 | 109,256[b] | 182 | 114 857[b] | 144 |
| Lands and buildings | 154,189 | 39·7 | 206,8[illegible]3 | 53·3 | — | — | — | — |
| Plant | 85,048 | 21·9 | 96 842 | 25·0 | — | — | — | — |
| Mains | 73,153 | 18·8 | 83,869 | 21·6 | — | — | — | — |
| Miscellaneous | 4,[illegible]3 | 1·25 | 2,667 | 0·688 | — | — | — | — |
| BALANCE OF CAPITAL ACCOUNT | - 33.348[b] | - 8·60 | 59 769 | 15·4 | 3.071 | 5·12 | -837[b] | -1·08 |

| | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
|---|---|---|---|---|---|---|---|---|
| **REVENUE—** | | | | | | | | |
| TOTAL | £78.284 | 4·470d. | £93,040 | 4·356d. | £10.999 | 4·085d. | £14.351 | 3·810d. |
| Revenue from supply | 73,898 | 4·220d. | 88,209 | 4·130d. | 9,605 | 3·570d. | 13,257 | 3·520d. |
| „ meters, &c. | 2.016 | 0·115d. | 2,295 | 0·107d. | 121 | 0·045d. | 134 | 0·036d. |
| „ public lighting | 1,823 | 0·104d. | 1,840 | 0·0[illegible]6d. | — | — | — | — |
| „ sale of lamps, &c. | 128[c] | 0·007d. | 16 | 0·001d. | — | — | 30 | 0·008d. |
| „ miscellaneous sources | 413[d] | 0·024d. | 683[k] | 0·032d. | 1.273[d] | 0·473d. | 930[c] | 0·247d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £34.656 | 1·980d. | £41.070 | 1·922d. | £7.627 | 2·833d. | £9 919 | 2·640d. |
| WORKS COSTS | 23.482 | 1·342d. | 29.859 | 1·397d. | 6.113 | 2·270d. | 8.200 | 2·176d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | 5,074 | [illegible] | 6,[illegible] | 1·5[illegible]d. |
| Fuel (including cartage, &c.) | 9,545 | 0·545d. | 15.045 | 0·704d. | 2,600 | 0·966d. | 4,155 | 1·103d. |
| Oil, waste, water, stores | 1,152 | 0·066d. | 1,406 | 0·066d. | 428 | 0·159d. | 524 | 0·139d. |
| Wages at station | 6,125[f] | 0·3[illegible]d. | 7,155 | 0·335d. | 1,280 | 0·475d. | 1,075 | 0·2[illegible]d. |
| Repairs and maintenance at station | 3,169 | 0·181d. | 3,077 | 0·144d. | 765[c] | 0·284d. | 1.175[j] | 0·312d. |
| *Distribution of electricity* | — | — | — | — | *1,039* | *0·386d.* | *1,271* | *0·337d.* |
| Wages, &c. | [illegible] | — | [illegible] | — | 1,039[e] | 0·386d. | 1,271[k] | 0·337d. |
| Repairs, renewals of mains, &c. | 2,951 | 0·1686d. | 2,610 | 0·122d. | | | | |
| *Public lighting* | *394* | *0·023d.* | *424* | *0·020d.* | — | — | — | — |
| Attendance | 394 | 0·023d. | 424 | 0·020d. | — | — | — | — |
| Renewals | | | | | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 11.174 | 0·638d. | 11.211 | 0·525d. | 1.514 | 0·562d. | 1.749 | 0·465d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | 2,8[illegible] | 0·133d. | 290 | 0·108d. | [illegible] | [illegible] |
| *Management* | [illegible] | [illegible] | [illegible] | [illegible] | 1,224 | [illegible] | 1,513 | [illegible] |
| Salaries | 6,580 | 0·376d. | 6.716 | 0·314d. | 700 | 0·260d. | 1,186[l] | 0·315d. |
| Stationery, &c. | 218 | 0·012d. | 236 | 0·011d. | 65 | 0·024d. | 48 | 0·013d. |
| Establishment charges | 363 | 0·021d. | 386 | 0·018d. | 148 | 0·055d. | 107 | 0·028d. |
| Law charges, &c. | 985[g] | 0·056d. | 1,027[l] | 0·048d. | 311[f] | 0·116d. | 172[m] | 0·046d. |

| | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
|---|---|---|---|---|---|---|---|---|
| **FINANCIAL RESULTS—** | | | | | | | | |
| WORKING PROFIT FOR YEAR | £43,628 | 15·03% | £51.970 | 14·63% | £3.372 | 3·09%[n] | £4 402 | 3·93% |
| Sum carried to Depreciation Fund | 12,281 | 4·23% | 12.945[m] | 3·6[illegible]% | — | — | 1,000 | 0·893% |
| Sum carried to Reserve or Sinking Fund | — | — | — | — | — | — | — | — |
| Net interest on loans (incl. Debenture charges) | 487[h] | 0·168% | 1,374 | 0·383% | 2.436 | 2·23%[n] | 2,146 | 1·92% |
| BALANCE FROM LAST ACCOUNT | 89 | 0·031% | 156 | 0·44% | 775[g] | - 0·709%[n] | - 210 | - 0·187% |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 31 923 | 11·0% | 37.802 | 10·7% | — | — | 675 | 0·603% |
| *Deficit* | — | — | — | — | [illegible] | [illegible]%[n] | — | — |
| ORDINARY DIVIDEND PAID | 14½%[i] | — | 14½%[i] | — | — | — | — | — |

| | DEC. 31, 1899. | DEC. 31, 1900. | DEC. 31, 1899. | DEC. 31, 1900. |
|---|---|---|---|---|
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 44·3% | 44·2% | 69·3% | 69·3% |
| Expenditure per kilowatt capacity | £8. 18s. 10d. | £10. 11s. 7d. | £12. 14s. 2d. | £12. 8s. 7d. |
| REVENUE PER KILOWATT CAPACITY | £20. 3s. 5d. | £23. 19s. 5d. | £18. 6s. 10d. | £17. 18s. 10d. |
| Expenditure per 8-c.p. lamp capacity | 5s. 9½d. | 6s. 9½d. | 8s. 1½d. | 7s. 11½d. |
| REVENUE PER 8 C.P. LAMP CAPACITY | 13s. 0½d. | 15s. 4½d. | 11s. 8½d. | 11s. 5½d. |
| REVENUE PER 8-C.P. LAMP CONNECTED | 9s. 2½d. | 9s. 11½d. | 12s. 11½d. | 12s. 4½d |
| Price charged for lighting, per unit | 6d. to 4d.[o] | 6d. to 4d.[n] | 6d. to 3½d. | 6d. to 3½d. |
| Price charged for power, per unit | 3d. | 3d. | 2½d. | 2½d. |
| Price charged for public lighting | £30 per arc per ann. | £30 per arc per ann.[o] | — | — |

ST. JAMES', LONDON.—REMARKS. *a* Capital reserve fund by premiums. *b* Over-expended. *c* From sale of steam. *d* Inclusive of rents £[illegible] [illegible] on purchases £[illegible] and transfer fees, £[illegible]. *e* [illegible] expenses £142. *f* Wages at distributing stations included in item "wages at station." *g* Includes auditing £[illegible] and [illegible]. *h* Amount [illegible] investments and advances less interest on bankers loans. *i* With preference dividend of 7[illegible]. *j* By discounts. *k* Inclusive of rent [illegible]. *l* Inclusive of £227 [illegible] testing meters. *m* Inclusive of £[illegible] loss on sale of old plant. *n* Subject to [illegible] discount. *o* Covering repairs and maintenance.

SMITHFIELD MARKETS, LONDON.—REMARKS. *a* Period of [illegible] months. *b* [illegible] purchase [illegible]. *c* Inclusive of lamp renewals, £[illegible]. *d* [illegible] being £1,875). *e* Plant and machinery £[illegible], and buildings £[illegible]. *f* Inclusive of law £[illegible], insurance £[illegible], compensation £[illegible], and trustees fees £[illegible]. *g* After adding £[illegible] proportion of preliminary expenses and £[illegible] proportion of [illegible] expenses. *h* Over-expended. *i* Net rent received for cold air store £[illegible]. *j* Plant and machinery £[illegible], and [illegible]. *k* Includes lamp renewals £[illegible]. *l* Inclusive of [illegible]. *m* Inclusive of law £[illegible], insurance £[illegible], and trustees fees £[illegible]. *n* Per cent. to capital at end of period.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*ll Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 16s. 0d. ... | 8s. 6d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## THE LEGISLATIVE ASPECT OF ELECTRIC POWER SUPPLY.

Mr. W. L. MADGEN's Paper before the Institution of Electrical Engineers on the 21st ult. was of an unusual character, inasmuch as it brought forward for discussion a feature of electrical undertakings never previously considered by that body of electrical engineers. The subject was the political or legislative aspect of electrical enterprise, and more particularly of that branch of electrical engineering represented by the "Electrical Power Bills of 1900." No apology was necessary for presenting such a subject to that Institution; we regard it as entirely within the province of the Institution to discuss not only the scientific and engineering aspects of electrical applications, but also their relation to and dependence upon political, social, and financial conditions. As one of the speakers in the debate aptly expressed it, there is no practical use in discussing dielectric hysteresis in cables, if the legislative conditions are such that it is impossible to have any cables for there to be dielectric hysteresis in. Considering, in fact, the enormous influence of legislation, both for good and ill, upon almost every one of the principal applications of electricity in the United Kingdom, it is surprising that the first Paper of the character presented by Mr. MADGEN should not have appeared until so late in the history of electrical development. Questions of the nationalisation of the telephone, of the municipalisation of electric lighting and of tramways, of the repeal or modification of relevant Acts of Parliament, such as the Tramways Act, 1870, are matters that might have been perfectly legitimately embodied in Papers, and with distinct advantage have been discussed by members of the Institution. We hope, therefore, that Mr. MADGEN's Paper will not stand alone in this respect, but that it will be followed by others initiating debates on similar aspects of other branches of electrical enterprise. On the other hand, if the full value of such Papers is to be reaped by the electrical profession, they must be brought forward by men who, to use a popular phrase, "have no axe to grind." Nothing will more speedily nor more surely cast an odious reflection upon the Institution, in the eyes of allied societies and of the world at large, than the suspicion that it is, either consciously or unconsciously, lending itself and its prestige to the interests of an individual or of a clique. This is necessary even in the case of ordinary Papers and of open discussions; but it is sternly imperative

where formal resolutions pledging the Institution as a body are to be proposed. We feel sure, however, that the Council may safely grant further encouragement to the political type of Paper without risk of its overstepping these obvious limitations.

Passing over the introductory part of Mr. MADGEN'S Paper, which attaches undue weight to the irresponsible opinions of certain non-technical newspapers, we find that he next enters upon a discussion of the effect of the Tramways Act, 1870, and of the Electric Lighting Acts, 1882-8, in retarding electrical industry. Although there is nothing novel in the assertion of this malign influence, and notwithstanding that plain on the page of history this assertion is abundantly justified, several speakers in the discussion sought to confuse the issue and throw the audience off the scent. Mr. HAMMOND, for instance—the first speaker at the adjourned debate—who, by-the-way, adroitly shifted the centre of interest from the Paper to himself for the remainder of the evening—endeavoured to convince members present that the whole cause of the retardation of electric lighting in this country was "gas at 2s. per 1,000 cubic ft." Apparently, however, the majority of the audience refused to accept so preposterous a reason, which failed to commend itself even to the numerous supporters of municipalisation who were in attendance. Indeed, the rival claims of local authorities and statutory companies to the rights of supplying electric light and power filled a considerable portion of the Paper, and was the most prominent feature of the debate. On this question it was asserted that local authorities supply electricity cheaper than do the companies; but those who made this assertion omitted to state how many of these local authorities are compelled to draw upon the rates in order to make up their annual financial deficits, or how few of them set aside yearly sums sufficient to meet the depreciation and antiquation of their machinery and other electrical equipment. If these matters had been duly brought before the meeting, members would have perceived that the apparent superiority of local authorities is fictitious, arising, as it does, from unfair and uncommercial advantages exclusively allowed to them. We are not opponents of municipal trading in electricity supply, provided that the local authorities enter the field upon the same terms as the companies are compelled to do, and provided that the two classes of undertaking are carried out on an equal footing.

But we will leave this well-worn subject of municipalisation, upon which our views have frequently been expressed already. We turn to the more fertile question of the advisability of Parliament granting facilities for the development of large electric power works to supply power over an extensive area. That, we take it, is the main issue which Mr. MADGEN sought to raise; and it would have been a more profitable and less contentious discussion if that had been the main topic of speakers in the debate. Electricity supply has been regarded, from its earliest days until quite recently, as a matter for the individual parish and township. Gas had been so regarded in earlier days; and, almost without exception, gas authorities had remained content with this state of affairs. It never occurred to gas experts to supply a whole county from a single gasworks; and why?—because the thing was not commercially feasible. Accordingly, it was perfectly natural that Parliament, in framing the Electric Lighting Acts, should impart to them this parochial character. This would not have been a source of the subsequent evils, however, had not Parliament also tacked the municipalisation clauses on to these acts, in virtue of which each local authority acquired the pre-emptive right to supply electricity within its own area. Had this experiment in municipalisation never occurred to the draughtsmen of the Electric Lighting Acts, companies would have been able to expand the areas over which they supplied electricity *pari passu* with the engineering and commercial practicability of so extending it. Large power electricity schemes would then have followed as a natural and normal development of electrical enterprise, and would not have involved special legislation conflicting with the Electric Lighting Acts. In other words, legislative consent would have proceeded parallel with engineering possibility. But the intrusion, as we have just said, of the municipalisation idea imparted to these acts an entirely different and more restricted sphere of action. It crystallised electricity supply into an affair of the parish and the local government borough.

Herein, then, were obviously conflicting conditions. On the one hand a public service that has grown capable of application over more and more extensive areas, and one that is all the more profitable when the area is enlarged. On the other hand, legislation that has compelled this useful public service to be broken up into a patchwork of municipal areas. How were these conflicting conditions to be reconciled, as reconciled they must be if the public were to derive the highest benefits from electrical engineering? Two solutions were open to Parliament:—(1) To grant to local authorities powers to combine together for the purpose of erecting and working a joint electricity undertaking; or (2) to grant powers to statutory companies to generate electricity wholesale for supply over extensive areas, the individual local authorities having their right preserved to them to distribute this wholesale supply over their own areas. With regard to the first of these alternatives, Parliament would have to consider whether the nature of the new system of electric generation and supply would not be too speculative to permit of its being placed under the control of a syndicate of local authorities, or perhaps under the control of some one single authority having jurisdiction over the entire area. The principle that local authorities, whether of parishes or of counties, should not be permitted to embark on trading enterprise that would risk ratepayers' money is one that Parliament has long recognised and acted upon; and it is a principle from which it surely would not be safe to depart in the present instance. The only feasible system for Parliament to adopt, therefore, would be one on the lines, broadly speaking, of the second of the above alternatives, inasmuch as it is the only solution that reconciles the speculative nature of electric generation on a large scale with the determination of local authorities not to be deprived of the rights granted to them by the Electric Lighting Acts, viz., that they should have the pre-emptive right to distribute and sell electricity within their own areas. This is the broad principle of the so-called electricity "in bulk" schemes, and it is their political justification.

## THE LATE PROF. G. F. FITZGERALD.

At the meeting of the Institution of Electrical Engineers on the 28th ult., a vote of condolence was passed, and the following touching references were made in connection with the lamented death of Prof. G. F. FitzGerald, F.R.S.:—

Prof. W. E. AYRTON said that he was proposing no ordinary vote of condolence, for in expressing in conventional form the sincere regret which the Institution felt in the death of the chairman of its Dublin local section he desired rather to give voice to the deep grief and sorrow at the loss of the dear friend of all and the willing helper of many. To some, FitzGerald was but a name—and why? Because his life's work was that of inspiration—inspiring others. He gave others his ideas; aye, he even

explained to them the real meaning of their own. Science to FitzGerald was what religion was to the highest type of priest—not a thing to be used to enhance the status or the life of its exponent, but as a great good to be poured forth without stint and without reference to reward or even remuneration, for the benefit of man and the world. Singularly fertile in suggestion on all subjects was their dead comrade. He knew his worth, but never claimed it. He knew his power, but whenever he used it, it was for them—for science. For him, abstruse mathematics had no difficulty; complex physical processes no obscurity. He seemed to be able to follow the interaction of invisible molecules more easily than they could grasp the working of visible machines. Only that day had he been looking at two letters from Prof. FitzGerald, one which reached him the very day that Duddell read his Paper in that room, in December, and the other a few days later. Every line of those letters breathed suggestion, encouragement, criticism, modification. Those two letters were a little treatise on the theory and possibilities of Duddell's devices. Single-minded, simple-hearted FitzGerald died as he had lived—respected, honoured and beloved.

Major-Gen. C. E. WEBBER mentioned that Prof. FitzGerald could trace his ancestry back to the Normans of Scandinavia, who conquered, among other places, Ireland, and there could not be any doubt that the brain tissue which had just been described, and the use to which it had been put, was strengthened and so brought down to him through generations of strong and powerful men. But not only was he strong, he was a man who was entitled to be called gentle. He begged to second the motion which would be read to the meeting.

Prof. SILVANUS P. THOMPSON said he wished to add his voice to that of Prof. Ayrton and Major-Gen. Webber in expressing condolence at the loss of one who was dear to them personally and so very helpful to every worker in science who had the good fortune to know him, however slightly. Not very long ago he was talking with some scientific men in Germany who were deploring that they did not or could not do in Germany that which was done so very effectively in England by the combined efforts of scientific men working together on committees, and they had instanced the committees of the British Association as examples of voluntary associations which did, from time to time, excellent work, carrying that work on in many cases in continuity from year to year in a way which did not happen in Germany, where the only combined action of effort was that which was done under the patronage of the Government or one of the universities and mostly by paid workers. But if there was one among the helpers of the British Association whose help on committees of that kind when organising scientific work had to be carried out during the course of the year and then considered again at the next meeting of that committee and again carried out with further investigation, that one was FitzGerald. They ought not to forget what a very important part his ideas played in the early development of the question of the propagation of electric waves. Before the researches of Hertz had resulted in the experimental methods of exploring electric waves, FitzGerald had already read at least two Papers before the British Association suggesting ways in which such waves might actually be started; in fact, making the suggestion beforehand that Hertz accomplished. One of the first, if not the actual first, suggestions for a coherer for detecting waves was made by FitzGerald. In thousands of ways did he suggest different things, but he left it to others to carry his ideas out. He gave them ideas to carry out which he could easily have carried out himself, but his mind was so fertile that he could not possibly have carried out one twentieth part of the brilliant suggestions that he gave freely to others and to the scientific world. He was a man who was, to a certain extent, overloaded with administrative and educational work that ought never to have been put upon him. He ought to have had freedom for research and means for carrying out experimental research. Whatever he did he touched with the finger of genius, and there were few of them who could claim in any sense of the word to have been workers in physics during the past 15 years who did not feel under a debt to Prof. FitzGerald. He had had the good fortune to be associated very closely with him during the last five years in quite a different capacity—viz., as a co-examiner with him in the University of London; and even in the routine work of examining candidates for their degree in Physics FitzGerald was as fertile of suggestion, as kindly, and as delightful as any man could possibly have been. A truer or better colleague in that capacity one could not have desired, and he remembered very well indeed being struck with the pains with which he read through and referred in detail to, and made small investigations himself about, the theses which were presented for the doctorate of science by candidates in physics. It was characteristic of the man that he should in that capacity also, when sitting as critic upon the work presented as theses for examination, act as the helpful critic and as the man of useful suggestion. There were few men in this world like Prof. FitzGerald. There were few indeed who could claim the ability in any walk of life which FitzGerald exercised in the highest branches of physics, and there were few whom he (Prof. Thompson) ever met whom he could say surpassed Prof. FitzGerald in kindly helpfulness to others.

The PRESIDENT (Prof. Perry) said that at the inaugural meeting of the Birmingham local section, the night before, he had said what he had to say to the Institution on this subject, and it would be printed in the *Journal*. He had intended going to Dublin on the Tuesday before for personal reasons, but he had eventually gone there as representing the Institution at the funeral. It only remained for him to read the following vote of condolence, which the members received standing and in silence:—"That the Institution of Electrical Engineers, in full meeting, desires to express its profound sorrow at the death of Prof. FitzGerald, and to place on record its high appreciation of his brilliant qualities as a man, as an investigator and as a leader of scientific thought, and to express to Mrs. FitzGerald and his family their heartfelt sympathy in the calamity which has fallen on them and on science."

## RECENT CENTRAL STATION PRACTICE.

BY R. D. SUMMERFIELD, A.M.I.MECH.E.

The sheet giving particulars of central stations in the United Kingdom, which is annually published in *The Electrician*, becomes year by year more interesting and instructive. The following article is an analysis from this sheet of the central stations which commenced supply last year, and of those now in progress, with reference to the description of plant put down and the systems of supply in vogue.

This sheet shows that in London and its suburbs there were five stations opened in 1900, viz., at Beckenham, Greenwich, and Poplar, at Shepherd's Bush by the Kensington and Notting Hill Company, and at Willesden by the Metropolitan Company. Of these stations one supplies low-tension direct current on the three-wire system, another high-tension alternate current with transformers in sub-stations; two stations generate high-tension two-phase current, which is transformed in sub-stations to direct current by means of motor generators; and the fifth station generates three-phase high-tension current, which is also transformed to direct-current in sub-stations. In all these stations Babcock and Wilcox water-tube boilers have been put down. The engines are all of the high-speed vertical-enclosed type, with the exception of one-third of the engines in the Greenwich station, which are of the slow-speed horizontal type. The electric generators are of a different make in each station, and comprise English, German and American machines.

In the provinces 26 stations were opened in 1900, all of them being in small or medium-sized towns (the small water-driven station at Ingleton not included), and it is a remarkable fact that every one of these 26 stations supplies continuous current on the 3-wire system, the station voltage varying between 400 and 600, the majority of stations having a maximum voltage of 500. These stations may be divided into three groups. First, the stations whose output does not exceed 200 kw.; of these there are 13. Secondly, the stations having outputs varying between 200kw. and 500kw.; of these there are 10. Thirdly, those stations whose output exceeds 500kw.; there being only three of these. In the first group eight stations are provided with water-tube boilers and five with Lancashire boilers; in the second group only one station has water-tube boilers, while nine have Lancashire boilers; and in the remaining group of three larger stations water-tube and Lancashire boilers are equally divided. Turning to the engines, in the first group of stations there are five installations of Willans engines, seven of Belliss or Belliss type of engines, and one station has Parsons steam turbines. In the second group three stations have Willans engines, and seven have Belliss or Belliss type of engines, while in the third group two stations have Willans and the remaining station Belliss engines. The dynamos installed in these 26 stations have mostly been supplied by various well-known British firms, and are of the multipolar type, with the exception of about half-a-dozen stations, where two-pole machines have been put down.

Turning from the stations which commenced supply in 1900 to those which are not yet completed, or have only been completed within the last few weeks, we find that there are 11 central stations in progress in London, and 50 stations in the provinces. Of the London stations seven are supplied with Babcock and Wilcox boilers and two with Lancashire boilers, while in two cases the boilers are not specified. Five stations have high-speed vertical enclosed engines, two stations have slow-speed horizontal engines, and in four cases the engines are not specified. Of these stations seven have adopted a continuous current three-wire system of supply, with from 250 to 550 volts across the outers, while one station generates two-phase current at 3,000 volts, and supplies a two-wire system from transformers in sub-stations. In three cases the system of supply is not given. The dynamos are nearly all of the multipolar type.

Of the 50 provincial stations, 18 have water-tube boilers (nearly all Babcock and Wilcox), 16 stations are equipped with Lancashire boilers, four with marine type boilers, two with Paxman "Economic" boilers, and in 10 cases no boilers

are mentioned. With regard to the engines, 33 stations have decided on the high-speed enclosed vertical type, in seven cases the kind of engine is not given, while the remaining 10 stations are provided with medium-speed vertical cross-compound engines, slow-speed horizontal engines, gas engines, or steam turbines. In the provincial stations there is very little difference in the system of generation and supply, as 38 out of the 50 stations generate direct-current and supply three-wire systems, with from 220 to 580 volts across the outers. Two stations supply direct-current two-wire systems, and three stations generate high-tension alternate-current and transform in sub-stations. Of the dynamos about one-third are two-pole machines, and the rest multipolar; 15 out of the 61 stations in progress have adopted accumulators, but this is probably not the total number, as the list is not quite complete.

There are several instructive points brought out by this analysis. It proves, for instance, that English engineers have come to the almost unanimous conclusion that the best electric supply system for towns—except perhaps the very largest—is a continuous-current three-wire one, with 400 to 500 volts across the outers, and accumulators or boosters to balance the two sides of the system. For London or other very large towns experience seems to point to the use of high-tension two or three phase alternate current, generated direct in a central station some distance from the area of supply and transformed in sub-stations situated in that area to continuous current by means of rotary converters or motor generators; these machines supply a three-wire system, with from 400 to 500 volts across the outers. In some cases it is found more economical to supply a two wire system than a three-wire one, and there seems to be an increasing tendency to make use of two-wire distribution now that higher pressures are in such general use.

As far as plant goes, the analysis proves that the favourite boiler for London and large provincial stations is the Babcock and Wilcox water-tube boiler, on account probably of its compactness, safety, and quick steam-raising properties. For small and medium sized provincial stations the Babcock and the Lancashire boilers seem to be equally preferred, the well-tried advantages of the latter, as far as steady steaming and low cost for cleaning and repairs go, enabling it to hold its own. Besides these two all other types of boiler make but a poor show in the list, as, out of 80 stations where the make of boiler is specified only eight have other boilers than Lancashire or Babcock and Wilcox.

With regard to engines, the use of the high-speed, vertical enclosed type is almost universal, except for very large units, in which case opinion is divided as to the merits of slow-speed horizontal Corliss engines or medium-speed vertical cross-compound engines. The high-speed vertical engines are of two main types, single-acting and double-acting, which figure on the list in nearly equal proportions, the balance being in favour of double-acting engines. Of the former class the well-known Willans engine is almost the only example; but the Belliss engine, the forerunner of the modern high-speed double-acting vertical engine, although put down in larger numbers than any other one make of double-acting engine, is attended by a number of very good engines of this type by other makers, as many of the leading engine manufacturers have of late years turned their attention to this class of engine with excellent results; in fact, in the design of such engines we are far ahead of American and Continental practice.

The analysis shows that the types of dynamos now being put down are very limited in number. For continuous current there are a few cases of two-pole machines, but the great majority are multipolar dynamos. These have cast-steel magnet frames, usually of circular shape, slotted drum armatures, commutators of large diameter with carbon brushes, and spherical bearings with self-oiling rings. Direct-coupling to the engine is the rule, with very rare exceptions. For alternate-current flywheel alternators are generally used, and with English engineers two-phase generators seem at present to be preferred, whereas on the Continent three-phase plant is more in favour. Single-phase alternate-current is now hardly thought of for English central stations; out of the 92 stations analysed only three have put down single-phase plant. Boosters and balancing machines are very largely used in modern direct-current stations, usually to balance the load on the two sides of the three-wire system, but there are several other uses to which these machines may be put.

To sum up, the plant of a typical English central station of the present day may be said to consist of either Lancashire or water-tube boilers, high-speed vertical enclosed compound engines direct coupled to multipolar dynamos, which generate continuous current at from 400 to 500 volts and supply a three-wire system, with accumulators and boosters to balance and steady the load.

## A NEW OSCILLATOR FOR STATIONARY ELECTRICAL WAVES.

BY DR. BERNOULLI.

Since the researches of Hertz,* who first succeeded in measuring the length of electrical waves, numerous experimenters have striven to improve upon his methods, and especial attention has been given to the production of oscillations of shorter wave length. As is well known, Hertz, in his experiments, used two large oscillator plates to each of which was attached a wire terminating in a metal ball. The terminals of an induction coil were connected to the plates, and the latter were so placed that the oscillatory discharge of the coil could take place across a spark-gap left between the balls. Opposite one of these oscillator plates was placed a third plate, which became charged by influence alternately positive and negative, and from which the electricity flowed into a wire which was about 60m. long and attached to the plate. At the free end of the wire the electrical waves were reflected, and the interference of the direct and reflected waves gave rise to stationary waves. At the end of the wires was found a loop of the electrostatic wave; that is, the potential at that point oscillated between its highest positive and negative values.

With the aid of detectors, or resonators, Hertz was able to show the presence of stationary waves produced in this way. These resonators consisted of conducting wires bent into the form of a circle or rectangle, with a short air-gap left between the ends. As one of these was moved along the wire carrying the oscillations, little sparks were seen to spring across the air-gap whenever the resonator was opposite a loop of the wave; when opposite a node, however, no sparks were to be seen in the air-gap.

Lecher† placed a condenser plate opposite each of the oscillator plates, and attached a wire to each of the former. These wires were then stretched out parallel to one another. Suppose now that with this arrangement one of the oscillator plates is charged with positive electricity; the condenser plate opposite immediately becomes negatively electrified by induction, and positive electricity is repelled from it through the wire. At the same time the other oscillator plate is negatively charged and induces positive electricity in the condenser plate opposite it, repelling negative electricity into the second wire. The result of this is that, as the induction coil is operated, points on the wire opposite one another always possess charges opposite in sign. In case the wires are bridged over by a metallic conductor, then the potential at the middle of the same must be zero, since the advancing potential functions on both sides of the middle are equal and opposite in sign—the potential wave has then a node at this point.

As in the case of a vibrating cord, so with the oscillator, waves of different length are sent out (the fundamental and its overtones). To prevent mutual disturbances it is necessary to isolate some one of these waves. To do this it is only necessary to so adjust two bridges placed on parallel wires that the distance between them is equal‡ to

* *Wied. Ann.* 34, p. 551, 1888.
† *Wied. Ann.*, 41, p. 850, 1890.
‡ More exactly, until the distance between the bridges plus one-half their combined length is equal to some multiple of a half-wave length.

some multiple of a half-wave length of that particular oscillation period. Waves of other periodicity are then destroyed by interference.

In order to show the presence of nodes and loops, Lecher placed a Plücker tube over the parallel wires. This tube lighted up when brought to a place over the wires where the fluctuations in potential, and consequently the P.D. at its electrodes reached a maximum—that is, at the loop of the wave. At the nodes, however, where there is no P.D. between the wires, the tube did not light up at all.§ A similar method was employed by Coln and Heerwagen,* also by Rubens.†

Arons‡ sealed the two wires into a glass tube which was about 2m. long and connected with an air pump. In a darkened room the wires at the nodes were invisible, but at and for some little distance on both sides of the loop they were highly luminous.

To those demonstrators who wish to avoid the trouble of using an air-pump in connection with this experiment, and who have at their disposal a high-frequency coil, I recommend the Blondlot-Coolidge§ oscillator (made by E. Leybold's Nachfolger, Cologne). By the help of this apparatus the nodes and loops of stationary electrical waves can be shown on wires which are not in a vacuum, but in the open air. This apparatus has also the advantage of enabling one to isolate, measure, and if desired photograph several of the overtones as well as the fundamental.

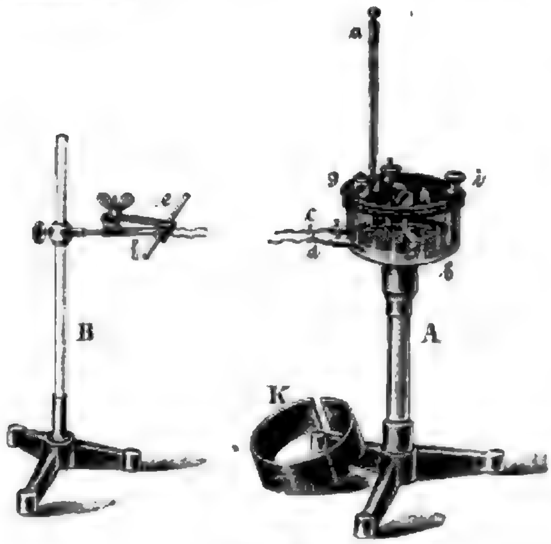


Fig. 1.

The Hertz oscillator plates are replaced by two semicircular conductors (Fig. 1), which terminate at one end in small brass spheres, and are connected with the secondary terminals of a high frequency coil. The sparks which give rise to the electrical oscillations pass between the two brass spheres. A second spark-gap serves to increase the intensity of the oscillations. Both spark-gaps can be very delicately adjusted by means of insulated screws. Directly beneath this primary circuit of the oscillator and insulated from it by means of a sheet of mica is a secondary circuit. This latter consists of a wire bent into a circle of the same radius as the primary circuit, its ends terminating in the binding screws, *c* and *d*, and corresponds to the condenser plate of Hertz's apparatus. The vessel in which the two circuits are fastened is filled with kerosene. The copper wires (0·1mm. in diameter) are held at one end by the screws *c* and *d*, and at the other by the insulated stand B. The ring K serves to darken the glass vessel.

If the apparatus is set in operation and the spark-gaps are properly adjusted, the wires become highly luminous throughout their entire length; and if now, by bridges properly placed on the wires, stationary waves are allowed to form, the wires at the nodes for a length of a few centimetres become invisible, while the other portions, and especially those half way between the nodes (the loops), remain luminous.*

§ Such a Lecher apparatus is described in Weinhold's "Physikalischen Demonstrationen," III., Aufl. p. 840.

* *Wied. Ann.*, 43, p. 368, 1891.

† *Wied. Ann.*, 42, p. 154, 1890.

‡ *Wied. Ann.*, 45, p. 553, 1892.

§ Blondlot, *Comptes Rendus*, 114, p. 283, 1892; Coolidge, *Wied. Ann.*, 67, p. 578, 1899. See also Drude, *Zeitschrift f. Phys. Chem.*, 23, 267, 1897.

* The phenomenon reminds one very strongly of the dust figures in the Kundt tube; and, in fact, the whole apparatus corresponds in many ways to the latter, although the vibrations are in the one case transversal and in the other longitudinal.

## MAGNETIC EXPANSION OF IRON AND NICKEL.

BY PHILIP E. SHAW, B.A., B.SC., AND S. C. LAWS, B.SC.

(*Concluded from page 651.*)

### IV.—Investigation of Iron Rods.

§ 1. A glance at the top of the three Tables A, B and C for iron will show the length and diameter of the specimens used. They were all of commercial soft iron, the middle iron being a galvanised piece, the zinc of which was melted and scraped away previous to use. Each end of the rod is soldered into a brass lug, the thick iron being screwed as well as soldered. This latter is a precaution against possible yielding of the ends in their beds. Every specimen was annealed carefully. To do this we wrapped them in asbestos sheet, then placed them in a length of combustion tubing, heated in a muffled gas furnace to a dull red heat, and cooled them slowly. The tables of results given below are self-explanatory:—

Table A.—*Thick Iron.*

Length = 7·4cm. Mean diameter = 0·49cm.

| Current × $10^2$ amps. | Movement in instrument units. | $\delta l \times 10^6$ cm. |
|---|---|---|
| 1·72 | 0 | 0 |
| 2·03 | 0 | 0 |
| 2·40 | − 2 | − 9 |
| 2·92 | 0 | 0 |
| 3·73 | + 2 | + 9 |
| 6·71 | + 5 | + 23 |
| 9·36 | + 11 | + 51 |
| 13·4 | + 30 | + 140 |
| 27·0 | + 117 | + 550 |
| 58·7 | + 530 | + 2,480 |
| 100 | + 860 | + 4,030 |
| 132 | + 830 | + 3,890 |
| 166 | + 770 | + 3,610 |
| 196 | + 650 | + 3,040 |
| 229 | + 520 | + 2,440 |

Table B.—*Medium Iron.*

Length = 7·7cm. Mean diameter = 0·26cm.

| Current × $10^2$ amps. | Movement in instrument units. | $\delta l \times 10^6$ cm. |
|---|---|---|
| 1·70 | 0 | 0 |
| 2·00 | 0 | 0 |
| 2·36 | 0 | 0 |
| 2·87 | 0 | 0 |
| 9·22 | − 3 | − 14 |
| 12·54 | − 5 | 23 |
| 13·2 | + 4 | + 19 |
| 26·6 | + 280 | + 1,310 |
| 57·5 | + 450 | + 2,110 |
| 100 | + 380 | + 1,780 |
| 135 | + 200 | + 940 |
| 170 | 0 | 0 |
| 200 | − 130 | − 610 |

Table C.—*Thin Iron.*

Length = 7·9cm. Mean diameter = 0·10cm.

| Current × $10^2$ amps. | Movement in instrument units. | $\delta l \times 10^6$ cm. |
|---|---|---|
| 1·70 | 0 | 0 |
| 2·01 | + 1 | + 5 |
| 2·38 | + 1·5 | + 7 |
| 2·89 | + 5 | + 32 |
| 3·69 | + 13 | + 61 |
| 6·64 | + 20 | + 94 |
| 9·27 | + 50 | + 234 |
| 13·2 | + 97 | + 454 |
| 26·7 | + 140 | + 656 |
| 39·5 | + 135 | + 632 |
| 56·1 | + 125 | + 586 |
| 85·0 | + 65 | + 305 |
| 115 | + 5 | + 234 |

§ 2. The smallest reading of $\delta l$ for thick iron is $-9$, appearing for a small current. We noticed this minus reading for various specimens of iron, and we are confident that it exists both for thick and thin rods. We hope later to deal with this point more fully. If the reader will examine the older curves, say in Bidwell's Paper,* he will notice that the slope of the curve for soft iron is sharply downwards towards the axis, and not directly to the origin; this slope indicates the likelihood that the curve does *cross* the axis before reaching the origin. Hitherto no measuring apparatus has been fine enough to detect this negative movement, which is of the order $9 \times 10^{-8}$ cm. The presence of this minus value gives us a distinctly smoother curve near the origin. It adds one more to the many peculiarities of the iron curve, which may be summed up now as follows, beginning at the origin: (1) a small minimum, (2) a point of inflexion on the up slope, (3) a maximum, (4) a point of inflexion on the down slope, (5) a limiting minimum reached asymptotically.

§ 3. Next come the curves for the iron rods. The horizontal axis represents current, and the vertical axis shows $\delta l$ as in the tables. The curve for thin iron is quite dwarfed by comparison with those of the medium and thick rods. But the curves show that the general law of the slope is as follows:—

For a thick rod the curve clings to the horizontal axis, then in rising to its maximum it cuts across the curves for thinner

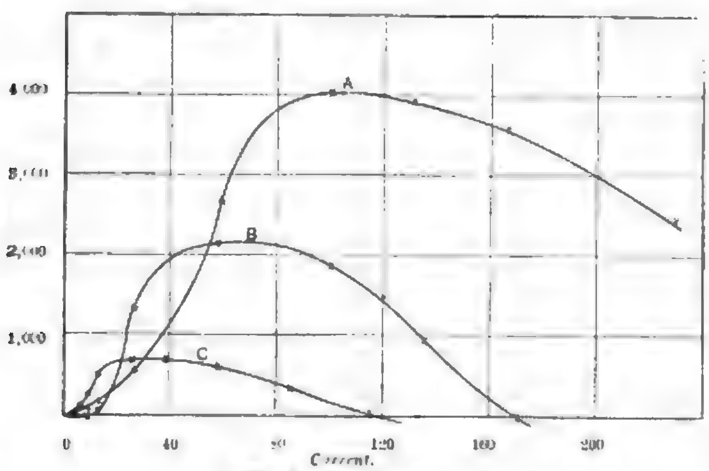


Fig. 4.—Iron Curves.

rods attaining a greater height than they, and then slopes down to cut the curves for thinner rods and attains asymptotically a lower minimum than they. We are not aware of any previous curves showing this general law, or of curves showing such extremes of maxima and minima, the highest being a movement of as much as $4{,}000 \times 10^{-8}$ cm. (*i.e.*, about the wave-length of sodium light). It will be seen later that the curves for nickel have a similar interpretation.

V.—Investigation of Nickel Rods.

§ 1. Three tables for nickel are given. The specimens were annealed just as were the iron rods. We found nickel easier to examine than iron for the following reasons:—(1) The curve is a simple one, having seemingly merely a downward slope, then a point of inflexion, and reaching finally an asymptotic minimum. (2) The permanent magnetism is very small in comparison with iron. Thus, whereas, as is well known, the permanent magnetisation of iron varies from about one-quarter to three-quarters of the whole, nickel seems from measurements we made to have the permanent only about $\frac{1}{150}$ of the whole magnetisation. Thus, if by any chance the permanent were not all wiped out before a reading was taken, it could have no such very serious effect in a nickel reading as in an iron one. (3) The nickel specimens are easily obtained pure and of constant composition, whereas iron has varieties innumerable, so that there is no certainty of getting two exactly similar samples of it, unless it is produced specially.

* *Loc. cit.*

**Table D.**—*Thick Nickel.*

Length = 7·6cm. Mean diameter = 0·75cm.

| Current × $10^2$ amps. | Movement in instrument units. | $\delta l \times 10^8$ cm. |
|---|---|---|
| 0·28 | 0 | 0 |
| 0·33 | 0 | 0 |
| [illegible] | 0 | 0 |
| 0·63 | – 1 | – 5 |
| 0·92 | – 1·5 | – 7 |
| 1·71 | – 2 | – 9 |
| [illegible] | 2 | – 9 |
| 2·39 | – 3 | – 14 |
| 2·90 | – 4 | – 19 |
| 3·71 | – 5 | – 23 |
| 6·68 | – 15 | – 70 |
| 9·31 | – 35 | – 164 |
| 13·3 | – 75 | – 351 |
| 26·8 | – 270 | – 1,260 |
| 58·7 | – 1,660 | – 7,730 |

**Table E.**—*Medium Nickel.*

Length = 8·0cm. Mean diameter = 0·19cm.

| Current × $10^2$ amps. | Movement in instrument units. | $\delta l \times 10^8$ cm. |
|---|---|---|
| 0·32 | 0 | 0 |
| 0·39 | 0 | 0 |
| 0·62 | 0 | 0 |
| 0·91 | – 1 | – 5 |
| 1·70 | – 2 | – 9 |
| 2·00 | – 3 | – 14 |
| 2·36 | – 4 | – 19 |
| 2·87 | – 6 | – 28 |
| 3·67 | – 8·5 | – 40 |
| 6·61 | – 22 | – 103 |
| 9·22 | – 62 | – 290 |
| 12·5 | – 195 | – 913 |
| 13·2 | – 225 | – 1,050 |
| 26·6 | – 1,010 | – 4,730 |
| 57·5 | – 2,400 | – 11,240 |

**Table F.**—*Thin Nickel.*

Length = 7·9cm. Mean diameter = 0·10cm.

| Current × $10^2$ amps. | Movement in instrument units. | $\delta l \times 10^8$ cm. |
|---|---|---|
| 0·28 | – 1 | – 5 |
| 0·33 | – 1·5 | – 7 |
| 0·39 | – 2·5 | – 12 |
| 0·63 | – 3 | – 14 |
| 0·92 | – 5 | – 23 |
| 1·71 | – 7·5 | – 35 |
| 2·02 | – 8 | – 37 |
| 2·39 | – 10 | – 47 |
| 2·90 | – 12·5 | – 58 |
| 3·71 | – 18 | – 84 |
| 6·68 | – 53 | – 257 |
| 9·31 | – 140 | – 656 |
| 13·3 | – 320 | – 1,500 |
| 26·8 | – 1,020 | – 4,780 |
| 58·7 | – 2,050 | – 9,650 |

§ 2. It is seen from the curves given below that the same law of the slope of the curves holds as for iron. The curve for the thick rod leaves the horizontal axis with reluctance, has its point of inflexion later than a thin rod, but then descends, cutting the curve for a thinner rod and finally attains asymptotically a lower minimum value. It is to be understood that we do not show the asymptotic conclusion of the curves for nickel or iron, but in each case it is an established fact, due to Bidwell, who used very large fields. As for iron, it is not possible to show the smallest readings in this diagram.

§ 3. It will be seen that we have not made any calculations of field intensity acting on the rods; we might have used the well known expression for field

$$H = 4\pi ni \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $n$ = number of turns in the magnetising coil per unit length, and $i$ = current in C.G.S. units. But for thick rods this is far from being the true value of H, and even for our thin specimens where the length is only 80 times the diameter it is not accurate. A considerable demagnetising force is in action,

especially for the thick specimens. This makes the true H less than that given in (1). Again, there is an expression for the true effective field

$$H' = H - NI \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where H is as defined in (1), N is a constant depending on the dimensions of the rod, and I is the magnetic intensity, but in using this either (1) we obtain unknown quantities N and I, or (2) we build on loose hypothesis regarding susceptibility, &c.

But another course seemed open, both simpler and safer, as follows:—It can be explained by reference to the next curves, Fig. 6. Let the horizontal axis represent the

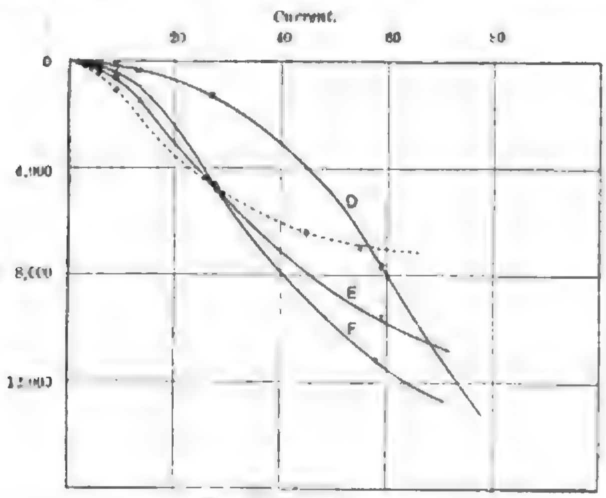


Fig. 5.—Nickel Curves.

diameter of the rod, while the vertical axis shows $\delta l$. Mark down the line representing the diameter of the thick rod, values of $\delta l$ for different magnetising currents at 1, 2, 3, 4, 5, 6. Then mark down the line representing the diameter of the medium rod, the values of $\delta l$ for the same currents at 1, 2, 3, 4, 5, 6. Do likewise for the line which corresponds to the thin rod. Now join 111, 222, &c., as shown, by smooth curves cutting the vertical axis as seen at the places 1, 2, 3, 4, 5, 6. Now these last-mentioned points represent

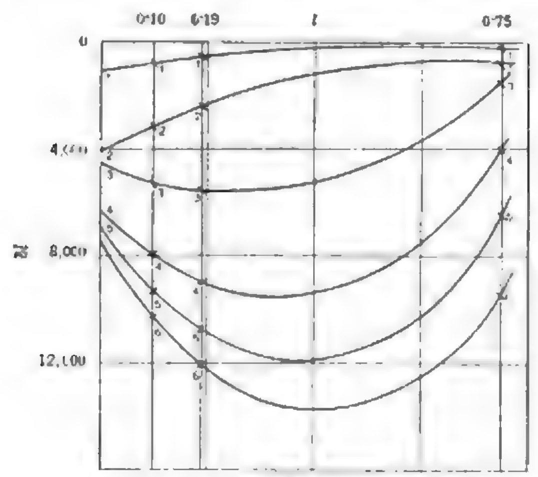


Fig. 6.

the values of $\delta l$ which would occur if the rod were of infinitesimal diameter, and of the same length as our three rods. This supposes that the slope of the curve continues when the curve is thus produced. Turn to the curves for nickel and put in a curve (dotted) for this ideal wire, which we may call the *attenuant*. This curve represents the lower limit for all possible wires. It will be seen to obey the general law mentioned previously.

Now, of the attenuant we can assert on the supposition already made that the expression (1) above is true, and from its curve we can obtain a true relation $\delta l$/H, according to any given magnetising current, since the demagnetising force for the attenuant is nil. As the coil had 1,064 turns and was 8·6cm. long, the value of H per ampere is $4\pi \dfrac{1{,}064}{8 \cdot 6} \times \dfrac{1}{10}$. Hence in the above curves current can be at once rendered in H.

We have not traced the attenuant curve for iron, preferring to leave this point for the present, on account of uncertainty in the composition of our iron wires.

### VI.—Summary of Results.

(*a*) The curves for the two metals in question can now be plotted nearer to the origin than in any previous research, yielding evidence of a retraction of iron when the curve leaves the origin.

(*b*) The instrument—the electric micrometer—used for measuring $\delta l$ is apparently capable of more minute work than any form of optical lever hitherto produced, whilst every other measuring arrangement appears to be "out of the running." The smallest readings taken were about $5 \times 10^{-8}$ cm.

(*c*) By using three specimens of one length, but of different diameters, we have shown that there is a general law as to the relation of diameter to slope of the curve, for both iron and nickel.

(*d*) This law leads to the idea of producing a curve for an ideal wire, which we have called the attenuant. This curve has interest in being the lower limiting one, but it also gives us a case in which the simple law for obtaining the field in a solenoidal coil is accurately true. Hence for it we can correlate H and $\delta l$.

We gladly acknowledge the furtherance in this work which we have had from Prof. W. H. Heaton, M.A.

## THE ELECTRICAL POWER BILLS OF 1900: BEFORE AND AFTER.*

BY WM. L. MADGEN.

(*Concluded from page 706.*)

There are a few examples of groups of provisional orders having been obtained for adjoining districts by arduous negotiations extending over several sessions. These undertakings typify many of the difficulties with which electrical engineers have had to contend, but they are not more fully referred to here as the form of procedure was not by power bill. There is, however, an important Northumbrian undertaking dealing with the north bank of the Tyne from Newcastle to North Shields (excluding the latter) with part of the hinterland, which belongs to both classes and should not be omitted from the list, especially as it has been one of the first to get to work.

The main purpose of the power acts is to keep the number of power-stations within economical limits, and by the selection of suitable sites and the equipment of works of considerable magnitude to enable electrical energy to be transmitted in such a manner that the retail price to the consumer will be reduced to a figure which will compare with, and in many cases be far lower than, that of any other form of power, whether gas, steam, oil, or other agent.

The enormous development of electricity in the United States and Canada and on the Continent of Europe, and the numerous great electrical power distributions over large areas in those countries are in themselves practical evidence in favour of the principles we are advocating. It cannot be urged that the requirements of this country, so far as trade and cheap production are concerned, are different to those obtaining in the countries mentioned.

The absence of undertakings of the kind in the United Kingdom has not been on account of any difficulty or impossibility on the engineering side, or from lack of suitable conditions. We have few large water powers it is true, but there is an equally good source of power available, and coal in this country can replace, on favourable terms, the water power available elsewhere for the generation of electrical energy. Moreover, even in those parts of the country where coal is more expensive than in the coal districts themselves relatively cheap electricity may be available if it is generated in sufficient quantity at large power stations, and the supply from such stations is distributed over a suitable area. Capital charges, management, rent, rates, and taxes usually form a larger proportion of power-station costs than fuel, but the greater the importance we have to attach to the fuel item, the more necessary it is to adopt the most comprehensive methods and to concentrate and economise its use.

* Paper read before the Institution of Electrical Engineers, Feb. 21.

Under the Electric Lighting Acts, and the conditions heretofore existing, the scarcity of the electricity supply in this country has been due to the high cost of production. Even in the more developed areas the cost has been too high as a general rule to admit of its being freely used by the consumer on terms more advantageous than those upon which he can employ steam or gas for industrial purposes, or gas or oil for domestic service.

Statistics have shown us that the average cost of production and supply to consumers becomes lower as the output of the power-station increases, but the difference between stations supplying 1 million units and 4 million units per annum is less, and not in proportion to that obtaining between smaller stations with much less difference of output. Without an increasing "diversity factor" this difference would tend to disappear as stations increased in size. A good "diversity factor" can only be achieved by combining with electric lighting the supply of energy for as many and as various other purposes as possible, and, so far as lighting is concerned, the supply to every class of consumer. As the area of supply is extended, the "diversity factor" tends to improve owing to the difference in the incidence of the demand in different districts.

I shall not attempt to follow the more technical aspects of the subject just now, as they afford scope for many Papers, and certainly for more discussion than you can give to them this evening; but it may be well to summarise the points for and against the old system and the new—*i.e.*, the supply from small local stations and the supply from main power stations :—

*Supply over comprehensive areas from main power-stations in selected positions.*

ADVANTAGES :—

1. Comparatively large field for development.
2. High load-factor obtainable, all the plant being used to the best advantage.
3. Cost of fuel and handling can be reduced to a minimum, as the power-station can be located where fuel is cheapest, fuel handling most economical, and water is available for condensing.
4. Low running costs, management expenses, and maintenance per unit sold, as the result of a very large and regular output.
5. The low cost of plant per kilowatt installed, and the increased economy in running with very large sets.
6. Low rents, rates and taxes; the difference between town and country.
7. Economical provisions for extensions to plant and buildings.
8. Low costs and charges for electrical energy for all purposes possible in consequence of above advantages.
9. Removal of the power-station, with its chimneys, &c., outside the residential district.

DISADVANTAGES from point of view of Local Authority.

1. The transmission mains must pass through their area whether supply be taken or not.
2. Sentimental preference for complete independent plant of their own.

*Supply in small local areas from separate stations.*

ADVANTAGES :—

DISADVANTAGES :—

1. Small field for development.
2. Relatively low load-factor.
3. Cost of fuel, handling it, and water supply depend on immediate local conditions, favourable or unfavourable.
4. High running costs, management expenses, and maintenance, the costs per unit sold being generally higher the smaller the station.
5. High relative cost of machinery per kilowatt installed and lower economy in running.
6. Rents, rates, and taxes relatively higher.
7. The extension of buildings is frequently very expensive, owing to disturbance and other difficulties incidental to town sites.
8. High charges for electrical energy for all purposes as result of these disadvantages.

The story of George Stephenson and the cow on the line has come down to us as typical of the prejudice and the ignorance with which* railways had to contend in their early days; and so, too, when the early history of the electrical industry comes to be written, the part played by the local authorities in their strenuous opposition to the power bills will be a record of reproach to them. For the purposes of this opposition there was a conference of local authorities in Manchester in January, and a meeting of the Association of Municipal Corporations in May. The object of the first meeting was to prevent the second reading, and that of the second to influence the decision of the Parliamentary committee.

The methods adopted by these who endeavoured to wreck the power bills were strongly condemned in the course of the second reading* debate, and the President of the Board of Trade found it necessary to repudiate a garbled report which had been circulated as to his remarks upon the bill for the Warsop project in the previous session. Everyone interested in the welfare of the industry should read and think over that debate. True, the bills were read a second time and committed, but what a curious light is thrown by the discussion upon the difficulties with which we have to contend! Perhaps there is time to mention two examples. Mr. Ritchie said,

". . . . I hope the House will give its attention to the very important considerations in this case before they decide to reject on second reading a bill that is fraught with so many possibilities. It is true, I think, that the electrical enterprise of this country is in an exceedingly backward condition; it is inferior with regard to light, and certainly with regard to the conveyance of power, to many European countries, and it is greatly inferior to North America and Canada. It may almost be said that there are villages in North America which are in possession of advantages in connection with electricity which some of our largest towns do not possess. It cannot be doubted that there is a great demand for something to be done. At present electric light matters are governed largely by the legislation of 1882, and it has been said that this bill is largely in opposition to many of the enactments in the Act of 1882. If no other charge or argument could be brought against this proposal, the arguments of the opponents to this bill would indeed be weak. It must be remembered that it was the Act of 1882 which more than anything else had delayed and hampered the development of electrical supply, and in so far as this bill departs from that act, I think its departure is amply justified by the condition of things at present existing in the electrical world."

Here we have a member of one of the strongest Governments of modern times, the Minister entrusted with legislation affecting the trades of the country, who has realised the extent and cause of our backward condition in relation to a great industry, and ingenuously confessing that during five long years of office one of the main causes of the trouble has remained effective upon the Statute Book.

Sir William Harcourt said,

". . . . I do not altogether share my hon. friend's† objections to great enterprises being carried on through private sources. That was a question which occupied 50 or 60 years ago the attention of this country, and that was at the time of the commencement of the great railway interest. That question was decided by the wisdom of the great statesman Sir Robert Peel. We know that Sir Robert Peel was much attacked at that time for throwing the railway enterprise of this country into private hands, and not adopting the system so largely followed on the Continent. I look forward to this question of electricity and electric supply as the great question of the future, and it is from that point of view that I wish to refer to the subject. If this company is prepared upon proper conditions to supply electricity to any part of the country, I am not opposed to that. No man can say to-day what part electricity may not play in the industry of the country, and that is a point which the House of Commons should keep in view. But what are the conditions which ought to be imposed? What was the policy which was pursued with regard to the railway companies? Parliament did not leave it altogether to particular promoters of bills; Parliament did not leave it to the discretion of individual committees. They placed the whole of that great enterprise, upon which more than a thousand millions of private money has been expended, greatly to the benefit of the country—a sum larger than the national debt, and now paying interest at least of 4 per cent., and one of the greatest investments for the savings of the country—under general legislation. I think that a model which we ought to follow in this instance. But what was the method which Parliament in those days adopted in dealing with the railways? They did not allow particular promoters to take their chance in individual committees. They placed the whole of that great enterprise, as I have said, under general legislation. . . ."

This statement of Sir William Harcourt goes to justify the charge that the Legislature has neglected an industry the importance of which he describes in suitable terms, and it also leads us to the economic aspect of the question. Comparisons have been drawn between the benefits first derived by every class of our community from the applications of steam power and of railways, and those which have accrued to other nations in larger measure than to ourselves from the uses of electrical energy. The United Kingdom itself has not yet lost any material part of its natural advantages for the manufacture of engineering material, or of scope for their employment. In what way has destructive legislation acted so as to place us in the position of inferiority we are reproached with to-day?

It has, among other things, tended to destroy cumulative investment effect. Savings out of the profits of a business tend to go back, as an additional investment, into that business or some department of trade allied with it. Part of the profits derived from railway enterprise undoubtedly went in again, and attracting new capital to it, provided means for building new lines and for equipping rolling mills, foundries, engine works, and other undertakings which have provided employment for thousands of our fellow-countrymen. No influence has done so much during the past hundred years to stimulate enterprise, to encourage commerce, and to develop the resources of any country. In our own time legislation has not only deprived the great mass of the people of the direct benefits of electrical

* In 1801 we had no railways in the sense we now use the term. To-day the railways of the United Kingdom extend to about 22,000 miles of line, constructed at a cost of about 1,300 millions of pounds. The annual gross receipts now exceed 100 millions, and of the expenditure, which amounts to over 60 millions, fully one-half is distributed in wages to over half a million employés.

* See *Parliamentary Debates*, No. 2, Vol. LXXIX., p. 1,374 and following, published by Wyman & Sons (Ltd.), Fetter lane. Price 1s. 3d.

† Mr. Broadhurst.

science, but it has made much of what little has been done indistinguishable to the investor from local government loans for drainage, refuse destructors, slaughter-houses, and other purposes most necessary in themselves, but somewhat in the back-yard of civilisation.

It may be replied that Sunderland, for instance, has just declared a profit out of its municipal tramways, but what advantage has this been to anyone? The fares have been substantially the same as would have been charged by private enterprise, or the amount would not have been earned. The local rates, we may be sure, will not go down, and if they are a trifle lower than they otherwise would have been, those to benefit most will be the railway company and other large ratepayers who have contributed least to the tramway revenue. The banks, insurance companies, and such institutions which provide much of the local government loan capital will get their 3½ per cent., and part of it may be re-invested in colourless loans elsewhere, but of that great encouraging influence towards the growth of healthy industry which I have imperfectly described as the cumulative investment effect there will be little or nothing.

And the money for the purpose has been deflected elsewhere. The subject is a complicated one, and it may not be in place to follow it here, but it is a significant fact that *exclusive* of foreign loans the yearly increase of capital from this country invested abroad averages at present about £30,000,000. One tendency of this has been to set more people to work abroad instead of at home, and to increase the competition against home industries.

In the interests of which class of the community the enactments I have referred to were passed and have been administered by the various authorities, it is difficult to say. They have not benefited the general public—the complaint made on their behalf is that they are debarred from the advantages of electricity; and least of all have they benefited the working man, who finds that while the electric light and comprehensive electric tramways are not for him, hundreds of thousands of pounds' worth of foreign-made plant and accessories are landed on our shores.

The working classes have suffered in another and, perhaps, a more serious way from the division of the country under innumerable local authorities endowed with powers such as I have described. The more or less arbitrary boundaries of these authorities, derived in some cases from the middle ages, are not and cannot be adapted to one and all the various means by which science and enterprise can be brought to the aid of the general community, and it can be shown that in practice the system tends to aggravate some of the grievous social and industrial problems of our own times.

These authorities number among them men of great ability and benevolence, but their collective action is frequently controlled by traders, property owners, and others who act upon the view that the best interests of their several districts lie in the direction of increase of rateable value and of population. Add to this a large official class alive to the advantage of increasing the importance of its own environment, and there need be little wonder that each district shows a tendency to "cuddle up" all it can attract, and that there should be grave reason for our being urged "to get rid of that which is really a scandal to our civilisation—the suffering which many of the working classes have to undergo in order to obtain even the most moderate, the most pitiable accommodation."

There may be many fibres to the scandal of the housing of the poor, but the conditions most favourable to its growth are to be found in our system of local government and its administration. The future of the electrical profession is so interwoven with social questions that we cannot escape their consideration. Mr. Balfour has said, "I believe that electrical traction is going to play a far larger part in the solution of this difficulty"—the housing of the working classes—"than any of the strange schemes I have analysed"; Mr. Lough said that, "It had been agreed by everybody that the chief means of improving housing accommodation is to spread out the city and destroy congestion, and it is agreed that there is no way of doing this effecually except by providing better facilities for traffic."

No one can question the advantages of improved traffic facilities, but if the direction morning and evening is to and from a congested trade centre the problem is only half solved. It is to electric power distribution on a sufficiently comprehensive scale to adapt the country districts to manufacturing purposes, in company with inter-urban connection by means of electric traction, that we must look for the greatest agency in ameliorating the conditions of the working classes in all their surroundings.

It can scarcely be asked what has all this to do with the Institution of Electrical Engineers, for we have seen that the community is conscious of the backwardness of our work, and faced by social phenomena such as those to which I have referred, we are called upon to perform our part in counteracting them. Electrical science is ripe for the occasion, and it therefore appears to be our duty and to our interest to convince the Legislature as to the means it should take to enable us to carry on the services assigned to us.

As some technical objection might possibly be raised to any action we may take in this direction, we shall find, on consulting the Memorandum and Articles of Association, which describe the scope and general organisation of the Institution, that (among allied objects) it was established

"*To promote the general advancement of Electrical and Telegraphic Science and its applications, . . .*" (*Sect. 3 B*), and "*To do all such other lawful things as are incidental or conducive to the attainment of the above objects.*" (*Sect. 3 D.*)

Article 53 says that

"*It shall be the duty of the Council to adopt all due means for the advancement of the Institution; to provide for properly conducting its business in all cases of emergency. . . .*"

and the preceding Article 49 provides that

"*. . . . . The Council may appoint Committees chosen from their own body, and Committees for special purposes consisting of Members of Council and Members, Associate Members, or Associates of the Institution and others, with such powers as the Council may prescribe.*"

Thus the terms of our constitution not only authorise action being taken, but they also appear to intimate the course to be followed in dealing with any obstacles with which we may have to contend, and I trust that the discussion will give the Council an indication as to the desirability of appointing a special committee, as provided by Article 49, to consider what steps should be taken to remove the restrictions upon us, some of the effects of which I have endeavoured to describe.

## DISCUSSION.

The PRESIDENT (Prof. Perry) read a letter from Mr. Vesey Knox. He had read the Paper with interest, and it seemed that so far as the mere electrical supply was concerned, Parliament had now in principle decided that any company offering economical advantages should be given an opportunity of supplying, with due regard for opposition interests. If the companies could supply cheaply they had now a wide field open to them; they could practically force local authorities whose orders were hung up to take current on offering it at a cheap price and without capital expenditure. The real reason why many people, not prejudiced in favour of socialistic experiment, had supported the municipalisation of electrical undertakings was that so many companies had charged high prices for current. This had been a short-sighted policy even from the point of view of the particular companies themselves, as, except in districts where people would have the best light at any price, the cost of supply at a high price was much greater than at a low price. The sliding-scale system of charging was a great drawback, but this was not going to be applied in the case of any of the great power schemes, and it was to be hoped that this would have the natural commercial effect upon the undertakings. He did not believe that the public was disposed to look unfavourably even upon monopolies if they had opportunities of making comparisions with other districts which had palpable facilities. After all, it was the public which, in the long run, controlled the local authorities.

Mr. R. PERCY SELLON said that so much of the time of the Institution was taken up in the discussion of subjects of a purely scientific character that it was seldom that a Paper of this kind, which dealt with electrical engineering questions from their political and industrial aspects, was read. The Paper dealt with principles rather than details, and it went down to the very foundations of the issues upon which the backwardness of the electrical engineering industry in this country depended, and upon these issues a great majority of the members of the Institution had to depend for their livelihood. In his opinion, therefore, this Paper was one of great importance, and its chief interest fell under two headings: First of all, there was the intrinsic interest attached to the large power schemes, and then there was the matter viewed from the collectivist, or political standpoint. Much depended upon this root question—viz., which is more in the public interests, a few large stations distributing over large areas or a larger number of small stations distributing over smaller areas? In this connection problems of generation and distribution would naturally arise, but he would only say in general terms that the spirit of the time which made for consolidation of industries and trades in all directions pointed by analogy to the intrinsic merits of these large power schemes over the small station located from town to town. It seemed to him that it was a reproach upon the Institution that the profession should be palavering and debating over the very question of whether these schemes were or were not possible, while countries which were far behind us in point of industrial progress half a century ago had already solved and were still solving these problems day by day by such stations as Niagara and Massena in America, Rheinfelden in Germany, Chevres in Switzerland, and Fiume in Italy. Why was it that we are at present in this state? He thought the answer was, as Mr. Madgen had pointed out, because the electrical industry in this country had not been determined upon its intric merits by political considerations.

It was a misfortune for the industry that its birth and growth had, up to the present, been coincident with the birth and growth of the municipal idea. Hence it had come about that the industry had become a plaything of politicians and of those who were ambitious to municipalise all public supply in the interests of the democracy. There was no doubt about it, in his opinion, that that was the real explanation of the fact that in this country we were quite without those large distributing schemes, while abroad they were already in existence. Look at the thing for one moment. The same difficulty had arisen at every stage of the industry. In the case of lighting they knew what had happened. They knew how the electric lighting acts retarded its growth. In the case of tramways they knew the story. The Tramways Act of 1870 was only, after great difficulty, amended by the Light Railways Act, which had really given electric tramways a possibility of existence, and now these electric power schemes seemed to have been the focus and battle ground to contending parties of municipalisation and of

those who advocated the placing of these schemes in the hands of private enterprise. It was quite true that the Legislature had made a tardy recognition at last of their errors of judgment in the past by the passing of these bills, and thus had recognised that public interests *did* point to these industries in their early stages being placed in the hands of private enterprise. He was of the opinion that this help had come almost too late. Investors, who after all supplied the sinews of war by which such schemes were rendered possible, had got to look askance on electrical enterprise. Parliament had bandied electrical concessions about in such a way by imposing so many regulations upon these schemes and pandering so much to the local authorities that it was very small wonder that the investor could now with the greatest difficulty be got to believe that there was commercial advantage for him by going into electrical enterprise. Our great competitors had all the advantages, material, financial, and technical, that we possess, and therefore the theory of leaving things to muddle themselves through much rather than taking them up by concerted and associated action was one which he contended must be dismissed with reference to this industry. What was the cure for this state of things? What could this Institution do to remove the disability from which the industry was suffering? He thought the answer lay in the suggestion thrown out by Mr. Madgen. He knew that as an institution they were on their guard—and rightly on their guard—in taking no action which might appear to prejudice one class of its members at the expense of any other class; but where the interests of the electrical engineering profession as a whole were at stake, in the face of industries with which the Institution was not concerned, he contended that it was open to the Institution to take a more active interest in the support of those who were trying to better the conditions under which electrical engineers had to work, and he believed that this could be done. They all knew that there were questions before the Board of Trade which were menacing the development of the tramways industry, power distribution schemes and the electric lighting industry at the present moment, and he hoped that the reception given to the Paper and the discussion upon it would strengthen the hands of the Council in feeling that the body of the members was behind it in lending weight and authority to the support of any remedial measures which would remove the disabilities under which the industry was suffering.

Mr. J. S. RAWORTH confined himself to two questions in view of the enormous number of side issues introduced by the Paper. The first was, "Are we behind the position which we ought to have achieved?" and secondly, "What are the causes which have brought that lagging into existence?" In meetings like theirs, which were usually confined to scientific questions, there must be a great many gentlemen present who, as it were, never got their noses away from their calculations. They knew they were busy, and that everybody around them was busy, and therefore they thought the industry was as flourishing as it ought to be. In comparing electric light undertakings with the gas companies, both of whom took their customers from the same people, the position was this: The total revenue for all the electric light companies, including power as well in the United Kingdom and Ireland amounted to £1,606,000 per annum. These figures were for the year 1898, which were the only ones available. But it would probably astonish them to hear that the increase in the revenue of the gas companies for the two years from 1896-8 exceeded the sum total of *all* the revenue from electric light, *i.e.*, the revenue of the gas companies had approximately increased from £19,000,000 to £21,000,000, making a total increase of £1,611,000, which, he thought, ought all to have gone into their own pockets. In the face of all the electric light stations that had been started, the gas companies had yet been able to steal that £1,611,000 and to put it into their revenue. Further, the profit which the three gas companies in London derived from the supply of gas was £1,665,000 a year, this profit being greater than the total revenue from all the electric lighting companies in Great Britain and Ireland. In the face of this who could say that the electric lighting industry had not been choked? They had been working at it as hard as they could for 20 years, and they had not got to more than that miserable £1,606,000. Some of them might say that electric light stations were being put down as fast as ever they could, but he pointed out that, whereas there were only 198 electric light stations working to-day, the gas companies has got 661, showing that they were still a long way ahead in numbers, let alone in the breadth of their operations and their power of collecting money. He did not object to a municipality trading, because they brought competition into the field of company operations, and he did not object to the ratepayers taking the risk upon their shoulders provided they were content to do so. His objection to municipal trading was based upon the grounds which he had explained at great length some two years ago—viz., that they did not manage the business as well as companies. In the great gas industry, which was based upon the principle of perfect equality between the company and the municipality, the latter had no advantage which the company did not get, and consequently the companies beat the corporations entirely and supplied a better article at a lower price. It was only when dealing with the questions of tramways and electric lighting that the new principle of giving the advantage to the corporations in preference to the companies had been introduced, and he maintained that if these advantages were taken away from the municipalities things would go back at once to the condition that the companies would have nothing whatever to fear because the corporations would not dare come into the field where there was free trade. It was the special provisions of the two or three acts of Parliament which were the cause of the mischief that the profession suffered from at the present time. Between the years 1882 to 1888 it was impossible for any electric lighting stations to be started because the capital could not be got at all. Then the period was extended to 42 years and the capital was being obtained—but with very great difficulty, which difficulty was further increased by the violent opposition of corporations to the granting of orders on fair terms. There were a great number of men quite ready to take the risk of the venture, but there must further be taken into account what a large amount of extra capital they had to spend to overcome the opposition of the local authorities. Mr. Vesey Knox had stated that if people were prepared to supply at a cheap rate they could now get permission to do so over a very large area. But let them try it, and they would find they had to spend weeks in those hot rooms of the House of Commons arguing the point with people who only wanted to get them out. These were the obstacles put in the way of legislation. If the legislation were removed and all were put upon equal terms, he was quite certain there would be no more trouble from municipalities.

Mr. A. A. C. SWINTON quite agreed with Mr. Sellon that this was a subject of very great importance, and it was a pity that discussions upon similar subjects were not more frequent at the Institution. He was quite aware that the Institution was a scientific one, but it was no use having discussions, for instance, upon the dielectric loss in cables if there were going to be no cables to have any dielectric loss in. Mr. Madgen had already given the chief reasons for the backwardness of electrical engineering in this country, and he would only make one remark upon this point. Up to a very short time ago if anyone adduced as the reasons for the backwardness of this country the reasons given in the Paper, there were always persons who said that the real reason was the speculation which took place in the electrical business. He did not think that the British investor had such a long memory that it took him back to the year 1882; the usual cycle of memory of the ordinary Stock Exchange investor was very much shorter than that. However, he thought there was no doubt that the primary reasons for the present backwardness were due to the terms of the two Electric Lighting Acts and to the administration of these by the Board of Trade. Mr. Madgen had stated that the Board of Trade was curiously named and somewhat curiously constituted. He did not know what name Mr. Madgen would like to give the Board of Trade, perhaps the "Board for the Restriction of Trade," but he had personally been at some pains recently to inquire into the constitution of the Board of Trade, and had had great difficulties in finding out anything about it. If they would look in "Whitaker's Almanac," or any ordinary book of reference, under the heading "Board of Trade" would be given the name of the president, secretaries, various under-secretaries, &c., but no mention of any board at all. But he had pursued his investigations, with the aid of the "Encyclopædia Britannica" and various books on constitutional law, and he believed he has at last got to the bottom of the matter. He found that the Board of Trade has been in existence for some centuries, it had led a very chequered career, it had been several times suppressed, and that as at present constituted it consists of a committee of the Privy Council. It was formed of various high officers of State, and included also as an ex-officio member the Archbishop of Canterbury. He need scarcely say that the particular book of reference from which he had quoted, went on to state that the Board of Trade was seldom called together, and, in fact, existed merely in name. He thought that this really went, to some extent, to the root of the matter. He had further found that in one period of the history of the country a Board of Trade really existed, and probably was of some considerable importance. Oliver Cromwell appointed on the Board of Trade 20 merchants of the City of London, and he was of the opinion that something of the kind should be done now to form a real constituted Board of Trade which would be representative of the industries of the country and which could guide the president and secretary. His next point was on the question of municipal trading. If anyone thought about the matter they must see that putting industries into the hands of municipalities must necessarily lead to that particular business proceeding very slowly. Municipalities employed the ratepayers' money, and they must not speculate. They must only go in for businesses the success of which was absolutely assured. At the beginning of a new enterprise there was necessarily a speculative period, and if enterprises of that description were put into the hands of municipalites they must of course wait until other people had shown the way in this country. We had had to wait until other countries had shown the way, and this was one of the objections which went to the root of all municipalisation. Private enterprise was the only way of trying new things. Even if the result in any particular town was that the corporation could supply electric energy cheaper than private enterprise that might be to the advantage of the particular inhabitants, but owing to the fact that it threw things back, it could not be to the advantage of the nation. Previous speakers had alluded to the fact that at the present moment it was not easy to raise money for electrical developments; he thought the reason was largely the fact that the greater portion of the electrical business of this country was in the hands of municipalities. As instancing the readiness of investors to put money into other electrical companies he mentioned Newcastle, which has two prosperous electric lighting companies. Two other towns, Scarborough and Cambridge, with which he was also connected, had companies which were almost entirely capitalised from Newcastle, the reason being that the people in Newcastle put money into other electric light undertakings because they found it was profitable. Carrying this idea out, it would be found that supposing the electric lighting in Edinburgh, Glasgow, Liverpool, Manchester, and all the big towns were in the hands of companies, there would be no difficulty in getting any amount of money for all the electrical enterprises they wanted.

Mr. L. A. ATHERLEY-JONES, M.P., said he frankly admitted that Parliament had been remiss in the efforts which it might have successfully made in order to encourage and develop the electrical industry, whether by way of traction or lighting, which had met with such marked success in other countries, and which in this country had not met with a corresponding success. But he thought they would all agree that within the last few years, at any rate, there had been a growing conception on the part of Parliament that the interests of the community could perhaps be better served by giving way to the dictates of private enterprise rather than the narrow and somewhat insular interests of municipalities; but he was far from saying one word which would reflect in the smallest degree upon our

municipal government. It had been recognised by recent legislation that the choice of the "board" system of local government—if he might use the expression—was one which, in certain directions, was best suited to serve the public benefit; but at present one of the greatest hindrances, probably, to the development of electrical enterprise was the veto which could be exercised by local authorities over the private enterpriser. This, however, he thought would be removed. Parliament, in passing the power bills last session, recognised that the will of the municipality was not to override the interests of the public at large. One other topic which had struck him forcibly in the Paper was the author's advocacy of the desirability of encouraging and developing electrical enterprises in the interests of the huge masses of the population where crowded in labour centres. He believed it was the opinion of that much abused body, the Board of Trade, that it was desirable that facilities should be afforded for tramway companies and light railway companies to construct under more favourable conditions than at present the means of transit from the centres of industry to those places where cheap habitation could be obtained, and if the president of the Board of Trade devoted his attention this session to some bill which would supersede the present Light Railway Act this would lead to the greater development of electrical enterprise in this country. In connection with this matter he was glad to be able to say that he had induced the president of the Board of Trade to receive a deputation to discuss the precise scope and direction of such a new tramway act, and these matters, which had been dealt with by Mr. Madgen, would undoubtedly be laid before him, and, he hoped, would bring forth good fruit.

Prof. S. P. THOMPSON thought that this question of being able to supply cheap power to our industries was really a national one, and he pointed out that there were one or two small and comparatively simple matters upon which it was desirable that we should have our minds quite clear. It had sometimes been urged against us that we advocated the establishment of these large power stations, and that the reasons adduced why they should be encouraged were the large power stations on the continent of Europe and on the continent of North America, and it was thrown back against us that these stations were almost without exception water power stations, and that there were no such waterfalls in England, and that it was impossible to work large stations without a natural source of supply like water. But he did not admit the argument. For instance, if there was a waterfall not taken up for power purposes, this waterfall belonged to somebody, and that somebody would want his price for it as soon as it was known that it was worth money. Whoever wanted a waterfall would have to pay for it, and the price fixed would be the price which he would have to pay for erecting his works in some way. This was a factor which set the price. Waterfalls were not had for nothing. In England, as everybody knew, we had cheap coal which nature also provided but which cost money to get it up. The economic problem was not coal versus water; it was how to make use of the natural source, whether it be coal or water. The engineering might be different, but the economic problem was really precisely the same. The dearer the power was in itself the more was there to be gained by distributing that power as economically as possible; so that if it be true that the power costs more to be generated by coal than by water this was all the more reason why we ought to have an economical system of distributing it. Whether there were large stations worked by coal as distinguished from large stations worked by water power, or whether there were coal stations for the purposes of sending power to long distances, was not the question. Where were there large stations economically transmitting electrical current to the districts round them for any purposes whatever? These were the things which were wanted in a comparison with the natural power stations when they had to talk to people who were impervious to the argument that water cannot be had for nothing. Another thing was, what was the proper process for reckoning out the suitable size of unit for a big station, and what was the size of the station at which it became no longer economical to make it larger, but better to put down a second one a few miles away at a convenient place? Unquestionably, such facts could be got at, but so far as he knew they had never been stated in any compact or useful manner that could be used effectively for the purpose of convincing those who did not understand what the real problem was. For instance, when a station reached, say, 10,000 H.P.—which he did not accept as a limit—would it pay to make it 20,000 H.P., or to put down another a little way off? The economic unit of size for electric stations must very clearly depend upon very different conditions from those which determine the unit of size for other things. Take for example the case of the water supply. In old days we had the parish pump, and then the village cistern or reservoir, and then we had the town supply, and look what all the municipalities in this country were doing in the way of providing themselves with immense water supplies. The same kind of progress as social conditions changed was obvious in other things besides water supply. Last autumn at the Bradford meeting of the British Association he inquired into some of the conditions which affected or would affect the supply of power to Bradford; and one thing not to be despised in considering the question of that area was this: In the town of Bradford practically the whole of the industries that required power were textile industries, and all the mills practically began and left off work at the same time. Anyone who knew anything about electric supply knew that that was not the most favourable conditions for the supply of electricity. It was much better to have a variety of industries which did not all start up at the same time or stop at the same time, and, therefore, in determining the area which would be economical for the supply of electric power it was inadvisable to confine that area to a place where the industries were all of one kind. It would obviously be more economical to include other towns which did not want a supply all at one time, and thus improve the load-factor. Comparing the state of things in Italy, which was relatively a poor country and very far behind us in many ways, and when one saw how station after station had been built up—stations with very large generating machinery, distributing power over wide areas—one felt perfectly ashamed of what was going on in our own country. He found in Bradford a firm which was supplying power looms to the textile industries of Lombardy, each one being fitted with an electric motor—in 99 cases out of 100 with a three-phase motor—while Bradford itself, the very centre of our English textile industries, was not supplied with a single loom fitted with a single electric motor. We had been told that we were a nation of amateurs, and he did not agree with the writer of the Paper that it was a matter to be lightly thought of that we did not put the same store upon education as some of the other nations. If they would go to one of the large factories which sent machinery to this country from the United States it would be found that practically every man in the factory above the grade of a fitter was a college graduate. They did not sneer at him because he was a graduate; they welcomed him and took him and made the best of him; the result they all knew; while in Germany and Switzerland in every department of the large factories, they would find men who had received the highest scientific and technical training as managers of the different branches, and it was brains that we had to fight against, both in the case of the American, Swiss, and German competition in these matters. They did not leave things to be "muddled" out, and they did not leave them to be done in an amateurish way, but they took the best trained brains and made the most use of them. One argument which he found very effective in talking to people who thought that little electric lighting stations could supply power in each little town up and down the country and that power schemes were not necessary, was to refer them to what had happened in London—viz., one station in each parish. But gradually these things were being altered, and we were finding that a central station was an absurdity. No station ought to be central; that ought to be looked upon as decided. We ought not to be carrying coals in and ashes out of the centre of a big population. The economic plan was to put a station as much outside big centres as possible, and a few big stations were much better than a lot of little ones, each in its own district. He concluded with a parable. He said, walk down Aldgate and they would see the pump—the famous Aldgate pump—surviving to this day, and reminding us of the times when every little bit of a parish had its own water supply. The time was not far distant when any vestry electric station, or any petty little town station, would be looked upon just as absurd for the purposes of a big power station to the industries that want mechanical power cheap as the Aldgate pump is for supplying water to London.

*Thursday, February 28.*

Mr. ROBERT HAMMOND said that several questions were still awaiting discussion and decision. First, what was the limit of distance from the generating works to consumers beyond which the extra cost of distribution counterbalanced the advantages of concentration of plant? Secondly, what was the limit of kilowatts installed in a central station beyond which the economy of concentration of plant ceased? This question arose on more than one of the bills, and there had been a very great difference of opinion with regard to it. Thirdly, there was the question of what are the means to be adopted in order to preserve uniformity of pressure so as to be able to give electric lighting within efficient limits? The Paper could be summed up under four heads. In the first place there was a dirge, for the fear that we in the United Kingdom were terribly behind in the matter of electric lighting. Secondly, there was an intimation that this backwardness was due to the ignorant legislation, the foolish Board of Trade, and the selfish local authorities. Thirdly, the Paper intimated that we should copy the German and American; and finally, there was an appeal to the Institution to form a committee in order to make the path of the company promoter a little smoother. He distinctly dissented from these proposals. He denied the soundness of the explanation given by the author as to why this country was behind in electric lighting matters. If any electrical engineer in that room had had to face a board of directors anxious to put their money into electric lighting or unwilling as the case might be, but anxious, at all events, to make a good investment, and also to face the committee of a town council equally desirous of extending the town investment but not wishing to make a mistake, he would know what was the feature that had kept matters so far backward. It seemed to him to be the ABC of the subject. Those who had passed through this had always been met with the answer that it was impossible to compete with gas at 2s. per 1,000ft. This had been said to him by capitalists in Leeds 11 years ago, with the result that they delayed starting works, and when he went to the corporation and tried to persuade them, they also were of the opinion that gas at 2s could not be competed with. Over and over again in this country the spread of electric lighting had been checked by the keen competition with the cheapest gas in the world. The real factor in the backwardness of this country in the electric lighting industry was not the one given by Mr. Madgen, but the cheap price of gas. Mr. Madgen also said that it was almost all due to the local authorities, but this was an absolutely mistaken idea. The local authorities of this country, out of an investment of 25 millions had put down 14 millions, and they owed a debt of gratitude to these local authorities. Local authorities had shown the companies how electricity could be produced at a low rate. Their average rates of charge were lower than those of companies. There were two undertakings in the industry that supplied below 3d., and these were both local authorities. There were six between 3d. and 3½d., all local authorities. There were 12 between 3½d. and 4d., nine local authorities and three companies. There were 30 supplying between 4d. and 4½d., 25 local authorities and five companies. There were 23 supplying below 5d., 19 local authorities and five companies, and if he had time he could carry the list up to show how when the price reached higher than 5d. the companies exceeded the number of local authorities. His work had taken him to Germany three times, and if they would go from one central station to another he would tell them what they were likely to see. Cross the frontier at Aix-la-Chappelle and there they would find the works were owned by the municipality. When they visited Germany this year their first night was to be spent at Hanover, but the works were owned by the municipality They were going to Dresden, but the works were owned by the munici-

pality. They were encouraged by the secretary to spend a few hours at Nuremburg, and they would find the works were owned by the municipality. They were also begged to spend some hours at Cologne, but the works were owned by the municipality, and all the big schemes out there were owned by the municipalities. Finally, he disagreed with Mr. Madgen's suggestion that a committee was necessary to put the local authorities right and to straighten out the Legislature. No; better far for someone to move an amendment for a committee to be formed to consider the engineering questions connected with power supply, and to report to the Institution to what extent the present power schemes were likely to overcome them. He would have done this himself, but as a member of the Council he was debarred.

Mr. SYDNEY MORSE thought Mr. Hammond did not dare to move such an amendment. He himself had been a member of the Council, and knew of no reason whatever preventing a member of the Council moving an amendment to a resolution moved by anyone else. He should have thought that as a member of the Council it was his duty as well as his privilege to do so. He had had an opportunity for some years of giving attention to these matters, and could say, without any fear of contradiction, that he did not put the slighest weight upon the remarks which had fallen from Mr. Hammond to the effect that the present position of electric lighting in this country was largely due to the unreasonable difficulties put in its way by the price of gas. He would not have discussed the matter from this point of view had it not been for Mr. Hammond, who, however, knew better than most of them the real underground reason which lay at the bottom of these difficulties and of the manner in which they had been put forward by the local authorities. No one could deny that our backwardness was almost entirely due to these difficulties. He agreed that Parliament was responsible, but at the same time it must be know that local authorities had gone further than merely acting in the best interests of their particular parishes. They had entered into an alliance such as ought not to have been permitted, and they had exercised the most undue and improper influence upon members of Parliament when matters of this kind came before Parliamentary committees. It was essential for the industry of this country that there should be available to every manufacturer throughout the country a supply of cheap power, available to him at all times of the day and night, which would enable him to compete with his foreign competitor. The reason why gentlemen having the means at their disposal had not taken steps to obtain these powers was that the local authorities had stopped it. Look what happened in connection with the second debate on the power bills last session. The local authorities went as an opposition body to the President of the Board of Trade, and in effect said that if these bills were allowed to pass they would vote against the Government *on all questions*. Was this fair opposition? That this was a fact he challenged anyone to disprove. Unfortunately the President of the Board of Trade was anxious not to prejudice the position of the Government, so he said, "Very well, gentlemen, ask what you like to ask, and we will agree." Whereupon the bills came out of committee with the condition that nothing could be done in the district of a local authority without the consent of the authority. All local authorities desired to spend the largest amount of money on their undertakings. They did not look at the matter with the aim of giving the manufacturer a cheap supply of electricity at his door. This was not an aim they considered in any way whatever, he was sorry to say; and, further, he was of the opinion that it was due to the last speaker, to a very large extent, that they took this view. He was quite prepared to prove this allegation. He submitted that electrical engineering should have free and fair play, and that schemes should be discussed on their merits. If the local authorities would agree to that proposition, instead of a total of 25 millions invested in electrical enterprise we should have a total nearer 250 millions, and he was astonished to hear anyone like Mr. Hammond say that 14 millions was a large sum. It was a very small and insignificant sum, and one which made traders of this country ashamed of the position we were in. If schemes were discussed on their merits a great benefit would accrue to the country, and he trusted that the Institution would put it forward as the word to all parties in this matter to let the trade have free play; let the traders have the right to have their schemes discussed on their merits, and abolish the veto which unreasonably and improperly had been given to local authorities to prevent that being done.

Mr. G. L. ADDENBROOKE was largely in agreement with Mr. Hammond's facts; but Mr. Hammond had drawn wrong inferences from them. He had been discussing electric light only, as if electric power had only just come in. He quite agreed with Mr. Hammond that electric lighting had had enormous obstacles to overcome, but whether municipalities could overcome them better than companies was quite another matter. He had been told that proper regulations which would put private enterprise on a fair basis could be arranged, and if such an act had been passed, he agreed with Mr. Morse that there would by this time have been more near 250 millions of capital invested in electrical undertakings. The way the electrical industry had been trammeled had been exemplified by these power bills. It was quite true what Mr. Hammond had said with regard to the state of affairs on the Continent, but it had always been his opinion—and this had been strengthened by his experience with the Midland Electric Corporation—that the prevailing conditions in England were quite different to the conditions on the Continent and in America. In these power schemes they encountered a set of local conditions and problems of their own, but if these were met in the way which he felt confident they could be met, we should be in the front rank of enterprise again.

Mr. E. GARCKE said he felt very strongly on this question. He had watched Mr. Hammond's career with considerable interest and great respect. He had commenced life as a man of business, and later on was a company promoter—a body of people he apparently looked down upon now. He was subsequently a contractor, and was now in the happy position of being a consulting engineer, and he (Mr. Garcke) had hoped that having had such a varied experience in the different branches of the industry Mr. Hammond would have given them the benefit of a fair-minded view of this very complex question. He had, inconsistently with the whole of his experience, offered an explanation which was most misleading to them and absolutely misleading to the younger members of the Institution. He (Mr. Hammond) wanted them to understand that the corporations had been customers of the electrical industry to the extent of 14 millions and then implied that if the corporations had not expended that capital it never would have been expended. The only criticism he could offer to this was to ask why should a debt of gratitude be owing to local authorities for the expenditure of that capital when capitalists were prepared to spend, and would have spent, that capital six or seven years earlier? It was not merely the amount of capital expended, but the vacillating manner in which the municipalities had proceeded with the work. He did not wish to enter into a discussion on municipalisation, for and against; it was not germane to the discussion. But there was one very important aspect which ought to be mentioned whenever the question of municipalisation was touched upon. Personally, he was strongly in favour of municipalisation, and always had been. He advocated the higher development of municipal functions, but he maintained at the same time that it was not one of the functions of municipalities or local government to effect to transfer all the profits of trade from private individuals to the collective capacity of local authorities. The function of government was an entirely different one, and if once this elementary economic principle was ignored there would soon be a limit to enterprise. He could speak with some authority on this point, and he assured them that such would be the case if local authorities assumed the position of common traders in the country. What did Mr. Hammond say about the real reason why electric lighting had not developed more completely: "The price of gas was so low that electricity could not compete with it." Were not the millions of electric lamps already installed competing with gas? If he had the time he would undertake to refute entirely the statement that gas had been any obstacle to the introduction of the electric light. He remembered Mr. Preece saying in that very room that the electric light was being made the poor man's light. He himself had preached the same thing all over the country, and he had heard Mr. Hammond do the same. And yet we were told that the low price of gas was a preventative to the development of electric light!

Prof. W. E. AYRTON said he was of the opinion that because the Institution was a scientific society therefore the present Paper was one well worthy of the most careful consideration. He ventured to think that there was a certain obscurity of logic characterising the eloquent speeches delivered at the previous meeting, for it was endeavoured to prove that the electrical backwardness of the country arose wholly from obstruction from local authorities, and he asked whether this charge was well founded. Let them take as an example the Metropolitan Railway, a considerable portion of which he saw being constructed over 40 years ago. Why were the trains on this line not run to-day electrically? Was it because of the restrictions imposed by the King, or the Government, or the London County Council or the City of Westminster? Was it not rather due to the lethargic chairman and directors of a private company? Coming to the question of the distribution of electricity was it a fact that in places under the control of municipalities electrical energy was always dear and in other places where the supply was under the control of a company it was cheap? He would take an example. A certain local authority wished to electrically light its own town. It was a small borough and they got out plans for boiler-house, engine rooms, &c., but within 2¾ miles of the boundary of the district a very large generating station was being put up by a very important private company. This had seemed to him a beautiful opportunity of carrying out the idea of transmission of electrical energy. Therefore, when he was consulted, he told the local authority not to lay the foundation stone of their own station, but to let him arrange terms with the said company for a supply in bulk, and the answer was "By all means; you carry out the negotiations." There was no difficulty about wayleaves or anything else, and the only condition imposed upon the company was that the current should be delivered to the boundary of the parish at a pressure of 200 volts, the amount required being about 500 H.P. But the company said that, after having gone carefully into the matter, even if the local authority entered into a contract with the company for 10 years to take the whole supply it might require, they could not undertake to supply it at less than 3d. per Board of Trade unit. It was cheaper to carry coal into the district and put up a generating station themselves. This brought him to a very important question, viz., the relative cost of carrying coal and transmitting energy through cables. He had got wholesale tenders for cartage of coal from all parts of the country to other parts, and he was sorry to say the prices came out very low. [Prof. Ayrton was prevented from saying more on account of the time limit.]

Mr. C. B. CLAY, of the National Telephone Co., speaking with regard to Government obstruction in connection with the telephones, read a few extracts from a leading article in *The Times* for June 13, 1884, and called attention to the moral which was drawn by this article. The history of the telephone had been one long fight—a fight to be able to carry on a business as it should be done, but so restricted that it was impossible for it to be done. With regard to trunk working, they were in the same position now as they had been at the very commencement. They had trunk wires from Brighton to London, but the National subscribers were not allowed the use of this unless there were subscribers at both ends, and they paid a rental of not less that 10s. for each mile of wire. The result was that each subscriber had to pay £82 per year—viz., £25 and the local subscription.

Major-Gen. WEBBER submitted on a point of order that Mr. Clay was speaking on a subject outside the Paper.

Mr. CLAY considered the title of the Paper a very wide one; it was "Before and After." Up to then he had been speaking of the "Before."

Mr. C. BRIGHT said that if this were so, it would be necessary to devote several evenings for all the members to give their experiences.

The PRESIDENT: I know you all rise on a point of order, but you only really want to interject a remark.

Major-Gen. WEBBER asked for an opportunity of answering the statements.

The PRESIDENT said other members could speak upon this point if they would only wait until Mr. Clay had finished.

Mr. CLAY, continuing his remarks "before" the power bills, referred to the value to everyone of the express message system which the company were prevented from carrying on. He urged the Institution to do everything possible, by committee or otherwise, to protect the profession from the obstruction of municipal authorities.

Major-Gen. C. E. WEBBER said that the Institution, before the Committee sat which passed the Telephone Bill of 1899, did the very thing which the last speaker had suggested they should do. The Telephone Bill of 1899 was the charter of all those wish to extend the use of the telephone in this country.

Mr. J. GAVEY considered that this question was rather off the subject of the Paper. However, he would say a few words on Mr. Clay's ancient history which he had brought up in such a way as to lead people to believe that the hampering regulations existed at the present moment. For instance, the rates in connection with trunk working might have been high in the early days before anyone knew how the matter was going to work out, but for years and years the company had had an absolutely free hand to charge really what they liked, and in some cases where the Post Office had been in opposition they had actually gone to the subscriber and given him free telephones and wires in order to induce him to leave the Post Office. It was also unfair for Mr. Clay to speak as he had upon several other points. It must be borne in mind that in acting as it had the Post Office was really protecting the rights of the Government under the Telegraph Acts, and these had been established in case the Post Office wanted to establish telegraphs or to take possession of the telegraphs of the country. But the Telegraph Acts, again, were the results of a public demand pressed upon the Government and carried by Parliament in response to this demand, and any subsequent action, whether of House of Commons Committees, the House itself, or the Post Office, had been done, generally speaking, as the result of public pressure. Further, if Mr. Clay or any other members of the Institution would turn back to the minutes of evidence that were taken before the last Committee of the House of Commons they would find that the general evidence was in favour of the telephones being taken over by the State, and therefore it was not on the initiative of the Post Office that this policy had been adopted; it was the wish of the public.

Col. CROMPTON found himself in full sympathy with the author after a careful perusal of the Paper. He agreed that it was not on account of inefficiency as engineers that we were behindhand; it was due to external causes, and one of these causes was, no doubt, the Tramways Act (1870), the first act that fettered private enterprise and enabled municipalities to compete with private enterprise by means of the rates. That early Tramways Act was the commencement of a curse that had hung over the country ever since. It was useless for Mr. Hammond to pose as a man with an inconveniently short memory. He had apparently forgotten how, years after the Electric Lighting Acts came out, municipalities had lying idle scores and scores of provisional orders which they never put into force. They never moved a finger until private enterprise showed them how electric lighting could be made profitable in this country. They would never have had 14d. invested, let alone 14 millions, if private capital had not been got together, and had shown that in England engineers could do what was done in America. There was no doubt that in the early eighties, when a few men were trying to work up the electrical industry municipalities were their enemies. They all remembered that stock phrase, "We *will* have control of our streets," which was always put forward if any facilities in the way of connecting up consumers were asked for. As a prominent actor in these things he spoke with some authority, and it appeared to him that we were in exactly the same position to-day with regard to the distribution of power on a large scale all over the country. Another important thing was the public impression that electrical engineers themselves were to blame for the backwardness of electrical progress here: a most shameful and most unmerited imputation, when it was considered what had been done. He claimed for England most of the things that had made electrical distribution possible. Look for instance at Hopkinson, Swan, and many others. Was it not England that produced the Willans direct-acting high-speed engine, which had made early electric lighting stations possible in crowded areas? Hundreds of other things could be mentioned, and there was not a thing in the electrical industry which was at present being done abroad that had not been done in England.

Mr. W. L. MADGEN, replying, said that he would not move a resolution, and Mr. Hammond was wrong in implying that he had said so. (Mr. HAMMOND: I beg your pardon.) Had he done so, however, he would have directed that the technical questions involved in this large movement should be referred to the committee which might very usefully be appointed. This was no sectional matter; it was no matter between one section of the Institution and another; but he was sorry that the question of municipal trading had been brought into the discussion mainly, however, by Mr. Hammond, who was drawing a red herring across the trail. They could gauge the value of Mr. Hammond's arguments by his alleging that the backwardness of electric lighting in this country was due to the cheapness of gas. He had never heard such a weak argument. The cost of gas had, in his opinion, very little indeed to do with the backwardness of electric lighting here. With reference to the point raised by Mr. Hammond and upon which he sought information—viz., the limit of size of a station—these matters had been gone into very carefully by himself and others who were instrumental in the promotion of the power bills last session, and they had gathered a great deal of information. It was impossible to compress the whole of these matters into the Paper, and he thought, in preparing it, that his first duty to the Institution was to point out the means by which the obstacles to the development of the idea should be removed. The technical questions arising in connection with the power bills might usefully absorb the evenings of the Institution for two or three years after; and even one of the points mentioned by Mr. Hammond would take two or three evenings to thresh out. With regard to the economic limit of a large central station five years ago this had been placed at 5,000 H.P., but now this figure sounded absurdly low. He referred to an article in the *Electrical World* of New York for August 13, 1899, which concurred in this view, and said he had come to the conclusion that it was the character of the area being dealt with which fixed the economic size of the station. Under some circumstances 100,000 H.P. would not be too large a station. He next read extracts from letters sent him from the president of the Boston Edison Company, Mr. Hale, an engineer in the States, and Mr. Gisbert Kapp, all confirming this view of the matter. These letters will be published in full in the *Journal*. Mr. Hammond had also referred to the valuable work which local authorities had done in this country and implied that they were under a debt of gratitude to them. Out of 212 municipal provisional orders nearly 120 were merely in the construction stage. He was afraid Prof. Ayrton had really earned for himself the title of "Professor Back-number." He could not speak of a simple question like this without raking up some back number dating from 1879. He felt specially strongly upon these remarks, because Prof. Ayrton exhibited his utter incapacity to grasp elementary commercial points. He had asked why the Metropolitan Railway was not run by electricity, and said that this could not be the fault of the local authorities. True, but it was entirely a question of business. It was impossible to upset such a complex system as a railway and convert in a short period. It took years to do it. He could understand the position, and sympathised with the Metropolitan Railway Co. Prof. Ayrton also referred to the case of a somewhat large generating station having as it neighbour a small local authority. But he was not surprised that the company would not supply 500 H.P. for, say, 3d. per unit. Why should a large company, with a large station, presumably supplying a large area, go out of its way to dislocate its system for one consumer of such an exacting character as a local authority for 500 H.P.? Coming to the suggestion that Mr. Clay had not been in order in speaking of the telephones, he said he had the very greatest sympathy for the difficulties with which the Telephone Company had been contending. They were not popular, and any whip was good enough to whip them with. Those not connected with telephone work could hardly realise the difficulties under which the Telephone Company had been carrying on its work. Practically the whole of their business was overhead, and they had to get way-leaves wherever they could, and, in fact, were at the mercy of everyone. In addition, they had been treated by the Government in a very shabby manner, and he was sorry to see such an honourable man as Mr. Gavey having official responsibilities. The Telephone Company had been the object of tyranny of the most ignorant and oppressive kind, and if they tyrannised over people they either made them liars or cowards, and frequently both.

Prof. AYRTON: Which is it in this case?

Mr. MADGEN said it was neither in this case. The Post Office and the Government were responsible for any expedients the company might have resorted to in order to preserve the business. He was glad that such a member of the Council as Col. Crompton had appreciated the intentions of the Paper. Dr. Thompson had finished his remarks with a parable and he would do the same. In most domestic circles, certainly in the one with which he was best acquainted, there was a small member who asked or wished to know why one left the house reasonably early and why one came home late. (Prof. AYRTON: Or reasonably late.) It was usual to tell this small person that it was for the purpose of earning her bread and butter. This was a bread and butter question; it was the question of the interests of the Institution as a whole. If private enterprise was any block to municipal trading in the same direction then municipal enterprise was wrong. It was to their interest to see that these legislative restrictions were removed. It was more than their interest, it was their duty. If the greatest evil of the present time to overcrowding, and the conditions in which the working classes were living, could be removed by this means then it was their duty to see that the path was cleared for it, and they must do what they could in the matter.

A hearty vote of thanks was then accorded to Mr. Madgen, and the meeting adjourned.

## BOOKS RECEIVED.

**Copies of any of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price.**

"Engineers' Year Book." By H. R. Kempe, 1900 (8th year). (London: Crosby, Lockwood & Son.) 8s.

"The Truth about the Belleville Boiler in the British Navy," by Engineer Wilcke. (Manchester: The Technical Publishing Co.) 1s. 6d.

"Model Boiler Making." By E. L. Pearce. (London: Dawbarn and Ward). 6d. net.

"The A B C of Dynamo Design." By A. H. Avery. (London: Dawbarn and Ward). 1s. net.

"Science Abstracts." February, 1901. (London: E. and F. N. Spon.) 2s.

"The Iron and Steel Trade of the United States." Report of the United States Treasury Bureau.

"On the Results of a Deep Sea Sounding Expedition in the North Atlantic during the Summer of 1899." By R. E. Peake. (London: John Murray.)

"L'Istituzione Elettrotecnica Carlo Erba Annessa al R. Istituto Tecnico Superiore di Milano, 1887-1900." (Milan: G. Pizzi.)

## A NEW CORD AND PLUG FOR TELEPHONE SWITCHBOARDS.

A weak point in telephone switchboards is the junction between the cord and plug with which connection is made to the jacks. After being in use a certain time the cords become damaged at the place where they enter the plug, and they require replacing frequently. A pattern of cord and plug, made by the Berlin firm of C. J. Vogel, claims to overcome this difficulty. In the cord the two conductors are both of fine metal strand, each being covered independently with a double lapping of cotton, and then braided with coloured silk to enable the two poles to be distinguished. The two covered wires are then laid up with a worming and combined in a round cord within a stout outer braiding. At the end of the wires small contact pieces are soldered, as seen in Fig. 1, and the end of the cord is stiffened by a thin spiral binding of whip cord, the pitch of the spiral gradually increasing, as seen in the figure. The plug itself differs from the usual construction by the fact that the hollow end for the reception of the cord has both an internal and an external screw thread see (Fig. 2). The cord is easily passed in at the wide end of the plug, and a round nut screwed over the end, as in Fig. 3, holds it tight, the internal screw thread pressing into the outer braiding and holding it firmly. It is claimed that while the remainder of the cord is quite flexible the end is sufficiently stiff not to be bent down sharply where it leaves the plug, and that it remains in the shape of an easy curve in spite of the tension produced by the counter-weights.

FIG. 1

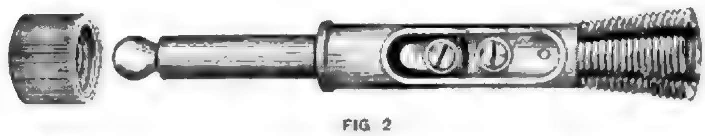


FIG. 2

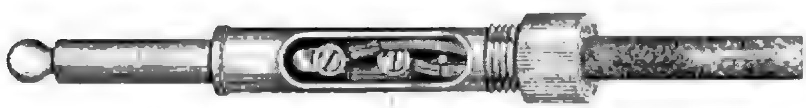
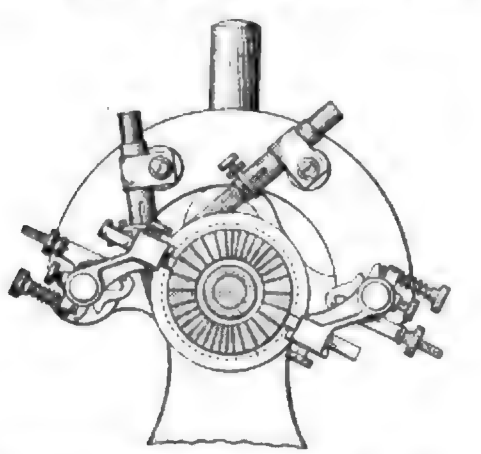


FIG. 3

## SPARKING IN DYNAMOS AND ROTATORY CONVERTERS.

Prof. Elihu Thomson has patented a dynamo with a commutator of unusual design for the purpose of obviating sparking, and an abstract of the patent is given as follows in the *Electrical Review* of New York: Prof. Thomson has gone on the theory that sparking is due to the fact that the current in coils undergoing commutation is not uniform during a revolution, while at the same time the resultant armature reaction varies, thereby varying the field strength under the pole-tips. It is thus impossible to find a fixed position for the commutator brushes such as will result in the suppression of sparking. The conditions require that the brushes should be moved backwards and forwards on the commutator or oscillated during each revolution, so that the coils of the armature, as they pass under the brush, may be in a position with respect to the field of the machine such as will induce therein an E.M.F. which will more or less balance that produced as the coil passes out from under the brush.



If the machine is operated as a rotatory converter, for example, the brushes during one portion of the revolution would require to have a positive lead and at other times a negative lead corresponding to the alternating generator and motor action in the machine. To illustrate: Suppose the machine to be driven by continuous current, thereby acting as an inverted rotatory converter; then, when the alternating wave is at a maximum, the lead of the brushes will be a generator lead, while, when the alternating current is zero, the lead should be a maximum negative or motor lead.

According to the present invention the inventor obtains this desired effect by constructing the commutator with segments of various widths, the segments being spaced closed together in some portions of the commutator and wide apart at others. The commutator being revolved at a uniform angular velocity, thereby causes what amounts to a variable velocity of the segments, whereby armature coils in advance of a neutral position first undergo commutation and then coils behind this position similarly undergo commutation. By this arrangement the several armature coils may be caused to pass under the commutator brushes at times during their revolution when the least sparking will take place due to commutation.

In the accompanying illustration is shown a sectional view of this commutator, from which it will be seen that the segments near some portions of the periphery are crowded together, while at other portions they are given a wider spacing. As already stated, the object of this spacing is to obtain a result equivalent to an automatic shifting of the commutator brushes backwards and forwards, thereby obtaining the advantages due to a periodic shifting of the diameter of commutation. The effect of this varying width of the segments is to cause some of the segments to be connected to points in the winding lying on approximately the same radius as these segments, while other segments are connected to points on the winding which, by reason of the spacing referred to, are angularly displaced from the segments to which they are connected. The spacing is so chosen that, as the armature revolves, the commutator brushes will, during a single revolution, first commutate current in a coil lying midway between the pole-pieces, then in a coil lying in a position advanced in the direction of rotation from this middle position, then gradually back again, step by step, to a coil lying midway between the pole-pieces, and from this position commutation takes place successively in coils lying in positions displaced by greater and greater angles measured from the middle position between the pole-pieces in a direction against the direction of rotation of the armature. The cycle of operations is completed by a step-by-step return to the position of the diameter of commutation by starting, which, as will be remembered, corresponded to a coil midway between the field poles. The result of this spacing is to produce an effect equivalent to an oscillation of the brushes on a commutator of the ordinary type, the result being due in this case not to an actual shifting of the brushes, but to an apparent variation in angular velocity of the commutator segments.

The utility of this shifting backwards and forwards of the point of commutation is said to be particularly valuable in commutating machines in which continuing current and single-phase alternating current flow between the armature and suitable co-operating collector rings and commutator. A machine of this type may operate either as a rotatory converter to change a single-phase alternating current into continuous current or as an inverted rotatory to produce the opposite transformation. The machine in either case may or may not operate to produce mechanical power as well. The General Electric Co. controls the patent which has been obtained by Prof. Thomson on this invention.

## BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

On Friday last, at the Westminster Town Hall, an inquiry was opened by the Board of Trade to consider the application of various electric lighting companies and local authorities for an alteration of the following proviso to No. B (6) of the regulations which have been made by the Board of Trade for ensuring a proper and sufficient supply of energy, viz.:—"Provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations are supplied with energy by the undertakers except with the consent of the consumer." The alteration applied for is that for the words "with the consent of the consumer," there should be substituted the words "on such terms and conditions as may be agreed upon between the undertakers and the consumer, or failing agreement, as may be settled by an arbitrator appointed by the Board of Trade," or words to that effect.

Sir Courtenay Boyle presided. Mr. Balfour Browne, K.C., Mr. R. Wallace, K.C., and Mr. D. Warmington appeared for the Westminster Electric Supply Corporation and some local authorities; Mr. Moon for the Chelsea Electric Supply Co. and the Metropolitan Electric Supply Co.; Mr. Alfred Lyttelton, K.C., and Mr. Talbot for the London County Council; Mr. Danckwerts, K.C., and Mr. W. J. Walter for the City of London Corporation; Mr. Littler, K.C., for the Windsor Hotel, and Mr. Roskill and Mr. A. B. Cane for the City of London Electric Lighting Co. Several corporations and a few metropolitan boroughs were also represented.

Mr. BALFOUR BROWNE, K.C., who stated the case for the Westminster Company, which had made the application for this inquiry, gave a short history of this concern and of the events which led up to the revised Board of Trade regulations which contain the proviso objected to. Since permission had been granted to supply at a higher pressure with the consent of the consumer, out of 5,500 consumers on the books of the Westminster Company only eight had refused to be changed over, and the fact that these eight had to be supplied at a lower pressure cost the company a great deal of money. The present price charged to 200-volt consumers was, on the average, 4·75d. per unit, whereas the 100-volt consumers were charged the full price authorised by the company's bill—viz., 8d.—not, however, as a penalty, but because they had no right to be supplied at the cheaper rate at the expense of others. The company were perfectly willing that these eight customers should go over to its rivals, but this they refused to do, and at present insisted on dictating their own terms if the change was to be made. This was the whole point which would have to be discussed. They were quite willing to submit the matter to arbitration, but to this the objectors would not agree.

Sir COURTENAY BOYLE: Have you offered arbitration at your own expense?

Mr. BALFOUR BROWNE said No, but his company were perfectly willing to submit to arbitration, and for the Board of Trade or some other body to fix their share of the expense. The objectors in question were the Junior Constitutional Club, who were advised by Mr. Cooper, consulting electrical engineer; the Dowager Duchess of Sutherland; Mr. Todd, of 33, Eaton-square; Mr. Norman, of Belgrave Mansions; the Hotel Windsor, also advised by Mr. Cooper; Messrs. Sellon and Cooper, of 3, Broadway, who only consumed some 70 units during 1900; and Prof. George Forbes, 34, Great George-street, who only consumed 17 units. While it was to the advantage of the company to have the whole of their system on the higher pressure, it was also to the consumer's benefit. For instance, at present the distribution losses were 12 per cent., while if the 200 volts were used entirely this would be reduced to 5 per cent., obviously a gain to the consumer. Further, owing to the greater capacity of the mains there would be less frequent interruption and pulling up of the street, in addition to which there was a steadier and more efficient supply. Was it reasonable, therefore, that a few customers should block the way to these advantages? St. Pancras and Glasgow, among other places, were working at the higher pressure satisfactorily. Mr. Cooper was standing out simply because the company would not agree to his terms. The cost of changing over in the case of every consumer so changed to the higher voltage was borne by the company, and up to now this had amounted to £45,000. On Prof. Kennedy's estimate, by supplying all their customers at 200 volts the company would save something like £157,000 during the next 21 years, but deducting the £45,000 spent on lamps and fittings there would be a net gain to the company of £112,000. This fact was significant to corporations, as the less capital expenditure incurred by the companies the less would local authorites have to pay for the undertakings when their lease expired.

Sir COURTENAY BOYLE: Why have your estimates been based on a period of 21 years?

Mr. BALFOUR-BROWNE replied that Prof. Kennedy had done this because at the end of that period he estimated that the duration of life of the mains would be exhausted, and consequently the distribution losses would go up to the full 12½ per cent. again, and no saving would, therefore, be made after that period. It had been stated that a larger amount of current for the same light would be used at the higher pressure, but this was not the case.

Mr. LITTLER, K.C., representing the Windsor Hotel, contended that the Board of Trade had no power to make the alteration required. Under this regulation the consumer had a vested right, and nothing but an Act of Parliament could deprive him of it.

Mr. DANCKWERTS, K.C., for the City of London Corporation, concurred in this view.

Mr. ALFRED LYTTLETON, K.C., on behalf of the London County Council, said that the companies were not seeking a fresh regulation, but merely the alteration of an existing one.

Sir COURTENAY BOYLE held that the Board of Trade had power to make the alteration. The present regulation did not *compel* the consumer to take 200 volts, and therefore his advice to the Board of Trade would be to the above effect.

Prof. A. B. W. KENNEDY, F.R.S., under cross-examination by Mr. Roger Wallace, K.C., said that it was in 1895, having discovered that reliable 200-volt lamps could be obtained, he advised the Westminster Company to make the change, and the actual changing over was commenced in 1896. His experience with 16 c.p. 200-volt lamps was that on first use they rose slightly in candle-power; at 500 hours they fell to 16 c.p. again, while after 1,000 hours' use they were about 14½ c.p., results which compared favourably with the 100-volt lamp. It was a mistake to think there was more danger. For one thing the company was working under Board of Trade rules, and, further, in any three-wire system the negative side was practically at earth potential, so that any consumer on the positive side had a pressure of 200 volts above earth potential in his house. Of course, if he wilfully put himself in the way of a shock he would get it.

Sir COURTENAY BOYLE: I suppose a shock at 400 volts would be severe.

WITNESS said he himself had had more than 400 volts. The danger from fire was not increased, because more pains were taken over the installation generally. There were advantages both to the company and to the consumer. First of all to the company there would be the saving of £7,500 per annum which it was necessary to expend on mains in order to keep the distribution losses down to 12½ per cent. Further, if the pressure could be changed to 200 volts the present mains could be used for approximately 21 years before the losses reached 12½ per cent., and they would be at once reduced to about 4⅞ per cent. In his report to the Westminster board of directors in 1896, and at other times to a few corporations, he had stated that the consumer had his share of the advantage of this save in capital expenditure. The company had spent more than £38,000 in the consumers' houses, reduced the price of current, and substituted new lamps for old. As the regulation now stood an objecting consumer could render it impossible to carry out the change, and this was a distinct loss to the shareholders. If it had not been for these eight consumers the whole of the Westminster system would have been changed over by now, whereas instead, special plant had to be installed in the station for the 100-volt current. The company had shown a generous disposition to reduce the price, and the average was 4⅞d. per unit

By Mr. LITTLER, K.C.: In the case of a man's business being dislocated while the workmen were in the place he did not know what would be done, probably arbitration. He did not agree that the life of lamps was shortened, and the suggestion that there was 33 per cent. less life with a 200-volt lamp than with a 100-volt was simply absurd. (This figure was quoted by Mr. Littler as having been given him by the managing director of the Electric Tested Lamp Co.) Neither was it a fact that the efficiency was less. All 8 c.p. 200 volt lamps to his specification had to run 1,000 hours or he would not accept them, and if they consumed something like 3½ watts per candle up to 4½ watts, he considered them satisfactory.

By Mr. DANCKWERTS, K.C.: The main advantage of the higher voltage over the lower was that there was the same current in the mains, but being at a higher pressure a great deal more work was done. He knew of no disadvantages. He had been concerned with Edinburgh, Oldham, and Dublin, where the voltage had been raised, and in all these cases the consumers' fittings had been overhauled or replaced as the case might be. The principle of indemnifying the customer from all expense seemed to him a fair one.

By Sir COURTENAY BOYLE: He did not think there was much more fear of the insulation breaking down with 200 volts than with 100 volts. The insulation tests made on the 100-volt mains were good enough for the 200 volts.

By Mr. DANCKWERTS, K.C.: If the insulation was not good for the 100 volts, it certainly would not be strong enough for 200 volts, but if the insulation in the first instance was really good, the increase in pressure made no difference. It was necessary for the supplier to overhaul the customer's fittings so as to ensure a greater sense of security, and in this respect the supplier's and consumer's interests coincided. The only new fittings necessary were the lamps as 100-volt holders were sufficient for 200 volts. From the higher voltage, *per se*, the consumer got no definite advantage, but from the way he was treated in comparison with a consumer who had not been changed he got a distinct benefit, because the whole of his installation was overhauled for him and he was presented with new lamps and a free inspection.

By Sir COURTENAY BOYLE: If the consumer supplied himself with new lamps he got no benefit in this direction at all.

By Mr. DANCKWERTS, K.C.: Leaving out the question of lamps and price of current, a consumer was no better off and no worse off if supplied at 200 volts. The prices of the lamps were about the same. His remarks on the question of lamps had not been confined to 16 c.p. With 8 c.p. lamps 200 volts was more satisfactory, but in regard to lower candle-power, such as 3 c.p. or 5 c.p., he said they were very rarely used even on the 100-volt current, and more often were used with pressures of 50 or 60 volts. Many thousands of such lamps were connected to the Westminster mains. The consumption of the consumers after the change over had been practically unaltered.

Mr. LITTLER, K.C., here explained that as it was possible to overcome the opposition in the Westminster area of the Westminster Company, he would like to postpone any further cross examination of Prof. Kennedy on behalf of the opposition, with the hope that an amicable arrangement would be arrived at before the next sitting. This was agreed to.

By Mr. ALFRED LYTTELTON, K.C.: Witness considered that if, after a consumer had met the requirements of the company, any point arose necessitating arbitration, it was only fair to ask the consumer to meet the expense of this.

By Mr. ROSKILL, K.C.: It was not his experience that a better light was obtained with 200 volts than 100 volts.

Mr. J. HEALD, chairman of the Electricity committee of the Lancaster Corporation, cross-examined by Mr. Roger Wallace, K.C., agreed entirely with Prof. Kennedy.

Mr. W. A. CHAMEN, electrical engineer to the Glasgow Corporation, was then called on behalf of the application. Cross-examined by Mr. Wallace, K.C., he said the Glasgow area amounted to 28 sq. miles, and that 250-volt lamps were used in consumers' premises. It was in 1893 that supply at 100 volts pressure on the three-wire system was commenced in Glasgow. Now, however, a very large proportion of the consumers were on the 250 volts, and it was only in about a dozen cases that obstruction was met with one of these being an absolute refusal. He considered most of them to be an attempt at extortion. A number of these were in the Kelvinside area, a system which had been taken over from the Kelvinside Company, and this necessitated the laying of special mains or the installation of a motor transformer in each case for the purpose of reducing the pressure from 250 volts. This latter course had been adopted in one case, but it was a most unsatisfactory proceeding. The smaller the motor generator the more troublesome it became.

Sir COURTENAY BOYLE: How often was it examined?

WITNESS said that the consumer examined it once a day, and that the Corporation sent to it once a week, and the cost, so far, to the Corporation was £150.

By Mr. WALLACE, K.C.: Glasgow Corporation had spent some £23,000 in consumers' houses consequent on the change. Where necessary he was in favour of arbitration, but in the majority of cases with which he was concerned there had been no need for it. The total number of consumers in Glasgow was 3,500. Of these 1,350 were supplied at 100 volts, and the remaining 2,150 were already on the 250-volt system. Of the 1,350 not yet changed, 460 were quite prepared and the remainder had not yet been dealt with, and he did not anticipate more than a dozen real objectors. All those at present changed over were entirely satisfied. He agreed with Prof. Kennedy on the question of danger and less pulling up of streets.

By Mr. DANCKWERTS, K.C.: At Glasgow it did not occur to them that any proceeding but to take the law into their own hands was necessary until after they had done it. The average cost to the Corporation per consumer for the change averaged about £14 or £15, and the saving to the Corporation was in the fact that a 14 per cent. or 15 per cent. distributive loss was now less than 5 per cent. The light was worse in the centre of the town than outside owing to the excessive overloading of the mains, but this was being gradually overcome by the change of pressure. It was much easier to maintain a constant pressure with 200 volts than with 100 volts on account of the greater distributive loss and difficulties of balancing, &c., in connection with the latter. They had various makes of 200-volt lamps at Glasgow, and only one had turned out unsatisfactorily. The average consumption was 4 watts per candle.

By Sir COURTENAY BOYLE: He had never known of any instance where the alteration of the fittings, &c., in a house had necessitated an expenditure in new tapestries or furniture, but if such did happen it was a matter he would like referred to an arbiter.

*Thursday, March 7th.*

The following is a summary of the day's evidence. A full report will appear in our next issue:—

Mr. Littler, K.C., announced that no decision had been arrived at yet in the matter of the opposition in the Westminster area of the Westminster Company, but that the matter was to be still further discussed. Mr. Moon, K.C., who next opened the case for the Chelsea Company, was followed by Mr. Percy Still, engineer to the Chelsea Electrical Supply Co., who gave evidence to the effect that, out of 2,082 consumers, 1,516 were supplied at 200 volts and 566 at 100 volts. Practically all their changed-over consumers had done so voluntarily. At 100 volts, consumers were charged at the rate of 6d. per unit whilst 200-volt consumers were charged on the Wright maximum demand system, viz., 6d. for the first 1½ hours and 3d. for every unit consumed afterwards. The advantage to consumers in the actual price charged during 1900 was a total saving of £3,000 for the same amount of light. The company was working at a loss in supplying the 100-volt consumers. The maximum they were empowered to charge under their bill was 10d., but they had given notice of an increase to consumers at 100 volts to 7d. per unit from July 1 next. He agreed that previously to the Board of Trade revised regulations in 1896, 200-volt lamps were not so efficient as 100-volt lamps but this was not the case now. He estimated a saving of from £2,000 to £4,000 per annum on mains if the pressure were doubled. In answer to Mr. Danckwert's query as to the practicability of motor transformers for a particular section of the undertaking if the 100-volt consumers were sufficiently concentrated, he did not think there would be any engineering difficulty, but it was a thing he himself would not do. He estimated the cost of such an installation at £600. In the Chelsea case, the consumers bore the expense of the alteration to fittings, &c. His experiments with 200-volt lamps had proved that some ran as long as 1,500 hours before breaking down. The next witness was Mr. Sydney Baynes, the St. Pancras Borough Council Engineer, who stated that great difficulty had been experienced with consumers on the question of the change, but he admitted that in one case they had threatened to discontinue supply unless the consumer consented to the higher pressure, a proceeding which he also admitted the Borough Council knew was illegal. The prices charged in the borough were, for the 200-volt consumer, either a "flat" rate of 5d. or Wright demand system at 6d. for the first hour and 2d. afterwards. Practically the revised Board of Trade regulations did not apply to St. Pancras, as their order was dated 1883, but the fact that a copy of the revised regulations had been sent them by the Board of Trade had induced them to consider they applied. Mr. Massey next objected on behalf of the Crown authorities, and Col. Crompton followed with evidence in favour of the change on general principles. Practically all the evidence he gave, he said, had been given by him years ago, when the question of raising the pressure to 100 volts was discussed, and the arguments against the 200 volts pressure were equally absurd.

This concluded the evidence in support of the application on general principles, special cases having yet to be dealt with.

The enquiry was adjourned until Tuesday next.

## THE MAXIMUM PRICE OF ELECTRICAL ENERGY.

On Wednesday, at the Board of Trade, Sir Courtenay Boyle presided over a conference of representatives of the Institution of Electrical Engineers, the electrical section of the London Chamber of Commerce, and of promoters of companies and local authorities seeking Parliamentary powers for the supply of electricity this session (all of whom were against the proposal of the Board of Trade to reduce the 8d. maximum per unit), and the London County Council (who supported the proposed change).

Among the parties appearing were Mr. Blaxland, solicitor to the London County Council, Col. Crompton and Mr. Mordey for the Institution of Electrical Engineers, Mr. R. Percy Sellon, Mr. W. Madgen, Mr. A. J. Lawson, and Mr. Musgrave for the electrical section of the London Chamber of Commerce, Mr. Sydney Morse for the Electrical Power Distribution and other companies, and Mr. Medcalf, Mr. Pritchard, Mr. Beveridge, Mr. Wakefield, Mr. Kennedy, Mr. Hooper, and others representing companies having provisional orders in Parliament this session for the supply of electricty.

Sir COURTENAY BOYLE, in opening the proceedings, said they were met to reconsider the maximum price for the Board of Trade to put into electric light provisional orders before Parliament this session. The Board had sent round a notice that they thought 8d maximum per unit should now be reduced. Since that the Institution of Electrical Engineers had urged reasons against the reduction this year, and the London County Council, on the other hand, supported the reduction.

Colonel CROMPTON, on behalf of the Institution of Electrical Engineers, said they considered that the proposal to reduce the maximum charge would prevent electric lighting in small country places. There were two distinct classes of electric light orders—viz., those for populous districts, and the orders for the remainder of the country which had not yet got the electric supply. The very small advantages to be gained by reducing the maximum in every district could not be weighed against the disadvantages of preventing the installation of electricity all over the country. The reduction could not result in any great advantage to the community in general, and the Board of Trade should hesitate before enforcing the regulation.

Mr. MORDEY also spoke for the Institution of Electrical Engineers.

Mr. R. P. SELLON, chairman of the Electrical Section of the London Chamber of Commerce, said in many cases people in small districts would be willing to pay a shilling or more per unit in order to have the electric light. The Board of Trade regulation would render it impossible for a corporation or a company to instal the light in a widely scattered population, where it would be so acceptable. He thought in certain cases a high maximum should be allowed.

Mr. SYDNEY MORSE, Mr. WAKEFIELD, Mr. PRITCHARD and others having spoken against the proposed reduction,

Mr. BLAXLAND, on behalf of the London County Council, said the contention of the Council was that the average maximum price should not exceed 6d. per unit. For instance, the regulations might allow of 7d. per unit for the first hour, and 5d. or 4d. in subsequent hours, but their desire was to have an average maximum of 6d. per unit.

Sir COURTENAY BOYLE, in reply, said he was exceedingly obliged to them for the courteous and able way in which the arguments had been laid before him, for the temperate and cautious expressions that had been used, and for the conviction that the Board of Trade were anxious to do the best they could for all the parties under all the circumstances. The Board of Trade were not in the least disposed to take any steps which would discourage the provision of electrical energy. On the contrary, they were most anxious that every facility should be given to encourage in the best way possible the development of electrical science and electrical distribution. They, therefore, would not lay down any hard-and-fast rule. They did think, however, that the normal 8d. per unit was too high. The Board said that very deliberately, so that that expression of opinion might sink into the minds of gentlemen concerned in the promotion of provisional orders. But as regarded this year, the Board would not adopt a hard-and-fast rule. In small places it might be left open to the promoters to show reasons why an 8d. maximum should be kept up, and, he said this distinctly, that the onus of proving that lay upon the promoters. The Board considered that anything they could do to encourage the maximum demand system ought to be done. The decision of the Board would be this: that it would not be a hard-and-fast rule to reduce the 8d. per unit to 6d., but where good cause could be shown for an 8d. or a 7d. maximum, with or without the sliding scale arrangement, the Board would take into their careful consideration the representations made to them on that behalf. He merely wished to point out one thing—viz.

that the wholesale consumer took care of himself, but the small retail consumer, who wanted electrical energy for a short time and in a small quantity, must rely upon the maximum limit of charge he had nothing else to rely upon. He said if this decision were not satisfactory he was open to receive further representations.

Mr. BLANLAND: The normal price is to be 6d., and the onus rests upon the promoters if they want more.

Sir COURTENAY BOYLE: No; I should think a 7d. maximum would be adopted in a normal case. In very large, populous places we shall try to adopt a 6d. maximum, in ordinary cases 7d., and in special cases cause must be shown why it should be 8d.

Col. CROMPTON, on behalf of the Institution of Electrical Engineers, said the arrangement was very satisfactory to them. He wished to point out that the maximum demand system protected the small consumer, though Sir Courtenay Boyle did not seem to think so. Under this system the small consumer got his light as cheap as anyone else.

The conference then concluded.

## CORRESPONDENCE.

### THE MAXIMUM PRICE OF ELECTRICAL ENERGY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the general interest created by the proposal of the Board of Trade to reduce the maximum price chargeable under provisional orders from 8d. to 6d., it may interest your readers to have the following copy of a clause suggested, after full discussion by the electrical section of the London Chamber of Commerce, in a recent letter to the Board of Trade as likely to meet the views of the Board, without any prejudice to the interests of the electrical industry and the use of the maximum demand system of charge.

The clause, which was brought forward by Mr. Percy Sellon, representing the electrical section of the Chamber at the meeting at the Board of Trade on the 6th inst., is as follows:—

Where undertakers charge any consumer by the actual amount of energy supplied to him, they shall be entitled to charge him at the following rates per quarter:—

For any amount up to 20 units 13s. 4d., and for each unit over 20 units 8d., provided that if any one year after the first complete year of working the general average price of electrical energy supplied for all purposes under the order exceeds —pence per unit, then for the following year a reduction shall be made equitably calculated to bring such general average price down to —pence per unit.

This suggestion appeared to meet with the general concurrence of the Board of Trade and of the majority of those present.—Yours, &c.,
KENRIC B. MURRAY,
Secretary London Chamber of Commerce.

London, March 6.

### CAPACITY IN ALTERNATE-CURRENT WORKING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As I am responsible for the statement in Mr. Minshall's remarks on Mr. Mordey's Paper, given in your last issue, that the Swinburne wattmeter, used in the tests marked thus †, was specially calibrated on a power-factor of 0·1, I should like to make a correction. The wattmeter itself was tested on a low power-factor and found satisfactory; but *the wattmeter in conjunction with the 20,000-ohm* series resistance as used by me at Croydon *was not so tested*. The 20,000-ohm resistance consisted of two 10,000-ohm coils made by Mr. Swinburne and wound in the manner described by him at the meeting.

In trying to find out whether the high power-factor of the Croydon cable was due in any way to its apparently low-insulation resistance, I tried the effect of varying the frequency when I noticed that at very low frequencies there was a distinct clicking sound in the 20,000-ohm resistance, which I traced to a brush discharge occurring between the layers of wire on the coils at each peak of the wave.

This brushing, which I noticed at the very low frequencies, may also be taking place at the ordinary frequencies, and leads me to doubt the accuracy of the tests taken with this Swinburne wattmeter when using the 20,000-ohm resistance in series with the P.D. coil.

Mr. Mordey and Mr. Mather have both drawn attention to the effect of wave-form on the capacity current of the cable, and it is interesting in this connection to note that when using alternators having wave-forms very different from a sine curve such as those at Croydon, the frequency of the cable current is several times the frequency of the alternator according as one or the other of the higher harmonics of the wave-form supplies the larger part of the cable current; so that it is impossible to completely compensate the capacity current by means of a choker. This is probably the reason why the observed alternator current when supplying cable and choker in parallel, even when adjusted to the best conditions, is generally much larger than the calculated value.—Yours, &c.,
W. DUDDELL.

London, March 4.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Prof. Ayrton having kindly lent Mr. Duddell the instruments and choking coil used when making tests elsewhere, we were able last week to make some tests on Helsby rubber cables comparable with those published; the only instrument not used elsewhere was an electrostatic voltmeter, which has since been calibrated at the Board of Trade laboratory.

Power factors of 0·0255, 0·0238, and 0·0228 were obtained on the same cable, using two different alternators. The result 0·0255 was obtained with the choking coil and cable in parallel, current being supplied by one of the alternators at a frequency of 103 ~ through a step-up transformer. The two other tests were made with the second alternator at a frequency of 50 ~, but without the choking coil; the 0·0238 result being obtained with the alternator direct on the cable, and the 0·0228 result with a step-down and step-up transformer between the alternator and cable.—Yours, &c.,
THE TELEGRAPH MANUFACTURING CO. (LTD.).
(A. Whalley).

Helsby, March 6.

### POWER LOSS IN CHOKING COILS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 1st inst. Mr. Clinker refers to the eddy-current losses in choking coils, and points out how serious these may become if large wire be used. I quite agree with him on this point. You will notice, however, that the wire in which he found the large loss was 0·162in. diameter or more than twice the diameter of the wire (0·080) used in the choker I exhibited at the Institution of Electrical Engineers on February 14; in fact, the wire there employed is only slightly larger than the 0·072in. wire in which Mr. Clinker found the eddy loss inappreciable. Before winding the choker above mentioned I made a calculation to ascertain whether the eddy losses in a coil of No. 14 wire would affect the intended measurements to any great extent, and found that the maximum error might amount to about 5 per cent. This error was not considered serious in the tests made on long cables. Moreover, applying the correction would, of course, make the power-factors of the cables tested come out somewhat lower than the values I gave. For more exact determination of dielectric hysteresis we constructed, some weeks ago, a choker wound with No. 18 wire, in which the eddy loss is insignificant in ordinary cases.—Yours, &c.,
T. MATHER.

London, March 4.

### THE "ACCURACY FACTOR" IN POWER DISTRIBUTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Although the audience spent two whole evenings hearing how the veto of local authorities barred the way to the development of power distribution in this country, it appears that many of those present are still quite in the dark as to the real character of this so-called veto. And yet the Parliamentary Committee that devoted nine weeks to taking evidence had for its chairman Sir James Kitson, who is not merely an M.P., but is the head of a great manufacturing firm, the director of a great railway, and the ex-mayor of a great city, and on June 27 of last year gave this most equitable decision:—

A local authority which undertakes and is prepared to give a full and ample supply of electrical energy for all purposes to consumers within its district ought not, without its consent, to be required to give facilities for the supply, within its district, of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide on reasonable terms and within a reasonable time a full and adequate supply of electrical

energy for any purpose to any company or person applying for the same within its district, such company or person should be at liberty, after notice to the local authority, to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose.

Now is it accurate, or even diplomatic, to call this decision one of "the obstacles set in the path of our industry by the governing bodies of this country," and is it not rather a decision which puts local authorities on their mettle?

For what the Committee decided comes to practically this:—If you local authorities realise what are your duties in providing for all your people "on reasonable terms and within a reasonable time a full and adequate supply of energy for any purpose" we will be no parties to any hindrance being put in your way. But if your district be one in which Bumbledom reigns supreme, then our declaration is that no municipal barrier shall be left standing to oppose the free entrance of those who come with offers of cheap electric energy.—Yours, &c., W. E. Ayrton.

41, Kensington Park-gardens, W., March 4.

P.S.—The "Accuracy Factor" may be defined as the ratio of truly what it is to apparently what it is.—W. E. A.

## SAG AND STRAIN IN TROLLEY WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have just noticed in your issue of Jan. 25 an article by B. Hopkinson on "Sag and Strain in Trolley Wires." The author has noticed the discrepancy between the calculated and actual values of the tension on trolley wires when strung at different temperatures, and rightly concludes that the tables giving values for these quantities are all in error on account of the neglect of the elasticity of wire.

I arrived at the same conclusion in this matter some four years ago, and published an investigation in the *Engineering News* of New York for Aug. 31, 1899. Under many conditions the elasticity is much the more important factor. As far as I am aware there are no tables in print which take account of this factor, and, therefore, all are in error. In view of this, the elaborate precautions taken by certain engineers in stringing wires by means of telescopic sights and with tables of sags at different temperatures are highly ludicrous, since these tables are all calculated without allowing for elasticity.—Yours, &c., Cary T. Hutchinson.

New York, Feb. 26.

## GAS POWER FOR CENTRAL STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was pleased to see that Mr. H. A. Humphrey, whose able contributions on this subject have recently attracted so much attention, replied to the criticisms in your leading article of February 1st. There can, of course, be no question as to the success at Winnington of the production of gas for power or fuel; and it is interesting to note that the original experiments with "Mond" gas were made on a 25 H.P. gas engine, whereas the last application of this gas is in working an engine of 600 H.P. The starting and control of these large engines I can confirm is now a matter of very great simplicity and should not give any trouble, least of all in a central station, and the exhaust can be satisfactorily dealt with without the trouble you suggest; indeed, should legislation at any time place any restrictions on the acidity of boiler chimney gases, gas engine exhaust shafts will stand very favourably. Like Mr. Humphrey, I do not follow the significance of your reference to the presence of carbon monoxide in producer gas. Surely this combustible constituent need not be taken into account unless it is assumed that pipes and connections will be leaky? With reference to the late Mr. Denny Lane, of Cork, did not that gentleman's suggestion apply rather to gas-driven sub-stations than to a gas-driven central station? As I follow his suggestion it is for the electric supply of a district to be carried out from a number of small stations with gas motive power, the stations to be placed as near the points of current demand as possible and inter-connected. Such a scheme, although perhaps rather bold in these days of concentration of generating plant, appears to have advantages—a greater degree of reliability would be obtained, the standing losses reduced to a minimum and much heavy expenditure on mains and feeders avoided.

The description of fuel gas supplied to such stations would be a matter entirely of local circumstances; and there is no doubt that many of the smaller gas companies throughout the country would have done something in this direction with advantage to all concerned but for the "dog in the manger" principle of local authorities and legislative restrictions. Gas of low calorific value as "Mond" gas has many advantages for use in gas engines; and it scarcely follows, in my opinion, that the gas-producing plant must be part of the central station. It might happen that the gas generators would be placed at some convenient point where "slack" could be readily delivered, and it is possible to transmit this low-value gas a very long distance under pressure at slight cost and without that depreciation in quality which would be the case with a gas rich in hydrocarbons under much pressure. It really becomes a question of gas *versus* electrical transmission. I do not think that the late Mr. Denny Lane would have confirmed your contention, for since his death various methods of producing non-illuminating gas have come to the fore. At Northwich, for instance, it is obviously better for the local electric supply company to be using four or five times the volume of "Mond" gas that would be necessary with coal gas, when the former is only 2d. per 1,000 cubic ft. and the latter probably 3s. 6d. or 4s. per 1,000 cubic ft., or about one-fifth the cost for the same power. It would be very interesting to know the facts relating to the abandonment of gas motive power in some of the recent central stations. Of course there have been instances in which gas engines have been employed for work for which they *were* not suitable, and, then again, there are several points about a gas engine which, unlike a steam engine, must be carefully considered; and a staff accustomed previously to steam plant is not, perhaps, the best to entrust with a gas plant. It was reported that the Belfast station was established to relieve the demand on the Corporation gas works, of which, however, the electrical department were until recently the best customers. Leyton also, although the original reports were very favourable, has gone in for steam; and the same question has been raised at King's Lynn. Possibly you will be able to throw some light on these points; and in this connection it will be remembered a small central station with gas power was opened on Saturday last on the Victoria Embankment by the London County Council.—Yours, &c., Chas. F. Botley.

Hastings, Sussex, Feb. 25.

# PARLIAMENTARY INTELLIGENCE.

## LONDON UNDERGROUND ELECTRIC RAILWAYS.

In the House of Commons on Monday, Mr. Bryce asked the President of the Board of Trade whether, in case the Government proposed the appointment of a Joint Committee of both Houses to consider the best lines of route for underground railways in London, all the bills for underground railways introduced in the present session would be referred to such a Committee, and whether the Government would consider the desirability of letting the reference be sufficiently wide to allow the Committee to report upon the whole question of so arranging and connecting underground lines as to enable these lines to afford the maximum of relief to surface traffic, and to secure rapid transit from the central parts of London to the suburbs.

Mr. G. BALFOUR said the reference to the proposed Joint Committee was framed so as to ensure that all the underground railway bills this session would be laid before the Committee, which would be invited to report as to whether the lines of route proposed were the best for present and future traffic, and if not, what alterations were desirable.

In the House of Commons yesterday it was agreed to appoint a Joint Committee of the Lords and Commons to consider and report upon:—

1. Whether the lines of route for underground railways on and near London, proposed by bills which have been or may be introduced during the present session, are best calculated to afford facilities for present and probable future traffic; and, if not, what modifications of those routes are desirable.

2. What special provisions, if any, should be made for the protection of the owners, lessees, and occupiers of properties adjacent to underground railways from possible damage and annoyance.

3. What special terms and conditions, if any, as to construction and working should be imposed upon the promoters.

4. Whether any, and which, of the schemes proposed by the said bills should not be proceeded with during the present session.

The House of Lords on Monday passed a similar resolution on the motion of the Earl of Morley.

# LEGAL INTELLIGENCE.

### Electrical and General Engineering Co. v. Aitken.

In the City of London Court, last Friday, the Deputy-Judge and a jury heard an action remitted from the High Court and brought by the plaintiff company to recover £111 from Mr. Albert J. Aitken, of Camden Wood, Chislehurst, for installing the electric light at his residence. Plaintiffs said defendant had paid £95 of the claim, but now the action had come into Court he not only refused to pay the balance, but had set up a counter-claim, in which he asked to be awarded £100 for plaintiffs' defective workmanship. The order for the work was given and a specification supplied for the installation in September, 1899. Plaintiffs suggested that the wires should be carried in enamelled steel tubes as a greater protection from injury, and the increased price of 25 per cent. was made for that. By a clerical error plaintiffs had only charged 20 per cent. It was arranged that defendant should select his own fittings, and that he was to receive a discount of 25 per cent. off the gross prices charged. The work was commenced in October and completed early in January, and in March plaintiffs sent in their account. Plaintiffs alleged that then defendant made a long list of complaints of leakage (due, plaintiffs averred, to the extreme dampness of the house), that he could not turn out the light in the hall, that he could not get the hall light to burn, and that the billiard-room was in darkness. Plaintiffs' workmen found considerable surface leakage caused by the dampness, and that the enamelled tubes had been damaged by defendant's builders. Fresh pipes were put in and the work left thoroughly complete. There was no cause for defendant's complaints.

Mr. J. A. BOWER, one of the plaintiffs, said their contract required that they should instal the light to the approval of the supply company at Chislehurst as well as the fire insurance company. Both of those had approved of his work, and the light was supplied after that approval to given. He was surprised to learn that defendant could not use the water in the lavatory because of the electric shock which he received upon putting his hands into the water, but such a shock would not be dangerous. It was not true that the work was done inefficiently or in an unworkmanlike manner. They had not infringed the rules of the supply company by leaving the wires uncovered. If the supply company said the installation was at the present time dangerous to their own mains, as well as to the lives of the people in the house, it would not be true. The house had been sweating in a marvellous manner, and when he was there last week the place absolutely tasted of dampness, and the walls were wet. They had put in the best material. They used open, not brazed joints. He did not know they had neglected to put any insulation between the main switchboard and the wall. His firm consisted of three persons—himself, Mr. Joseph Bower, and Mr. Louis Schram. He was an associate of the Institute of Electrical Engineers and had had 10 years' experience. They could have supplied moisture proof tubing instead of the enamel steel tubing, but the difference in price would have increased the expenses by 50 per cent. The tubing used was of the best kind and of the sort which was generally found in houses. There was a better class of tubing obtainable in which there were no joints. A lined tubing would cost three times as much. The defendant could have had insulated steel tubing, but that was a fad. He had never used brazed steel tubing, and if he had it would have made no difference.

Mr. L. SCHRAM said there was no ground for suggesting that naked wires were put under the drawing-room floor. The electric light had been in use in the house for 18 months now. The reason he did not use tubing with sealed-up joints to exclude the moisture was because it was not specified for. He did not know that the rubber round the wires had, in some instances, burned away in consequence of the current escaping. They did not take any exceptional precautions to provide against dampness.

Mr. F. J. BOWER said he had had 10 years' experience as an electrician. The wire which was used was insulated with vulcanised rubber.

Mr. H. C. Hall, A.I.E.E., arbitrator to the London Chamber of Arbitration, said he acted for the City of London Electric Lighting Co. and other large concerns as an expert. He had spent five years in the manufacture of rubber, and he was of opinion that the rubber covering of the wire used by plaintiffs in defendant's house was of the highest class used for house-work. It was pure rubber. There was no such thing as vulcanised rubber. There was no remedy for the leakage which had been complained of. It was impossible to prevent it. If plaintiffs had contracted to fix up an impossibility that was no affair of his. The only way to get rid of the condensation was to dry the place and then it would disappear.

Mr. COLAM, for defendant, said defendant's complaint was that he had been put to serious inconvenience. He had had to pay for a vast amount of electric current which had been wasted in consequence of the very defective way in which plaintiffs had installed the light. It was impossible to estimate the defendant's loss because the electric current had been escaping all over the house. Defendant had never had the supply that plaintiffs had contracted to give. At present he had only a partial supply. The supply company would not allow him to leave the current on during the night, and he was compelled to shut it off during the greater part of the day. The great charm of the electric light was its convenience, and defendant had been deprived of that convenience on account of plaintiffs' gross neglect. Furthermore, defendant was still uninsured, because the installation of electric light had been carried out so badly that the fire insurance companies would not accept the risk. He therefore asked the Court to give him something to cover his risk of non-insurance.

Mr. GUY C. FRICKER, M.I.E.E. (Messrs. Fricker, Miller & Co.), adviser to the Liverpool, London, and Globe Insurance Co., said he was requested by the company to inspect defendant's premises on Jan. 30. The company's rules had not been complied with, and he could not advise the company to accept the risk. Directly the main switch was put on there was a dead earth. That was very serious, and it might cause fire and be dangerous to life. In his view this defect was not all due to dampness, but was caused by imperfect material. Open joints had been laid in plaster work, and that was an improper thing to do. He did not notice that the house was particularly damp, as had been alleged. The insulation had not been properly fixed, and the work was by no means high class. The wire was not the best that could be furnished. Wires enclosed in damp plaster ought to be put in hermetically sealed conduits.

Mr. F. S. HANNING, of the Chislehurst Electric Supply Co., said his company had supplied electric current to defendant's house, but their requirements had not been complied with in the installation. There was considerable danger attaching to the way in which the work had been done, and defendant only had a limited use of the light. There had been short circuits.

The jury decided that plaintiffs were not entitled to more than the £95 which had been paid them on their claim, and on defendant's counterclaim awarded him £25 damages. Judgment accordingly.

### Sotheby & Co. v. Minturn.

Mr. Justice Channell had before him yesterday this case—a claim for work and labour done and material supplied in the installation of the electric light in a private house for £51.

Mr. DAVID (for plaintiffs) said defendant, a lady, seemed to have employed Mr. Swinton to negotiate the matter for her. The work in question had to be done on terms agreed within 14 days. That was the original work, which came to £27. As soon as plaintiffs commenced work there was a stoppage, and afterwards alterations and additions were made to the contract, and the whole thing, which commenced in February, did not get finished till May. The lady kept asking for estimates for very small items, and wished to impose penalty clauses, and in May plaintiffs declined to do any more work. Defendant claimed £79 by way of liquidated damages in her counterclaim, being at the rate of £1 a day for the time over and above that stipulated for in the contract, and also for injury done to her premises by reason of negligence of plaintiffs' workmen.

Judgment was given for plaintiffs for £41. 15s. 10d. on the claim, and for plaintiffs also on the counterclaim.

### Callender's Cable and Construction Co. v. Killarney Electric Lighting Co.

In the Dublin High Court on Wednesday an application was made for leave to eject the defendants from their premises for non-payment of rent, notwithstanding the appointment of a receiver. The action was brought by plaintiffs for debt. A receiver was recently appointed over defendants' undertaking, and there was two years' rent due.

Mr. P. A. O'C. WHITE said that the receiver was appointed to prevent the sweeping away of the assets of the Killarney Company by execution creditors for the benefit of debenture-holders. The company had been very badly managed, and two years rent had been allowed to accumulate. Messrs. Callender were willing, if these proceedings were stayed, to pay the two years' arrears of rent due, amounting to £30. 10s., and a sum of, say, £10. 10s. for the costs of the action, and a small sum for the costs of the motion.

The MASTER of the ROLLS approved the acceptance of the proposal, and the order was made accordingly.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The governors of the Northern Polytechnic Institute, Holloway, London, are prepared to appoint a principal at a salary of £500 per annum. An advertisement gives some additional particulars, and applications have to be made before March 30. Mr. W. Macbeth is clerk to the governors.

An electrical engineer is required to take charge of the plant at the Royal Prince's-parade, Bridlington. Applications to town clerk (Mr. A. E. Matthewman), Town Hall, Bridlington, by March 14. See advertisement.

Coventry Electric Light committee invite applications for the position of manager of their electricity works. An advertisement contains further particulars, and applications must be delivered at the office of the town clerk (Mr. Lewis Beard) by 5 p.m., 22nd inst.

Ilford District Council require an assistant electrical engineer, an engine-driver, assistant driver, two stokers, two switchboard attendants, two arc lamp trimmers, and a meter fixer and inspector. Applications to clerk (Mr. John W. Benton) by 11th inst. See advertisement.

The London Electric Supply Corporation require an assistant engineer. Applications to engineer-in-chief, 25A, Cockspur-street, London, S.W. See also advertisement.

A motor inspector is wanted by the Bradford Corporation. Applications to city electrical engineer (Mr. R. A. Chattock, M.I.E.E.), Town Hall, Bradford. See advertisement.

Perth Corporation require a switchboard attendant at the electricity works. Commencing salary £1. 10s. per week. An advertisement gives some further particulars, and applications have to be in by 20th inst.

The British Electric Traction Co. are prepared to admit a limited number of qualified students as pupils. See advertisement.

Lambeth (London) Borough Council require a chief engineer for their baths and washhouses, Kennington-road, S.E. Applications to town clerk by 12 noon of March 20.

West Bromwich Corporation require an accountant-clerk for their electricity department. Applications to town clerk by March 13.

Lincoln Corporation require an engineer and manager for their electricity works. Applications to deputy town clerk by March 11.

A charge engineer is required for Plymouth Corporation electricity works. Applications to borough electrical engineer by March 12.

---

Bath Electric Light committee recommend the appointment of Mr. Francis Teague, late of Paisley, as city electrical engineer, in succession to Mr. G. F. Metzger, who was recently elected chief electrical engineer at Manchester. Mr. Teague's commencing salary is £350 per annum. There were over 50 applicants, and this number was finally reduced to three, viz.:—Messrs. Teague, Pullen (Ealing) and Sayer (Hampstead). The committee's selection was made by a unanimous vote.

Having completed the electrical equipment of the Dublin United Tramways Co.'s system (as resident engineer for the British Thomson-Houston Co., Ltd.), Mr. Arthur Jacob, M.I.E.E., has severed his connection with the Dublin company, and has been appointed acting manager to the Johnson-Lundell Electric Traction Co. (Ltd.).

Plymouth Electricity committee have decided to promote Mr. E. G. Okell, the chief assistant electrical engineer, to the position of borough electrical engineer, in succession to Mr. John H. Rider, at a salary of £350, increasing by annual increments of £50 to a maximum of £500. Mr. S. T. Allen, charge engineer, has been promoted to the position of chief assistant at £200 per annum, increasing by increments of £25 to a maximum of £300.

The Manchester City Council, on Wednesday, endorsed the appointment of Mr. S. D. Pearce, chief engineer at the Shepherd's Bush generating station of the Central London Railway Co., as deputy chief electrical engineer, at a salary of £500 per annum.

Mr. Frederick Coutts, of the Dundee Tramways, has been appointed manager of the Ayr Burgh electric tramways department.

---

**Aberdeen.**—Application has been made for further borrowing powers, to the extent of £81,000, to meet additional expenditure on machinery, buildings, &c., for the electricity department.

**Barcelona.**—The Barcelona Tramways Co. has received authorisation to equip its lines from Barcelona to Sarriá, from Barcelona to Las Corts, and from Las Corts to Sarriá for electric traction, in substitution of the horse and steam power now in use.

**Barrow-in-Furness.**—The Council decided on Tuesday to apply for sanction to a loan of £12,500 for main extensions, &c. The Council also resolved not to purchase the local tramways from the British Electric Traction Co. They are willing to confer with the company as to leasing and converting the lines to electric traction or to consider any other proposal.

**Basingstoke.**—In a lengthy report by the consulting engineer (Mr. R. P. Wilson) the Council are recommended not to part with their provisional order, but to either themselves establish electricity works or lease the order to a company. The cost of establishing a municipal system is put at £17,200, and, if a dust destructor is added, an additional £750. After two years the undertaking would, it is calculated, be a financial success.

**Bedwellty (Glam.).**—The Council are to engage an electrical engineer to report upon the cost of an electric lighting scheme for the Rhymney Valley area.

**Blackpool.**—The salary of the tramway manager (Mr. J. Lancaster) has been increased to £300 per annum, and when the profits of the tramway undertaking reach £15,000 a year he is to have £350, and £400 when these profits reach £20,000. Mr. Lancaster had practically received the appointment of manager of the Burnley Corporation tramways at a commencing salary of £350, but he will now remain at Blackpool.

**Bolton.**—At Wednesday's meeting of the Council the question of repaving the tramway track in the centre of the town, at a cost of £10,000, was referred back owing to the Streets committee not having consulted the Tramways committee. The tramway receipts for February were £5,020. 17s. 8d., compared with £3,033. 8s. 8d. last year, and the number of passengers carried showed an increase of 476,696.

**Bombay.**—The *Glasgow Herald* is informed that the Bombay municipality has granted a concession to Mr. W. Gentry Bingham (on behalf of the British Pioneer Electric Light and Power Co. of India, Ltd.) for the electric lighting of the city and for the electrical equipment of the existing 60 miles of horse tramways; and that a group of City financiers has guaranteed the necessary funds, amounting to about £2,000,000 sterling.

**Burnley.**—The Corporation will acquire the Burnley and District Tramways Co.'s undertaking in Burnley for £53,000. Electric traction will be introduced at an estimated capital expenditure of about £120,000. The Electricity Sub-Committee recommend the Corporation to abolish the present system of charging for current, and to adopt the uniform rate of 4d. per unit for all current supplied.

**Bury St. Edmunds.**—The principal thoroughfares are now illuminated electrically, current having been switched on for the first time on Thursday evening last.

**Darlington.**—The Imperial Tramways Co. offered to sell to the Corporation so much of their undertaking as lies within the borough for £9,500, and the Council have made a counter offer of £7,500.

**Derby.**—An inquiry has been held here into the application of the Corporation to borrow £35,850 for electric lighting extensions. There was no opposition.

**Dudley.**—The Tramway and Electric Lighting committee reported to the Corporation on Tuesday that, having considered the organisation of the staff on the completion of the electricity generating station, and being of opinion that it was important to continue Mr. R. P. Wilson's connection with the undertaking until such time as it might be considered to be in complete working order, recommended that he be engaged as chief engineer, and be responsible for the whole of the work of the engineering department, at a salary of £300 per annum, on the conditions that he retains Mr. Marsh as assistant engineer and engages one other qualified assistant, both to be paid by him.

A deputation from the committee recently waited upon the Local Government Board to urge a reconsideration of their decision not to sanction any loan for "free" wiring of premises, but being unable to obtain any alteration in the decision, which the deputation were informed must be taken as final, they now recommended that the scheme be abandoned.

Consumers are to have the option of taking current at a uniform rate of 5d. per unit or 6d. for two hours a day and 1½d. after. No meter rental is to be charged.

**Dumfries.**—Mr. Ritchie (Messrs. Carrick and Ritchie) has been engaged to report upon the feasibility of utilising the water power of the Glen Burn for the generation of electric current.

**Dundee.**—The official inspection of the east end electric tramways took place on Wednesday.

**Electricity in Mining.**—The extensive scheme for working the Kolar gold mines of Mysore by electric power generated from the Cauvery Falls has now assumed practical shape. The design of the work has been completed, and contracts placed for the necessary plant. The distance of the Falls from the mines is about 90 miles, and 4,000 H.P. is to be generated for transmission. Profs. George Forbes and W. C. Unwin, with others, have formed an advisory committee on the subject, and tenders have been sent in by American, German and Swiss contractors for the plant. The contracts have been placed with the General Electric Co. of America, and with Messrs. Escher, Wyss & Co. of Zurich, the latter firm supplying the hydraulic plant. The total cost of the completed works is estimated at £257,390, and when completed an immense saving in the working cost of the mines is calculated upon.

**Eccles.**—It was explained at the meeting of the Town Council on Tuesday, that the deficit on the working of the electricity department in 1900 was due to the enhanced price of coal and loss on the day load. Arrangements had been made to economise on the day load, to increase the supply, according as demand arose, to double the present output, and to introduce a new scale of charges as follows:—For office and workshop lighting, 6d. per unit; shops, 5d.; places of worship and private residences, 4½d.; and clubs and public-houses, 4d. The Electricity committee have arranged to meet a representative of the Trafford Park Supply Co. to discuss the question of the supply of electricity in bulk.

**Electricity on Battleships.**—Four new battleships (the "Drake," "Montagu," "Albemarle" and "Kent") have been launched this week, and in each case a large part of the ship's work will be performed by electrically-driven machinery. We understand a feature has been made of the electric lighting installations, and also that a complete telephonic service has been furnished for all parts of the vessels. The ships are provided with electric search lights, electric rudder indicators for the conning towers and bridges, and ventilation is effected by means of electric fans.

**Exhibitions.**—An English exhibition is to be held at the Taurida Palace, St. Petersburg, in November next. Exhibits can be forwarded by the Baltic Railway via Reval at ordinary rates from July 1, and at the close of the exhibition are to be sent back free of charge as far as Reval.

The Council of the County Borough of West Ham propose to hold an electrical exhibition at the Town Hall, Stratford, during the week ending May 25, and makers of electrical apparatus are invited to exhibit. No charge will be made for floor space, and current (at 100 volts, 50 periods) will be supplied free of charge. Applications should be addressed to the borough electrical engineer (Mr. James K. Bock), Electricity Station, Abbey Mills, West Ham, E.

It is announced that an exhibition of industries, arts, and sciences is to be held at Ponta Delgada, St. Michael's, Azores, in June next.

**Gravesend.**—The Council have re-affirmed their resolution to retain Mr. W. H. Trentham to prepare plans, &c., in connection with the application to borrow money for erecting electricity works.

**Grays.**—The Council have increased the salary of the surveyor to £300 per annum in consequence of his acting as clerk of works of the electricity station buildings.

**Guadeloupe.**—A recent report of the United States Consul at Guadeloupe deals with the subject of the demand for machinery in that country. The report is dated November, 1900, and amongst the requirements is specified the equipment of a station for the lighting of the city of Guadeloupe by arc and incandescent lights. Export houses interested in this matter should communicate with Mr. T. Papin Beauford, Bâteaux à Vapeur, Pointe-à-Pitre, Guadeloupe, to whom catalogues and particulars should be forwarded.

**Ilkley.** The Council have declined the offer of the Yorkshire Electric Power Syndicate for a supply of electric current.

**Kingston-on-Thames.** The borough electrical engineer (Mr. J. E. Edgcome) has reported as to carrying out the powers obtained in their 1900 Act for wiring premises, and the methods favoured are:—(1) The Corporation should enter into agreements with consumers on the lines of hire-purchase for wiring and supplying fittings to premises, according to the individual requirements of each consumer, the work being carried out by a contractor, and the borough electrical engineer testing and approving of each installation; or (2) make agreements with consumers on the lines of hire-purchase, but should themselves employ a staff to carry out the installation work. The first system will probably be adopted.

**Leeds.**—The salary of the electric tramway engineer (Mr. John Burbridge) has been increased from £400 to £500 per annum.

**Lecture.**—Mr. R. W. Hogarth, consulting engineer, Edinburgh, delivered a lecture before the East of Scotland Engineering Association on Monday on "Electricity as a Motive Power for Railways." Mr. Hogarth said that, at the end of 1900, 1,600 miles of tramway and light railway track were in operation and 300 miles of route authorised or under construction. The amount of capital invested in electric traction in Great Britain had risen from £8,500,000 sterling in 1897 to £26,000,000 in 1900. Discussing the Central London Railway, the lecturer expressed the view that the electrical locomotive has no future before it, as on the broad lines of flexibility of operation, safety, economy, and improved service, the multiple unit system was that which must necessarily displace the locomotive, at any rate for passenger lines. Had the multiple unit system been adopted on the Central London line, the lecturer urged that the congestion of the morning and evening traffic would have been obviated. The lecture was freely illustrated with limelight views, and the lecturer was accorded a hearty vote of thanks.

**Leith.**—The accounts of the Electricity department were presented and approved by the Council on Tuesday. The capital expended amounts to £44,014. 4s. 10d., and £35,000 of that sum had been borrowed for 30 years at 2¾ per cent., and £9,000 for five years at 3¼ per cent. £1,000 was taken last year from the burgh general assessment to meet the estimated deficiency, and £650 was required, £350 being carried forward. This year it was hoped that the revenue account would meet all the charges, but it had been found necessary, owing to the high price of coal, to charge against the assessment a debit balance of £378. 10s. 10d. The income from public lighting was £3,041; from motive power, £1,247; from public lighting, £2,160; miscellaneous receipts, £15—total, £6,385. Cost of generation and distribution was £4,743, leaving a profit of £1,641. This, added to the balance forward, gave £2,370 to meet interest (£1,602) and repayment of capital (£1,208).

A sub-committee has been appointed to discuss the practicability of wiring consumers' premises, hiring out motors, &c. Further additional plant is to be erected at the station, and the Council are recommended to make a reduction in the charge for current for lighting and power.

**Light Railway.**—The Isle of Thanet Light Railways (Amendment) Order has been submitted to the Board of Trade for confirmation. Objections by 29th inst.

**Manchester.**—At the meeting of the City Council, on Wednesday, the chairman of the Electricity committee (Dr. Bishop) explained the position in regard to the recent notice as to the supply of electric current for lighting. He said there seemed to be a prevalent opinion that the committee had deliberately withheld the supply of current for lighting in order that they might utilise it for the tramways. That was a total misapprehension. They had at the present time sufficient power to take on a considerable number of consumers for lighting; but if they were to do that now they might find, when they came to take on the heavy load of the autumn, that they would have to disconnect these new consumers. They hoped within a few weeks to be able to state distinctly whether sufficient machinery would be running at the new Bloom-street station by October to justify them in taking on fresh customers. They had recently received applications for current for 10,800 8 c.p. lamps, bringing the total waiting connection to 60,000 lamps. As to the electricity works, the machinery was waiting to be erected. Plant had been appropriated at the Dickenson-street works to provide power for the cars on three routes, and the committee hoped to be able to set aside a portion of the plant at other places for tramway working.

The following increases of salaries of officials have been sanctioned:—*Tramways Department.*—Mr. J. M. M'Elroy, general manager, from £400 to £500 a year; Mr. James Wood, accountant, from £230 to £260; and Mr. D. G. Mallalieu, permanent way inspector, from £3 a week to £182 a year. *Electricity Department.*—Mr. F. E. Hughes, secretary, from £350 to £400; Mr. W. E. Fojden, accountant, from £200 to £230; Mr. W. F. Long, assistant engineer, from £210 to £235; Mr. J. A. Constantine, steam assistant, from £220 to £240; and Mr. I. A. Cookson, draughtsman, from £200 to £225.

**Middlesbrough.**—The Corporation on Wednesday authorised application being made for a further loan of £21,000 for providing additional generating plant and extending the mains.

**Municipal Telephony.**—Aberdeen Corporation have instructed a special committee to report as to the propriety of obtaining a licence from the Postmaster-General to establish a municipal telephone exchange for the city and district.

The Portsmouth Telephone committee have decided to instruct Mr. A. R. Bennett to prepare specifications with a view to inviting tenders in connection with their municipal telephone scheme.

**Newcastle-under-Lyne.**—The Council have appointed Messrs. Lacey, Clirehugh and Sillar consulting engineers for their electricity supply scheme.

**Official Vocabulary of Compulsory Code Words.**—The authorities at Berne have reached the letter V in the compilation of the new edition of the Official Vocabulary of Code Words, and are consequently approaching the end of their labours.

**Perth.**—Although the electricity works have not yet been started applications have been received for the equivalent of 14,000 8 c.p. lamps. As the capacity of the present plant is only equal to 12,600 lamps extensions will have to be considered immediately.

**Presentation.**—Mr. E. Cross, who is leaving Aberdeen to take up the position of borough electrical engineer at Rotherham, was entertained on Thursday evening by the staff of the electricity department and presented with a case of drawing instruments, a collection of books on electrical and allied sciences, and a photograph of the staff. The city electrical engineer (Mr. J. Alex. Bell) presided over the meeting, and, in making the presentation, said Mr. Cross was the first Aberdeen assistant who had been appointed a chief electrical engineer, which showed that Aberdeen was growing in standing and importance in electrical distribution. He referred to the excellence of the work carried out by Mr. Cross during the two and a-half years he had been connected with the department, and expressed his sincere regret at losing him. He was confident Mr. Cross would fill his new position with credit to himself and to Aberdeen.

**Private Bill Legislation.**—The following bills were read a second time in the House of Commons on Monday:—Blackburn Corporation, Bradford Corporation, Bury Corporation and Tramways, Caledonian Electric Power, Clyde Valley Electrical Power, Derby Corporation, Derbyshire and Nottinghamshire Electric Power, Eccles Corporation, Mansfield Corporation, Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board and Yorkshire Electric Power.

The Islington and Euston Railway, the North-East London Railway, the Piccadilly and City Railway and the Manchester and Liverpool Express Railway Bills have been read a second time in the House of Lords.

**Robbery.**—At the Sussex Assizes two hawkers, named Perks and Mann, were recently charged with stealing 340lb. of copper wire from the premises of the National Telephone Co., at Hastings, in December last. Gow, a foreman wireman, said there should have been 600lb. of wire on the premises. It was stacked on the roof, and about 400lb. was missed. The police recovered 60lb. in connection with another charge. The wire lost was worth between £9 and £10. The jury found prisoners guilty, and Mann was sentenced to six months and Perks to four months hard labour. On another charge of a similar nature a prisoner named Catt, also a hawker, received a sentence of four months hard labour.

**Shoreditch (London).**—The consulting engineers (Messrs. Kincaid, Waller and Manville) estimate that the supply of constructional steel and ironwork for the new generating station at Haggerston will cost £7,000. The estimate includes provision for coal handling plant, coal storage bunkers, elevator tower, roofing, &c. The borough surveyor has been instructed to prepare plans for the extension of the Evelyn-street sub-station and the construction of a cable tunnel under the canal from the new generating station to Great Cambridge-street.

**Shoreham.**—The Brighton and District Tramway Co. have submitted a scheme for the conversion of their system to electric traction, and the Council propose to convene a conference of all the interested local authorities to discuss the subject.

**Stockton.**—The manager of the electricity works (Mr. Ford) has submitted estimates for providing additional plant and carrying out extensions of the mains at a cost of about £21,000. Plans are to be prepared and tenders invited for another engine.

**Stepney (London).**—The Borough Council have decided to expend £120,000 in electric lighting extensions. About 100 miles of cable are to be laid, and about 280 arc lamps erected in the principal thoroughfares.

**Sunderland.**—The Board of Trade inspection of the new Southwick, Tatham-street and Hylton-road electric tramway routes took place on Wednesday. The Tramways committee recommend the Council to undertake the extension of the electric tramways to the east end of the town at an estimated cost of between £9,000 and £10,000.

**The Alleged Cutting of Telephone Wires.**—At the Central Criminal Court the Grand Jury have thrown out the bill against John Nolan, committed from Stratford petty sessions on a charge of maliciously cutting telephone wires the property of the National Telephone Co. Particulars of the case appeared in our last issue.

**Torquay.**—The salary of the borough electrical engineer (Mr. P. Storey) has been increased from £200 to £300 per annum. Mr. Storey has been instructed to report upon the cost of constructing four lengths of electric tramways.

**Tunbridge Wells.**—A determined effort is being made to establish electric tramways in Tunbridge Wells. Two meetings were held on the 27th ult. to discuss this matter. The decision of one of the meetings was against the project, and that of the second in favour. Those who are acquainted with the charming Kentish town will watch the development with interest. In order to ascertain public opinion on the subject the above two meetings were called, but only a slight interest is at present shown in the project by the ratepayers.

An inquiry will shortly be held into the application of the council to borrow a further £10,000 for establishing a municipal telephone service.

**Water Power Utilisation.**—The town of San Mateo de Gallego (Spain) has recently been equipped with an electric supply station driven by water power.

The water power of the river Werra is to be utilised for driving generating plant for lighting, &c., the town of Mihla (Germany).

**West Bromwich.**—An inquiry was held here last week into the application of the Council to borrow £10,000 for electric lighting. The town clerk (Mr. A. Caddick) explained that the application was made under sec. 29 of the West Bromwich Corporation Act, 1900, which gave the Council power to supply electric fittings and also to undertake the wiring of houses. According to the estimate of the consulting engineer (Mr. R. C. Quin), the capital would be spent in two years from the date of commencement. They wished the loan to be for ten years. For the hiring of motors they would require £5,000, and for wiring houses, purchase of materials, &c., another £5,000. It was stated that so far £11,500 out of the loan of £30,000 had been spent in connection with the electrical undertaking, and they would probably be in a position to commence supply in about a month. There was no opposition.

**Wimbledon.**—Mr. F. Barnes Spencer has yielded to the Electric Lighting committee's desire that he should remain with the Council as chief electrical engineer, and the committee recommend that his salary be raised from £300 to £400 a year from April 1, for two years, when the matter will be further considered. This recommendation was carried unanimously, Mr. Casswell urging that to have lost Mr. Spencer just now would have been nothing short of a calamity.

**Worcester.**—In his annual report on the working of the electricity department the city electrical engineer (Mr. C. J. Sutherland) states that it is a matter for congratulation that the accounts show a small profit, in spite of the increase in the cost of coal of £1,051. 8s. The cost of coal per unit had increased from 0·707d. to 1·027d., while the weight of coal used had only increased from 11·19lb. per steam unit to 11·27lb. The total works cost showed an increase of 0·323d., and, as coal alone was responsible for 0·320d. of the amount, he thought the result might be considered satisfactory. Every other item of cost per unit, including salaries, &c., had decreased except insurance, which showed a small increase of 0·004d., owing to the committee having decided to insure the works more fully against fire and the alternators against self-ignition. The total costs had increased 0·211d. per unit. Current used for public lighting had slightly decreased, while current sold to private consumers had increased 17·62 per cent., against 20·73 per cent. last year. The waterworks used 24·22 per cent. more current for their motors, the total units being higher than any previous year. The mean price per unit obtained had risen from 3·638d. to 3·708d., owing to the increase in the price of current, which came into force in the last quarter of the year. The average price obtained for private lighting only was 4·48d. per unit, which proved the advantage of the maximum demand system of charging to the consumers, for as a whole they paid less than 4½d. per unit. The number of new customers connected during 1900 was 69, against 51 in 1899. The water power had proved much better than during the previous year, the result being that practically half their units were generated by water power, the actual figures being 50·87 per cent. by steam and 49·13 per cent. by water. One result of the increased water power was that they were able to run both motors at the waterworks more frequently, and consequently the units used for pumping were much higher than usual. The contract formerly existing between the National Electric Wiring Co. and the Corporation was terminated last June, up to which time they had obtained 44 customers. From June till the end of the year nine customers had availed themselves of the Corporation's "free" wiring system, and there seemed every probability of its becoming more popular as its advantages were more fully realised. The Ferranti plant had run well during the winter load, but there was an unfortunate breakdown of the Ferranti engine in November, and for some eight weeks it could only be run on the high-pressure side, which caused a large increase in the coal used during those weeks. The new generating station in the town was well under way, but it was doubtful if the plant would be available for use before the spring of next year. The total capital expended, up to the end of 1900, was £82,629. 14s. 5d., compared with £76,235. 14s. 10d. in 1899. The capital expenditure worked out at £2. 7s. 10d. per lamp connected, or £91. 16s. 2d. (£103. 5s. 8d. during the flood) per kilowatt installed, compared with £2. 10s. 9d. and £99. 0s. 1d. (£113. 3s. 1d. during the flood) in 1899. The amount set aside for interest was the same in each year (£1,944. 15s.) and for sinking fund £1,721. 9s. 9d., compared with £1,755. 15s. 2d. in 1899. The revenue from electricity supplied was £8,980. 12s. 3d. in 1900, compared with £7,779. 6s. 9d., and from meter rents and other sources £688. 6s. 9d., compared with £598. 17s. 4d. The total revenue was £9,668. 19s., compared with £8,378. 4s. 1d. The total costs amounted to £5,999. 5s. 7d., compared with £4,587. 0s. 9d., and the gross profit was £3,669. 13s. 5d., compared with £3,791. 3s. 4d. The total works cost, interest and sinking fund together, was £9,665. 11s. 4d., compared with £8,287. 11s. 11d., and the net profit was £3. 7s. 6d., compared with £90. 12s. 2d. in 1899. The total units sold numbered 625,739, compared with 551,437. The lamps connected at the end of the year in 33 watt 8 c.p. were 34,494, compared with 31,202, and the number of consumers was 593, compared with 433. 842,132 units were generated, compared with 710,416. Of those 106,049 were supplied to public lamps, compared with 109,600, and to private consumers 519,690, compared with 441,837. The mean price per unit obtained was 3·708d., and the total cost 3·707d., leaving a mean profit per unit of 0·001. The report and accounts have been approved by the Council.

At Tuesday's meeting the electric committee recommended the Council to undertake the supply of current for lighting to consumers outside the city boundary, consumers undertaking to bear the expense of laying mains beyond the boundary. The proposition was agreed to.

**Worksop.**—The Council have fixed the charge for electric current for lighting at 6d. per unit and 2d. for power.

**Worthing.**—The Council will apply to the Light Railway Commissioners for an order for the construction of four lengths of electric tramway in the borough.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

An advertisement appearing in our last issue, of the *British Electric Traction Co. (Ltd.)* (on behalf of the Gravesend and Northfleet Electric Tramways), has been cancelled, and the former company now invite tenders for the construction of new tramways in Gravesend and Northfleet, and the reconstruction of the existing lines in Gravesend; also for the supply and construction of the necessary electrical equipment for working on the overhead system. Specifications can be obtained from Mr. Charles Dale, secretary of the British Electric Traction Co., Donington House, Norfolk-street, Strand, W.C., and tenders have to be sent in not later than 25th inst. An advertisement gives some further particulars.

*Newport* Corporation invite tenders for the supply and erection of constructional steel-work, bunkers, &c., steel flue, coal and ash conveyor, winches for outside coal handling, overhead travelling crane, water tube boilers, mechanical stokers, fuel economiser, water storage tanks, compound condensing vertical engines, electric generators, condensing plant with cooling towers, and feed pumps. Specifications from the consulting engineer (Mr. H. F. Parshall), 8, Princes-street, Bank, London, E.C., and tenders to the town clerk (Mr. Albert A. Newman), Town Hall, Newport, Mon., by 5 p.m. March 25. An advertisement contains further particulars.

*Warrington* Corporation invite tenders for the supply, delivery and laying of steel rails, paving, &c., and for the supply, delivery and erection of steel poles, brackets, trolley wire, insulators, &c., and for electric tramcars. An advertisement contains further particulars, and specifications may be obtained at the offices of Messrs. Preece and Cardew, 13, Queen Anne's-gate, Westminster, S.W. Tenders to town clerk (Mr. J. Lyon Whittle), Town Hall, Warrington, by noon 27th inst.

*Wallasey* Urban District Council invite tenders for the supply and delivery of electrically-worked tramcars. Specifications from the engineer (Mr. J. H. Crowther), Great Float, near Birkenhead, and tenders, addressed to Mr. H. W. Cook, clerk and solicitor for the Council, Public Offices, Egremont, Cheshire, must be in by 14th inst. An advertisement contains further particulars.

*West Ham* Corporation invite tenders for the supply of (1) high and low-tension, paper-insulated cable, boxes, &c., (2) double-pole house cut-out boxes, (3) recording wattmeters, (4) transformers and transformer tanks, (5) house wire and wiring accessories, (6) engine-room stores. An advertisement contains further particulars, and forms of tender, &c., may be obtained at the borough electrical engineer's office, Electricity Station, Abbey Mills, West Ham, E. Tenders to the office of the town clerk (Mr. Fred. E. Hilleary), Town Hall, West Ham, E., by 4 p.m. March 22.

*Burnley* Electricity committee invite tenders for the supply, delivery, and laying of cable required in connection with the lighting extensions and tramway scheme. Some further particulars are given in an advertisement, and specifications, &c., may be obtained from the borough electrical engineer (Mr. Robert Birkett), Aqueduct-street, Burnley. Tenders, addressed to the chairman, must be delivered at the offices of the town clerk (Mr. A. Steele Sheldon) by March 21.

*Burnley* Tramways committee also invite tenders for rail bonds. Specification, &c., from the borough electrical engineer (Mr. Robert Birkett), and tenders, addressed to the chairman, must be delivered to Mr. A. Steele Sheldon, Town Hall, Burnley, by March 23.

*Burnley* Tramways committee also require tenders for overhead equipment of tramway line. Tenders by March 23.

*Walthamstow* District Council invite tenders for wiring and supplying and fixing fittings for the electric lighting of the town hall, public baths, public library and technical institute. Plans and specifications from the office of the consulting engineer (Mr. James Enright), 47, Victoria-street, London, S.W., and tenders must be delivered to the clerk (Mr. E. J. Gowen) by 5 p.m. March 19. An advertisement contains further particulars.

*Ayr* Corporation invite tenders for the supply, delivery, and erection of water-tube boilers, stokers, &c., condenser and pumps, accumulators, &c., balancers, and boosters. Plans and specification may be obtained from the borough electrical engineer (Mr. Arthur J. Fuller), and tenders must be lodged with the town clerk (Mr. A. G. Young), Town Buildings, Ayr, by March 20. See advertisement.

*Gorton* District Council invite tenders for the supply of electricity in their district for lighting for five, seven, nine, or 12 years. Particulars from the clerk (*pro tem.*), Mr. C. T. Singer, Town Hall, Gorton, and tenders by March 22. See advertisement.

*Shipley* District Council invite tenders for house terminals, boxes and switch-gear, motors and switch-gear, meters, wiring, cables, wires, switches, fuses, fittings, &c. Specifications can be obtained at the Council Offices, Manor House, Shipley, and tenders must be in by March 19 to the clerk (Mr. Jno. S. Rhodes). See advertisement.

The Borough Council of *Fulham* (London) invite tenders for wiring the Central Library, 592, Fulham-road, S.W. Specification may be seen, and forms of tender obtained from the librarian (Mr. F. T. Barrett). Tenders to the acting town clerk (Mr. W. H. Denselow), Town Hall, Walham Green, London, S.W., by 4 p.m., March 20. See advertisement.

*Colwyn Bay* District Council invite tenders for a 120kw. steam dynamo and switchboard extensions. Specification, &c., may be obtained of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, London, S.W., and 78, King-street, Manchester. An advertisement contains further particulars, and tenders should be sent to the clerk (Mr. J. H. Roberts) by March 22.

*Darwen* Corporation invite tenders for the supply and delivery of feeder cables, pillars and overhead electrical equipment. Specifications, &c., may be obtained at the offices of the borough engineer (Mr. R. W. Smith-Saville, A.M.Inst.C.E.) or the borough electrical engineer (Mr. Stanley Clegg), and tenders, addressed to the town clerk, Municipal Offices, Darwen, must be in by 9 a.m., 25th inst. An advertisement contains additional particulars.

*Buxton* District Council invite tenders for an electrically driven triplex pump of approximately 17 H.P. Specifications from the town surveyor (Mr. W. H. Grieves), and tenders to the clerk to the Council (Mr. Josiah Taylor) Town Hall, Buxton, by 23rd inst. See advertisement.

*Buxton* District Council invite tenders for a 250kw. steam dynamo and a Belliss engine coupled to two 43kw. dynamos. Tenders by noon March 12.

*Shoreditch* Borough Council invite tenders for supply and construction of various stores and works for one year and five days, from March 26, 1901, to March 31, 1902, inclusive. Tenders to Dr. H. Mansfield Robinson, town clerk, Shoreditch Town Hall, Old-street, London, E.C., before 3 p.m. March 12.

*Sunderland* Corporation invite tenders for indiarubber-covered cables, stoneware casing, wrought-iron piping, cast-iron piping and cast-iron box frames and covers. Tenders to chairman of Lighting committee by noon 29th inst.

*Cardiff* Corporation require tenders for steam and exhaust pipes, injection and overflow pipes, feed and drain pipes, engine house flooring, switchboard gallery and central service gangway for their tramways department. Tenders to town clerk by March 18.

*Bray* District Council invite tenders for a Lancashire boiler and accessories, a 150kw. high-speed steam alternator, and a 25kw. rope-driven alternator and accessories. Tenders by 4 p.m. March 14.

*Clyde Navigation* Trustees invite tenders for a 3-ton electric wharf crane. Tenders to Mr. T. R. Mackenzie, 16, Robertson-street, Glasgow, by noon March 11.

Tenders are invited for the electric lighting of St. John's Church, *Cheltenham*. Tenders to Mr. Weaver, Carlton-place, Hewlett-street, Cheltenham, by March 25.

*Brighton* Corporation invite tenders for steel and ironwork required in the construction of an electric power house at Southwick. Tenders to town clerk by 10 a.m. April 26.

*Wimbledon* District Council invite tenders for various stores and materials for their electric lighting department for 12 months. Tenders by March 15.

*Croydon* Guardians require tenders for electrical fittings and appliances. Tenders to offices, Mayday-road, Thornton Heath, by March 18.

*Edinburgh* Corporation invite tenders for electrical fittings and stores, brass castings and materials for arc lamp repairs, engineers' stores, casings, &c. Tenders by 16th inst.

*West Ham* Corporation invite tenders for erecting a dynamo house at their Dagenham Small Pox Hospital. Tenders by 12th inst.

*Kettering* District Council invite tenders for a refuse destructor. Tenders by 27th inst.

*Wimbledon* Electric Light committee invite tenders for erecting additions to the electricity generating station. Tenders by 22nd inst.

*Southampton* Corporation invite tenders for insulated electric cables, and frames and covers, &c. Tenders to town clerk by noon March 11.

*Southampton* Corporation also desire to purchase three motor omnibuses. Tenders to town clerk by 16th inst.

*Aberdeen* Electric Light committee require a fuel economiser and boilers. Tenders to city electrical engineer before noon March 15.

*Newport* (Mon.) Corporation require tenders for foundation work in connection with the tramway power house. Tenders by 25th inst.

*Hammersmith* Borough Council invite tenders for the supply of electrical stores. Tenders by 13th inst.

*Copenhagen* Corporation want four Tischbein and two water-tube boilers for their electricity works. Tenders to Kjobenhavns Belysningsvaesen, Vestre Boulevard B, by 23rd inst.

## TENDERS RECEIVED AND ACCEPTED.

Hull Corporation have received the following tenders for the supply of a multipolar dynamo for coupling to a Belliss high-speed engine:—

| | | | |
|---|---|---|---|
| International Electric Co. (Liege) (*accepted*) | £734 | Witting Bros. | £1,005 |
| British Westinghouse Co. | 1,605 | Ditto | 975 |
| Crompton & Co. | 1,537 | Ditto | 955 |
| Sunderland Forge Co. | 1,382 | E. Scott and Mountain | 985 |
| Thomas Parker (Ltd.) | 1,352 | Mather and Platt | 970 |
| Brush Co. | 1,250 | Anchor Electric Co. | 960 |
| Johnson-Lundell Co. | 1,210 | Siemens Bros. & Co. | 950 |
| D. Bruce Peebles & Co. | 1,200 | Greenwood and Batley | 925 |
| Electric Construction Co. | 1,165 | Bergtheil and Young | 897 |
| Mavor and Coulson | 1,052 | British Schuckert Co. | 860 |

The *British and South African Gazette* states that complementary contracts have been placed for plant for the Durban (Natal) electricity works as under:—

| | |
|---|---|
| Carrick and Ritchie (10-ton overhead travelling crane) | £280 |
| Tangye Tool Machine Co. (slotting machine) | 70 |
| J. Lang & Sons (two lathes) | 336 |
| J. Archdale & Co. (screwing, drilling, and shaping machines and grindstone) | 250 |
| Kendal and Gent (saw-bench and blacksmith's forge) | 66 |
| Brush Co. (switch-boxes) | 124 |
| Dick, Kerr & Co. (condensing plant) | 2,545 |
| Reunert and Lenz (supplementary boiler) | 940 |
| Babcock and Wilcox (steel chimney) | 1,025 |
| Hubert Davis and Spain (rails for 3-mile Congella tramway extension) | At previous contract price. |

Worthing Town Council received three tenders for wiring premises in the borough—viz., from Bostel Bros., Page and Miles, and Whittaker Bros., the latter tender, however, not being in accordance with the conditions. The two tenderers have been asked to state whether they are prepared to enter into a contract if the Corporation lets the work in two separate contracts, and Bostel Bros. were also asked to state the rental charge per lamp for clusters of lamps where controlled by one, two, or three switches respectively.

Worthing Council have placed an order for 100 Hookham electricity meters of various capacities at £4 each, and 12 2½-ampere electrolytic meters at £1. 18s. each.

Dublin Electric Lighting committee have accepted the revised tender of Messrs. J. and W. Stewart, Belfast, for the erection of the power station at the Pigeon House, at £29,051. 10s. 9d.

Aberdeen Corporation have accepted the tender of Messrs. Alley and Maclellan for condensing plant at the Dee Village electricity works at £1,697.

Glasgow Tramways committee have accepted the tender of Messrs. James A. Millan & Co. for 50 tons of tie-bars at £8. 9s. 9d. per ton; that of Lorain Steel Co. for 3,000 tons of 60ft. tramway straight-track rails at £6. 12s. 6d. per ton, 300 tons of curved rails at £6. 12s. 6d. per ton, and 50 tons of fish-plates at £7 per ton; that of the Telegraph Manufacturing Co. for a mile of rail-return cable for depot connections at £1,072. 10s.; and that of the General Electric Co. for telephone apparatus in connection with the tramways at £769. 9s. 1d.

The tender for a steam alternator for the Eccles Corporation has been secured by Messrs. Browett, Lindley & Co., Messrs. Rosling, Appleby and Fynn being the sub-contractors for the alternator.

Wolverhampton Corporation have accepted the tender of Mr. H. Holloway for constructing the permanent way of the new electric tramway from Tettenhall to the borough boundary at Bilston, 4½ miles. There will be about 7½ miles of single track.

Cardiff Corporation have accepted the tender of Messrs. W. Symonds & Co. for the erection of an electric tramway power station at Roath for £16,100.

## BUSINESS NOTICES.

We are informed that the works and business of the Hiram S. Maxim Electrical Corporation (Ltd.) have been sold to the Sir Hiram Maxim Electrical and Engineering Co. (Ltd.), who will pay all debts owing by the corporation and receive all accounts at their head offices, 65 to 67, Gracechurch-street, London, E.C.

Messrs. Johnson and Phillips' Electric Cable Works have opened a West-end depot at 37, King-street, Covent Garden, London, W.C., where a large stock of the standard sizes and qualities of Johnson and Phillips cables will be kept for immediate delivery.

Dr. Julius Juttke, who has been associated for 11 years with Dr. H. Aron in connection with the Aron electricity meter, and who has been for the past three years managing director of the Aron Electricity Meter (Ltd.), has relinquished that position.

## BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. C. E. Dovey, C.A., Gordon-chambers, Queen-street, Cardiff, gives notice of application for discharge as trustee in the bankruptcy of Sydney Ferris Walker, lately trading as Sydney F. Walker & Co., electrical engineer, Cardiff. The statement of affairs shows that the receipts, estimated to produce £751. 13s. 6d., realised £315. 3s. 2d. The cost of realising this sum was £213. 8s. 8d. Preferential creditors and a small allowance to debtor leaves a balance of £2. 7s. 5d. The assets have not realised sufficient to pay the preferential claims, and there is consequently no dividend for creditors.

The estates of W. G. Higgs, electrical engineer, 10, Percy-street, Glasgow, have been sequestrated. Meeting to elect trustee, &c., will be held on 13th inst. at the Faculty Hall, St. George's-place, Glasgow.

A first dividend is about to be declared under the deed of assignment executed in November last by Geo. Margetts, electrical engineer, 53, Brown-street, Manchester, and creditors must send in particulars of their claims to the trustee, Mr. R. V. Critchley, 6, St. James's-square, Manchester, by March 15.

---

**For Sale.**—An advertisement contains particulars of a 47 B.H.P. Crossley gas engine and an E.C.C. shunt-wound dynamo for sale. Applications to Messrs. Shephard and Watney, consulting engineers, Greek-street Chambers, Leeds.

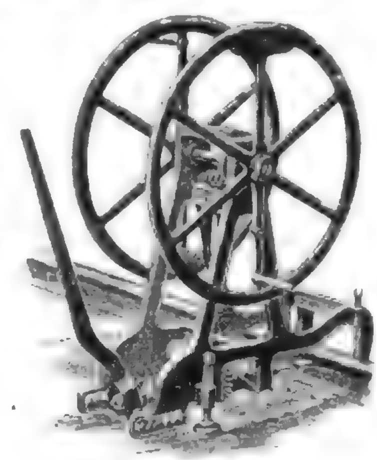
The Dudley Electrical committee have for sale two compound belt-driven railway generators, two shunt resistances, a Westinghouse enclosed engine, &c. An advertisement contains further information of the plant, and full particulars may be obtained from Mr. Reginald P. Wilson, consulting engineer, 66, Victoria-street, S.W., or from Mr. J. A. T. Marsh, Springamere Power Station, Dudley.

**For Disposal.**—An electrical engineering business in the east of England is for disposal as a going concern. See advertisement.

**Agents Wanted.**—A leading British manufacturing firm making cables and wires, arc lamps, meters, instruments, &c., wish to appoint selling agents in important industrial centres. See advertisement.

**Legal Notice.**—As announced in an advertisement, creditors of the Electric Resistance and Heating Co. (Ltd.) are invited to send in particulars of their claims to the liquidator (Mr. William Chaplin), 130, Dashwood House, New Broad-street, London, E.C., on or before April 19.

**Overhead Trolley Line Fittings and Material.**—Messrs. Estler Bros., 25, Laurence Pountney-lane, Cannon-street, London, E.C., have issued a comprehensive catalogue of "Ambroin" insulation for overhead trolley lines, &c. It is claimed for Ambroin that it is mechanically strong, does not absorb moisture, has a high electrical insulation, and does not deteriorate with age. To substantiate this latter claim, Ambroin for overhead trolley work under ordinary conditions is sold under a two years' guarantee. A large variety of line and strain insulators of various patterns, turnbuckles, dampers, arm suspensions, frogs, cross-overs, and ears are described and illustrated, as are also several forms of telephone guards. An assortment of Ambroin accessories for high and low tension work, line tools and apparatus required in the general equipment of the overhead trolley system are also shown. The illustration below shows a "Sweet"



The "Sweet" Track Drill.

track drill, which drills a straight or tilting hole from the smallest possible size up to 1 [illegible]in. in diameter. It is stated that one man with this machine has drilled 6,500 [illegible]in. holes for bond wire 65lb. T rails in 9 days. The drill can be locked over the rail on either the inner or outer side, and for work on repairs can be thrown over on the balance wheels to give a track clearance of 29in. The wheels can also be used as trucks when the machine is moved. The drill is fitted with a special bearing, for which particular advantages are claimed.

**Engine Packings.**—We have received from Creswell's Asbestos Co. their latest list of asbestos goods. This company manufacture packings in all varieties, from the old-fashioned chalk and junk ring to the latest conceptions in fibrous, semi-metallic, and metallic forms of packings. In specially-modified forms the anti-friction and frictionless packings sent out by this company have been adapted to such varied uses as steam hammers, refrigerating machinery, hydraulic machinery and accumulators. For this latter purpose the packing is made capable of withstanding 1,000lb. pressure to the square inch. The catalogue before us gives in a condensed form much information relating to asbestos packings for all purposes.

**Floor Lights.**—Particulars of a new floor light, especially devised for use in electricity stations for switchboard platforms, &c., where a perfectly insulated platform is required, are issued by Messrs. Hayward Brothers and Eckstein. These lights have been supplied to Glasgow, Brighton, Wallsend-on-Tyne, &c. At Glasgow more than 3,000 sq. ft. of this flooring is fixed on the switchboard platform.

**"Silbo" Lamps.**—Price list and particulars of the "Silbo" lamp, manufactured by the Premier Electric Lamp Co., Pearl Assurance Buildings, Liverpool, are now ready.

**Self-Vulcanising Jointing.**—Messrs. Poth, Hille & Co. are supplying "Empress" self-vulcanising jointing for use in connection with the high-pressure steam pipes (ranging from 4½in. to 12in. diameter) at the Glasgow Exhibition, working at 160lbs. pressure per square inch.

**Tumbler Switches.**—The Electrical Trades' Supply (Ltd.) are issuing a new list of high-voltage tumbler switches.

**Underfeed Stokers.**—The American Blower Co. are sending out illustrated leaflets describing the Jones patent underfeed stoker for boilers, &c., of every description.

**Rubber, Gutta Percha and Dermatine.**—A pamphlet giving a short account of the discovery and manufacture of indiarubber and

guttapercha and a description of the special characteristics and qualities of Dermatine is issued by the Dermatine Co., 95, Neate-street, London, S.E.

**Calendar.**—Somewhat belated, we have to acknowledge the receipt of a serviceable hanging calendar from the Peckham Manufacturing Co, whose representatives in this country are Messrs. Robert Blackwell & Co. The sheets contain illustrations of the Peckham Company's manufactures of electric railway and tramway plant.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from Feb. 27 to March 5, with the ports of destination:—

*Africa*—Alexandria, £95; Cape Town, £15,563 (including £14,449 telegraph material); Durban, £191; East London, £31; Port Elizabeth, £86. *Argentina*—Buenos Ayres £386 including £319 telegraph cable). *Australasia*—Adelaide, £279; Brisbane, £24 (telegraph material); Launceston, £134; Melbourne, £4,903; Sydney, £1,243. *Belgium*—Antwerp, £130. *Ceylon*—Colombo, £198. *China*—Shanghai, £296; Tientsin, £21. *France*—Havre, £190. *Germany*—Hamburg, £200 (telegraph material). *Greece*—Syra, £7. *Holland*—Amsterdam, £131. *India*—Bombay, £40; Calcutta, £946; Madras, £285. *Japan*—Yokohama, £573. *Spain*—Vigo, £23. *Sweden*—Gothenburg, £23. *Uruguay*—Monte Video, £1,445. Total £30,924, against £128,630 in the corresponding week last year (Feb. 28 to March 6).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co. *Chartered Patent Agents, of 79, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 4, 1900.

22,019. A. MEYGRET. London. Improvements in storage batteries.*
22,021. J. VELLE and THE MERCURY CYCLE MANUFACTURING CO. LTD.). London. Improvements in arc lamps.*
22,022. A. J. BOULT. London. Improvements in or relating to secondary or storage batteries or accumulators. (L. Sauvad, France.)
22,026. A. J. BOULT. London. Improvements in electric wave telegraphs. (American Wireless Telegraph Co., United States.)*

December 5, 1900.

22,069. A. C. HEAP. London. Improvements in the construction of instruments for the measurement of electrical energy.
22,090. J. W. GRAYDON and J. O. EGERSTORFF. London. Improvements in the production of electric light.
22,118. J. BAXTER, O. CLARK and C. HILLMAN. London. A new or improved endless electric conveyor for conveying tin plates from the bath of molten metal to a suitable or desirable place.
22,142. E. S. HAGEMANN and V. POULSEN. Strand. A new or improved telephony relay.*

December 6, 1900.

22,182. H. G. NICHOLSON. London. Improvements in or connected with electrical contact makers or switches, for use at the insulated junctions of sections of electrical tramways and railways, and for analogous purposes.
22,196. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric arc lamps. (E. Thomson, United States.)*
22,197. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric arc lamps. (E. Thomson, United States.)*
22,230. W. J. GLOVER. Liverpool. Improvements in or relating to electric cables or conductors.
22,233. C. KANDO. London. Improvements in or relating to electric railways, tramways, and the like.*
22,234. C. KANDO. London. Improvements in or relating to automatic electrical relays for operating pneumatic brakes in electrically-propelled vehicles and the like.*

December 7, 1900.

22,240. S. COWPER-COLES. London. Improvements in the electrolytic refining of metals.
22,253. E. T. PARKER. Wolverhampton. Improvements in and relating to electric switches for use in controlling motors.
22,272. T. E. GAMBRELL and C. T. GAMBRELL. London. Improvements relating to galvanometers, voltmeters, and like apparatus.
22,273. C. T. GAMBRELL and T. E. GAMBRELL. London. Improvements relating to electrical plug resistance boxes and like apparatus, and to switches therefor.*
22,281. E. FLETCHER. Birmingham. Improvements in the means for suspending electroliers, electric lamps and the like.
22,285. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in current collectors for electric vehicles. (S. B. Stewart, United States.)*
22,286. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric switches. (W. B. Potter, United States.)*
22,287. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in synchronizing apparatus for electric alternators. (F. T. Dow, United States.)*
22,288. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in means for attaching pole pieces to electric machines. (H. G. Reist, United States.)*
22,290. S. G. BROWN. London. Improvements in telephone and telegraph apparatus.
22,313. A. N. THORIN. London. Improvements in manufacturing laminated cores for electrical apparatus.
22,316. W. J. GLOVER. Liverpool. Improvements in or relating to electric cables or conductors.
22,330. W. M. MORDEY. London. Improvements in alternate current measuring and indicating instruments.

### SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

25,275. WEBSTER. Clock-controlled electric switches.
25,282. STEELE. Earthing devices and safety fuses for electrical circuits.
25,346. FRAMPTON and MUIRHEAD. Perforators for use in connection with automatic telegraph transmitters.
25,396. BURNABY. Electrically-propelled vehicles and permanent way therefor.
25,417. DELAVEAU. Electro-magnets.
25,420. LAMME. Alternating current induction motors. (Date applied for under International Convention, May 24, 1899.)
25,421. LAMME. Alternating current generators. (Date applied for under International Convention. May 24, 1899.)
25,439. CADET and CHEVALLIER. Electrical contact apparatus for automatic signalling.
25,509. HOLMES, SMITH and BURROWS. Methods or means of insulating electric wires.
25,576. VERITYS LIMITED and STEELE. Resistance switches and automatic cutouts for starting, regulating and protecting electric motors and their circuits.
25,622. LUNDBERG and LUNDBERG. Method of fitting the covers of electric light fittings to their base parts.
25,740. LAMME. Current collectors for electrical machines. (Date applied for under International Convention, June 5, 1899.)
25,741. WURTS. Lightning arresters. (Date applied for under International Convention, June 8, 1899.)

1900.

164. STEAD and CARR. Electric incandescent lamps.
182. NORTHEY and ELECTRIC MOTIVE POWER CO. LTD. Electric ignition devices for internal combustion engines.
400. LEE. Electric arc lights or lamps.
435. HOLLINS and AMENDT. Apparatus for electrically interlocking the doors or gates with the operative machinery of hydraulic or other lifts.

## COMPANIES' MEETINGS AND REPORTS.

### Charing Cross and Strand Electricity Supply Corporation (Ltd.).

The annual meeting of this Corporation was held on Friday last, Mr. JOHN M. GATTI presiding.

The SECRETARY (Mr. E. Wilmot Seale) read the notice calling the meeting and also the certificate of the auditors.

The CHAIRMAN said: Owing to the enforced absence of our chairman and vice-chairman I have assumed, at somewhat short notice, the position of chairman to-day. I feel in the circumstances that I may confidently ask you to perhaps extend to me a little more indulgence than otherwise you would do, as it is my first experience of the kind. I have the advantage, I hope and trust, of addressing a contented body of shareholders, for the position of the Company can be described as in every way satisfactory. The commodity we sell—electricity—is one the demand for which is steadily increasing. The more it gets used the more people want it. We find that the longer we work a district the better are the results which are shown. Take our old district of St. Martin's, in which we started, and in which the Corporation from its inception has carried on operations. Notwithstanding all these years of working we find, during the last year, that we had added nearly 14,000 lamps in this one district; in the Strand district we have added nearly 16,000—15,600, and in the districts of Holborn and St. Giles, a small portion only of which we supply, we have added another 7,000 lamps. A new demand has been springing up lately that also is promising, namely, for motor generators and heating apparatus. During the year we have doubled our supply under these heads, and now that we are going down Fleet-street and tapping the great printing centre of London, we find the demand for power by this industry and the engraving industry decidedly satisfactory. In fact, we have been asked—and the Board are considering the matter—whether we could not follow the example of the gas companies and hire out motors and heating apparatus to consumers. I think it very possible that we may later on adopt this policy, and so comply with the requirements of many in these industries, and I may add that this class of business is extremely valuable on account of the long hours that the motors and apparatus would be in use. If we pass now from the supply to the results we find, first, that the gross revenue is in the same satisfactory state. The increase of gross revenue as compared

with the previous year is just below £16,000—namely, £15,962. This increase is half as big again as was that of last year over the preceding year, and it will, perhaps, give you an idea of the rate of increase of our business when I tell you that for the past year our gross revenue is double what it was as recently as 1897. In the three past years we have doubled our gross revenue. Now I come to the point which will probably interest you more, and that is the net revenue. I can imagine shareholders who have been listening to me asking how it is that, if the demand is so satisfactory, the supply increasing, and the gross revenue larger, we cannot show a better net result—how is it that we propose to pay only the same dividend as last year, and that even in paying that we have to fall back on some of the carry forward of the previous year? There are two causes for this, both of which were absolutely beyond our control, and one of which we have shared in common with every other electric company and gas company—namely, the enormously increased price of coal. Our contract expired in the first half of the year, and for the last six months we had to pay whatever was asked. And not only had we to pay an increased price, but the demand which caused the higher price to be obtained also caused a great scarcity of good coal, so that in effect we had to pay more for an inferior article, and we consumed more of the dearer coal than we should have done of the better coal. To show how serious this item is, I may tell you that but for this increased price of coal in the latter half of the year we should have added between £7,000 and £8,000 to net revenue account. In other words, we have £7,000 or £8,000 less to net revenue account for the purpose of the dividend owing to that one item alone. The second difficulty that we had to contend with, and that also was a serious one at the time, although I am happy to say that all traces of it have now been wiped away, was the fire at the beginning of last March at our Maiden lane station. For months we had to work without a proper switchboard—with a make-shift arrangement—and it is wonderful that we were able to carry on the business at all, and it reflects the highest credit on the engineer and the whole staff that they were able to carry us through with all their switchboard gone; but though they did it, the system of working was not economical. We had little means of getting the proper distribution of the current, and at times of high load we had to supply as much as 20 per cent. volts' pressure in excess of the normal condition. This we did deliberately, because the Board felt that the true policy to adopt at such a crisis was not one of sparing and looking to an immediate loss, but of using every effort to keep up the reputation for quality which the Corporation had earned for its current. Notwithstanding the very serious inconvenience caused to many consumers during the first period after the fire, the number of customers we lost through that fire could be easily counted on the fingers of one hand. Another point I must not overlook, and which will be present in your minds, is that part of the capital called up recently is not yet productive, though in a very good way of becoming so; but though it is not yet productive we have had to pay dividends on it. I will now with these few remarks just glance through the report. It will probably be interesting to you to know something as to how our stations are going on. Well, our chief steam-generating station at Lambeth is for all practical purposes fully occupied. There is no room for any more machinery there, beyond some auxiliary plant, but nothing that will increase the output. At Short's Garden we have 1,500kw. in motor generators and 400kw. in batteries. This station was fortunately ready at the time of the fire. The increase in the business to which I referred at the beginning of my remarks, in this district, in St. Martin's, and in the western district generally, makes it imperative for us to have a new station in the neighbourhood, and we have acquired a site in St. Martin's-lane, where we are in course of erecting a station, and I hope by the end of the year—in fact, I take it for certain—that the station will then be in full swing, and at the same time we are availing ourselves of the site there to erect new offices. The accommodation for the staff, which has been steadily growing, has got cramped beyond all endurance, and we hope at our next annual meeting that we shall meet on our own premises. I am pleased to say that within the last few days we have started the supply at Ludgate from the Ludgate station itself. We have already working at Ludgate-hill a plant of 600kw., capable of supplying 30,000 lamps. We are pushing on with the Fenchurch-street station, and hope to be working towards the end of the year, and also the Bow station. Of course the Fenchurch street station we cannot supply from Lambeth as we can the Ludgate station, but we are pushing on with the new station at Bow at the same time as we are completing the Fenchurch-street sub-station. We are also negotiating, and I think the negotiations will turn out satisfactorily to us, for the acquisition of another sub-station to supply the south and mid-central portion of our City area. All these stations, and our present stations, will be linked up together, so that we shall have a supply from both Bow and Lambeth, and at an emergency they will be capable of being linked up and helping each other. I do not know that there is very much more in the report which calls for explanation. The only point that I ought, perhaps, to say something about is the way in which we propose to provide the dividend. We propose to pay a dividend for the year of 9 per cent., and for that purpose to diminish our carry forward from £4,500 to £3,485. I think the shareholders will agree with the Board that that is a proper course for us to take. It has never been our policy, and I hope it never will be, to divide up to the hilt. We have always thought it prudent to contemplate the possibility of emergencies arising when we should have a fund to fall back on to equalise our dividends, and we have no hesitation, therefore, in recommending that this money should be taken from the carry forward and divided this year. I may mention that we are now supplying current in 166 streets in our western area, and in 55 streets in the City. I now move the adoption of the report and accounts.

Mr. LAURIE: Have you been able to make a satisfactory contract with regard to coal for the current year. We are told that coal has fallen some 4s. or 5s. per ton, and although it is likely to fall still lower, according to competent judges, still, perhaps, there would be no harm in making contracts at the present prices. Also you might perhaps give us a little idea how the new company is getting on.

Mr. NEVILLE: I observe in No. 5 account—net revenue account—there is a sum of £1,357 for interest on temporary loans to December 31, 1900. Am I to understand from that that we have not sufficient working capital and have been obliged to resort to the bankers in order to keep the Company going? It would be better to use our own capital than to pay interest to the bankers. Some of our debentures are stated as 5 per cent. debentures. In the present state of the trade of this country could not an arrangement be made by which the interest on the debentures was reduced, or a further issue made in lieu of the 5 per cent. debentures. I think that 4 per cent. would be an ample rate of interest for debentures secured on the business of a company of this description.

Mr. MAKINS: Is there any chance of protecting ourselves in future against such a serious loss as that we have suffered by the fire in Maiden-lane, either by insurance or some other means? I think I heard that this fire was supposed to have been occasioned by a match. We seem to run a good deal of risk if a match can put us to the loss of over £6,000. I should also like to ask if there is any chance of further capital being required by the Company, and, if so, how it is to be raised?

The CHAIRMAN: We have this year concluded a contract for Welsh coal at a rate which, though not so favourable as that which was obtaining some 18 months ago, is still a considerable improvement on what we have been paying. We hope at this time next year that we shall be able to tell you that we have had a saving of between £3,000 and £4,000 in the net cost of coal. It is true the price of soft coal has fallen considerably, but not the price of Welsh coal, which is the coal we use. Mr. Neville inquired about the temporary loans, and in his further remarks supplied his own answer. It was because of these 5 per cent. debentures being paid off that we obtained those loans. The debentures are all paid off now, and we have no debentures in this Company at the present time. As to insurance, the station at Maiden-lane was insured, but as the result of the fire we have learned something as to the proper distribution of insurance on the various items. We found that while we were more than covered by insurance for most portions of the buildings and machinery, we were far from being sufficiently covered as regarded the switchboard station and mains.

The motion was then carried unanimously.

Resolutions approving of the dividends set out in the report, of the re-election of the retiring directors Messrs. W. F. Fladgate and Richard Chadwick), and of the re-appointment of the auditors were then carried.

One thousand guineas was voted as remuneration to the directors.

Mr. LAURIE: I thank the Chairman for his reply about the coal and I should like to say that from accounts I have received from reliable sources in the country, I understand that through the wholesale blowing out of furnaces and the contraction of trade, we may expect a considerable drop in the price of Welsh coal. I understood the chairman to say, we should probably be raising further capital, and that we should have a scheme laid before us shortly. I think, in the present state of the market, and with the demand for this class of security, I should not, with all due respect to the Board, delay the matter too long. I think that the present, or the next few weeks, would be a fitting time for issuing the new capital, particularly if it is to be a high-class security, such as debenture stock. I now wish to propose a vote of thanks to the chairman, directors and staff of the Company.

The resolution was carried unanimously, and the chairman, Mr. Wilmot Seale (the secretary) and Mr. W. H. Patchell (engineer-in-chief) having responded, the proceedings terminated.

## Metropolitan Electric Supply Co. (Ltd.).

The fourteenth ordinary general meeting of this Company was held on Tuesday, under the presidency of Mr. W. HARRISON CRIPPS.

The SECRETARY (Mr. E. Cunliffe Owen, C.M.G.) read the notice calling the meeting and the report of the auditors. The report of the Directors was taken as read.

The CHAIRMAN said: In rising to move the adoption of the report and accounts I will begin by going over the capital expenditure. At the end of 1899 it amounted to £1,244,254, and at the end of last year it was £1,417,000 odd—that is to say, there was an increase during the year of £173,000 odd in our expenditure of capital. This money has chiefly been expended upon two principal items in our undertaking. A considerable amount of it has been spent at Willesden in developing our machinery, and also on the general plant, but that I will refer to later on. The remainder of the amount has been spent in the alteration of our system from alternating to the continuous current. As you know, we decided upon this policy some two or three years ago, on the ground that the working by the continuous current was very much more economical than working by alternating current. At the present time this change has nearly been completed in our mid London area, and we are at the present time laying down cables in the south portion of our west London or Marylebone area. We had great hopes that that portion might be completed before next winter, so that we should be able to supply the continuous current during next winter; but we found that there was so much delay in obtaining the necessary consents for extending our Manchester-square station that I am afraid it will be impracticable in the forthcoming winter actually to work through the new mains; but there is no doubt whatever that they will be in working order very soon after that time. Another item of expenditure has been on our offices. We were under great disadvantage before in our small leasehold premises at Baker-street, and a good opportunity having occurred to buy what is practically a freehold house in Stratford-place at the small ground rent of £5 a year to the City of London we thought that it was a good investment of our money,

As to the way in which the capital was raised for this expenditure, I may say that we first issued £125,000, the remaining portion of the 3½ per cent. debentures; and when I remind you that we were able to issue those debentures at what was, after all, rather a bad time in the financial market at £96 for each £100 debenture, and when I see this morning that those debentures stand in the market at from 98 to 99, I think it shows that the credit of this Company is exceedingly good. The remaining portion of the money—£150,000 of new capital—has been raised by the issue of the remaining portion of the shares—15,000; and in deference to the widely-expressed wish at the meetings last year and in the previous year, the Directors decided that they should be issued to the shareholders at par value, which was accordingly done. I now turn to the revenue account of the year. The gross revenue of the past year was £209,420; that is an increase of £30,000 upon the revenue of the previous year. The cost of generation was £106,000, or an increase of £15,000 odd over the cost in the previous year. This additional cost is largely due to the price of coal. Notwithstanding this we have been able to increase the dividend from 5 to 6 per cent. The price of coal, as you all know, rose very largely, especially towards the latter half of the year. We, fortunately, at that time made very short contracts, which we were able to renew at the beginning of this year for a short period at a very much better price than we should have been able to do had we taken a long contract, and there seems to be every prospect that we shall be able to renew it on even more favourable terms for the remaining portion of this year. The repairs, as you see by the accounts, have come to rather a large amount, but this, I think, is chiefly explained by the way we were bound to use our stations in the year 1899. To get a sufficient amount of electricity all those stations had to be worked at high-pressure, with the result that a good deal of damage was done to our chimney shafts, boilers, &c.; but these have all been put in first-rate order now, which accounts for the large item of repairs. There is another point which I think will interest you. Last year we spent £2,215 in buying current, but this year the total amount of current that we bought was £25. I thought it would be interesting to you to know that; and I may say that at the present time we have a large amount of superfluous machinery, which will produce quite as much current as we are at all likely to want at present. I now come to law costs and parliamentary expenses. Last year they amounted to something over £1,900, but this year, I am glad to say, that they have only been a little over £170. Further than that, there was the action that was brought against us last year—an important matter—in connection with what they call Rucker's patent; that action was brought against the united companies to restrain us from using our transformer system. It was heard before one of Her Majesty's judges, and was eventually decided in favour of the companies. What is, perhaps, I was going to say, even rather more exceptional than anything else, we actually got some of our law costs returned from the solicitor on the other side. I thought that that would appeal to you as something novel. We have set aside this year £14,000 for depreciation. That is the amount which, after very careful consideration last year with our auditors and advisers, we found, working automatically, and being gradually increased year by year, would give us a very substantial and efficient reserve for what we should want at the end of our concession. I may say that practically we have already set aside £100,000 for reserve. It is true that £22,000 is not shown in the accounts, as that amount has been written off, but when we transfer this £14,000 to the depreciation and reserve fund we shall have £78,000 invested, and not invested in this company, but in first-class securities outside; so there it is for us at any time as a valuable asset that can be realised. Our progress as regards the increase of lamps during the year has been very satisfactory. We have added no less than 70,000 lamps during the year, and I may say that in the weekly applications we have, no falling off is shown; and if you look at this diagram (indicating a chart suspended against the wall) you will see the gradual, in fact, the regular rise, that there has been year by year, which really shows our increase of business. I now want to refer for a moment to Willesden. Of course, in order to meet this rapid and steady rise in our business, it has been necessary to extend, and extensively extend, the machinery at Willesden. We have at the present time three of those magnificent Westinghouse engines (which many of you have seen) working there, and we have in course of erection, to be completed by the middle of this summer, another two engines of the same capacity. That will give us at Willesden alone a capacity of 12,500 H.P., which in itself is sufficient to supply 500,000, or nearly 500,000, lamps connected. Taking that in conjunction with our London stations, which are kept in a most perfect state of efficiency, you will see that we have not only sufficient power for our supply, but a most adequate reserve. That leaves the rather hard-and-dry figure part of the report, and we now come to what is referred to in paragraph 6 of the report—namely, our negotiations with the Marylebone Vestry, or the Borough Council, as it has now become; and I do not think that I ought to neglect this opportunity of drawing your attention to what those negotiations were, and what our relationship is with this body. I may remind you that in 1882 and 1888—two years of electric lighting acts—the vestries were given the first choice whether they would undertake the supply. At that time, although electric lighting was an engineering success, it had been by no means proved that it would certainly be a commercial success in London. The Marylebone Vestry, having considered the matter thoroughly, were afraid to undertake the risk; they thought it too great. What did they do? They encouraged this Company to come in. We got our bill with their sanction, and also with the special agreements they made with us, which gave us rather less favourable terms than the ordinary electric lighting acts. When we first started we had to do a great deal of pioneer work, with the result that after some years' working, we were still paying no dividend. Then, worse than that, we had an injunction against us for a nuisance arising from our engines, and it was only with the greatest difficulty that we got over that crisis. It meant renewing a considerable part of our machinery, and to do that we had to raise more capital and at that time not under very advantageous terms. But, gentlemen, when in 1898 we began to pay a fair dividend, the Marylebone Vestry, having withheld their hands all the time we were in difficulties, said, now that the Company is making a profit, the time has come for us to apply to Parliament to compete with them. They applied to Parliament; they brought evidence before one of the Parliamentary Committees and their bill was thrown out. I must tell you that that put us to great expense. However, not satisfied with this, they in the following year brought in a second bill to compete with us. That shared the same fate as their other bill. After that they thought that they would negotiate with us to see if they could buy our concern at some cheap rate. The negotiations, however, came to nothing at that time, but they were renewed last summer. The Directors appointed a small committee of their number, and the Marylebone Vestry also appointed a committee, and there were several conferences between us. And I may say that all this was carried on by the members of the Marylebone committee with the utmost courtesy and straightforwardness in every way. We eventually came to what I believe was a fair and just provisional agreement to sell the Marylebone portion of the undertaking to the then Marylebone Vestry. The agreement was provisional in this sense—that we, the Directors, could not conclude the agreement without the sanction of the shareholders, and, therefore, if the provisional agreement had gone on we should have come to you for your sanction. The Marylebone committee had also to make the agreement subject to the sanction of the Vestry. Lastly, the agreement was subject to the figures we brought before the Vestry being verified by an independent accountant appointed by themselves. This provisional agreement was brought before the Vestry on Aug. 3, and it was passed by a very large majority; but a month later, when the minutes had to be confirmed, the Vestry changed their minds, or were influenced, and they refused by a small majority to confirm the minutes agreeing to the provisional arrangement as to purchase, with the result, of course, that the agreement fell through. We have done our best to work amicably with the local authorities; we have tried our best to come to terms with them, and we have not succeeded; and now I can only say that the Directors intend to offer the most strenuous opposition they can, and to do their best to throw out the competing bill which the Marylebone Vestry have in Parliament this year. I will not waste your time by saying anything about the general question as to rate-aided trading—we all have our views of that; but I am confident that it could never have been thought possible, when the electric lighting acts were contemplated and passed, that we should have trade rivals in the vestries. The powers of supervision given to vestries by Parliament or acquired by agreement are very stringent. They have powers which they use; and we should not mind those powers if they were exercised by any independent authority, but if they were exercised by the vestries trading against us, it would be unfair. They watch us in the most jealous way. We have our chimney-stacks constantly observed, we have our voltage tested, and we have our mains examined. Not only that, but they have an electrical specialist, who has power to come into our works at any time, which he constantly does. He is entitled to look around. He sees many of our new devices and experiments, and he prys into what I may fairly call our trade secrets. If the Vestry had the power to supply in competition with us, what is to prevent this knowledge which he acquires from being used for the benefit of our rival? Undoubtedly it would be so used. Further than that, according to our act, we cannot lay a new main, we cannot connect a single customer without giving notices varying from two days to a month to the Vestry, who have the right, if they like, to withhold their consent. When they become trade rivals with us they will have this knowledge, and they will say: "Here is a customer waiting to be connected"; and they may say to him: "Why wait for a month to be connected by the Company? We will connect you to-morrow." They have the means of knowing all our customers, and exactly what we intend to do. We do not fear competition. Of course we would rather be without the worry and annoyance of competition, and we believe that it would be much better for all parties concerned if we were allowed to develop our concern to the best advantage during our comparatively limited concession. But if we are to have competition let it be fair and open. Let us be competed with by another company who are under the same obligations as we are as to the notices they give, as to restrictions, and, above all, as to the time of the concession. That, however, is not the competition that we are threatened with. We are threatened with competition by this Vestry or Borough Council clothed with these extensive powers of supervision given to them by Parliament. I do not call that competition; I call it confiscation. I can only say, in conclusion, that I never can believe for a moment that a Parliamentary committee will sanction such a scheme, inflicting, as it would, a blow upon free and independent trading, which I consider to be the life and soul of commercial enterprise in this country. I now move the adoption of the report and accounts.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously.

The Hon. J. B. Lubbock, Sir James Pender, Bart., and Mr. J. Carr Saunders, the retiring directors, were re-elected, as were the auditors.

An extraordinary meeting was held subsequently, at which confirmation was given to the special resolution passed at the meeting on the 19th ult., approving the bill conferring further powers on the company.

A vote of thanks terminated the proceedings.

## Chelsea Electricity Supply Co. (Ltd.)

The annual meeting of this company took place on Wednesday, under the presidency of Mr. IRVING COURTENAY, chairman of the company.

The SECRETARY (Mr. S. J. Clues) read the notice convening the meeting and the report of the auditors. The directors' report was taken as read.

The CHAIRMAN said: The dividend recommended on the ordinary shares is 5½ per cent. for the year being ½ per cent. lower than that paid for the last few years. This may have been anticipated by you in view of the high price of coal. But notwithstanding that we have had to pay over £1,800 more for coal than we should have paid had the previous year's prices been maintained, this circumstance alone would not have lowered the dividend. Three causes have operated to bring about this. The increase in the price of coal, the diminution in the amount of revenue per unit sold resulting from the reduction in price to consumers who take the supply at 200 volts (a decrease amounting to ½d. per unit on the whole supply, or close upon £3,000), and the unusually light weather in the first and last quarters of the year 1900, which we estimate to have diminished the revenue by more than £1,000. The reduction of price introduced with the "maximum demand" system of charging has been gradual in its effect, as it comes into force only when a consumer takes the supply at 200 volts—our original supply having been at 100 volts; and, although the system has been in use for little over a year, it has already resulted in bringing on a number of small but regular consumers, whose consumption will be really more remunerative at a low price than is that of the more wealthy consumer at the higher price—I mean the consumer who uses the light regularly for long hours, and is practically always in town, such as the smaller householders and tradesmen; indeed, the lamps fixed by the smaller customers in the less important streets have, as a rule, a far better earning capacity than the lamps fixed in houses in the more fashionable districts, for in the latter case many of the houses are occupied for only a few months in the year, and the light is used irregularly. A further reason for our belief in the success of the system lies in the fact that in this short time there is an increase in the units sold per lamp—only of half a unit, it is true, though that amounts to something on nearly 150,000 lamps, and that this foreshadows a more substantial increase in the future, as the advantages of the system become better known. The reduction in price was absolutely necessary in order to develop our business and compete seriously with gas. A large proportion of our customers being now supplied at 200 volts, it has been found unremunerative to continue to supply others at 100 volts, as the distribution at that pressure is more wasteful, and we have to keep special machinery going for the purpose. We have, therefore, felt obliged to give notice of our intention to raise the price for the 100-volt supply to 7d. The cost of production has remained about the same, with the exception of the increase in the cost of coal, and some slight reductions in the cost per unit under other heads. There has, however, been a further reduction in the actual weight of coal burnt for each unit generated, and we are still testing appliances for greater economy of coal consumption, while the price of the Welsh steam smokeless coal is falling. The equipment of the Alpha-place works has been completed, and we now have a convenient and efficient generating station which is yielding excellent results. The plant has given very little trouble, and has been maintained in a high state of efficiency. The workshops which have been provided in the same building have been found to be exceedingly useful. A large amount of repairing and construction work has been carried out at a considerably lower cost than formerly. The new sub-station at Milner-street is equipped and working. The company now possesses all the necessary distributing sub-stations for dealing with the increase in the demand for a supply of electricity for many years to come. Several important extensions of the mains have been carried out, and the company is in a position to supply electricity at short notice to premises situated in any part of the area of supply. The number of lamps added during the year was 16,410, which is about the same number as were added during the previous year (16,280), and the number of customers connected up was 371, comparing with 274 in the previous year. The fact that in order to obtain the same total number of additional lamps it is necessary to connect on a larger number of customers is, in a way, a good sign, as it indicates the bringing in of a more remunerative class of customer. I hope that we shall increase this class of customer, because it is an absolute necessity that we should increase the low average of the number of units consumed per lamp. The capital expenditure is nearly £22,000 less than that of 1899. £3,000 has been added to renewals and depreciation, and the amount received on account of premium up to December last on the new issue of shares has, after some deductions, been carried as before to reserve. In 1898 we obtained an Act of Parliament giving the Chelsea Company powers to purchase compulsorily certain lands and properties for the purposes of its business, and we shall have to invest a substantial sum before the end of this year in acquiring these properties, which we estimate will give us sufficient space for all buildings necessary for the supply of current to the whole of the borough of Chelsea. I now move the adoption of the report and accounts, and that the dividends therein set out be approved.

Major-Gen. C. E. WEBBER, C.B., seconded, and, after some further remarks from the chairman, in reply to shareholders, the motion was carried, with three dissentients.

The retiring directors, Mr. Nugent Daniell and Mr. George N. Marten, were re-elected, as were also the auditors, Messrs. Cooper Bros.

A vote of thanks to the chairman and directors brought the meeting to a close.

## Notting Hill Electric Lighting Co. (Ltd.).

The eleventh annual report of the directors of this company deals with the year to Dec. 31 last. Expenditure on capital account has been increased during the year by £27,659. 9s. 4d., and now stands at £164,990. 2s. 11d. The capital items for the year were £12,196. 16s. 11d. for new mains, £3,336. 15s. 6d. for freehold property, £3,177. 14s. 5d. for buildings, and £8,282. 2s. 9d. for machinery for equipping these stations. To provide capital for this expenditure the balance £19,000 of debentures was issued, and the capital increased by £100,000. Of this fresh capital 2,200 £10 shares have been issued to shareholders at £2 per share premium.

The following table shows the progress of the company:—

| Year. | No. of lamps. | Profit. | Year. | No. of lamps. | Profit. |
|---|---|---|---|---|---|
| 1891 | 6,056 | £553 18 6 | 1896 | 25,716 | £4,736 9 8 |
| 1892 | 9,438 | 112 6 1 | 1897 | 33,000 | 6,854 1 2 |
| 1893 | 12,153 | 1,481 7 1 | 1898 | 46,066 | 7,251 13 7 |
| 1894 | 15,669 | 2,101 17 8 | 1899 | 59,154 | 10,360 17 4 |
| 1895 | 20,307 | 3,227 14 10 | 1900 | 68,605 | 9,856 0 0 |

The number of consumers is now 1,191, and of these 91 per cent. are supplied at 200 volts.

For the first time the net profit shows a decrease, notwithstanding that the gross revenue showed an increase of 10 per cent. This is accounted for by increase in expenditure for coal (£1,000), and by the expenditure of £1,200 on repairs to accumulators, which involved the entire renewal of one set of batteries. Moreover, in May the directors found the new works in Wood-lane would not be ready for the winter supply, and had to refuse fresh supply contracts, the result being that the fresh capital expenditure has been unproductive, and the increase in the number of lamps was only 9,400.

It was estimated that the cost of the new generating station at Wood-lane for supplying current wholesale to the Notting Hill and Kensington companies jointly would be £100,000, and this estimate has not been exceeded. These works are now approaching completion, the machinery is running, and the tests having proved satisfactory, some current is being supplied to the respective companies.

The premium from the issue of shares and debentures during the year amounted, after deducting expenses, to £4,257. 17s. 7d., and this has been added to £742. 2s. 5d. out of current revenue (making £5,000), and this has been transferred to depreciation, renewal and reserve, bringing that account up to £11,000. Although the expenditure on accumulators might have been taken from this fund, that charge has been made against the revenue for the year. Of the remaining net profit, after paying interest on debentures and new ordinary shares, depreciation, &c. (£7,444. 14s. 8d.) the directors recommend the payment of the usual dividends of 6 per cent. on both the preference and ordinary shares (absorbing £5,670). £887. 7s. 4d. (one half the balance) is credited to the founders' shares, and the other half to the ordinary and preference shares, making the distribution on both 7 per cent. for the year, with £1. 12s. per share on the founders' share.

The directors place on record their appreciation of the services of the engineer and manager, secretary, and staff generally.

**CHARING CROSS, EUSTON AND HAMPSTEAD RAILWAY CO.**—At a special meeting on Monday resolutions approving the company's bills for conferring further powers and authorising agreements with the Brompton and Piccadilly Circus and the Central London Railway companies, empowering the company to extend their authorised railways to Highgate and Victoria, authorising agreements with the Midland, the Central London, the Baker-street and Waterloo, the Brighton, and the Victoria and Pimlico Railway companies, and the South Eastern and Chatham Railway companies' managing committee, and for incorporating and conferring powers on the Finchley and Hendon Tramways Co., were passed.

**EDWARDS' AIR-PUMP SYNDICATE (LTD.)**—The report of the directors for the year ended Dec. 31 states that the royalties booked during the 12 months showed an increase of over 32 per cent. on the previous year. The revenue for 1899 amounted to £3,219, and for 1900 £4,266. The ordinary expenditure shows a reduction of £126, but extraordinary expenditure in respect of testing and alteration of jet-pumps, and in complying with the requirements of foreign Governments in respect of patents, &c., was responsible for an increase of £164. The value of the test referred to is demonstrated by the fact that during the past year the jet-pumps booked exceeded by four times the number booked in 1899. The balance on the revenue account for the year amounts to £1,634, and, adding the £633 from last year there is £2,267, which the directors propose to transfer to sinking fund account for redemption of cost of acquiring patents (£1,000) and to pay a dividend of 5 per cent. on the called-up capital, leaving £374 to be carried forward.

**NATIONAL ELECTRIC SUPPLY CO. (LTD.)**—The annual meeting of this company was held last week. The chairman (Mr. J. Booth) said he was disappointed that they were not able to recommend a larger dividend. They had done considerably more business, they had paid off the whole of their loans and debentures, so that everything now belonged to the shareholders, and the company was never in so sound and prosperous a position. Had it not been for their having had to pay more than double the price for coal, their cost per unit generated would have come out lower than ever before, and that in spite of the fact that their assessment for rates had during the year been more than trebled. The dividend would therefore be, instead of 8s. a share, 6s. The extra amount they had paid for coal and the extra rates amounted to nearly as much as would have paid a further 3s. per share. Their prospects for the new year were very promising. Their more efficient machinery was getting to work, and they had already obtained several very large new consumers. Their new engine and boiler house was nearly completed and one of the two new 800 H.P. set was now running. They expected to have the other set going this month. They should then still have room for four larger sets, and he thought it would not be long before they would be required. The total capital of the company was now £184,943, of which £105,568 has been subscribed, leaving a balance of £79,376 to be issued as required in 4 per cent. preference shares. They had heard nothing from the Corporation about the electric tramways, although they had offered to supply current on exceptionally favourable terms. 4 per cent. for the year was declared on the preference, and 3s. 6d. on the ordinary shares, which, with the interim dividend, equals 6s. per share for the year.

**NEWCASTLE ELECTRIC SUPPLY CO. LTD.)**—The annual meeting was held last week. The chairman (Ald. T. Gibson) said the profit for the past year was £8,749, against £6,501 for 1899, an increase of about 36 per cent. After adding £1,811 from last account the available balance for dividend was £10,605, against £7,495. The directors proposed dividends of 5 per cent. on the preference and at the rate of 8 per cent. on the ordinary shares. There now remained unissued 10,000 ordinary and 6,250 preference shares, which would be offered to the shareholders during the autumn on the same terms as last issue. They had expended during the year £15,997 on Pandon Dene in further plant. They had had to increase the condensing plant and to add a cooling tower, which had been found necessary to minimise the steam from the condensing plant. The cooling tower was working satisfactorily and giving good results. Meters and transformers cost £2,504, and they had added two continuous current 500kw. machines. The greatly increasing demand for power in the town could not be supplied from the alternating plant that they started with. The capacity of their plant was equal to supplying 90,000 8-c.p. lamps, and they were supplying at present 75,000 to about 1,160 customers. The power station taken over at Wallsend had cost them £74,696, and this would enable them to supply the Wallsend and Walker Union Gas Co.'s district, and their own extended wants at Gosforth, Willington Quay, &c. With a view to further extension of works, the directors had secured a site of 11 acres at Carville, by the river Tyne, at a cost of £22,000, the vendor taking shares at £1 premium for the purchase price. They had laid during the year 5 miles of mains, and had now about 31 miles of mains in the town.

---

**NORTHALLERTON ELECTRIC LIGHT AND POWER CO. (LTD.)**—The directors' report for the past year was presented at the annual meeting on Wednesday, and showed an adverse balance of £473. 17s. 5d. During the year the demand for current by private consumers had greatly increased, and had necessitated a large extension of the works and alterations and additions to the plant. It was estimated that the consumption for private lighting and motors for the next quarter would be over 10,000 units. The contract with the District Council had proved a heavy loss, and the directors felt it their duty to give notice to the Council to terminate in May. The directors had been hampered by the want of sufficient capital, as the shares and debentures were not taken up by the public.

---

**NORTHAMPTON ELECTRIC LIGHT AND POWER CO. (LTD.)**—At the annual meeting, last week, the chairman Mr. F. H. Thornton said the year had been one of considerable progress. The equipment of 5,696 8 c.p. lamps had been connected, compared with 6,000 odd last year, and the mains had been extended a considerable distance. The number of consumers had also satisfactorily increased. The number of motors had increased from 14 to 18, and to 61 H.P. against 54 H.P., while 15,000 units for motor power had been used against 5,700, so that the use of electric current for motor power had been almost trebled. Owing to the increased cost of coal and the unexpected delay in the delivery of machinery their plant had been working uneconomically, with the result that no improvement could be recorded so far as net revenue was concerned. Dividends on the 6 per cent. and 5 per cent. preference shares, and 2 per cent. on the ordinary shares were declared.

---

**OXFORD ELECTRIC CO. (LTD.)**—The report of the directors for the year ended Dec. 31, states that the profit, including £73. 10s. from last year, amounts to £5,125. 3s. 8d. After providing £1,965. 10s. 11d. for debenture and other interest, and writing off £254. 0s. 11d. on account of hire purchase installations, there is available £2,905. 11s. 10d. A dividend at the rate of 5 per cent. per annum (absorbing £2,500) is proposed, and £250 is added to reserve and renewal of plant, leaving £155. 11s. 10d. to be carried. Since the last report the equivalent of 3,722 8 c.p. lamps have been connected to the mains. The exceptional cost of coal and in the price of materials generally acted unfavourably on the cost of production. Notwithstanding the reduction in the price of current from 7d. to 6d. per unit, the revenue shows an increase of £336. 4s. 2d. over the preceding year. There is every reason to anticipate that the rate of increase for the current year will exceed that of 1900. The capacity of the sub-station at North Parade has been doubled, and the distribution mains have been considerably extended. To provide for new plant and other capital expenditure during the year the directors are issuing 2,500 shares at par.

---

**RICHARDSONS, WESTGARTH & CO. (LTD.)**—At a meeting on Tuesday the Chairman, Sir C. Furness, M.P., said the company had been established to carry on the business of marine, electrical and mechanical engineers, &c. Their extensive business included an electrical department, the company being the sole representatives in this country for Messrs. Brown, Boveri & Co. They had on hand large contracts for electric lighting and power plants. The amalgamation of the businesses of Thomas Richardsons & Sons, Sir Christopher Furness, Westgarth & Co., and William Allen & Co. had been attended with the best results. Their works were occupied to their full capacity, and the prospects of the combination were very satisfactory. The work of extending the electrical and boiler shops at Hartlepool was in progress, and would lead to greater economy in production. The amalgamated undertakings constituted the greatest marine engineering concern in the world. The shareholders might rely upon it that the directors would not be found wanting in regard to the application of electricity to the several industries in which the company was interested. The twentieth century, it was agreed, was to be the age of electricity, and the developments of electrical science would be closely watched, and their apprentices would have an opportunity of attending technical instruction classes, and in every other way be fitted to qualify themselves to meet the keen competition of America and Germany. The old days of rule of thumb were over and the present was the era of scientific knowledge and technical skill.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**BRITISH ELECTRICAL MANUFACTURING CO. (LTD.)**—Registered Feb. 28, with a capital of £10,000, in £1 shares, to acquire the business of J. D. F. Andrews & Co. (Ltd.), and to carry on the business of electrical engineers and manufacturers, electric light contractors, electricians, engineers, suppliers of electricity for all purposes, &c. The subscribers include D. R. Broadbent (electrical engineer), and N. Knowles (electrical engineer), each with 250 shares.

**COOKE'S PATENT TRAMWAY SYSTEM LTD.**—Registered on March 1, with a capital of £5,000, in £5 shares, to acquire provisional patent No. 16,356 (1900) granted to H. J. Cooke and M. Ehrenfeldt, to construct, erect and maintain railways, hydraulic and electrical works, &c.

---

**ACCUMULATOR INDUSTRIES (LTD.)**—The annual return to Jan. 14 gives the capital as £10,000, in £1 shares, 5,534 of which have been taken up; £1 has been called up and paid on each of 584 and 5,000 are considered as fully paid. No mortgages or charges.

**ACCUMULATOR SYNDICATE (LTD.)**—The annual return to Dec. 30 gives the capital as £30,000, in £1 shares, all of which have been taken up. £1 per share has been called and paid on 5,000 ordinary shares and 25,000 are considered as fully paid.

**AFRICAN TRANSCONTINENTAL TELEGRAPH CO. (LTD.)**—The annual return to Dec. 28 gives the capital as £300,000 in £1 shares, 170,300 of which have been taken up. £1 has been called up on each share, and £169,305 has been received.

**ELECTRIC LIGHTING AND TRACTION CO. OF AUSTRALIA (LTD.)**—According to return to Jan. 21 the capital is £300,000, in £5 shares (30,000 preference), of which 4,834 ordinary and 20,000 preference have been taken up. £5 per share has been called up on 2,003 ordinary and 20,000 preference, and £110,015 has been received. £14,165 is considered as paid on 2,831 ordinary shares. Mortgages and charges £65,000.

**ELECTRIC RAILWAY, TRAMWAY, AND CARRIAGE WORKS CO. (LTD.)**—According to the annual return to Oct. 17 last the capital is £150,000, in £5 shares, all of which have been taken up and paid for in full. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 28⅜d. per oz. (March 7). Consols (2¾ per cent.) 96⅞—97 for money, 96⅞—97 for account; 2½ per cent. 96—96½ (March 7). Consols Pay Day April 3. Stocks and Shares Continuation Days, Mar. 12 and 26, Ticket Days, Mar. 13 and 27; Pay Days, March 14 and 28; Mining Share Carry-over Days, Mar. 11 and 25.

**ANTWERP.**—A company called the Société Nouvelle du Centre d'Anvers has been formed in Antwerp with a capital of £20,000 to establish electricity generating works.

**BROMPTON AND KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)**—The directors are making an issue of 8,000 7 per cent. cumulative preference shares of £5 each at £8 per share: £53,750 of the receipts will be applied in paying off the 4½ per cent. debenture stock at 107½.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—Subject to audit, and after making due provision for depreciation, it has been decided to recommend payment of the full dividend on the preference shares, and to carry forward about £11,350.

---

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Feb. 23 | 548 | + 85 | 38 | 25,850 | + 3,405 |
| *Birmingham Tramways. | Mar. 2 | 4,159 | + 22 | 8 | 32,016 | + 442 |
| *Blackburn Corporation.. | | ... | ... | ... | | ... |
| Blackpool Corporation... | Feb. 28 | 189 | + 30 | 48 | 29,710 | + 7,626 |
| Blackpool and Fleetwood | Mar. 2 | 139 | 33 | 9 | 1,228 | − 62 |
| Bolton Corporation ..... | " 3 | 1,279 | ... | 48 | 65,537 | ... |
| Bradford Corporation... | " 3 | 797 | + 411 | 48 | 29,359 | +11,020 |
| Brisbane Trams ......... | Jan. 16 | 2,096 | + 250 | 2 | 3,991 | + 453 |
| *Bristol Trams & Carriage | Mar. 1 | 3,671 | + 628 | 9 | 32,113 | + 8,776 |
| *Buenos Ayres & Belgrano | Feb. 3 | 2,745 | + 441 | 5 | 13,793 | + 2,000 |
| Carlisle Trams. Co. ... | Mar. 2 | 132 | ... | 9 | 975 | ... |
| Central London Railway | " 2 | 6,023 | | 9 | 54,807 | |
| City & South London Ry. | " 3 | 1,915 | + 525 | 9 | 19,073 | + 7,600 |
| Cork Elec. Trams ......... | Feb. 28 | 339 | + 14 | 8 | 2,847 | + 304 |
| Dover Corporation ...... | Mar. 2 | 158 | + 13 | 48 | 10,155 | + 647 |
| Dublin & Lucan Rly. ... | " 2 | 74 | + 17 | 9 | 655 | + 165 |
| Dublin United ............ | " 1 | 3,041 | + 51 | 9 | 17,970 | + 2,690 |
| Dublin Southern Dist.... | " 1 | 643 | + 3 | 9 | 6,429 | |
| *Dundee Corporation ... | Feb. 27 | 445 | + 7 | 41 | 10,355 | + 2,535 |
| *Glasgow Corporation ... | Mar. 2 | 8,207 | − 6 | 9 | 75,294 | + 2,513 |
| Halifax Corporation ... | " 3 | 735 | + 176 | 40 | 36,471 | − 7,800 |
| *Huddersfield Corpn. ... | " 2 | 722 | + 79 | 48 | 33,091 | + 2,778 |
| Hull Corporation ......... | " 3 | 1,495 | + 775 | 35 | 50,339 | +27,296 |
| *Liverpool Corporation... | Feb. 23 | 7,627 | + 727 | 8 | 62,070 | + 9,482 |
| Liverpool Overhead Rly. | Mar. 3 | 1,431 | − 1 | 9 | 13,103 | + 256 |
| Portsmouth Corporation | " 2 | 509 | − 7 | ... | ... | ... |
| *Sheffield Tramways ..... | " 3 | 2,915 | + 1,047 | 9 | 24,723 | + 8,569 |

* Partly electrical.

**COMMERCIAL CABLE CO.**—A quarterly dividend of 1¾ per cent. has been declared, payable April 1, out of the net earnings of this Company The transfer books will be closed from 20th inst. to April 1 inclusive.

**DAVIS AND TIMMINS (LTD.)**—The directors recommend the payment of the dividend on the 6 per cent. preference for the six months to Dec. 31, and on the ordinary shares at the rate of 8 per cent. per annum.

**GAS, WATER AND GENERAL INVESTMENT TRUST (LTD.)**—At the annual meeting on Tuesday, the chairman (Mr. J. B. Braithwaite) said that during 1898 the Utah Light and Power Co. earned $245,273, and in 1899 $314,611, an increase of a little over $60,000, or about £12,000. During the year ended Dec. 31, 1900, the earnings had risen to $381,602, showing a further increase of more than £13,000.

**GREAT NORTHERN AND CITY RAILWAY CO.**—The fifth and final call of £1 on the preferred ordinary class "A" shares is payable on the 25th inst.

**MUNICIPAL ISSUE.**—Brighton Corporation have made an issue of £600,000 3½ per cent. redeemable stock for constructing tramways, extending electricity works, &c.

**ROYAL ELECTRIC CO. (OF MONTREAL).**—A drawing of 4½ per cent. debentures, to be redeemed on April 1, will take place on 9th inst.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has ordered 400,000 £1 shares (Nos. 1 to 400,000) of the *Cape Electric Tramways (Ltd.)*, and 20,000 6 per cent. cumulative preference £5 fully paid shares (Nos. 1 to 20,000) of the *Electric Lighting and Traction Co. of Australia (Ltd.)*, to be quoted in the official list. The committee has also been asked to appoint a special settling day in 34,601 ordinary £10 (£6 paid) shares (Nos. 1 to 34,601) and 66,000 4 per cent. preference £10 (£6 paid) shares (Nos. 1 to 66,000) of the *Baker Street and Waterloo Railway Co.*, and 37,396 £5 (£3 paid) shares of the *Johnson-Lundell Electric Traction Co. Ltd.*)

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 27. | | Price Wednesday, Mar. 6. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 6. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | | |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch Dist'ct Elec. Lt. Ord (fully pd.) | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £100,[illegible] | Stock | ... | Do. 4½ 1st Deb. Stock [illegible] (red.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 15 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,061 | 5 | 2/6 | Brompton & Kensington Elec. Supply Ord. (fully paid) | 7½ | 8½ | 7 | 8 | 3 15 0 | ... | 7½ | 7½ |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference (fully paid) | 8½ | 9½ | 8 | 9 | 3 17 9 | March and September | 8½ | 8½ |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 50,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9½ | 10½ | 9½ | 10½ | 4 3 1 | February and August | 10½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6½ | 5½ | 6½ | 3 13 3 | " " | 5½ | ... |
| 34,000 | 5 | 2/6 | Chelsea Electricity Supply Ordinary | 6½ | 6½ | 6 | 6½ | 4 12 4 | March | 6 | ... |
| £180,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% [illegible] yr. Gold Bonds (red.) | 109 | 110 | 109 | 110 | 4 10 11 | April and October | ... | ... |
| 70,670 | 10 | 8/0 | City of London Electric Lighting Ord. | 7 | 8 | 7½ | 7½ | 5 8 5 | February and August | 7 | 6½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | 14 | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 121 | 127 | 3 18 9 | June and December | [illegible] | 123½ |
| £200,000 | Stock | | Do. 4½%, 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 40,000 | 10 | 6/0 | County of London and Brush Prov. Ordinary | 8 | 9 | 8 | 9 | 6 13 4 | ... | 8 | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | 107½ | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10½ | 11½ | 10 | 11 | 4 18 [illegible] | ... | ... | ... |
| 10,000 | 5 | 4% | Do. 5 per Cent. 1st Pref. | 6½ | 7 | 6½ | 7 | 4 2 [illegible] | January and July | ... | ... |
| £73,000 | Stock | [illegible] | Kensin. & Knightsb. Co & Notting Hill Co (Jnt. Stk.) | 103 | 105 | 103 | 105 | 3 16 2 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,500 | 5 | 3/0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 99 | 101 | 99 | 101 | 3 19 3 | Mar., June, Sept., Dec. | [illegible] | ... |
| 85,000 | 10 | [illegible] | Metropolitan Elec. Supply Ord. | 13 | 14 | 13½ | 13½ | 4 8 11 | April and October | 13½ | [illegible] |
| 13,700 | 10 | ... | Do. (£5 paid) | 7 | 8 | 7 | 8 | ... | ... | ... | ... |
| £725,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £250,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 98 | 99 | 98 | 99 | 3 10 8 | ... | 99 | 98½ |
| 4,453 | 10 | [illegible] | Notting Hill Electric Ordinary | 15½ | 16½ | 15½ | 16½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 18 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 13 6 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tract'n, Ltd., 5% 1st Mor. Deb. | [illegible] | [illegible] | [illegible] | [illegible] | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 170 | [illegible] | [illegible] | [illegible] | 4 6 6 | April and October | ... | ... |
| £115,000 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 105 | 103 | 105 | 4 7 5 | " " | ... | ... |
| 40,000 | 5 | 9/- | St. James's and Pall Mall Electric Ordinary | 14 | 15 | 14 | 15 | 4 16 8 | February and August | [illegible] | 14½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | [illegible] | Do. 3½ per Cent. Debenture Stock (red.) | 99 | 101 | 99 | 101 | 3 9 6 | ... | 100½ | 100 |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | 2 | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 89 | 90 | 89 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | [illegible] | Westminster Electric Supply Ordinary x d | 12 | 13 | 12 | 13 | 4 0 9 | March and September | 12½ | 12½ |
| 37,100 | 5 | [illegible] | Do. Do. x d | 12 | 13 | 12 | 13 | ... | ... | [illegible] | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | [illegible] | [illegible] Tramways x d | 14 | 16 | 14 | 15 | [illegible] | ... | ... | ... |
| £167,900 | 100 | 5% | [illegible] Tramway 5 per Cent. Debentures | 101 | 104 | 101 | 103 | 4 1[illegible] 0 | ... | ... | ... |
| 50,000 | 10 | [illegible] | Bristol Tramways and Carriage Ordinary x d | 24 | 24½ | 24 | 24½ | [illegible] | February and August | ... | ... |
| 25,000 | 10 | 6% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 11½ | 3 15 [illegible] | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 113 | 114 | 113 | 114 | 3 6 1 | February and August | ... | ... |
| [illegible] | 10 | | British Columbia Electric Railway Ordinary | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 13,650 | 10 | [illegible] | Do. 5% Pref. | 9½ | 10½ | 9½ | 10½ | 4 17 7 | May and November | ... | ... |
| [illegible] | 100 | | Do. 4½% 1st Mort. Deb. | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | 99½ | ... |
| 65,000 | 10 | 6/0 | British Elec. Trac. Ord. | 14½ | 15½ | 14½ | 15½ | 5 9 7 | ... | 15 | 14½ |
| 65,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | February and August | 12½ | [illegible] |
| £350,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 122 | 4 1 4 | ... | 122½ | 121½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 5 | 5½ | 5 | 5½ | 5 16 3 | ... | 5½ | [illegible] |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5 | ... | ... | 4½ | ... |
| £220,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | 106 | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stock Prov. Certs (all pd.) | 95 | [illegible] | [illegible] | [illegible] | 5 1 4 | ... | ... | ... |
| 206,297 | 10 | 2/6 | Central London Ordinary | 9 | 9½ | 9 | 9½ | 2 17 10 | June and December | [illegible] | ... |
| [illegible] | Stock | 1½% | City and South London Railway Con. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | 2 11 0 | February and August | ... | ... |
| 37,500 | 10 | [illegible] | Do. Ordinary (Nos. [illegible]) | 4 | 5 | 4 | 5 | ... | " " | 4½ | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 127 | 131 | 122 | 127 | 3 [illegible] 9 | ... | ... | ... |
| [illegible] | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 115 | 121 | 115 | 121 | 3 16 11 | May and November | ... | ... |
| 60,000 | 10 | [illegible] | Dublin United Tramways (1896) Ltd., Ordinary | 11 | [illegible] | 12½ | [illegible] | [illegible] | ... | ... | ... |
| [illegible] | 10 | [illegible] | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| [illegible] | 100 | ... | Do. [illegible] Debentures | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| [illegible] | 5 | ... | Electric Lgt. & Traction of Australia [illegible] Pref. | ... | ... | [illegible] | [illegible] | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | [illegible] Tramways Ordinary | 21 | 23 | 21 | 23 | 3 12 [illegible] | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | [illegible] | " " | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debentures x d | 114 | 116 | 112 | 114 | 3 19 11 | January and July | ... | ... |
| 20,000 | 10 | 1/3 | Kidderminster & District El. Lt. & Traction Co. Pref. | ... | ... | ... | ... | ... | May and November | ... | ... |
| 37,600 | 10 | 3½% | Liverpool Overhead Railway Ordinary x d | 8 | 9 | [illegible] | 9 | 4 1 1 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference x d | 13 | [illegible] | 13 | [illegible] | 3 11 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debentures | 112 | [illegible] | 112 | [illegible] | 3 17 2 | January and July | ... | ... |
| [illegible] | $1,000 | 5% | [illegible] | 102 | 105 | [illegible] | 102 | 4 15 [illegible] | ... | ... | ... |
| [illegible] | Stock | [illegible] | [illegible] | 81 | 83 | [illegible] | [illegible] | ... | ... | ... | ... |
| [illegible] | 100 | 5% | Montreal Street Railway [illegible] | 104 | 105 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. 4½% Debentures (1922) | 102 | 104 | 102 | 105 | 4 [illegible] 7 | ... | ... | ... |
| [illegible] | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | | ... | | ... | ... | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | [illegible] | ... |
| [illegible] | 10 | [illegible] | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 6 10 11 | February and August | ... | ... |
| £115,000 | Stock | [illegible] | Do. 4½ per Cent. Debenture Stock | 105 | 108 | 107 | [illegible] | [illegible] | ... | ... | ... |
| [illegible] | Stock | 1% | Waterloo and City Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Feb. 27. | Price Wednesday, Mar. 6. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 6. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | £ s. d. | | | |
| £80,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 98 103 | 98 103 | 3 18 5 | January and July | ... | ... |
| 36,000 | 10 | ... | Amazon Telegraph | ... | ... | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 75 85 | 55 65 | ... | ... | ... | ... |
| £512,720 | Stock | 17/6 | Anglo-American | 52 55 | 51 54 | 5 12 11 | Feb., May, Aug., Nov. | 52½ | ... |
| £3,098,640 | Stock | 30/0 | Do. Preferred | 97 99 | 96 98 | 6 2 6 | " " | 98 | 97 |
| £3,098,640 | Stock | 5/0 | Do. Deferred | 8¾ 9½ | 8½ 9 | 2 14 0 | " " | 9 | 8¾ |
| 13,333,300 | $100 | 8½ | Commercial Cable Capital Stock | 165 175 | 165 175 | 4 13 3 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,059 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 104 | 102 104 | 3 16 11 | " " | 103½ | ... |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ 8½ | 7½ 8½ | 6 9 5 | February and August | 8¼ | 7¾ |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 17 | 16 17 | 5 17 8 | " " | ... | ... |
| 12,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ 4½ | 3½ 4½ | 4 8 10 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 10 | 9 10 | 5 0 0 | " " | ... | ... |
| £80,800 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% 104% | 100% 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 10 10½ | 9¾ 10½ | 6 16 7 | Jan., Apr., July, Oct. | 10⁷⁄₁₆ | 9¾ |
| £109,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 to 1,200) (red.) | 99 102 | 99 101 | 4 8 8 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary | 145 150 | 144 148 | 4 14 1 | Jan., Apr., July, Oct. | 145½ | 145½ |
| £1,826,500 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 95 98 | 94 97 | 3 12 0 | " " | 94½ | 96 |
| £1,432,360 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 117 | 113 117 | 3 8 0 | May and November | 113½ | 113 |
| 250,000 | 10 | 2/6 | Eastern Extension | 14½ 14¾ | 14¼ 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14½ | 14⁷⁄₁₆ |
| 50,000 | 10 | ... | Do.(Nos.250,001to300,000)£2½pd,is'd at £2pm,all pd | 13½ 14½ | 13½ 14½ | ... | ... | 14½ | 13¾ |
| £330,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 110 115 | 110 114 | 3 9 7 | February and August | ... | ... |
| £900,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 102 | 99 102 | 3 18 3 | February and August | . | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101% 104% | 101% 104% | 3 17 8 | May and November | 101 | ... |
| 180,227 | 10 | 1/9 | Globe Telegraph and Trust | 9¾ 10¼ | 9¾ 10¼ | 5 2 5 | Jan., Apr., July, Oct. | 10¼ | 9¾ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14¾ 15½ | 14¾ 15½ | 3 18 8 | " " | 15 | 14¾ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 32 34 | 33 34 | 3 13 6 | January and July | 33½ | ... |
| £82,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos 1 to 1,200) (red.) | 99 103 | 99 102 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European | 47 51 | 47 51 | 4 15 0 | May and November | .. | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 xd | 104 107 | 103 106 | 5 13 2 | March and September | 103½ | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 102 | 99 102 | 3 18 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7½ 8½ | 7½ 8½ | 4 14 1 | April and October | ... | ... |
| 8,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 128 | 124 [illegible] | 4 16 0 | " " | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2½ 3½ | 2½ 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) xd | 99 102 | 97 100 | 5 0 0 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ¾ 1 | ¾ 1 | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 103 | 99 103 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ¾ 1 | ¾ 1 | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 7 | 6 7 | 8 11 6 | " " | 6½ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 7 | 5 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 106 | 103 106 | 4 14 4 | January and July | . | ... |
| 207,920 | 10 | 3/0 | Western Telegraph (late Brazilian S'bm'rine) | 13½ 14½ | 13½ 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14¼ | 13¾ |
| £75,000 | 100 | 5% | * Do. 4 per Cent. Debs. (2nd Series, 1906) | 101 104 | 101 104 | 4 15 3 | June and December | ... | ... |
| £344,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 105 | 102 106 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 3½ | 3 3½ | 5 14 4 | August | ... | ... |
| 234,251 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/6 3/3 | 2/1 2/6 | 6 11 6 | April and October | ... | ... |
| 72,680 | 1 | 2½% | Monte Video Telephone Ordinary | ½ ¾ | ½ ¾ | 5 0 0 | November | ... | ... |
| 96,493 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ 1 | ¾ 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 2/6 | National xd | 3½ 3¾ | 3½ 3¾ | 3 8 0 | February and August | 3¾ | 3½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference xd | 12 14 | 11 13 | 4 12 4 | " " | 12½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference xd | 11 13 | 11 13 | 4 12 4 | " " | 11 | ... |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ 5 | 4½ 4¾ | 5 5 3 | " " | 4⁵⁄₁₆ | 4⁵⁄₁₆ |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 94 97 | 94 97 | 3 12 2 | June and December | 95½ | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 98 101 | 98 101 | 3 19 6 | ... | 99½ | 97 |
| 171,504 | 1 | 0/6 | Oriental | 1 1½ | 1 1½ | 5 3 9 | April and October | 1 | . |
| 58,000 | 5 | 2/6 | United River Plate | 4½ 5 | 4½ 5 | 7 0 0 | July | 4½ | 4½ |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ 5½ | 4½ 5½ | 4 18 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 106 | 103 106 | 4 14 9 | June and December | 104 | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. xd | ¾ 1 | ¾ 1 | 5 0 0 | ... | ... | ... |
| 135,000 | 1 | 1¼d. | Aron Electricity Motor 6% Cum. Pref. | 1¼ 1⅜ | 1¼ 1⅜ | 7 3 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ... | ... | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ... | ... | ... | ... | ... | ... |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 90 | 85 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary xd | 11 12 | 10 11 | 6 16 4 | July and February | 10½ | ... |
| 70,000 | 5 | 5/0 | Do. 6 per Cent. Preference | 5¾ 6½ | 5¾ 6½ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ 4¾ | 4½ 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 1/2½ | Brush Electrical Engineering | 1½ 1¾ | 1½ 1¾ | 6 8 4 | September | 1⅝ | 1½ |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| 90,000 | 2 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2¼ 2¾ | 2¼ 2¾ | 5 9 8 | " | 2⅜ | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | ... | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock xd | 105 110 | 103 108 | 4 3 2 | March and September | 107 | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 103 | 101 103 | 4 7 5 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 16½ 16½ | 15 16 | 4 13 9 | " " | 16⅛ | 14½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ 6 | 5½ 6 | 4 3 4 | " " | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 109 112 | 100 113 | 3 13 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 1½ | 1 1½ | 6 8 0 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | [illegible] 97 | 94 97 | 4 12 9 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ 1 | ¾ 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ 1½ | ¾ 1½ | 5 6 8 | ... | ... | ... |
| 54,000 | 2 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3½ 3¾ | 3½ 3¾ | 6 0 0 | January and July | 3⁹⁄₁₆ | 3⁹⁄₁₆ |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 103 | 100 103 | 4 17 6 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ 1 | ¾ 1 | 6 0 0 | ... | ... | ... |
| 99,281 | 5 | 1/6 | Edison & Swan United ("A" Shares) £3 paid, xd | 1½ 2 | 1½ 2 | 0 0 0 | February and August | 1¾ | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) xd | 3½ 4½ | 3½ 4½ | 6 13 4 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 85 90 | 85 90 | 4 8 11 | June and December | ... | ... |
| £100,000 | Stock | 2/4½ | Do. 5% 2nd Deb. Stamp. Guar. Certs (all pd) | 95 100 | 95 100 | ... | ... | ... | ... |
| 36,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ 5½ | 4½ 5½ | 0 1 10 | Half-yearly | ... | ... |
| £276,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 106 | 101 106 | 4 5 1 | ... | ... | ... |
| 112,500 | 2 | 1/2½ | Electric Construction Co., Limited | 1½ 2¼ | 1½ 2¼ | 5 13 2 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ 3 | 2½ 3 | 4 13 4 | July | ... | ... |
| £191,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | ... | Gülcher Electric Light and Power Co. Ord. | ½ | ½ | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 16 17 | 16 17 | 4 6 3 | February and August | 15¾ | 15¾ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 6 | 5½ 6 | 3 15 0 | " " | 5½ | 5⅞ |
| £250,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) xd | 107 110 | 107 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21½ 21½ | 20½ 21½ | 4 13 0 | " " | 21¾ | 21½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 104 | 101 104 | 3 17 8 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintenance | 41 43 | 39 42 | 5 0 0 | March and July | 41 | 39 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1903 | 101 104 | 101 104 | 3 17 0 | January and July | ... | ... |
| 21,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 12 | 11 12 | 5 5 4 | ... | 11⅝ | 11½ |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | - | 5½ 6 | 4 3 4 | ... | 5¾ | 5½ |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 11 12 | 11 12 | 5 0 0 | April and October | 11½ | 11½ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6¾ 7½ | 6¾ 7½ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 107 | 105 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,191. [No. 21. Vol. XLVI.] FRIDAY, MARCH 15, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Parliament, in its attitude towards electrical enterprise, has on several occasions shown itself disposed to adopt a synthetic method of legislation, by which we mean the establishment of a general principle of legislation by means of a Joint Committee prior to the passage of specific enactments affecting individual schemes. The inquiry as to the municipalisation of the telephone, the Joint Committee on the principle of electric supply "in bulk," and now recently the proposed Joint Committee on the general principles of legislation for metropolitan tube railways, are cases in point. We are by no means intending to imply that this synthetic process was first adopted to meet electrical legislation, for such is far from being the case; but we do wish to lay stress on the fact that there is a danger that over-elaboration in general legislative principles, in the case of such comparatively novel engineering as electric tube railways, may seriously and unnecessarily delay the growth of an important public service.

Apparently all this excessive anxiety on the part of the Legislature and a section of the general public, has arisen out of the alleged serious vibration troubles with the "Twopenny Tube." There is an expert committee busily inquiring into this matter, and we should have thought Parliament would wait until the report of this committee had been presented before assuming that the entire question requires legislative discussion on general principles by a Joint Committee. No less than 14 bills are now awaiting the sanction of Parliament for tube railways; yet Mr. J. W. Lowther, as Chairman of Ways and Means, in moving the resolution for the Joint Committee to be appointed, stated that if this committee, "as he hoped it would, arrived at conclusions on these broad principles this session, it would enable those who proposed to bring forward such bills to proceed on clear lines next session."

An unnecessary waste of time, and one that will seriously postpone the advent of much-needed reform in the transportation facilities of the metropolis. London is only half-civilised in these matters, with its horse 'busses and tramways and its dirty "Underground." The "Twopenny Tube" has shown it a glimpse of what real civilisation would mean. Yet London is asked to wait a year or more before the Legislature will consider any special bills for further development of this highly popular mode of travel. In the meantime, it will decide academically a number of "principles" which, from the nature of the case, we predict it will not be able to adhere to in many specific cases.

What, in fact, are these precious principles? Wherein do they involve any problem that railway projects have not presented to Parliament over and over again in the past? They are embodied in the resolution as follows:—

(1) Whether the lines of route for underground railways in and near London, proposed by bills which have been or may be introduced during the present session, are best calculated to afford facilities for present and probable future traffic; and, if not, what modifications of those lines of route are desirable. (2) What special provisions, if any, should be made for the protection of the owners, lessees, and occupiers of property adjacent to underground railways from possible damage and annoyance? (3) What special terms and conditions, if any, as to construction and working should be imposed upon the promoters? (4) Whether any, and which, of the schemes proposed by the said bills should not be proceeded with during the present session.

Now, how is it possible, for instance, for Parliament to co-ordinate a system of projected and possible future railways until the individual schemes in their final form are fully before it? It is futile to decide academically on general principles of route and interconnection, on the safeguarding of buildings and parks and rural heaths, and on the other general questions, when the promoters of the railways may find it commercially impossible to proceed on the terms of these paper principles. Surely the proper time to consider such questions is when the definite schemes are before Parliament in their regular committee stage? And, surely, sufficient

uniformity for all practical purposes would be obtained by bringing all the bills before one strong committee, as was done with several of the power bills last year?

THE report of the Board of Trade committee appointed to consider the advisability of modifying the Patents Acts will shortly be published. In May last we announced the appointment of this committee to consider the following reference:—

(1) Whether any, and, if so, what additional powers should be given to the Patent Office to (a) control, (b) impose conditions on, or (c) otherwise limit the issue of Letters Patent in respect of inventions which are obviously old or which the information recorded in the office shows to have been previously protected by Letters Patent in this country; (2) whether any, and, if so, what amendments are necessary in the provisions of sec. 22 of the Patents, &c., Act, 1883; and (3) whether the period of seven months priority allowed by sec. 103 of that act to applicants for Letters Patent under the International Convention may properly be extended, and, if so, on what conditions.

We understand that the report is signed by Sir EDWARD FRY (chairman), Lord ALVERSTONE, Sir E. CARSON, K.C., M.P., Sir W. H. HOULDSWORTH, M.P., Mr. F. J. S. HOPWOOD, Mr. S. E. SPRING-RICE, Mr. FLETCHER MOULTON, K.C., M.P., Col. T. W. HARDING, Mr. E. CARPMAEL, and Mr. H. HUGHES. We shall deal more fully with this matter when the official document is completely before us; but we may now observe that among the numerous important recommendations it contains a proposal that the Patent Office should make official inquiry as to prior patenting within the previous 50 years. There is, however, to be no inquiry in the case of "obviously old" inventions, as to whether they have been previously patented.

ON another page of this issue we give a brief illustrated description of the Solvay form of mercury cell now installed at Jemeppe, in Belgium, and at Donetz, in Russia. This differs from the usual form of mercury cell—in the absence of any mechanical movement as a whole, and in this respect it is held to be an improvement upon the Castner and Rhodin cell. It is interesting to note that the Solvay company of Brussels, who own and control the Castner patents in Europe, are stated to have adopted this new form of cell at the two works named, and that their operation of the Castner cell is said to be restricted to the works at Osternienberg, in Germany, erected at an earlier date. It is possible that the mercury cell—which is being worked by the Griesheim "Elektron" Company at its numerous subsidiary factories throughout Europe—is constructed upon the same principles as the Solvay cell; but as this company have not patented their form of cell, and as they refuse to divulge any facts concerning it, reliable information upon this point is lacking. With regard to the electrolytic alkali developments now occurring in Russia, it is not improbable that the financial crisis which has occurred in connection with new industrial ventures in that country may seriously hamper the completion of the various works planned at Donetz, at Slaviansk, and at Zombkowice.

CANTOR lecturers differ greatly in their style and treatment of their subjects. Some of them deliver a series of technical discourses that, when published, serve as useful sources of reference for professional men for years afterwards. Others are content to afford a non-technical audience popular instruction in a topic of the hour, caring little or nothing for the more technical aspects of their subject. Both these types of lecture serve a useful purpose, and each is wisely encouraged by the Council of the Society of Arts. Major PHILIP CARDEW's maiden lecture on Monday last belonged to the latter class; and in dealing with the subject of "Electric Railways," he sought to give his hearers an outline of what has actually been and may yet be accomplished, rather than to enter upon a technical disquisition on the engineering conditions under which these railways must be worked. Unfortunately for the complete success of this plan, the lecturer elected to read his address and omitted to illustrate it by any experiment; though certain diagrams and lantern slides gave a measure of relief from the monotony of the reading. Incidentally we learned that the lecturer attaches great importance to the separate excitation of motors on locomotives or motor cars. One of the advantages of this is the possibility of returning kinetic and down-grade energy to the line, instead of wasting it by brakes. A system of electric traction which is to be described in a later lecture—and the name of which, though not mentioned in Monday's lecture, it is not difficult to guess—was stated to have the merit of returning no less than 66 per cent. of the energy to the line, owing to the use of separate excitation in regulating the motors. Of this, much more anon.

IN an admirably lucid and entertaining lecture at the Society of Arts, on Wednesday last, Mr. F. B. BEHR described his ingenious system of high-speed mono-rail electric traction, prefacing his discourse by a short history of the development of the mono-rail principle. The first railway of this type, it appears, was laid down in Algeria in 1883, the train, hauled by animal power, being used for collecting esparto grass. From this primitive and pioneer undertaking it is a far cry to the elaborately designed express railway proposed by Mr. BEHR for erection between Manchester and Liverpool, the trains on which are to run at 110 miles an hour. It will be remembered that the bill seeking powers for this railway undertaking was rejected by a committee of the House of Commons last year. Not daunted by what a less sanguine or persevering engineer would have regarded as a crushing defeat, Mr. BEHR has succeded in reviving interest in his project, and a second bill will shortly be considered by Parliament. We heartily wish it better success than its predecessor.

SIR WILLIAM PREECE, who occupied the chair, opened the discussion on this lecture by recounting some of his own personal experiences in connection with the Manchester-Liverpool scheme, for which he is the consulting electrical engineer. The chief points raised by subsequent speakers dealt with the important questions of brakes, acceleration on curves and at starting, and of signalling, all of which apparently have been carefully considered by the inventor. With regard to brakes, we have already (see *The Electrician*, Vol. XLV., p. 119) expressed the view that braking at such high speeds is a serious problem that will tax all the resources of the engineers. "At 110 miles an hour a train weighing 45 tons would," we estimated, "possess kinetic energy amounting to 11 million foot-pounds." Mr. BEHR's trains are to be some-

what heavier, and he expects to be able to stop them, in case of dire emergency, within 500 yards. Prof. Carus-Wilson gave figures showing that, to effect this, several thousand H.P. would be necessary, and that the retardation would amount to 8ft. per second per second. It may be doubted whether either the electric or the Westinghouse air brakes would develop this enormous retarding force; but it is certain that, if they ever did so, the passengers would have a very unpleasant half-minute or so. On the other hand, being only used in rare cases of "dire emergency," this unusually high retardation may be justified, even though all the passengers were to be thrown into a heap at the forward end of the car and all the electric brakes were to be burned out. Better these things than an accident that would certainly kill everyone on the train. Mr. Behr, however, relies mostly on the extreme improbability of this emergency ever arising; and, considering the numerous safeguards, there is much force in his contention.

The protected character of the railway and the elaborate system of signalling contribute to this high degree of safety. By a development of the electric interlock and block system of signalling, the rear of every train is covered by danger signals for a distance of 14 miles; and on approaching the first signal guarding this danger limit two alarms—one electrical and the other mechanical—are automatically rung in the driver's cabin, and continue to ring until stopped by him. Accordingly, in ordinary circumstances, there is ample length of track over which to apply the brakes before any actual rear collision can occur. The retardation in these conditions would be scarcely perceptible to the passengers. Similarly, the normal acceleration at starting is well within the limits of comfort to passengers, the full speed of 110 miles an hour being attained in 1¾ miles from the start. There is another kind of acceleration, however, viz., centripetal acceleration in passing round a curve, which needs to be carefully kept within limits, if the comfort of passengers is to be preserved. This is not a case of dire emergency, but one that affects every train in ordinary service. Mr. Behr claims for his mono-rail system that it permits of a train being carried at high speed round much sharper curves than are possible with ordinary railway tracks. We grant that, as a matter of engineering, this is the case; but from the point of view of the passenger it is another story. Unless the curves on a railway built for these high speeds are set out on liberal lines the natural inclination of the passengers (considered as mass particles possessing inertia) to obey Newton's first law of motion may prove too strong for their human inclination to stick to their seats. Accordingly, where high-speed passenger traffic is to be provided for, Mr. Behr's claim that the mono-rail principle allows of sharp curves cannot be conceded.

Criticisms such as the foregoing are not inconsistent with a thorough belief in the efficacy of the Behr system as a whole. Indeed, they involve matters which, as Prof. Carus-Wilson remarked, must inevitably be raised before the engineers of the Manchester-Liverpool scheme when it goes before a Parliamentary committee. Nor can we believe that so practical and experienced an engineer as Mr. Behr has failed to face these difficulties and find a solution for them. It must not be forgotten that in many respects his Brussels railway presented even more difficult problems, and the trains on that line were run successfully at 83 miles an hour on a much more trying track than will be adopted for the Manchester-Liverpool line. "The main results of the trial [on the Brussels railway] were that, given a proper line of sufficient extent to acquire the proper speed, and a properly constructed electrical station, very high speeds up to 120 miles to 180 miles an hour," says Mr. Behr, "can be attained with absolute safety and moderate expense." The mono-rail principle is one that is eminently adapted to high-speed electric railways; and, even for this consideration alone, it may be expected to meet with considerable acceptance by railway promoters and engineers in the immediate future. Certainly the Manchester-Liverpool scheme ought to have a fair trial.

**Baslow Electricity Works.**—The water-power electric light works at the little Derbyshire village of Baslow are, we understand, to be started to-morrow.

**Cable Interruptions.**

| | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Pernambuco—Ceara | Nov. 29, 1900 |
| Marseilles—Barcelona | Jan. 7, 1901 |
| Sao—Bushire | Mar. 7, 1901 |

**Royal Society.**—The following Papers were down for reading yesterday:—C. E. S. Phillips, "The Action of Magnetised Electrodes upon Electrical Discharge Phenomena in Rarefied Gases"; C. T. R. Wilson, F.R.S., "On the Ionisation of Atmospheric Air"; and E. Matthey, "On the Preparation of Large Quantities of Tellurium."

**Cooper's Hill.**—As a result of urgent representations which have been addressed to him, Lord George Hamilton has intimated that the seven professors whose services were recently dispensed with are to be permitted to state their cases to the visiting committee of Cooper's Hill Engineering College, after which the matter will be further considered by the Secretary of State in Council.

**Personal.**—Prof. J. J. Thomson, F.R.S., has been elected a member of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of nine persons of "distinguished eminence in science, literature, the arts, or for public services."——The senate of Glasgow University has resolved to confer the honorary degree of LL.D. upon Prof. A. W. Rücker, Sec. R.S., at the graduation ceremony on April 23rd.

**Serious Overhead Wire Accident in Vienna.**—On Thursday last week, there was a heavy fall of snow in Vienna, leading to a serious catastrophe, somewhat resembling the accident which occurred recently in Liverpool. In addition to destroying innumerable telegraph and telephone wires, the weight of the snow broke the overhead conductors of the electric tramway. As a consequence horses and foot passengers received severe shocks. Many horses were killed, while several passers-by were more or less injured.

**Wireless Telegraphy.**—The captain of the Ostend mail steamer "Princess Clementine," which is fitted with wireless telegraph apparatus, reports that when on the voyage from Dover to Ostend the French lightship, stationed 25 miles off Dunkirk to mark some dangerous sand banks, signalled the mail boat. It was then learned that the lighting apparatus was out of order, and the lightship would be unable to show a light that night unless assistance were promptly sent. The mail boat at once despatched a wireless message to La Panne, whence a telegram was sent to Dunkirk, and in a short time a tug was sent out to the lightship to effect the necessary repairs.

**Works Management.**—The third lecture of the course on "Works Management" at the Institution of Junior Engineers was delivered by Mr. A. H. Barker, at the Westminster Palace Hotel, on the 7th inst. Further consideration was given to questions relating to the foundry, including lifting appliances, sand mixing, compressed air, and hydraulic installations, moulding machines, dressing devices, best relative positions of the different parts of the foundry, &c. The general scheme of successful works management was then entered upon, the objects to be kept in view being defined. The duty of the manager was discussed, and the directions in which he was likely to fail were indicated. The next lecture takes place on Tuesday, March 19th.

**Breakdown at Aberdeen Electricity Works.**—For the first time since the starting of the works in 1894, the electric lighting of Aberdeen was totally suspended during a brief period last Monday. We give herewith a correct and authorised version of what was the cause. The failure of supply was due to the racing of a 420kw. set, which was still in the hands of the contractors, who were then adjusting the governors preparatory to the official test, which was arranged for Wednesday. This racing caused a break in the steam-pipe connections, which necessitated steam being shut off at the boilers, thereby cutting off supply. According to the recording instruments, the lighting of the town was affected for 45 minutes, and the electric tramcars were stopped for 28 minutes. The lighting was cut off for this length of time owing to the fact that upon starting up on the town at nearly maximum load an armature of one of the sets was burned out.

**Submarine Boats.**—Some particulars have been made public with regard to the five submarine boats provided for in this year's naval estimates. These boats, it appears, have already been ordered, and are under construction at the works of Messrs. Vicars, Sons, and Maxim, at Barrow. They are of the Holland type, with some modifications and improvements, and measure 63ft. 4in. in length and 11ft. 9in. beam, with 120 tons displacement when completely submerged. The maximum speed on the surface has been estimated at 9 to 10 knots, and under water 6 or 7 knots. On the surface a 160 H.P. gasoline engine will be employed for propulsion, but under water a waterproof electric motor. The latter will be driven from storage cells whose capacity will suffice for a four hours' run at 7 knots. It is also intended that the boats shall carry a fuel supply sufficient for a run of about 400 nauts on the surface. Some electric lamps will be employed on the boats, and supplied from the battery. It is expected that the first of these boats will be launched next May and the remainder during the year.

**The British Insulated Wire Co.'s Staff Dinner.**—The annual dinner of the British Insulated Wire Co.'s staff took place last Friday, at the Adelphi Hotel, Liverpool. In addition to the directors, and the large works and outside staff of the company, many guests had been invited, including several central station engineers. The chairman of the company, Mr. W. Marriner Brigg, presided. In a humorous speech, the Hon. Arthur Stanley, M.P., proposed the toast of the electrical industry, and explained that he probably knew less of this industry than anyone present. It was, however, not unusual, he said, for a member of Parliament to speak on a subject about which he knew nothing. Since Irish members were allowed to speak on the question of law and order until 6 o'clock that morning, why should he not speak on electricity? Mr. Ferranti, in responding to this toast, referred to the rosy future of the electrical industry and to the new power schemes. He pointed out the effect that these would have in reducing the cost of electrical energy in comparison with the cost of the present methods of distribution over smaller areas, and he alluded to the adoption of electric traction on main railways as probably the next step in advance. He reminded his hearers that the British Insulated Wire Co. had looked ahead, and had in hand the first of these power distribution schemes over large areas. Mr. W. M. Mordey replying to the toast of the "Visitors," proposed by Ald. T. Snape, quoted a remark made in the discussion at the Institution of Electrical Engineers on the previous evening, that cables represented the greatest item of expenditure in electricity works, and were therefore as important as boilers, engines, dynamos, and everything else put together. Cables, however, he said, were not made of Papers, but of paper. Referring to his own recent Paper at the Institution, he remarked that, whether it was wrong or right in principle, it had had the good result of drawing attention to paper-insulated cables. The toast of the evening fell to Mr. Raworth, whose characteristic after-dinner humour was greatly appreciated. In the more serious part of his remarks he raised his voice in warning against undue competition, and deplored the effect of competition in the City of London, which had shaken public confidence in electrical undertakings. Mr. Nisbett's speech in proposing the health of the directors, in which he sketched the proceedings at an imaginary board meeting also met with applause.——On Saturday a visit was made to the company's works, all departments of which were in active operation. Special interest attached to the wire-drawing department, some new American wire-drawing machinery having been recently added, in which wire was being drawn through nine consecutive dies in one operation. The company can now manufacture a large proportion of its own copper wire, and finds it especially advantageous that it is able to gain considerable time in completing manufacture of special sizes, being in a position to produce, at its own works, diameters between the usual gauges, and also flat wires.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), March 15th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary Meeting. Paper to be read: "Combined Trolley and Conduit Tramway Systems," by A. W. Connell.

**SATURDAY, March 16th.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture IV. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

INSTITUTION OF JUNIOR ENGINEERS.

*6.30 p.m.* Anniversary Dinner at the Westminster Palace Hotel.

**MONDAY, March 18th.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture II. on "Electric Railways," by Maj. P. Cardew.

**TUESDAY, March 19th.**

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Lecture IV. on "Works Management," by A. H. Barker, at the Westminster Palace Hotel.

**WEDNESDAY, March 20th.**

ROYAL METEOROLOGICAL SOCIETY.

*7.30 p.m.* Ordinary Meeting at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W.

INSTITUTION OF ELECTRICAL ENGINEERS.

*7.30 p.m.* Students' Meeting. Paper to be read: "Indoor Electric Fittings at the Paris Exhibition," by G. E. Turnbull.

ROYAL MICROSCOPICAL SOCIETY.

*8 p.m.* Ordinary Meeting at 20, Hanover-square, W.

INSTITUTION OF MINING AND METALLURGY.

*8 p.m.* Annual General Meeting at the Geological Museum, Jermyn-street, W. Among the Papers down for reading is "The Electric Power Station at the Pierrefitte Mine," by E. H. Davies.

**THURSDAY, March 21st.**

ROYAL SOCIETY.

*4.30 p.m.* Ordinary Meeting at Burlington House.

INSTITUTION OF ELECTRICAL ENGINEERS—DUBLIN SECTION.

Meeting at the Royal Dublin Society.

**FRIDAY, March 22nd.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Chemical Lecture Theatre of the University College, Gower-street. Agenda: (1) "On the Expansion of Silica," by Prof. Callendar, F.R.S. (2) "The Spectroscopic Apparatus at University College," by Dr. E. C. C. Baly.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Engineering Question Night, at the Westminster Palace Hotel.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse, by H. T. Brown, F.R.S. Subject: "Some Recent Work on Diffusion."

**SATURDAY, March 23rd.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture V. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Atomic Weights.*—It is now generally agreed that Prout's law, that the atomic weights of the elements are exact multiples of the atomic weight of hydrogen, is decisively contradicted by experiment. The case of chlorine, whose atomic weight is 35·455, is in itself conclusive so far as the supposed law is concerned. But, as pointed out by R. J. Strutt, there remains the fact that many of the atomic weights approximate very closely to whole numbers, so much so as to suggest strongly that some law of nature is in question, as distinct from the action of chance. The author therefore carries out the interesting process of calculating the chance that the atomic weights should approximate to whole numbers as closely as they do. Taking the nine best known atomic weights—viz., bromine, 79·955; carbon, 12·001; chlorine, 35·455; hydrogen, 1·0075; nitrogen, 14·045; oxygen, 16·000 (standard); potassium, 39·140; sodium, 23·050; and sulphur, 32·065—the sum of the deviations from the nearest integral number is 0·809, or about 0·1 for each element. The probability of that occurring by chance is about one in 1,000, so that we have "stronger reasons for believing in the truth of some modification of Prout's law than in that of many historical events which are universally accepted as unquestionable." When a larger number of atomic weights are taken, the probability of chance is still smaller.

[R. J. Strutt, *Phil. Mag.*, March, 1901.]

*Telegraph Wires on Snow.*—The fact that snow is a good insulator has been practically recognised by the employés of the Puy de Dôme observatory for a number of years. The double line which connects the Observatory with the station of Rabanesse and with the telegraph office of Clermont is often interrupted during the winter season. The breakage is due to the fact that the poles, covered with a layer of hoar frost, which can attain a diameter of 3ft., offer too large a surface to the winds, which blow with great violence. It often happened that in the execution of repairs the workmen drew a line of wire across the snow covering the Temple of Mercury, so that the wire was in contact with the snow over a length of 30 or 40 yards. Even when the poles remained standing it often happened that their tops were covered with snow, and that quite 1,000 yards of wire were in immediate contact with it, without the messages being disturbed on that account. It might be urged that the best expedient would be to lay the wire always on the snow, as in the case of the Etna and Mont Blanc observatories. But on the Puy de Dôme the snow is not "eternal," and it is often either melted or blown away, leaving the bare rock.

[B. Brunhes, *Comptes Rendus*, February 25, 1901.]

*Secondary Radio-Activity.*—The secondary Röntgen rays discovered by Sagnac have their counterpart in the secondary Becquerel rays studied by H. Becquerel himself. These were brought out by an interesting experiment. A leaden block 84mm. long, 21mm. wide, and 7mm. high had a groove 1mm. deep cut along its upper surface, and the groove was filled with a radium preparation of great activity. The block was placed on a sensitive plate for 18 hours, and the latter was then developed. A strong impression was found to have been made, in spite of the fact that the rays had to penetrate from 6mm. to 20mm. of lead. The rays, when filtered through the lead, were even found capable of penetrating two sensitive plates in succession and producing an impression upon a third. A peculiarity noticed by the author was that a strong geometrical impression was created where the under surface of the lead block had rested upon the plate, and that this impression was not eliminated by inserting a plate of mica. Small plates of any metal laid within reach of the rays, instead of weakening the impression by absorption, actually strengthened it by virtue of the secondary radio-activity produced, more especially at the edges directly exposed to the rays. Such secondary Becquerel rays have, however, very little penetrative power.

[H. Becquerel, *Comptes Rendus*, February 18, 1901.]

*Electrodynamics and Crémieu's Experiment.*—H. C. Pocklington deals with the threatened position of our present electrodynamic theory in consequence of the negative result of Crémieu's experiment (see *The Electrician*, March 8th, p. 725). He carefully distinguishes between experimental facts and assumptions. The latter are four in number, and are as follows:—The electric force satisfies differential equations; the magnetic force is connected with the electric force by a differential equation; the component in any direction of the electric force produced by a changing magnetic field is equal to the induced E.M.F. in an element of wire lying in that direction; and the motion of a body produces no motion in the ether through which it moves. The difficulty in the discussion of Crémieu's experiment lies in the fact that we cannot say with certainty whether a conducting envelope can, by screening off the electric force, reduce the magnetic force also to zero, or whether the surface of the wire in a coil can exert such a screening effect (either partial or total) on the substance of the wire. If a total or considerable partial screening cannot be shown to be theoretically impossible, Crémieu's experiment does not afford any decisive evidence of the want of truth of the hitherto accepted equations of electrodynamics.

[H. C. Pocklington, *Phil. Mag.*, March, 1901.]

*Wireless Telephony.*—The evolution of the wireless telephone is making rapid strides in the hands of the German physicists. E. Ruhmer, whose ingenuity seems to know no bounds, has modified both the transmitter and the receiver in a radical manner. After pointing out that a small current intensity in the "speaking arc" is bad for acoustic effects, but very good for the fluctuations of luminous intensity used for transmission, he proceeds to dispense with the arc altogether, and substitutes for it a chalk or zircon block mounted on the telephone diaphragm itself and heated in the usual way by means of an oxy-hydrogen flame. The slight vibrations of the telephone disc suffice to alter the position of the luminous body in the flame, and thus to vary its luminosity in a manner suitable for the transmission of speech. At the receiving station, the high resistance of selenium cells has hitherto presented a difficulty. The author gets rid of it by substituting for the selenium cell a "radiomicrophone," a kind of carbon coherer mounted in the focal line of a parabolic mirror. The differences in temperature produced by the impact of the light upon the carbon are sufficient to actuate a telephone receiver. The author also suggests a bolometer as a receiver.

[E. Ruhmer, *Phys. Zeitschr.*, March 2, 1901.]

*Effect of Invisible Rays upon the Eye.*—The impression produced by Becquerel, Röntgen, and ultra-violet rays upon the human eye has a certain fascination on account of its possible utilisation in the case of blindness. Rays which penetrate opaque bodies may reach an optical nerve cut off from the outer world by turbid humours or integuments. F. Himstedt and W. A. Nagel have made a long series of experiments in this matter, but practically useful results are much interfered with by the rapid "fatigue" of the eye. After a few exchanges the subject is unable to say which of two packets, one filled with sand and the other with a radium preparation, contains the active element, though at first the latter produces a general luminosity in the eye. It appears certain that none of these rays produce fluorescence in the human eye, though they do in the eyes of some animals. Also, that it is the rods and not the cones of the retina that are chiefly affected. Geometrical impressions may be temporarily created in a blind eye by means of Röntgen rays transmitted through lead plates in which patterns are cut. A radium preparation produces a luminous sensation, which appears to proceed from the side on which the preparation is held. This is a hitherto unexplained effect.

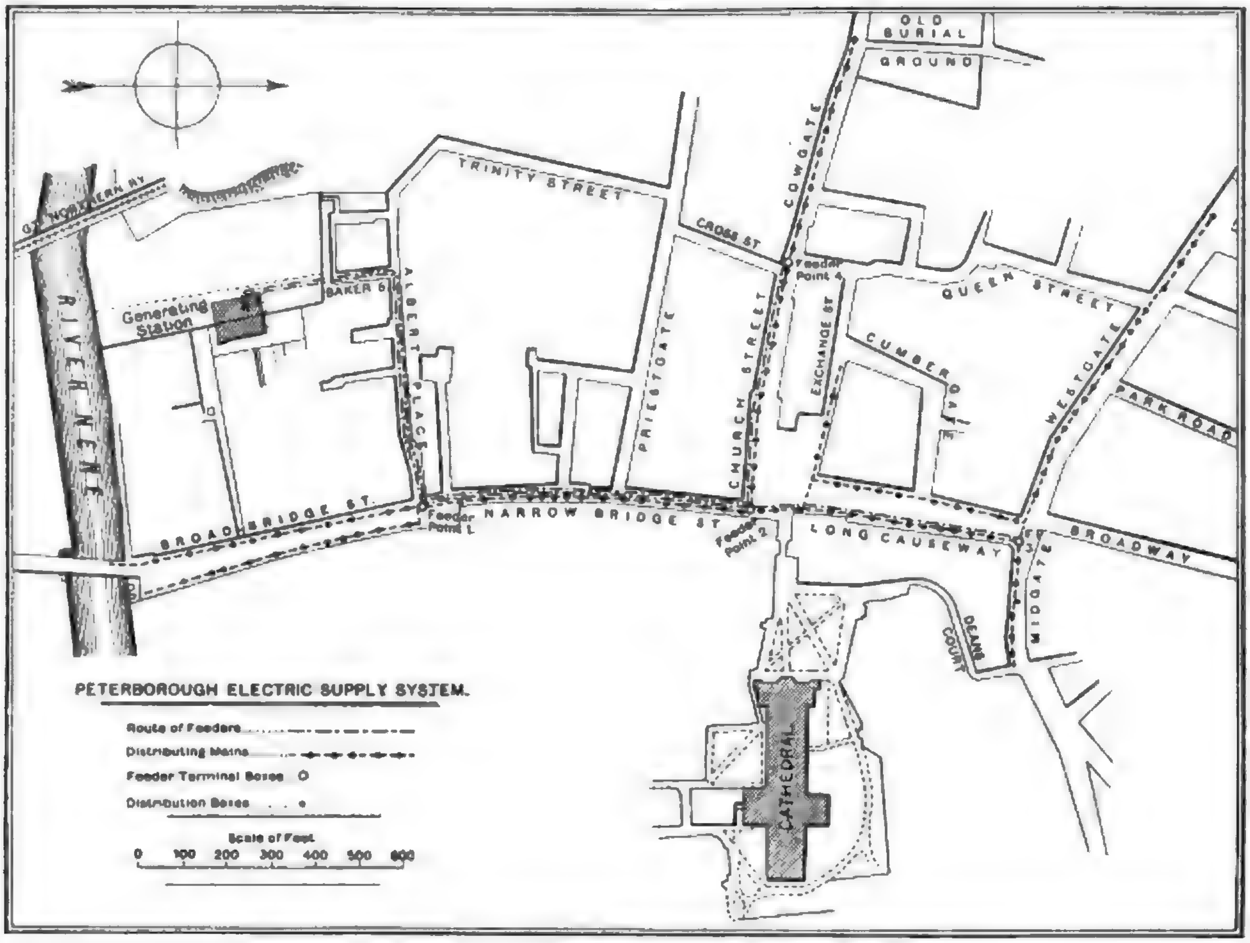
[Himstedt and Nagel, *Ann. der Physik*, No. 3, 1901.]

# PETERBOROUGH CORPORATION ELECTRICITY WORKS.

In 1889 the subject of electric lighting came before the Peterborough Town Council upon the application of two different companies for the consent of the Council to their obtaining a provisional order. In 1890 the same two companies again gave notice of their intention to proceed, and there was also a third company in the field. To all these applications the Corporation objected on the ground that they would themselves apply for the necessary powers when they considered it advisable to do so. In 1894 the Corporation obtained their provisional order, and towards the end of 1895 instructed their waterworks engineer, Mr. John C. Gill, A.M.Inst.C.E., who had done all the preliminary engineering work, to prepare detailed plans and estimates in consultation with Dr. J. A. Fleming, F.R.S., of University College, London. Council, and, after hearing their views, sanctioned a loan of £15,000.

During all these struggles of ways and means there was no Electricity Committee, and these works have been begun, continued, and ended without any special committee. But throughout all these years Mr. Ald. Clifton worked hard and consistently to keep the undertaking in the hands of the Corporation.

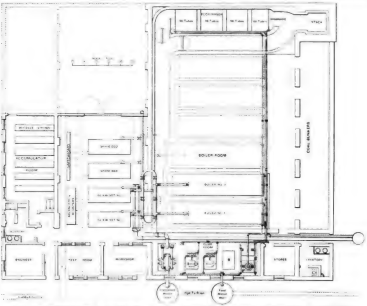
The delay in getting permission to raise the money by loan was not an unmixed evil, because it resulted in the generating station being constructed on a much better site than was originally contemplated, the Board of Trade doubled the permissible voltage at consumers' terminals, and satisfactory 200-volt lamps had made their appearance on the market.



PETERBOROUGH: MAP SHOWING POSITION OF THE POWER STATION AND MAINS.

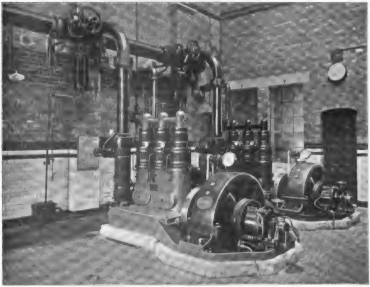
The first scheme prepared by the engineers included both private and street lighting at an estimated cost of £20,000, and for this amount the sanction of the Local Government Board was sought, and the resolution to apply to the Board having been passed in Council, after much opposition, by a majority of one vote only, an inquiry was held on May 6, 1896. Strenuous opposition was brought forth at the inquiry, the immediate need of duplicating the water supply carrying most weight, and the report was to the effect that as the money might be wanted for a pressing sanitary need they could not give their sanction to borrowing £20,000 for electric lighting. In November, 1897, the Local Government Board was again approached without success for permission to borrow £15,000. Another Local Government Board inquiry was held on February 8, 1898, and sanction to borrow was again refused. In the same year, however, the Local Government Board consented to receive a deputation from the Town The adviser to the Corporation, Dr. J. A. Fleming, had therefore no hesitation in recommending that the supply pressure to consumers should be 200 volts, and that the system of supply should be a three-wire system, continuous current, with a pressure of 400-460 volts on the outers, and on these lines a new scheme for the Corporation electric lighting was drawn up by Dr. J. A. Fleming and Mr. J. C. Gill. This allowed the generating station to be placed in a position a little less central, but still within easy reach and economical range of the whole borough by the continuous current.

The site of the station is a piece of land about 3½ acres in extent, which was already the property of the Corporation, and known as the Albert Place Meadow. It is bounded on the south by the river Nene, and on the west by the main line of the Great Northern Railway. It therefore offers an unlimited supply of water for condensing and boiler feeding, free of cost, and facilities for getting coal to the station without



**B**, Spare Bed for Electric Pump. **C**, Centrifugal Pump. **E**, 3 throw Electric Pump. **S**, Spare Bed for Steam Pump **P**, Steam Pump.

Peterborough: Plan of Generating Station.



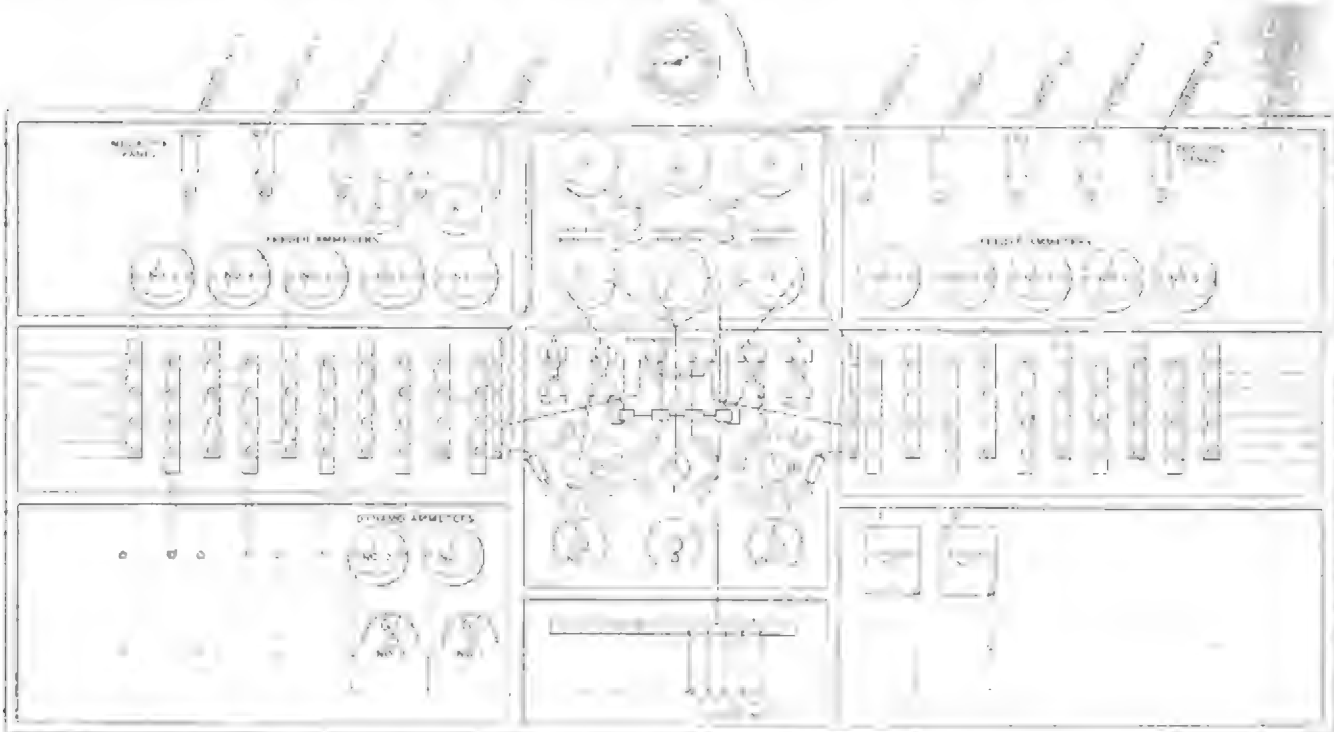
Peterborough: View of the Generating Sets

cartage, both items of considerable importance when considering the economies of running. The only drawback to the site was the quantity of concrete required in foundations. These had to be taken down to a bed of gravel 14ft. below the surface of ground and considerably below the water in the river; this was difficult and expensive work, steam pumps having to be kept constantly going. The whole station is built upon concrete arches and the floor level raised to such a height as to be safe against floods. This work was done by Corporation workmen under the immediate superintendence of the engineer, and cost upwards of £2,000. The buildings were designed and the plans and specifications prepared by Mr. J. C. Gill and his chief assistant, Mr. C. R. Barlow.

The erection of the buildings was commenced on November 13, 1899. Plans and specifications for the generating plant were drawn up by Dr. J. A. Fleming and Mr. J. C. Gill. and invitations to tender were publicly advertised in March, 1899. A large number of tenders were returned for the six sections of the plant, and after these had been considered and

At the present time the boiler room is occupied by two Lancashire boilers with Galloway tubes, 30ft. long and 7ft. in diameter, each having an evaporative power of 6,000lb. of water per hour and working at a pressure of 160lbs. to the square inch; the fittings are of Dewrance's make, asbestos packed, and Poulton seating blocks are used. Space is left in the existing boiler room for one more boiler of the same size without extension of building, and the building, when completed, would accommodate six such boilers. The flue gases pass off to a long horizontal flue which at the end of the boiler house farthest from the pump room divides into a bye-pass flue and also an accumulator flue. Space is left in the accumulator flue for a Green's economiser of 452 tubes, but at present only 96 tubes have been erected, the scrapers being driven by one of Green's special high-speed engines.

The shaft terminates in an octagonal chimney stack 120ft. high, 6ft. internal diameter at the bottom, and it is lined with firebricks to a height of 45ft. The footway is 9ft. 9in., below which there is a bed of concrete 7ft. 6in. deep. The top of



A, Switch for Booster Field. B, Battery Regulating Switch. C, Rheostat for Booster Fields. D, Rheostat for Balancer Fields. F, Rheostat in Armature Circuit of Balancers. F, Minimum Cut-Out. G, Field Rheostat. H, Equalising Voltmeter. I, 'Bus Bar Voltmeter, 480 volts. K, Voltmeter, 480 volts. L, Battery Switch.

PETERBOROUGH: ARRANGEMENT OF SWITCHBOARD. FRONT VIEW.

adjudicated upon by the engineers the Council finally accepted tenders as below:—

| | | | |
|---|---|---|---|
| Buildings (Main, Kendall and Main) | £2,334 | 8 | 4 |
| Boilers (Edwin Danks & Co.) | 1,650 | 0 | 0 |
| Engines and dynamos (General Electric Co.) | 1,952 | 0 | 0 |
| Switchboard (Crompton & Co.) | 634 | 0 | 0 |
| Pipes, tanks, condensers, &c. (Ashton, Frost & Co.) | 1,700 | 0 | 0 |
| Accumulators (Pritchetts and Gold) | 849 | 0 | 0 |
| Cables (Callender's Company) | 3,949 | 0 | 0 |
| | £13,068 | 8 | 4 |

When complete buildings will cover a rectangular site 108ft. wide and 96ft. long, but at present only half of this area is occupied—viz., a space 108ft. wide and 48ft. long. This consists of three sheds, a boiler-house, and an engine and dynamo room, and an accumulator room parallel to one another. The end facing the railway is occupied by the offices, test room, workshop, pump room, and stores. The elevation of the building, as shown by the illustration, has a very pleasing appearance, although there are no elaborate architectural features. It is made of yellow brick, the engine room being faced with red brick except for a dado of white glazed, finished off with several layers of dark brown bricks. The floor is laid with hard-wood bricks grouted in with cement.

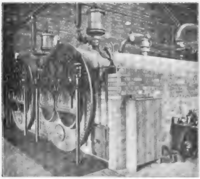
the stack is provided with a handsome stone coping, giving the shaft a very pleasing appearance.

The boilers send their steam through 5in. pipes into a steel ring main, 8in. in diameter, from which 4in. branch pipes are taken to the engines. In the engine room two 60kw. steam dynamos are at present fixed, each consisting of a Willans three-crank compound engine coupled to a General Electric Co.'s multipolar shunt-wound dynamo, running at 470 revs. per min. There is also a booster and a balancer set, made by the General Electric Co., consisting of two multipolar dynamos as balancers, coupled directly to two bi pole dynamos used as boosters.

The switchboard, of which we give an illustration, is made by Messrs. Crompton & Co.; it is a handsome structure, consisting of three panels for positive, negative and middle mains, and contains the regulating switches for boosters and balancers, the inter-coupling plug switches on the positive and negative boards, and the main feeder switches and duplex cutouts. Behind the board are placed the regulating resistances belonging to the field dynamos of the boosters and balancers.

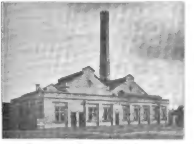
Parallel with the engine room is the accumulator room, containing two batteries each of 120 cells, of Messrs.

Pritchetts and Gold's manufacture. They have a capacity of 325 ampere-hours when discharging at the rate of 36 amperes, and 240 ampere-hours when discharging at the rate of 60 amperes. From the switchboard proceed four feeders; these are 0·25 sq. in. section copper, and are laid solid in bitumen in trenches laid in the road. With each feeder is laid three pilot wires to the feeder points, and any of these pairs of pilot wires can be connected to two Kelvin electrostatic engine room voltmeters placed in the engine room, which show the pressure at the feeder points on the two sides of the three-wire system.



PETERBOROUGH: VIEW OF BOILERS.

The pump room is very completely equipped. Owing to the proximity of the river Nene, there is no difficulty in getting any amount of water for condensation; accordingly, two wells, 7ft. in diameter, have been sunk outside the pump-room, and these are supplied by two 12in. earthenware pipes leading to the river, about 120 yds. distant, the water flowing in by gravitation. In the pump-room there is a dry well, lined with cast iron, at the bottom of which is placed an electrically-driven centrifugal pump; this pump takes water from the wells, and sends it through a 10in. delivery pipe laid along the boiler-house wall, from which there are branches to ejector condensers fixed to the engines. The waste water is taken to a drain laid in the exhaust pipe trench, leading to a sump outside the engine room, which is drained to the river.



PETERBOROUGH: GENERAL VIEW OF STATION.

The motor pump was supplied by Messrs. Ashton and Frost, and is able to deliver 42,000 gallons of water per hour for condensing purposes, the total lift being 35ft. The motor is of the enclosed type, it works on the outers, and provision is made for a second pump to be placed in the well when required. The condensers are of the Ledward (B) type, and are capable of condensing easily 2,000lb. of steam per hour; they are each provided with an automatic check valve, an inlet water stop valve, a steam inlet stop valve, and water pressure and vacuum gauges.

The main exhaust pipe is 14in. in diameter, it is laid in a trench, and is connected to the existing engine by 6in. branches, provision being made for 8in. branches for future 200 H.P. engines. At the end of the exhaust is a 14in. delivery pipe, carried up well above the roof of the engine house.

The boiler feed can be taken direct from the wells or from a cast-iron tank 8ft. by 15ft. 6in. by 4ft. erected over the pump house. At present there are two pumps, one a Tangye duplex steam pump, the other an Ashton and Frost three-throw electric pump, each being capable of delivering 18,000lb. of water per hour against a boiler pressure of 160lb. The arrangement of feed pipes is such that any service of water, cold or hot, can be delivered to the boilers (*a*) direct from well by pumps or injectors; (*b*) direct from tank by pumps or injectors; (*c*) through economiser from well; (*d*) through economiser from tank.

Distributing mains of 0·12, 0·06, and 0·12 sq. in. section have been laid throughout certain streets of the town, as shown in the diagram. These mains are laid in 6-way Callender casing, there being three spare channels left for additional mains.

Current was first supplied to consumers on December 19, and has given general satisfaction. There is every probability of the undertaking being commercially successful, as 3,500 lights of 8 c.p., or their equivalent, have already been connected, and, in fact, more plant will be required for next winter, and the Local Government Board is already being approached for the requisite funds.

The price of gas in Peterborough, supplied by the Peterborough Gas Co., is 3s. 4d. per 1,000 cubic ft., and the price of electric current, as fixed by the Corporation, 6d. per Board of Trade unit for lighting and 3d. for power.

Mr. John C. Gill, Assoc.M.Inst.C.E., who was already the city waterworks engineer, has also been appointed the city electrical engineer, with Mr. J. M'Kenna as engineer in charge of works. Our thanks are due to Prof. Fleming and to Mr. Gill for the great assistance they have rendered to us in the preparation of this article and during our visit to the works.

## BIRKENHEAD ELECTRIC LIGHTING AND TRAMWAYS WORKS.

Considerable extensions are taking place in connection with the electricity supply at Birkenhead. A small lighting station has been running there since 1896. It was originally designed by Mr. J. N. Shoolbred on the two-wire system at 230 volts, or, to be more accurate, the mains were laid on the three-wire system and connected to the generators on the simple two-wire system. The present engineer, Mr. W. Bates, took over the station in 1898, and shortly afterwards it was converted throughout to a 2 × 230 volts three-wire system.

The works are at present equipped with one 225kw. Mavor and Coulson dynamo, two 150kw. Siemens machines and three 50kw. Crompton units. The three larger machines generate at 460 volts, and the Crompton machines at 230 volts to balance the three-wire system. All these are driven by Willans compound engines—the largest by a three-crank engine and the others by two-crank engines. Regulation is effected in the ordinary manner by means of a battery. Steam is supplied by Lancashire boilers which are fed through a Babcock and Wilcox water softener, the feed water, taken from the town mains, being extremely hard. The boilers are fired by Vicars stokers, which are driven by a small motor. On one occasion considerable inconvenience was experienced by the armature of this motor burning out, it being extremely difficult to fire by hand the boilers fitted with Vicars stokers.

Consequently, a spare motor has been put down in case a similar accident should occur again. The economiser scrapers are driven by a separate motor.

Around this station, which lies nearly in the centre of the supply area, there is a fairly good load, but at further distances from the station the load is rather patchy. Two miles off, on the boundaries of the borough, a battery transformer sub-station has been erected to serve the outlying townships of Bidston and Noctorum. This contains a 600 ampere-hour battery of 230 E.P.S. cells and motor driven boosters. The cells are charged in the daytime and discharged at night, the load being entirely a residential one, as, in fact, is the greater part of the load on the Birkenhead station. The sub station is in charge of a single attendant, who need only be there from 1 p.m. to 9 p.m. each day.

In quite a different direction an electric tramway line of 2½ miles long has recently been opened, its nearest point being 1½ miles from the present station. Although, in addition, 12 miles of tramways will, it is expected, be opened during the year, and be supplied from a large station now in course of erection adjacent to the lighting station, it was decided that a small station should be erected at about the centre point of the line just mentioned. In addition to running this 2½-mile line, it is just possible that at some future date this little station may be extended to supply a lighting load as well, as a new residential district is springing up in this neighbourhood. This is, however, not quite certain, as one reason of there being three stations to supply a comparatively small load, such as that at Birkenhead, is that the lighting and tramways committees are separate and independent entities, although Mr. Bates is the electrical engineer to both of them. The arrangements are a strange contrast to the present wholesale power distribution movement.

The small tramway system is situated on a very favourable site on the Mersey, on the confines of the new wharves which the Mersey Dock and Harbour Board are about to construct. The site is large enough to allow of considerable extensions, and one end of the building is temporary with a view to this. It may be mentioned that the Corporation refuse destructor adjoins this station, but instead of supplying the heat energy to the latter, its own furnaces have to be assisted with coke. The station includes two 150kw. four-pole Scott & Mountain over-compounded direct-driven units, each being fitted with a switch for adjusting the amount of compounding if desired.

The feature of the station, however, is a Highfield compound reversible booster. This machine carries further the principle of the reversible boosters in use at St. Helens, as it can be used with compound-wound instead of shunt dynamos, thus keeping the feeder pressure at its correct value automatically. During the hours of light load the machine boosts up the pressure of the accumulators so that they can supply the line, and subsequently it acts in the reverse direction, adding volts to enable the batteries to be charged from the switchboard 'bus bars, and to take up at the same time the peaks of the load. The machine, which we believe to be the only one of its kind, has been giving absolute satisfaction since it has been running. The battery is made up of 240 cells, and the battery room presents an unusual appearance, as the employment of the Highfield booster renders regulating cells and their connections unnecessary. The cells are of the 21 R type Chloride make, with a capacity of 630 ampere-hours at a 7-hour discharge rate.

The remaining equipment of the station consists of a Zschocke cooling tower, a Wheeler Admiralty type condenser, and two Lancashire boilers 27ft. by 7ft., fitted with McDougall coking stokers, which as well as the economiser scrapers are electrically driven. The switchboard is practically of the B.T.H. standard pattern, with such modifications as are necessitated by the special booster.

On the line, where eight cars are running at present, the chief feature is the exclusive employment of bogey cars. The reason for this is that a low bridge makes it impossible to employ double-deck cars, and it was considered advisable to have great seating capacity. The cars have been built by Messrs. J. F. Milnes & Co., with B. T. H. equipments. Each has a separate smoking compartment. The line construction is centre and side pole, no span wires being employed.

## THE THEORY AND USE OF THE ALTERNATE CURRENT WATTMETER.

BY CHARLES V. DRYSDALE, B.SC.

The recent Paper by Mr. Mordey at the Institution of Electrical Engineers, and the discussion thereon, show how much difference of opinion still exists on the subject of alternate current power measurement particularly at low power factors. The prevailing opinion at present seems to be against the use of wattmeters, as some of the errors to which these instruments are liable are at last becoming known, and no one seems to have shown fully how these errors may be corrected for or eliminated.

The wattmeter is undoubtedly by far the simplest and most convenient instrument for power measurement, and the writer is decidedly of opinion that power measurements may be made by it far more accurately than by any other method. In order that this should be the case, however, the instrument should be properly designed, and it should be used with some idea of

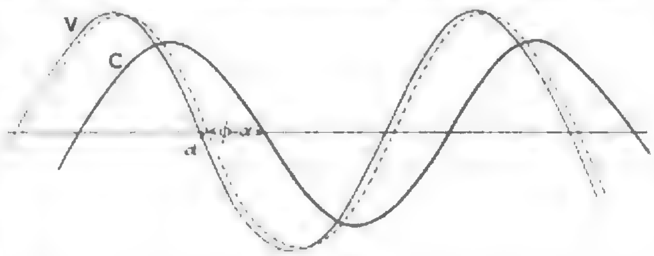


FIG. 1.

the errors to which it is liable. As the matter does not seem to be well understood by electrical engineers, and it is of the greatest possible importance to them, it may be well if it is dealt with from first principles. In Fig. 1 let V represent the P.D. wave on an alternate current circuit, and C the corresponding current wave (in this case a lagging one). The power-factor given to the circuit at any instant is given by the product of the P.D. and current at that instant, and the mean value of this product during the period represents the actual power given to the circuit.

In the wattmeter, as is well known, we have two coils usually at right angles, one being fixed and carrying the main current, while the other one swings and is connected as a shunt to the circuit. The turning moment or torque between these coils at any instant is proportional to the product of the main and shunt currents; and *if the shunt current*

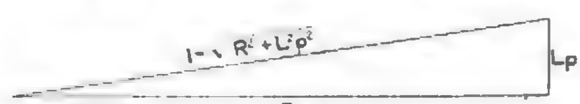


FIG. 2.

*is proportional to the P.D. at every instant* the mean torque between the coils is proportional to the true average power supplied to the circuit, and it can be measured by a torsion head as in a Siemens dynamometer. Since, however, the force between the coils depends on the magnetic fields produced by them, it is clear that the shunt coil must have self induction, and this self-induction destroys the simple relation of the wattmeter reading to the power. Fig. 1 also shows approximately the effect of the self-induction of the shunt, where the dotted curve represents the current in the shunt coil. The effect of the self-induction of the shunt is twofold: (*a*) It reduces the amount of the current passing through it, and (*b*) it causes the shunt current to lag behind the P.D. which produces it. It is, therefore, necessary to study the result of these effects, which are simplest when the waves are of the simple sine form.

*Wattmeter Correction with Sinusoidal Waves.*—From the above considerations it is easy to deduce the ordinary correction factor given in the theory of the wattmeter. If $\bar{A}$ and V

are the R.M.S. values of the current and P.D. as given by an ammeter and voltmeter, W the "apparent watts" $= \bar{A}\,\bar{V}$, and $w$ the "true watts," we know that

$$w = \bar{A}\,\bar{V} \cos\phi = W \cos\phi.$$

Let R be the resistance of the wattmeter shunt in ohms, L its self-induction in henrys, and $p = 2\pi n$, $n$ being the frequency of the circuit, we then have, Fig. 2,

$$\text{Impedance of shunt } I = \sqrt{R^2 + L^2p^2}.$$

$$\text{Tangent of angle of lag, } \tan\alpha = Lp/R.$$

It is clear ($a$) that the wattmeter reading is reduced in the ratio of R to I, and ($b$) that the angle of lag between the two coils will be reduced to $\phi - \alpha$, hence the wattmeter reading which should be $kW\cos\phi$, will in reality be $w' = kW\frac{R}{I}\cos(\phi - \alpha)$, or $kW\cos\alpha\cos(\phi - \alpha)$ since $\cos\alpha = \frac{R}{I}$. $k$ is here the constant of the wattmeter. Hence correction factor

$$= \frac{\text{True watts}}{\text{wattmeter reading}} = \frac{kW\cos\phi}{kW\cos\alpha\cos(\phi-\alpha)} = \frac{\cos\phi}{\cos\alpha\cos(\phi-\alpha)}.$$

Expanding $\cos(\phi - \alpha)$ the expression reduces to

$$\text{Correction factor} = \frac{1 + \tan^2\alpha}{1 + \tan\phi\tan\alpha} = \frac{1 + \frac{L^2p^2}{R^2}}{1 + \frac{Lp}{R}\tan\phi},$$

which, when multiplied by the watts given by the wattmeter, gives the true watts. This is the usual correction formula given in the books, and it is pointed out that if $\alpha = 0$ or $\alpha = \phi$ the correction factor is unity, *i.e.*, the wattmeter reads correctly. This formula is rarely used in practice, but where the load is not very inductive and the wattmeter has considerable self-induction, the correction may be applied. For this purpose $\cos\phi$ may be approximately determined by dividing the power determined with the wattmeter by the apparent power as given by an ammeter and voltmeter, and the corresponding value for $\tan\phi$ determined from tables and inserted in the formula. Of course R, L and $p$ must be known, which is, unfortunately, rarely the case in practice. The correction factor, however, breaks down utterly when the lag or lead of the current approaches 90deg. Under these circumstances $\tan\phi$ is very large, and varies so much with $\phi$ as to be quite indeterminate. Since $Lp/R$ can never be absolutely zero, and $\tan\phi$ is infinite when $\phi$ is 90deg., the correction factor is useless: and as this is the case in which it is most needed there is little wonder that it seldom appears outside text-books.

The writer has, however, worked out the correction formula in a new form, especially applicable to circuits of low power-factor, which is more easily applied than the former, and is perfectly determinate. We have seen that the wattmeter reading $w' = W\cos\alpha\cos(\phi - \alpha)$, and expanding

$$w' = W\cos\phi\cos^2\alpha + W\sin\phi\sin\alpha\cos\alpha.$$

$$\text{Hence} \qquad w = w\cos^2\alpha + W\sin\phi\sin\alpha\cos\alpha,$$

$$\text{from which true power } w = \frac{w'}{\cos^2\alpha} - W\sin\phi\tan\alpha,$$

$$\text{or} \qquad w = w'\left(1 + \frac{L^2p^2}{R^2}\right) - \frac{Lp}{R}W\sin\phi.$$

If P is the true power factor of the circuit $= w/W$ and P′ is that given by the wattmeter $= w'/W$ we have

$$P = P'\left(1 + \frac{L^2p^2}{R^2}\right) - \frac{Lp}{R}\sin\phi.$$

This correction is never indeterminate, as $\sin\phi$ only varies between $-1$ and $+1$. The correction appears somewhat complicated, but is very simple in practice, as if $Lp/R$ is small, we

$$\text{have} \qquad w = w' - \frac{Lp}{R}W\sin\phi.$$

The simplification is much greater when the load is very "inductive." For a circuit having great self-induction $\phi$ is nearly 90deg. and $\sin\phi \doteq +1$, while for a capacity $\phi$ is nearly $-90$deg. and $\sin\phi \doteq -1$. We therefore get

$$w = w' \pm \frac{Lp}{R}W,$$

or $P = P' \pm Lp/R$ the + sign being used for leading, and the − sign for lagging currents.

An interesting deduction from this result is that with a capacity current having a power-factor equal to $Lp/R$ the wattmeter should give no reading, and that if the power-factor is less than this amount the wattmeter reading will be negative. It has just been pointed out by Prof. Ayrton, in an article in the *Electrical Review*, that a Thomson meter should rotate backwards with a leading current having a smaller power-factor than $Lp/R$, an effect only too well known in practice to central station engineers. We see however, generally, from the above investigation, how to obtain either accurately or approximately the wattmeter correction, and thus to obtain the true power on a circuit or low power-factor even with a fairly inductive wattmeter. Sin $\phi$ may be taken within 1 per cent. of unity for all power-factors less that 0·14, while the quantity $1 + \frac{L^2p^2}{R^2}$ would be increased by 1 per cent. when $Lp = R/10$. If we take $p$ as 628 (100 ~ circuit) $L/R = 1/6{,}280 = 0\cdot00016$ and no wattmeter for ordinary circuits would have anything like this time constant.

*Effect of Capacity in the Shunt.*—Special consideration must be given to this matter, as it is probable that serious errors are frequently made in power measurements by neglect of capacities in the resistance coils in the shunt circuit. In order to eliminate the effect of self-induction the coils are wound non-inductively, but this brings together sections of wire at very different potentials. With a varying P.D. there is, therefore, a capacity current flowing between the wires as well as a conduction current through them. The effect is that of a condenser shunting the resistance coil, and its influence on

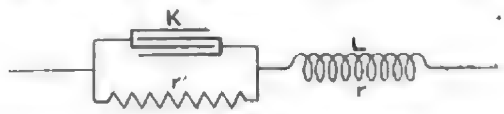


FIG. 3.

the reading can be calculated. In Fig. 3 let L be the self-induction of the wattmeter coil, $r$ its resistance, $r'$ the non-inductive resistance in series, and K its capacity, it can be shown that

$$\text{Impedance of circuit } I = \sqrt{\frac{(R - LKr'p^2)^2 + (L + Krr')^2p^2}{1 + K^2r'^2p^2}},$$

$$\text{and} \qquad \tan\alpha = \frac{L - Kr'^2 + LK^2r'^2p^2}{R + K^2r'^2rp^2}p.$$

In obtaining this formula it is supposed that the capacity of the wattmeter coil and the self-induction of the non-inductive resistance are both negligible. This assumption is sufficiently closely accurate for all practical purposes. It will be noticed that if L and K are large the lag depends on higher powers of the frequency. If, however, these quantities are small so that $Kp$ is negligible in comparison with $r'$

$$I = \sqrt{R^2 + (L - Kr'^2)^2p^2}$$

$$\text{and} \qquad \tan\alpha = \frac{L - Kr'^2}{R}p.$$

Further, if the resistance $r$ is small in comparison with R, $r'$ may be taken as R, and

$$\tan\alpha = \left(\frac{L}{R} - KR\right)p,$$

but L/R is the time constant due to the self-induction = T, and KR that due to the capacity = T′.

Hence $\tan\alpha = (T - T')p$, which is also the correction to be made in the power-factor when using the wattmeter.

Hence we have generally

$$P = P' - \frac{(L - Kr'^2)}{R}p\sin\phi = P' - (T - T')p\sin\phi \text{ for sine waves,}$$

and when both T$p$ and T'$p$ are very small in comparison with P, and at low power-factors

$$P = P' \pm \frac{(L - Kr'^2)}{R}p = P' \pm (T - T')p.$$

It will further be noticed that if $L = Kr'^2$ the correction factor vanishes *for all periodicities*. This will not, however, be true if L or K are large, as then the higher powers of the frequency have influence.

As an example of the serious error which may be caused by capacity, let us take a non-inductive resistance of 100,000 ohms. It can be calculated that the effective capacity of such a coil would be about $\frac{1}{10000}$th of a microfarad or $10^{-10}$ farads. Hence the correction to be applied to the power-factor at $100\sim = 10^{-10} \times 10^{10} \times 628 = 0{\cdot}0628$ or between two and three times the total power when testing dielectrics. The effect of capacity is, of course, to increase the reading on leading currents, and to decrease it on lagging ones. The remedy is simple. If the resistance is split into two separate sections the capacity can easily be seen to be only one-fourth, while if 10 separate resistances were used the capacity would only be $\frac{1}{100}$th of the above. Mr. Swinburne has recently suggested winding the non-inductive coils in layers, instead of double, which would certainly be an improvement on the ordinary plan, but the splitting up of the resistance into separate bobbins reduces the capacity much more, and give greater insulation and heat radiation when used on high voltages.

*Influence of Wave Form.*—This a matter which is unfortunately too often lost sight of when designing instruments or making tests. For instance, it might be assumed that since the correction above obtained could be easily made, there is no necessity for wattmeter shunts to be very non-inductive. On many circuits in practice the P.D. wave is very closely sinusoidal, and the correction applies with very considerable accuracy; but in the case of inductor alternators, &c., the P.D. may depart very widely from the sine form, as, for example, in the case of the wave forms shown by Mr. Minshall at the discussion on Mr. Mordey's Paper. It cannot be too strongly pointed out that these departures from the sine law may cause the most serious errors in all measuring instruments having self-induction. In the writer's own experience a good form of electromagnetic recording voltmeter altered in reading 3 per cent. on being switched over from a Ferranti alternator to a Parsons' turbo machine, the voltage and frequency of both machines being identical, and neither wave-form differing very greatly from the sine curve. It must not be forgotten that although the higher harmonics are, as a rule, small, their inductive effect increases with their frequency.

Writing our equation in the form $w = w' \pm \frac{(L - Kr'^2)}{R}p$W, the correction is obviously $\frac{(L - Kr'^2)p}{R}$W.

If the frequency is increased $a$ times, the correction will become

$$\frac{(L - Kr'^2)ap}{R}W.$$

If the amplitude of the P.D. wave of each harmonic is the same, the apparent power W is inversely proportional to the frequency. For since $A = V/lp$ approximately on a very inductive circuit, $W = AV = V^2/lp$, where $l$ is the self-induction of the main circuit. We thus see that the amount of the correction for each harmonic having the same amplitude is the same. Of course, the amplitudes of the higher harmonics are much smaller generally than that of the fundamental wave, but it may easily be possible for the correction to be doubled. If $C_1$ is the correction for the fundamental wave of amplitude $V_1$ the total correction will be approximately

$$C_1\left\{1 + \left(\frac{V_2}{V_1}\right)^2 + \left(\frac{V_3}{V_1}\right)^2 + \dots \left(\frac{V_n}{V_1}\right)^2 + \dots\right\}.$$

This correction must be applied to the total power, not the power-factor. Of course, this assumes that the inductance of the main circuit is constant, which is not the case where iron cores are used. If, however, we arrange our wattmeter so that the correction for sine waves is less than one-half of the amount of error allowable, it will be sufficiently accurate on any wave form in practice.

*Influence of Eddy Currents.*—A few words must be devoted to this matter as serious errors have frequently been made in measurements with wattmeters having metal supports or cases. The currents flowing in the main and shunt coils induce eddy currents in these metal parts which affect the torque on the swinging coil. Of course, the remedy is to get rid of metal in the construction of the wattmeter as much as possible, but as commercial instruments generally have a considerable amount of metal about them it is at any rate well to know the direction of the error that they cause. The eddy currents induced by the main coil need the greater attention as those induced by the swinging coil are much smaller both in magnitude and effect. The E.M.F.s induced in the metal parts obviously lag 90deg. behind the main current. The eddy currents themselves, if in brass, will probably not lag much behind the induced E.M.F., but in copper they may. Assuming them first to be in phase with the E.M.F. they will be in quadrature with the main current. If the main circuit is non-inductive the eddy currents will also be in quadrature with the shunt current, and consequently will not affect it. Hence, eddy currents in brass parts of a Siemens' dynamometer are not very serious. With a lagging load the current lags behind the P.D. and the eddy currents lag again behind the main current. Consequently, on very inductive circuits the eddy currents are nearly opposite in phase to the shunt, and diminish the reading. It is for this reason that the Swinburne wattmeter gave lower readings, and hence higher efficiency on open than on closed circuit transformers. With capacity loads by the same reasoning the eddy currents increase the reading.

In the copper coils or other copper parts of the instrument the eddy currents lag considerably behind the induced E.M.F. They consequently have most effect at high power-factors and then tend to reduce the reading. This effect is comparatively unimportant, unless the copper conductors are large, as a considerable amount of power is then being measured. Eddy currents in the copper plates of large Siemens dynamometers cause considerable error.

The effect of eddy currents induced by the shunt coil will similarly be nil if they are in phase with the induced E.M.F. If the eddy currents lag they should have effect, but if the metal is symmetrically placed the reading will not be altered. In any case the induction should be very small.

*Use of Transformers in Wattmeters.*—For use on high-voltage circuits, it has recently been the practice to construct wattmeters having transformers in the shunt circuit, the new form devised by Mr. Mordey being an example. These instruments are very convenient and portable, and fairly accurate on circuits of high power-factor, but for low power-factors they are worse than useless. If the current in the secondary coil of the transformer were exactly 180deg. behind the primary P.D. the instrument might read fairly correctly, but an error of 1deg. in this angle at a lag of nearly 90deg. corresponds to an error of 0·0175 in the power-factor (nearly the whole amount in dielectrics). As the angle may differ 3deg. or 4deg. from 180deg. the readings have no meaning whatever. Where high voltages are used the only course is to employ a high non-inductive and non-capacity resistance in series with the shunt coil.

*Construction of Accurate Wattmeters.*—Having now considered the errors to which wattmeter measurements are liable, and how they may be corrected for, it is easy to see how an instrument should be designed in which these errors are entirely eliminated. Some of the conditions are well known, but they are so universally disregarded in commercial instruments that a concise enumeration is advisable.

(*a*) The self-induction and capacity of the shunt circuit should be small in comparison with its resistance. In order to measure a power-factor correctly to an accuracy of 0·001 on a 100-volt circuit we have seen that R in ohms must be at least 628,000 times L in henrys. The capacity error $= KRp$; hence for this to be only 0·001, K must not be greater than $\frac{0{\cdot}001}{Rp}$.

To fulfil the first of these conditions *the control of the wattmeter must be small.* Deflectional pivoted wattmeters,

therefore, as those of the Weston type, cannot be accurate at low power-factors, since the pivot friction requires considerable control, and hence great self-induction. To avoid capacity errors as shown above, the non-inductive resistance should be split into a number of separate bobbins. As it has been shown above that the effect of capacity is opposite to that of self-induction, both of these quantities might be comparatively large if balanced against one another. This has often been done or proposed, but the writer is strongly of opinion that as it is easily done each error should be separately eliminated for accurate work. The balancing of the errors looks much easier on paper than in practice. Where, however, a fairly accurate instrument is required for general use, a suitable condenser may be used to shunt the non-inductive resistance such that $Kr^2 = L$.

(*b*) Mutual induction between the series and shunt coils should be avoided. This is always the case where the coils are at right angles, as in most wattmeters, but in the Kelvin watt balance the coils are parallel and considerable mutual induction exists between the circuits. The effect of mutual induction might be considered, but it seems preferable to get rid of this further source of error by the simple placing of the coils at right angles, and reading, not by deflections, but by a torsion head.

(*c*) Eddy currents should be avoided by getting rid of all metal near the coils, even screws, and brass cases should never be used.

*Description of the Wattmeter used at the Northampton Institute.*—Fig. 4 shows the construction of the wattmeter designed by the writer for the laboratories of the Northampton Institute, and made by his assistant, Mr. G. Marinier. It has proved so satisfactory that similar instruments are being made. The main coils M are two in number, each wound with 10 turns of eight No. 16 D.S.C. copper wires, the eight wires being very carefully stranded together so that each circuit has the same magnetic effect on the shunt coil. The 32 ends thus obtained are brought down to two rows each of 16 mercury cups with two troughs running by them. This arrangement has two great advantages. In the first place, the coils may instantly be connected in any series or parallel grouping so as to make the instrument capable of accurately reading with currents varying from $\frac{1}{10}$th of an ampere to 100 amperes; and, secondly, the stranding effectually avoids eddy currents in the substance of the main coils. Great care has been exercised in making all the circuits identical both as regards self-induction and resistance, to avoid reactions between the coils when in parallel.

The shunt coil S is composed of 800 turns of 2·4 mil. D.S.C. copper wire, and its dimensions are 3in. by 2in. Its resistance with suspensions is 555 ohms, and its self-induction 7 millihenrys. This coil is suspended with a 2·4 mil. round wire (not strip), the top suspension being 12in. and the bottom 6in. long. The suspension is always under strain between spring contacts, and the round wire is found to give much better proportionality and permanence of zero than flat strip. This is probably owing to the fact that it is extremely difficult to mount strip so perfectly axial that there is no liability to buckle with great torsion. With the suspension used the torsion head may be rotated 360deg. in either direction and the zero does not alter a fraction of a degree, even when the suspension has been newly put in. The base and supports of the instrument are all of varnished teak, and wooden or fibre clamps are used to fix the coils. No metal work of any description is near the field of the coils. In order to facilitate readings as far as possible the torsion head is made very large (500mm. exactly in circumference) and the (millimetre) divisions are marked on the rotating head so that the readings are always opposite the eye. To ascertain the zero position a reflecting mirror might have been used, but it was found quite sufficiently accurate to use a light aluminium pointer moving over a scale on a parallax mirror. A cardboard cover, not shown, having a slit in it for reading, is used to protect the instrument from air currents when reading. The sensitiveness of the instrument is such that when used normally with 100,000 ohms in series with the shunt coil it gives a reading of about 1mm. on the torsion head for one watt. This is when the main coils are arranged in series. The external resistance which has been used up to the present has been composed of 10 coils of about 10,000 ohms each.

The capacity of this arrangement would be roughly about $1{\cdot}6 \times 10^{-11}$ farads. Hence $Kr$ would be $1{\cdot}6 \times 10^{-6}$ and $Krp$ at $100\sim = 10^{-3}$, and the greatest possible error in the power factor on sine waves due to capacity would be 0·001. The self-induction as above mentioned was 7 millihenrys hence $Lp/R = 7 \times 628/10^8 =$ say, $4{\cdot}5 \times 10^{-5}$ which would be the maximum error in the power factor due to self-induction. As the capacity effect is not negligible another resistance is being constructed with 100 coils of 1,000 ohms each, which will reduce the capacity effect to one-hundredth part of its present value. These coils are being wound in notches on ebonite sheet, an arrangement which has been formerly used for high resistances. This resistance will serve for measurements on 2,000 volt circuits, since the power will be 40 watts, which, when distributed over 100 bobbins, will not cause over-heating.

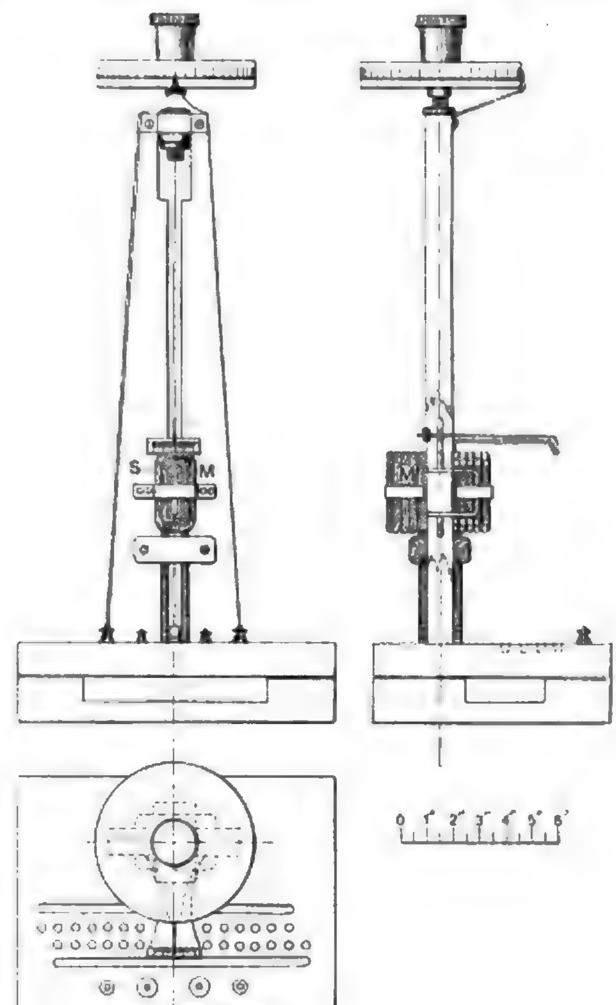


FIG. 4.

As ordinary resistance boxes are not safe on high-voltage circuits, the writer has formerly employed a liquid resistance suggested by his assistant, Mr. A. C. Jolley. It consists of a 5 per cent. solution of cadmium iodide in amyl alcohol with cadmium electrodes. A tube about 6in. long and $\frac{1}{2}$in. diameter gives a resistance of about a megohm, and the arrangement is very cheap and convenient. If any appreciable current, however, is taken, it drops in resistance with the heating produced, so that it is well to check its resistance frequently.

In conclusion, the writer would urge upon engineers the necessity for great accuracy in alternate-current power measurements at low power-factors. The low load-factor on all alternate-current lighting systems causes the losses in transformers and mains at light load to be of the greatest

possible importance. The writer ventures to doubt whether the efficiencies of transformers and motors at light load, so often published, are really known with any degree of accuracy, in view of the ignorance which prevails on the subject of power measurement and the extreme liability to error at low power-factors. Of all methods available for such measurement the only two of the slightest value for low power-factors are the wattmeter method and the electrometer method recently revived by Mr. Addenbrooke. The electrometer method theoretically should be the method par excellence, as it is free from inductive errors and can be used with special convenience on high voltage circuits. Electrometers, however, have a number of errors peculiarly their own, and the writer's experience with various forms leads him to doubt their capability for accurate measurements, especially at low pressures. An explanation from Mr. Addenbrooke as to how the various sources of error in electrometer measurements may be eliminated, and to what accuracy the readings may be relied on, would be of great value.

## WIRELESS TELEGRAPHY.

BY PROF. DR. F. BRAUN.

During this winter I have delivered two lectures before Strassburg scientific societies on a part of my practical and scientific experiments in wireless telegraphy, and I take the liberty of giving a short account of the substance of these lectures.* My experiments were commenced in the summer of 1898, and were at first devoted to methods of signalling through water in a more effective manner than hitherto. This, however, will be referred to on another occasion.

Following these, experiments on the Marconi system were undertaken with a view, in the first instance, to increase the action of the transmitter. At that time the general idea, and also Marconi's, was that he was working with Hertzian—*i.e.*, with relatively short waves. In fact, the introduction of the Righi oscillator was manifestly with the intention of increasing the frequency of the waves as much as possible. One might be doubtful, however, to what extent this assumption was correct, for the question here was obviously to what distance the charge had already travelled in the transmitting wire connected to the Righi balls at the moment when the balls themselves are charged up to the sparking potential. If one takes the simpler connection with only one spark-gap the natural conception would be that the whole transmitter would be charged to practically constant potential owing to the slow charging process, and that it would thus behave as a Hertz oscillator; this assumption alone would explain the fact that the effects at a distance increased with an increasing length of transmitting wire. But, if these views were correct, Marconi's transmitting arrangements were not favourable. Then, his transmitter has small capacity, and this cannot be increased so long as the transmitter remains open. But oscillations of this character die out very quickly, as one knew from numerous experiments; they are damped too quickly by the sparks, a fact which Hertz expressed in the form that if the length of the spark is to remain "active" a certain size must not be exceeded.

All these considerations led to arrangements in the following manner.—Condensers with a capacity of about the order of the usual Leyden jars were charged singly or in combination to a high potential, and their discharges through appropriately dimensioned self-inductions were employed to feed the transmitter directly or indirectly. Here, for the first time, slower oscillations than Hertz's were undoubtedly employed, and the first question that occurred was whether a coherer with the ordinary connections—where it is embedded in a circuit which is closed in the geometrical sense—would still act sufficiently. Then, the usual idea, which seems to be supported by facts, was that the coherer only responds to very short waves, as only these would produce a potential difference between the two poles sufficient to break down the gap in the coherer. This view seems to be directly confirmed if one first considers the coherer entirely insulated and exposed to the electric waves; and, secondly, if one is certain that it does not follow the periodic currents, but the periodically varying potential difference.

Experiments with the Leyden jar discharges well defined in every respect gave a positive result. First, the conditions of the experiments were varied to a considerable extent, among the arrangements tested being the connections now employed by Slaby and Count Arco. Especially closely examined was an arrangement which I denote as inductive excitation of the transmitter, and to the description of which I will confine myself at present. It is characterised by the fact that one leaves the transmitter quite sparkless, and excites the oscillations in it by induction. The condensers discharge through a primary circuit, and this excites the oscillations in the lower spirally-wound end of the transmitter. The lower end of the latter remains insulated from the earth, and it follows that its assistance in increasing the action to a distance, which Marconi found to be the case with his connections, cannot be interpreted in the usual manner. As a matter of fact, the earth acts, it may be mentioned parenthetically, in causing the transmitter to take up a greater electromagnetic energy.

The advantages of my connections are as follows:—

1. In the primary circuit a large amount of energy can be employed usefully; the action of the transmitter increases with the energy employed to a much greater extent than with the Marconi connections, and can be augmented by increasing the capacity of the condensers as well as by increasing the potential.

2. The oscillations of the transmitter are, as is known, hardly active physiologically, in spite of their high potential, and a danger from unintentional contact is therefore quite excluded.

3. Less attention need be paid to the insulation of the transmitter than in the case of electrostatic excitation.

4. The oscillations of the primary condenser circuit are slightly damped, as has already been known for a long time (for instance, from the classical experiments of Feddersen). They excite in the sparkless transmitter waves which are still less damped. If, therefore, both are brought to resonance, they increase in the latter case to a very high amplitude.

5. Thus they fulfil the fundamental conditions necessary for electrical tuning between a transmitting and receiving apparatus. The region of useful rays of oscillations will at the same time be extraordinarily extended, as is particularly desirable for this purpose.

The first assertion is proved by the following table:—

| Primary Current in the Induction Coil. | Relative Electromagnetic Energy in the Transmitter. | |
|---|---|---|
| | Marconi Connection. | Inductive Excitation. |
| 2 amperes | 8 | 26 |
| 2½ to 3 amperes | 10 | 40 |
| 4 amperes | 10 | 55 |
| 6 amperes | 10 | 62 |

The table shows that the mean energy of the waves in the Marconi transmitter (in consequence of the spark) soon reaches its limit, while it increases considerably in the case of inductive excitation; and, further, that for the same energy expended in the primary, the latter system far surpasses the Marconi transmitter. The second and third claims scarcely need a proof. If, as I demonstrated in my lecture, one connects a Marconi transmitter to earth by means of a long damp thread, the apparatus refuses to work while the inductively excited transmitter is hardly affected by such a connection. The two last claims follow from resonance experiments. That the waves of the transmitter serve perfectly for a tuned telegraphy will be shown at the conclusion of this article.

Experiments in the open air have demonstrated a superiority over the Marconi transmitter under all conditions. The first observations in Strassburg, in the summer of 1898, already proved this, when the sender and receiver were in sight of one another (partly) as well as when they were hidden from one another by obstacles. The tests were resumed at Easter,

* The lectures were delivered November 16, 1900, and January 31, 1901, and notices of them appeared in the daily newspapers.

1899, at Cuxhaven, and in the winter of 1899-1900 telegrams were sent to Cuxhaven (Kugelbake) from the small steamer "Silvana" of the North Sea line, in her journey to Heligoland. With a transmitting wire of 15 metres in height on the "Silvana," and a receiving wire 29 metres high at Kugelbake, regular and perfect messages were received to a distance of 32km., and signals could be distinguished at distances of 50km. During the experiments in the autumn of 1900, between Cuxhaven and Heligoland (63km.) with masts 29 and 31 metres in height respectively at the two stations, comparative tests were made. While with inductive excitation all the signals were received, of 450 transmitted with Marconi connections not a single one could be observed at the receiving station although the supply of energy was pushed to the extreme limits. The remaining conditions were strictly identical. The following table gives a comparison in which the figures referring to the Marconi transmitter are taken from official reports reprinted in the *Elektrotechnische Zeitschrift* :—

| — | Distance of transmission (E). | Height of masts. | | Product of the heights of the two masts (P). | $\frac{E}{P} \times 10^3$ * |
|---|---|---|---|---|---|
| *Inductive Charge Method*. | km. | metres. | metres. | | |
| "Silvana"—Kugelbake.. | 32 | 15 | 29 | 435 | 74 |
| Elbe I.—Kugelbake ...... | 32 | 30 | 29 | 870 | 37† |
| Heligoland—Kugelbake.. | 63 | 31 | 29 | 900 | 69 |
| *Marconi Transmitter*: | | | | | |
| Borkum—Borkum Fireship ......... ... ... | 32 | 40 | 38 | 1,520 | 21 |
| North American Navy... | 13·5 | 13·5 | 39 | 526 | 25 |

The last column in the table gives the distance over which signalling should be possible, calculated according to a well-known rule. On the significance of the rule and the assumptions under which it applies see Hertz, *Wied. Ann.*, Vol. 36, p. 1, 1888. Even if one does not take this rule literally, the summary above proves the undoubted superiority of the transmitting arrangement described. The distance attainable should be, from the present facts and material, two and a-half to three times that by the Marconi transmitter, although the receiver employed in the experiments was less sensitive than Marconi's. The fact that large amounts of energy must be available in order to signal over considerable distances with low masts may of course be troublesome in some instances, but in many cases it will hardly come into consideration.

The connections have here been described in their simplest form; they can be varied in different ways and the energy of the transmitter thus increased. The extent of its applicability in radiating large amounts of energy, whether in the form of long or short waves, is not fully portrayed in the above article.

In conclusion, the experimental proof that the oscillations produced are slightly damped remains to be given. This was done by means of resonance experiments. It is known that the Hertz waves, which die away quickly, excite in the resonator its natural period of oscillation to a considerable extent, a phenomenon which at first led to the assumption that a Hertz oscillator, similarly to the light of an incandescent body, received a continuous succession of vibrations, and to which the name of multiple resonance was later given. In distinction to this, the oscillations employed here show sharply pronounced resonance phenomena. In my lecture I showed discharges which made 10,000,000 complete oscillations per second, and thus approached closely to Hertz's. These had a visible effect on a distant wire circuit in which a Geissler tube was included, provided this circuit was in tune.

It would thus be possible to base on these discharges a tuned system of telegraphy. But resonance phenomena of this kind are not favourable for other reasons; they show, it is true, that good conditions are fulfilled in the transmitter, but the task still remains to construct a correspondingly good receiver.

The problem was, therefore, attacked in another manner. The object was, on the one hand, to tune the oscillating systems between narrow limits, and on the other to increase the receiver effects. This latter could be done in two ways. One way would be to make as great as possible the energy taken up by the receiver—a course which was not followed in this case. If one considers the energy taken up as a fixed quantity, it only remains to *concentrate* it on the receiving apparatus, so that the latter benefits by it as far as possible, exclusively. The arrangement then works as a lens, which does not increase the energy of the light but concentrates it. I confine myself here to mentioning experiments which I showed in my lecture. These demonstrated that the electric waves which pass the receiver can be concentrated 20 times or more. Then they can be made to act in the form of heat on a microphone contact or on a coherer of the most suitable form, and the latter may be placed in such a way that its action cannot fail whether it reacts with current or potential difference.

I further showed in the lecture the sharpness of the tuning. Very slight changes in the tuning immediately diminished the localised energy very considerably. As the energy only collects in the tuned parts, the other parts will refuse to act, and thus the problem of the so called multiplex telegraphy is solved in a very complete manner.

* The product of the heights of the masts should be about proportional to the distance attainable.

† The smaller figure is because the actual distance is much smaller than what would have been attainable.

## THE USE OF STORAGE BATTERIES IN CONNECTION WITH ELECTRIC TRAMWAYS.*

BY G. A. GRINDLE, M.I.E.E.

The first serious attempt at electric traction was made at Portrush, in Ireland, when, in 1882, a line was equipped on the third-rail system some 6 miles in length, running from Portrush to Bushmills, and some years later this was followed by a second line in Ireland on somewhat similar lines, running between Bessbrook and Newry, with both of which your chairman for the present year was closely identified, and in the case of the second one was actually responsible for. In the meantime, abroad, far more particularly in America, matters had been marching steadily onwards. The third-rail system, as adopted on the two lines just mentioned, was experimented with on several lines; but after having been given a careful trial was found to be wanting, at any rate in its capacity to meet the demands of American practice, and somewhere about the year 1884 the idea was conceived, by whom actually I believe some doubt exists, the idea having been claimed and attributed to several, of stringing the conductor overhead from pole to pole, and obtaining the power from it by means of a collector. It is an interesting fact that a similar method of collecting power was adopted in the same year on the Bessbrook and Newry Tramway, where at wide road crossings the third rail was interrupted, and the current collected from a suspended overhead wire. In none of these schemes, however, was a storage battery utilised, and it was not until 10 years later, or 1894, that the first recorded instance of its employment occurs. In that year two tramway systems came into operation, on both of which batteries were adopted, one being the Douglas and Laxey Tramway, in the Isle of Man, the design and equipment of which again your chairman was responsible; the other case the Zurich Electric Tramways.

As to which system it was first contemplated to employ accumulators on it is impossible to say, or whether the designer of either scheme was aware what the other was doing or contemplating. It is possible that the idea of employing batteries was arrived at in both schemes entirely independently, at any rate the object and method of employing them was entirely different. In the first instance the battery was employed at an outlying sub-station, situated somewhere about midway between the terminal points of the line. The battery in this instance was operated by means of a special feeder from the generating station at Douglas, the charging being effected by means of an ordinary motor generator installed in the battery house. The function of the battery was to assist the line load, which at the point of the line where the battery was installed was of an exceptionally heavy nature at times, generally to assist in maintaining the line potential at or about the centre of the system, and to obviate the necessity of sending the maximum amount of current demanded over the long feeders from the power-house. Variations of the battery potential were compensated for by a portion of the battery being employed as regulating cells, the regulation being effected by hand. In the second instance the battery was installed at the power station, the principal functions of the battery being to equalise the

* Abstract of a Paper read before the Manchester Section of the Institution of Electrical Engineers, Feb. 26.

load on the generators, allowing a much smaller power plant to affect the operation of the line. The battery in this case was charged by means of an auxiliary generator in conjunction with the main generator, and the regulation effected by means of regulating cells cut in or out as necessary by means of an automatic switching arrangement.

These two first instances of the adoption of batteries to traction working, though neither of them can, when compared with recent practice, be considered as ideal methods of employment, nevertheless are distinctly interesting in view of subsequent development, and have gone far to demonstrate the necessity for a storage battery. One has only to take a glance at the load curve of any traction system to see the necessity and call for the employment of a storage battery. The usual load curve reminds one of nothing so much as an attenuated mountain range, with one moment lofty peaks ranging skywards, and the next moment low-lying passes down at times to "sea-level." The accompanying load curves will very clearly show this, and though the wide ranges may tend to decrease in number on large systems, the liability to their occurrence still exists and has to be provided for. Nothing more detrimental to a generating plant can well be imagined, the violent stresses between full and no load occurring so suddenly and often consecutively following on each other. The necessity also arises, when it is desirable to maintain the voltage as nearly as possible constant. No matter to how fine a point the governing of the engine is carried, it is impossible for it to respond with anything like the rapidity with which the variations in the load takes place. The most perfect mechanical governor has a distinct time-factor as compared with that of switching on a motor, nor can even a generator itself respond so quickly, with the result that the voltage of the line rises and falls.

Diagram No. 1 shows an interesting example of the difference of the load on the generator obtained on the same line before and after the installation of a battery under precisely similar conditions. Diagram No. 2 shows the results obtained in the variation of the voltage. The upper curve in each diagram gives the result before, the lower after the employment of the battery; the upper curve and lower curves in No. 2 show the results upon the voltage before and after respectively. The variation in the load you will note on Diagram No. 1 before the introduction of the battery was as high as 270 amperes, while subsequent to the employment of the battery it amounts to 50 amperes only. These curves, however, must not be taken as in any way approaching what can be effected with a battery. In this instance the battery was installed without any boosting or special compensating arrangements. In conjunction with a suitable booster there would be at the least as much improvement again. The results to be obtained by employing a suitably-designed booster will show as great an improvement over the results obtained by the employment of a battery as the employment of a battery shows over working without. A battery is, further, a distinct necessity where it is desirable to centralise as much as possible the operating plant, as is nearly always the case, and often saves an additional station, with its attendant staff. A battery is an absolute necessity where the available power is limited to little more than the mean day load, as is often the case where water power is employed; and in many instances small falls of water, which by themselves would be quite inadequate to successfully operate a small line, with the assistance of a battery can do so easily.

Admitting therefore the necessity for a battery, we will next consider the advantages to be obtained by the inclusion of a battery on the power system. The first and undoubtedly foremost advantage to be gained by a reliable battery, properly installed

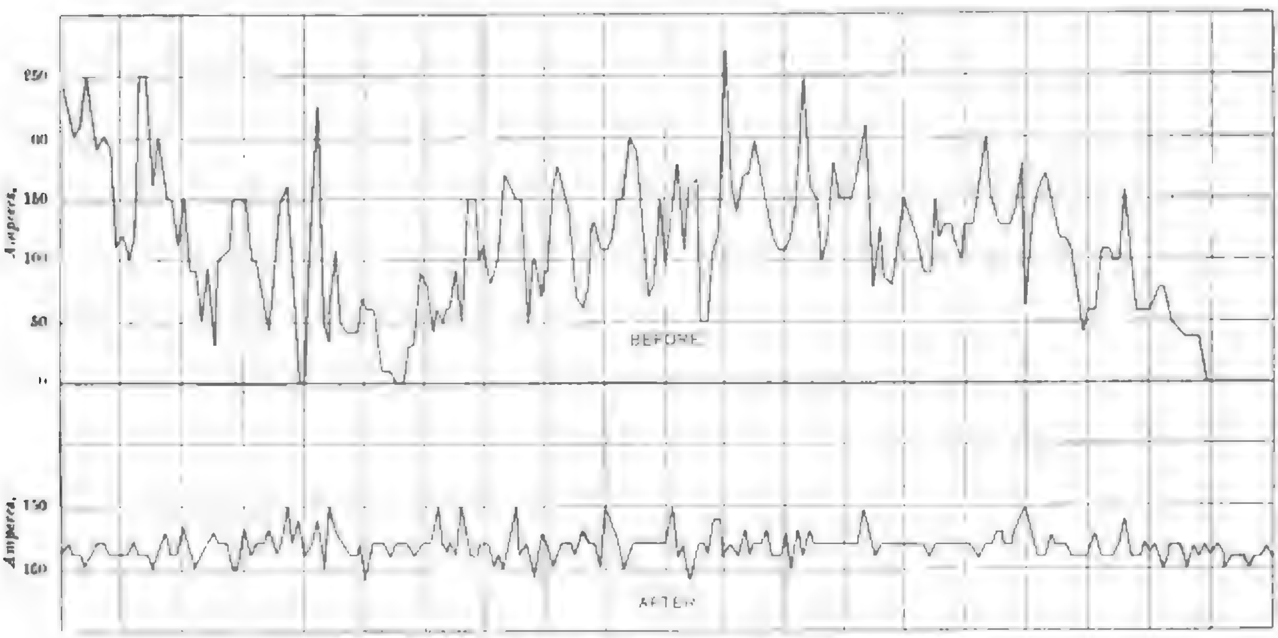


DIAGRAM 1.—Load Variations before and after Storage Battery Use.

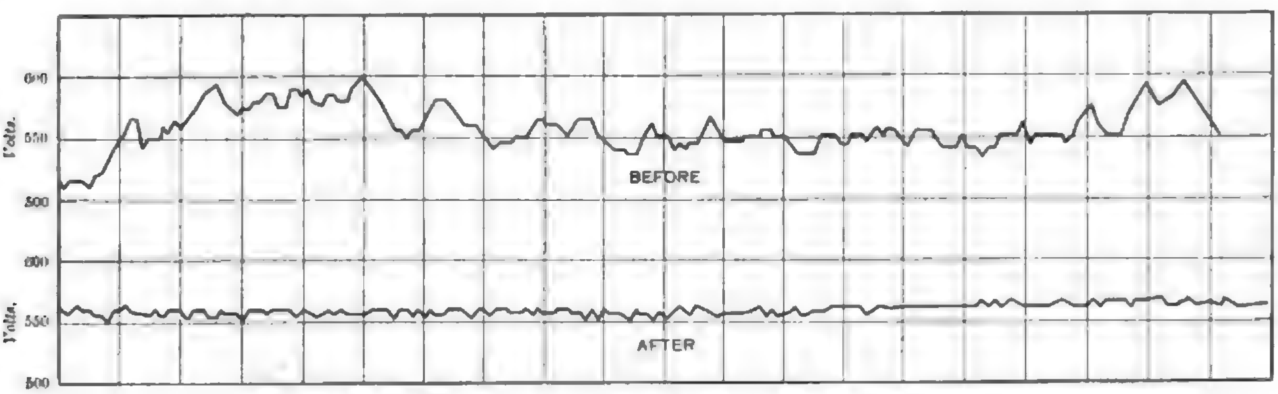


DIAGRAM 2.—The Voltage Curves in a Station before and after installing Storage Batteries.

and duly proportioned for the work it has to effect, is the simplification of the question of generation of energy, resolving this from being one of a constantly varying nature, varying from nothing to several times its mean, to the one simple question of generating an even, steady, and pre-determined load. By enabling the prime motor to be run constantly at an even load, it naturally follows that this load can be arranged to be the most economical one for the motor employed, which will result in an enormous economy over what could be obtained by employing a prime motor, which would of necessity have to be at least three times its size, in order to enable it to cope with the maximum demand, which may from time to time be thrown upon it. In fact, it is almost impossible to conceive an engine being run under more disadvantageous conditions than those which obtained in the production of energy for an average railway system, where no battery is employed.

This advantage is best evidenced by the coal bill. The pounds of coal per horse-power-hour on electric traction systems is, I think it will generally be admitted, beyond all reason, in many instances ranging up to 10lb. and even more; by the employment of a storage battery there is not the slightest reason why this should not be reduced down to the best engine practice, namely, from 2lb. to 2½lb.

sudden overload on the line, the extra demand of current will be immediately taken by the battery and not by the generator. Should the "short" be sufficiently great to throw out the circuit-breaker, there will still be no variation on the generator load, the battery absorbing it all. While when the circuit-breaker is closed again, even though the cause of throwing it out may have been removed, there is almost certain to be an abnormal demand on the line for current, due to the almost simultaneously re-starting of the cars. All this will be immediately taken by the battery, without any abnormal load whatever being thrown upon the engine. In fact, the investment in a battery may be looked upon as a very excellent form of machinery insurance.

In cases where belts are used for driving, experience has shown that where a battery is not employed, a severe shock will almost invariably break the belt before releasing the cutout. While where a battery is in operation, the circuit-breaker will invariably operate, first saving the belt. Another advantage, and one of considerable importance, is that the battery will often carry through where, without one, a stoppage would be absolutely inevitable. I do not say that every accident which has caused the stoppage of an electric line might have been prevented by the employment of a battery; but a

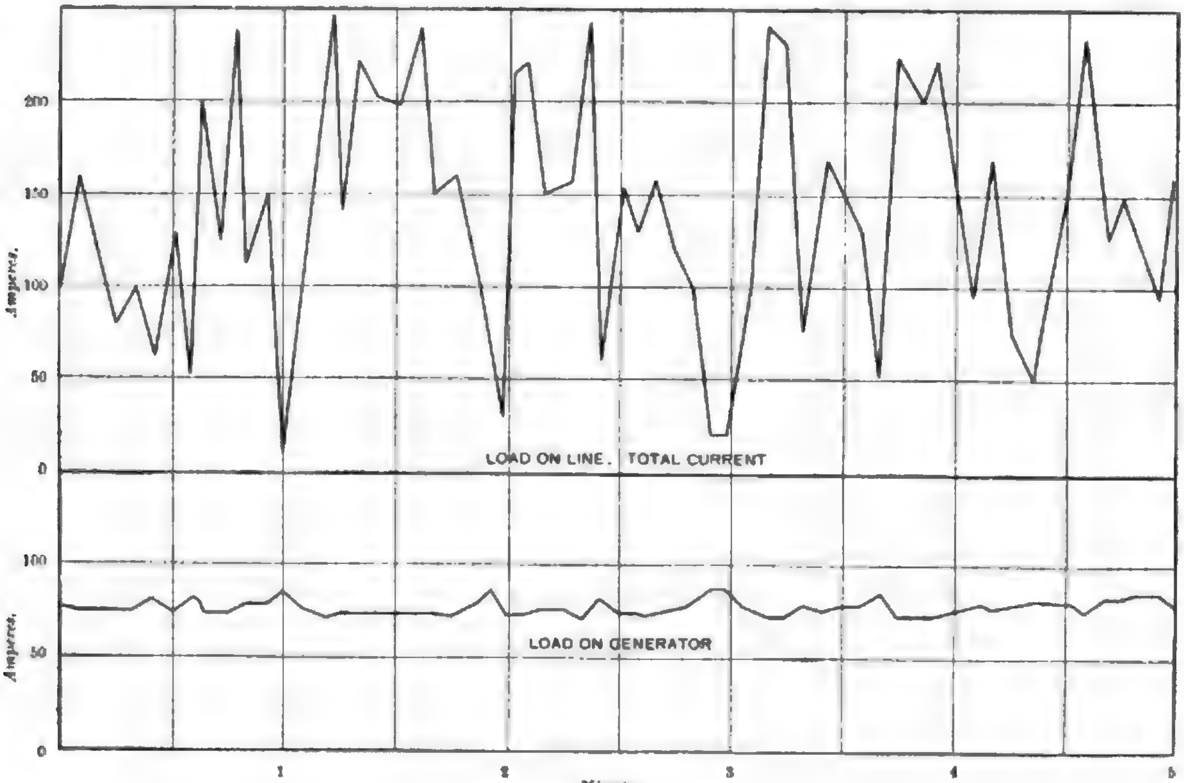


DIAGRAM 3.—Load Diagram.

An advantage, and an important one from a point of cost, is the reduction of the engine-room hours. In this country few, if any, tramways run the full 24 hours, but where they do (and it is as well to bear in mind that there is a growing tendency towards its adoption), what may be termed the "night-load" is of the smallest nature; this load can be taken entirely by the battery. Apart from the question of where a 24-hour system is in force, and where the current English practice has only to be provided for, the employment of a storage battery enables a considerable reduction of hours to be made in the daily work, and will, in most instances, easily bring the running of the station within the limits of two shifts, leaving the early and the late cars to be both operated entirely off the battery. In an average station this should be at least a saving of from £150 to £200 per annum.

It is a distinct advantage in the saving of wear and tear of machinery, not only in the power plant, but also the cars, the sudden and violent variations or voltage, which must of necessity continuously occur where no battery is used, throw a large amount of unnecessary strain on the running motors, which is much modified, if not entirely eliminated, when a battery is employed. A distinct advantage is shown in the running of the cars; better time can be kept and more even running. The car lighting will be steadier, and the destruction of lamps decreased. An important advantage is the safeguard it effects against accidents, more particularly fly-wheel accidents and breaking of belts in cases where the latter are employed, as in the event of a "short" or

vast number of stoppages which have occurred, have been due in many instances to mere trifles, and would never have taken place. The advantage of being able at any time to shut down an engine for a few minutes, I venture to think will be universally acknowledged. A very strong factor amongst the advantages of employing batteries on traction systems is the facilities they afford when, as is often the case, extensions or increased car service become imperative. By the installation of batteries at the extremities of existing lines extensions become feasible without any interference whatever with the existing arrangements and consequent expense, in many cases saving the necessity for additional power sub-stations, which, unless the extensions are very great, must work under most disadvantageous conditions.

Having admitted the necessity and the advantage of employing a battery there yet remains one great factor to be consulted, and one which, in the present day, there is a very lamentable tendency to unduly exalt, and at the shrine of which many a good scheme and many a good job have been unfortunately sacrificed—it is the question of cost. There are two things that require to be very carefully avoided—first, schemes that cannot possibly pay if properly carried out; second, lavish expenditure that cannot be recouped. Eliminating these from our consideration, and provided that no cheese-paring policy is adopted of endeavouring to make one pound's worth do the work of two, or, in other words, it being ensured that an adequate battery will be properly installed and equipped, as to whether or no the necessary outlay which must be incurred to include such a battery on a traction system is justified, there are no two questions,

as there is not the slightest doubt whatever that it is the means of a material saving both in the prime outlay on operating plant and the subsequent cost of operation of same.

*Saving in Operating Plant.*—The judicious and adequate employment of accumulators will very materially reduce the amount in construction cost of a generating plant; that is to say, the boilers, engines, and the generators at the power station, and also, in consequence, the cost of station buildings. If we take a typical load curve of a power station operating an average sized tramway system in this country it will be found that the mean load throughout the day approximates very closely to one-third of what may be termed the peak load or line, eliminating from the calculation the abnormal peaks, which would occasionally occur. To meet this load fairly and effectively the plant must, if a battery is not employed, be capable of generating the peak line, or, in other words, three times the mean day load, with the consequent result that, taking the day through the plant is only loaded to one-third its capacity, a very uneconomical state of affairs, which will not by any means be improved by the varying nature of the load. Diagram No. 3 is an interesting example of this, showing, so far as the upper or "load on line" curve is concerned, even a more aggravated state of conditions. The generator in this case is steadily doing the mean day load and the battery is dealing with everything above. These readings were taken every five seconds for a period of five minutes at the time of heavy load at 7 o'clock on a September evening. The load variation, you will notice, ranges from 15 to 250 amperes, and that, as a matter of fact, no part of this extreme variation came upon the generator, the generator output actually falling at the moments of heavy load.

Let us for a moment compare the cost of two plants, one operating without and one with a battery, taking for instance a system calling for a mean load of 150kw., representing a moderate-sized system of some 20 running cars. Under the typical conditions mentioned above the maximum load which may from time to time be demanded will rise as high as 450kw. To deal with this, therefore, in the first instance it will be necessary to instal a plant capable of generating this output, or no less than 300kw. over and above the mean load, and on taking the cost of a complete installed plant at £30 per kilowatt, which, I think, will be admitted to be a fair and reasonable figure, this means no less than £9,000 in surplus plant over and above the £4,000 to £5,000 plant which must of necessity be employed to deal with the mean load. In the second instance, by employing a battery to deal with the demand over and above the mean load, it will require that there should be installed a battery capable of delivering as a maximum 300kw. The cost of a battery to comply with these conditions would approximate somewhere about £12 per kilowatt, including booster and switchboard arrangement, or an expenditure of £3,600 as and against the £9,000 in the first instance or a clear saving in capital expenditure of approximately £5,400.

In both the above instances no allowance has been made for spare plant; this must, of course, be provided in both cases, but the necessary amount will be considerably less in the case where the battery is employed. The above examples apply to the case in which the battery is installed at the power-house. Where the battery or batteries are installed in sub-stations their introduction will effect in addition a great saving in the cost of feeders, varying, of course, according to the existing conditions of the line, distance from power-house, and various other factors. Owing to the number of these factors and the wide variations that may exist in them, it is practically impossible to formulate any idea as to what may be effected in the way of saving, though a rough idea may be easily arrived at, if we consider for a moment the work which is usually performed on any traction system by a feeder. This, of course, must necessarily vary considerably in accordance with the traffic upon the line, but it is extremely doubtful if the aggregate of the day's working amounts to more than 10 per cent. of its full capacity. With a battery installed at a sub-station, the full carrying capacity of the feeder can be employed during the whole of the operating hours of the power station. As an instance of the enormous saving that may at times be effected, the case of the Union Traction Co.'s system at Philadelphia is a marked instance. The extension of this line was found to be necessary, and the service practically increased to double. It was found that it would be necessary either to build a new power-house or instal a battery sub-station, as to attempt to augment the feeder system to the extent that would be demanded would necessitate such an enormous outlay for copper as to render it commercially impossible. The most carefully made calculations proved that the cost of copper alone would amount to from four to five times, excluding the cost of laying, the total cost of battery installation necessary to fully meet all the requirements, while the question of an additional power-house was found to be absolutely out of the question on account of the heavy operating expenses which would necessarily be incurred, apart from the fact that the capital cost of the battery station was considerably less than 50 per cent. of the estimated cost of the power station. These figures are sufficient to show how, on the question of cost alone on the first outlay, a battery is an undoubted saving.

(*To be concluded.*)

## INSULATION ON CABLES.*

BY MERVYN O'GORMAN.

*Introductory.*—The value of cables made annually in England is, I estimate, £1,000,000 to £2,000,000, excluding submarine and telephone cables.† The gross profit might be £200,000, a good fraction of which goes to electricians, electro-chemists, managers, and little enough to purely scientific research. Yet such research might appear to be specially needed by the peculiarities of the industry, not only from the uniqueness of indiarubber, gutta percha, lead, and copper, and from the large quantities used, but because in a cable factory, unlike other engineering works, the materials cost from 10 to 18 times as much as the labour of assembling them. A factory with 150 skilled and 150 unskilled hands can turn over £300,000 worth of goods in a year—*i.e.*, £2,000 per skilled man—without complex machinery, and it is therefore essential, not only to buy with the utmost discretion, but to study the peculiarities of the materials and give importance to that branch of the "intelligence department," which deals with their electrical, chemical, and physical properties.

We scarcely realise how unlimited and how little explored are those fields of research. Suppose that by dint of mixing gums, resins, oils, powders and solvents, we should get a perfect dielectric, *waterproof* for 100 years, *flexible and extensible, so volt-resisting* that the thinnest film suffices, with a specific *capacity* almost as low as that of air, yet adjustable to a high value; sufficiently firm not to decentralise, yet fluid enough when heated by an arc to close in and *seal-up* a fault. Suppose, besides all this, we can make it at 5d. per pound applied, what will be the reward? Far more than the value of the three-wire patents or the Dunlop tyre, plus the benediction of all electricians. Even if this insulator is not forthcoming, we may note that it is from studying electrolytes and dielectrics that we may solve not only some mechanical difficulties of armature design, capacity difficulties in submarine telephony, or the hygroscopic and electrolytic difficulties in wiring and electrolytic tramway work, but also that we shall get in touch with discoveries such as the Nernst filament, or modern investigations of the most burning interest, such as the dielectric strains due to Hertz waves or Dr. Pupin's submarine telephony.

The subject is a large one from another point of view, for it is the value of the cables that practically decides us for alternating or direct currents, or that makes us prefer two or three phases, high or low voltages. It would be interesting to dissect critically the capital expenses of the electric supply industry (for power, or light or tramways or railways) and count the instances in which great expenditure has been made upon transforming plant of one kind or another, elaborate high-tension switchboards, extremely expensive insulation, to avoid an outlay on the copper of cables which time would have amply justified. Such a search would involve re-estimating most of the schemes, but it would show, I believe, that an important fact is lost sight of, the unparalleled endurance of copper. In the case of a large low-tension cable conveying, say, 1,000 kw. when the insulation has become valueless after an interval which may on the ordinary allowances for deterioration be fixed at thirty years, the value of the copper remains unaltered, say up to 70 per cent. of the value of the cable (supposed drawn into a duct). In the case of such a high tension as 10,000 volts, however, should the insulation become worthless, the amount of copper in it is too small to be reclaimed, and at the end of 30 years' life, a low-tension cable is worth 50 per cent. more than its rival. It is improbable that cable makers trouble about this, and in any case a high-tension cable, though a riskier thing to make than a low-tension one, is also more profitable, and is a better advertisement; so that even if they were consulted, which they are not, they would not discourage high-tension work. A cable maker, in so far as he resells copper which he has recently bought, is a merchant and obtains only a merchant's profits; in so far, however, as he converts by means of his patent and secret processes, paper, jute, or rubber into an applied dielectric, he is a manufacturer, he takes certain risks and gives certain guarantees, but he obtains upon this material and labour the very much larger manufacturer's profits. Owing to the necessary subjection of the technical to the commercial side, we find the scientific manufacturer becoming submerged in the merchant who knows his markets for the valuable gutta-percha, rubber, lead, copper, and we find him biassed in favour of any good dielectric that will sell, and that will enable him to continue his profitable dealings in these goods, rather than turn his attention to the riskier channels of new dielectrics. He does not only object because the dielectrics are new; the merchant in him objects to the fact that he is not acquainted with the markets in which the new materials in question will have to be bought. As things are, he is right. He is assured of the permanency of the cable demand, and his fetish is a

* Abstract of a Paper read before the Institution of Electrical Engineers, March 7.

† Last year's total cable produce in the United States is reported to be 15,000,000dols. (*Western Electrician* century number.)

large turnover. Truly, where there is a large turnover there will be good profits. In confirmation, we have seen in recent years (through the garb of more than one prospectus which reveals the form it seeks to hide) how a cable maker's "goodwill" may fetch the sum of £10,000, £80,000, and £100,000. I think the public are well advised to buy, even where there is included in the goodwill item a job stock of provisional rights and assorted patents of doubtful "fighting" value. The investor is justified by the permanency of the demand.

It is partly because the profits are great that the intelligence department does not strain forward. It is nothing to the commercial manager that all electric manifestations are essentially phenomena of the dielectric, or that in learning how to fill the intermolecular spaces of an oil with another oil, or a gum, or a powder, in linking constituents together or grading them to withstand disruptive stress, or in building up with design a substance of known dielectric constant, we cannot help tackling, and probably solving, many problems of enormous scientific interest. This does not mean that manufacturers have not done, particularly at the inception of each new undertaking, some splendid work; but cables cannot be thrashed out like arc lamps, or coherers, and few are the cable makers who have read Oliver Heaviside or struggled with Maxwell.

The sources of expert information on the subject are very few outside the circle of manufacturers, each with his own ship to steer, and necessarily preoccupied if not biassed by that employment. Price lists still provide somewhat misleading schedules which show an increase of about 20 per cent. in price to correspond to a large though almost useless gain in the measured megohms per mile, whereas whatever superiority there may be in a dearer quality of rubber, for example, is entirely dependent on the good faith of the maker, and is usually unverified by the purchaser, however scrupulously he exacts his extra megohms. Those who are ignorant on the subject must rely on the well-established makers' reputation to the detriment of new firms, however good their product and however much cheaper it may be. Within certain limits of price this is prudence, beyond these limits it is bad engineering, because there enters into the definition of "engineering" a word often omitted in academic books, the word "cheaply"—cheaply to apply the forces of Nature to the service of man. For example, when insulators other than rubber were first brought in, it was noticeable that new firms, whose guarantors were good, were sometimes passed by in spite of a difference of some thousand pounds in their favour; this difference, other things being equal,* is a measure of our deficiency of knowledge. Such things occur even now, and there still exists the rubber bigot and the paper bigot. Details of manufacture are not our only weak point, *e.g.*, it is only two years since the discovery was announced by Steinmetz† that the disruptive effect of a sinusoid alternating voltage on heavy oils is greater than that of peaky volt surgings from an induction coil, or high-frequency oscillations. Should not this have been known many years ago!

There is a work wanted in the electrical world on the lines of Prof. Unwin's "Strength of Materials." When this exists we shall be more secure in throwing a stone at the "factor of safety" of civil engineers by calling it a mere "factor of ignorance" without fear of *tu quoque* in the matter of dielectrics, where we freely use factors of 20 or more.

Kapp, 15 years ago, foresaw a future for lead-covered cables in low-tension work, but owing to the high capacity shown by Marcel Deprez's 45 miles of experimental cable, Kapp concluded that "with the high pressure employed the lead covering of the cable acted as an enormous condenser and gave rise to heavy electrostatic induction. Lead-covered cables would only be applicable for currents of low E.M.F." He was not considering the all-compelling element of cost; dear rubber and cheap mineral products have turned the tables nowadays, and for 20,000 volts most engineers would consider rubber out of the question for any but short wires.

*Degrading Rubber.*—The first step of the rubber-cable makers in compounding down their material was a step in the right direction, a step in the direction of experimental research which, in those days, was probably as valuable to the life of the electrical industry as the invention of the glow lamp. Nevertheless, that research was sometimes, and I believe is even at present often conducted in an unscientific way; otherwise the cable people who were the first in the field would never have let the industry slip so largely from them to the advantage of separate makers of the lead-covered and bitumen systems. There are many stories of how an individual foreman in the mixing shop used to discover by persistent minute modifications a recipe which succeeded, and which he hid from his mates and his employer, revealing just enough to show that he had now become indispensable. An intelligent foreman himself told me that his payment was based on his producing cables at a reduced cost; he got half the reduction, whatever it was, on a certain schedule of prices: that foreman might mix how he liked so long as he passed the tests and the cables were sold. In three years he made such a good thing of it, that he, a workman, refused to compound and cancel his agreement for £600 a year, and he could not be got rid of.

This system of secret recipes may be unavoidable, but is, I think, a bad one for the industry, because instead of producing a school of scientific chemists learned in the art and selling their skill at a fair price, each progressing from where the other left off, the mixing foreman in any factory is prone to go independently over the old ground and make the same errors at the expense of, sometimes the purchaser and sometimes his employers. Several large companies employ expert analytical chemists versed in the matter of rubbers, but even these have too many heterogeneous duties to conduct a really productive research in an extremely difficult subject.

When too much loading is given to any rubber to hold, the rubber leaves go before very long, as is well known in the case of cheap garden hose. If such an excess as this is not reached there is still a danger that the rubber may fail to entirely envelop the extraneous particles. The mixture then attains a quasi-hygroscopic quality which can only be detected electrically after a protracted immersion of a fortnight or a month. In this case the insulation resistance, which is often very high initially, steadily falls, while the specific capacity goes up. The test is easy to make in theory, but as cable is always wanted in a hurry and the maker is by no means disposed to cumber his tanks with a fortnight's produce (the tanks would have to be as big as his factory, and he says so in plain words) this test is hardly ever made.

*Hygroscopic Material in Metal Tubes.*—The value of this development, which we owe to the search for cheapness, need not be enlarged on. The relative prices of rubber and of such hygroscopic materials are somewhat as follows:—

| | £ per ton |
|---|---|
| Para rubber | 400 |
| Congo rubber (balls) | 300 |
| Celluloid | 200 |
| Amber grease M.P. 105°F. | 26 |
| Hard grease M.P. 114-116°F. | 33 |
| Refined special cotton oil | 16·25 |
| Oxidised cotton oil (nearly solid) | 26 |
| Thick resin oil | 11·25 |
| Ordinary resin oil | 6 |
| Resin | 6 |
| Mineral oil | 4·5 |
| Pitch......from £40 to | 2·25 |
| Trinidad bitumen | — |
| Stearine pitch (flexible) | 5·15 |
| Castor oil | — |

These hydrocarbons other than rubber are mostly supported on fibrous bases which themselves vary largely in price, and have different advantages, dependent on their cellular construction. Thus:—

| | |
|---|---|
| Good cotton (Egyptian) free from sheive | 7d. per pound. |
| Good linen yarn, unbleached | 7d. ,, |
| Fine manilla paper | 5d. ,, |
| Good fine jute, free from dirt and sheive | 3d. ,, |
| Wood paper | 1¾d. ,, |

*Permanency.*—Of these the best are unsized manilla paper and fine jute, because they possess some at least of the essential qualities of a cable dielectric, first among which is permanency. Whatever are the faults of permanent substances, we can know them and provide against them. Their capacity does not suddenly go up, or their insulation down. Permanency is always difficult to prove, and is always claimed for new compounds. I need hardly say it is very rarely found. Many of us have made dielectrics excellent in most respects, but which developed, in the course of a year, crystalline structure which, on bending the cable, fell to powder. This is a common and more dangerous fault than is generally realised, and is often forgotten when a perfectly sound cable is withdrawn after a few years from one site and re-laid in another.

*Dielectric.*—The object of the insulation is to insulate, but high megohms per mile of cable are important only in feeders to facilitate fault finding, and unimportant in distributor cables and house wires where there are many terminals. The number of probable terminals per mile of distributor or "points" per mile of house wire, settles the useful insulation by giving a measure of the weakest link in the chain. If the allowable leakage at any exposed point, say on a porcelain block, were measured by 10 megohms, the leakage of the cable connecting these points might be measured by about 10 megohms also, and we are thereby led to tolerate in practice a cable test of, say, 1 megohm per mile for house wires and distributors. Such wires would be quite satisfactory when a consumer's premises are supplied by a separate transformer. Ten times this might be required when the supply comes from a low-tension network; but even there the insulation need not be so good when there are only small local networks supplied by small sub-stations which are not interconnected.* The advantage of getting such a low test admitted verbally as well as tacitly, is that

* Of course, "other things" very rarely are equal.

† Quoting from a Paper by Northrup and Pierce, *Electrical World*, Nov. 6, 1897.

* C. H. Wordingham points out this difference in the M.E.A. 1896 *Proceedings*.

it throws open to research, and later, perhaps, to practical use, a large number of otherwise impossible substances, such as celluloid, low-grade acid-free pitch, clay, perhaps, even, some such chemical treatment as case hardening on iron conductors, rust, oxide on aluminium conductors, &c. A further advantage of low insulation is that it diminishes the probability of high oscillating pressures when metallic switches are opened (as beautifully illustrated by Mr. Duddell recently), owing to the condenser being always shunted by a fairly low resistance.

Although there has been a feeling that the dielectrics of cables give lower tests under high pressures, there is some doubt as to the truth of this. It would seem that the lower tests are due to increased leakages at the ends, for experiments on dielectric liquids have shown that they obey Ohm's law, and that their specific resistance does not vary with the E.M.F. nor with the area of the opposed electrodes.* A high E.M.F. would be useful in testing, however, by tending to decompose with sufficient rapidity for detection any water in the dielectric which might escape notice with lower voltage. Ohm's law, though not true for gutta, can probably be extended to plastic substances like bitumen, but no definite experimental data exist as far as I know for solids like paper and jute, with which there are great difficulties in experimenting, partly from the uncertainty as to the absence of water and the variations of chemical composition, and partly because it is not easy to say what the thickness of a piece of paper is.

In the case of feeders, especially for high-tension, the utility of being able to make a simple loop test to localise a high resistance fault without making allowances for the resultant of the normal leakage is good enough reason for using a high specific insulation. This property is, at least in the case of paper, resin, resin oil, and I believe also in the case of bitumen and rubber, not only not coincident with high specific disruptive strength, but is to some extent inversely as the strength. This, of course, is a reason in favour of allowing moderate megohms even on feeders.

As the price of cable depends upon its overall diameter to an extent not usually realised, every effort must be made to find substances of which very thin films give a high puncture resistance. If these could be got, we might be tempted to neglect the megohms on feeders as well as on distributors. As an example: The economy if the B.I.W. Co's Deptford main could have had a "radial" of 0·3in. instead of 0·5 in., and if the Board of Trade had waived the rule requiring $\frac{1}{10}$th of an inch per 2,000 volts, would have been some hundreds of pounds.† On the other hand, the megohms would have been less, not in proportion, but according perhaps to an inverse log law, except in the unlikely event of the new substance possessing both insulation and disruptive strength in a proportionate degree.

*Electrolytes at High Voltages.*—Moreover, if we accept the electrolytic theory of dissociation, we find that absolute insulation will not protect us against decomposition by electrostatic attraction of the ions if an electrolyte is on either side of the supposed absolute insulator. Nernst‡ and Ostwald have made the experiment under the microscope, and it is well to be on the safe side and adopt their conclusion that it also occurs in a degree at all practical voltages, however small. Further, as cations and anions travel at different velocities, we have no certainty, where any electrolyte is present within the pores of a perfect insulator, that even an alternating current at ordinary frequencies is a full security against decomposition.§ If this consideration is of any importance we must avoid electrolytes, that is, acids, bases and salts, and confine our dielectrics to chemically inactive organic compounds, or non-electrolytes, whose class distinction is: (i) Non-conductivity, and (ii) that they exert a normal osmotic pressure (that is, in accordance with the law $PV/T = iR$).

I think that rubber makers sin in this particular way by using electrolyte salts in their compounding. Mr. Alexander Siemens, himself a large maker of rubber cables, made the following pronouncement before the M.E.A. in 1896:—"His firm had long ago come to the conclusion that rubber cables, unless lead-covered, were no good., They were absolutely certain to lose their insulation, especially in places where they were alternately wet and dry." Mr. O. Schaefer, of the Duisburg Cable Co., also prefers not to guarantee any rubber not lead-covered. This absence of acids, &c., has never yet been entirely secured, as far as I know. On the other hand, Prof. Kennedy gave evidence in 1898 before the Joint Committee on "Electric Energy" to the effect that modern mains might be relied on for 30 years; and, as large numbers of modern mains contain electrolytes, this is testimony to the slowness of the action in question, at all events at modern relatively low voltages. The amount of the presumable increase of what might be called electrostatic depreciation, including the formation of ozone, &c., at very high pressures, is, as far as I am aware, unknown up to the present, and must be risked, unless some of the great power companies choose to pay for having this and many other important matters scientifically investigated before buying their cables, for there is no doubt that the present fashion of shirking voltages above 10,000 maximum must pass away if we are to make serious progress in long-distance work.

*Volt-Resistance.*—Such a research would incidentally explain a surprising fact about our high-tension cables, namely, the large thickness of dielectric required compared to the actual strength of the materials employed. A single strip of pure dry manilla paper, weighing 70 grammes per square metre and about 0·003in. thick, will resist 1,000 volts maximum (for weeks, and I think indefinitely) when tightly wrapped on a length of small wire and tightly lead-covered; four such papers impregnated with resin and resin oil will sometimes resist as much as 12,000 volts alternating on a length of cable; and yet 20 such papers, making a thickness as 0·06in. (an ordinary low-tension radial depth), cannot by any means be expected to withstand 50,000 volts on long lengths, though on a yard length of 7/16, say, they frequently will. A suggested reason for the superior strength of the short piece is that in a 100yd. length the probability of a streak of dirt or moisture, or of metallic particles, or of the oil having been crushed out of the paper in bending the cable, or of a bubble or vacuous space, or of an irregularity in the dielectric capacity, is one hundred times greater than in the 1yd. length. Indeed, except to verify the mechanical effect of severe bending, any high-pressure test on a *short* length of cable proves nothing whatever about the bulk.

Similarly, a test for disruptive strength on small thicknesses proves nothing about a large thickness of the same material, because a diminishing dielectric strength with increasing thickness is apparently inherent in most insulators, unless we allow that the experimenters whose results are available have made errors of remarkable similarity. I think Prof. Perry would ascribe part of the apparent extra strength of small thicknesses to the preponderance of skin-resistance when the total resistance is small. The weakness of the larger thicknesses might also be partly ascribed to the fact that when the electrodes are no longer very large compared to the spark-gap, the stress lines will no longer be uniform, and the potential gradient will at some part of the insulation be greater than is given by the total voltage divided by the total distance between electrodes. There is also the extra likelihood of impurities.

*Bubbles.*—Not only must the mechanical formation of the smallest bubble be avoided in cable manufacture, but their electrical production must be guarded against. The insulation of a cable between concentric conductors or under the lead differs greatly from the slabs of the substance to which inventors are always so happy to apply high voltages by means of a couple of brass balls or plates. The brass ball test is worthless. *The* way to test a dielectric is on a length of cable. The area of surface of insulator under strain in a length of cable is enormously greater than in the case of a slab; the contact between metal and dielectric is more thorough, the curve of stress is totally different, the cable material will necessarily have to be bent about and handled, and, most important, the average value of the insulator, bubbles and all, is tried, instead of a single selected square decimetre. Bubbles are a great enemy of permanency, and tend to loss of energy. If we refer to Berthelot's experiments* (*Science Abstracts*, 1,050, Vol. II.) on layers of dielectrics subjected to a high alternating E.M.F., we shall see that large numbers of substances are either polymerised under the treatment, or give off bubbles of hydrogen or water.†

The reason for objecting to bubbles is not usually appreciated: not only does the possibility of a single bubble increase the thickness of the dielectric throughout and thus add to the cost of the cable, but even the increased thickness is not as effective as the thinner

* Nicuari, *N. Cimento*, 8. 4, pp. 259 260, 1896. The accident by which Ohm's law does not hold with gutta percha, paraffin and sulphur probably gave rise to the original impression that no insulator obeys it. For example, thin gutta shows less insulation resistance (specific) than thick, and is also less insulating when measured with higher current densities.

† As a matter of fact, they did gain some hundred pound's worth of lead and insulation by the use of sector-shaped copper on the outer conductors. This will be separately considered under "Conductors," loss in stranding, &c.

‡ *Zeitschr. Phys. Chem.*, 3, p. 271, 1888.

§ This consideration is not altered by Carmichael and Swyngedauw's experiments, which, in so far as their results were negative, only show that a circuit, if composed entirely of electrolytes, is not decomposed. Thus they made a transformer with an electrolyte secondary: they also formed a closed circuit of electrolytes, the contacts between which gave rise to an E.M.F., and observed no decomposition (*Comptes Rendus*, 131, p. 375, Aug. 1900).

* *Annal. Chim. Phys* 16, pp. 5 80, 1899.

† Thus olive oil is polymerised in 24 hours; alcohol gives off hydrogen and ethane; the ethylene series is polymerised, loses hydrogen and approaches the camphene series; formenes are converted into ethylenes. The fatty alcohols will absorb nitrogen, if present, from amidines and give off hydrogen. Some of the particular substances here mentioned are interesting because their reactions tend to preclude the use of that most promising modern material, celluloid, in the solution and treatment of which they are used. Berthelot used induction-coil currents, which, as before stated, are less severe than sinusoid currents in puncturing if not in chemical effect. However, high-frequency currents probably occur on every system, direct and alternating.

dielectric if the insulator were continuous. This inefficiency of the thicker material (unless the increased thickness is equal to the diameter of the bubble) is shown by an experiment which is perhaps not as well known as it deserves to be:—If we arrange two conductors, A, C, at such a distance apart that the air is just able to withstand for an indefinite time, say, 10,000 volts maintained by a transformer, and then introduce between them a strip or two of glass or ebonite, D, B, the insulation breaks down, although the glass is a more volt-resisting substance than an equal thickness of air. This experiment was shown by Tesla, and taken by him to show that ebonite was a less resisting substance than commonly supposed. The explanation, however, is very different and quite simple: the rate of fall of volts per centimetre of air is the highest the air can withstand; as glass has a higher specific capacity the potential gradient in the glass is less steep than in the air, and the consequent increased steepness in DB punctures the air; and the heated glass thereupon soon gets hot and gives way under the alternating potentials.*

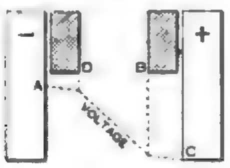


FIG. 1.

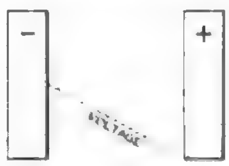


FIG. 2.

*Uniformity of Texture.*—This experiment leads up to the idea of uniformity of texture in all classes of insulating materials which are built up in successive thin layers, especially when the layers as in paper cables may not be closely compacted together for fear of losing flexibility, or when the layers as in rubber cables have (to economise the more expensive insulators or to separate the copper from sulphur) to be composed of dissimilar compounds. With our present methods of manufacture it would seem that security is got in the one case by seeing that the impregnating oil has approximately the same specific capacity as the paper fibre, and avoiding crumpled paper—not a difficult matter; and in the other by avoiding too great a difference between the compositions of the coats.

It is usual to make rubber cables with the better grade material next to the pure rubber (this can be tested any day by stretching the insulation of a cable till it breaks, the outer coat always gives way first), because a higher test is got in this way with less of the high-grade

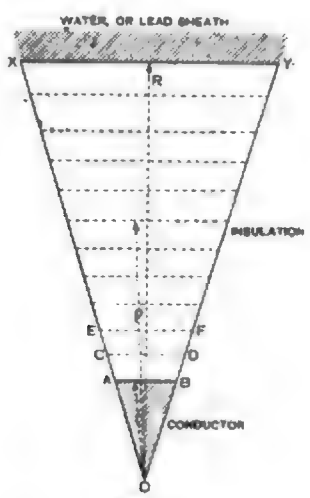


FIG. 3.

material; but unless the specific capacity of the high and low grade is properly adjusted or made to be the same, which it usually is *not*, the disruptive strength of the finished cable will suffer under alternating pressures.

"*Grading.*"—I suggest this name for a method of adjusting the specific capacity, dielectric strength and conductivity of the covering of a cable so that the materials composing it occupy the best possible positions, whether for resisting puncture or diminishing the energy loss in the insulation. This is to be done by departing from the strict homogeneity above recommended for cables as hitherto manufactured. Let us consider what happens in a cable dielectric where there is a difference between the potential of the core and that of the lead sheath. The insulator and conductor may be supposed made up of layers of equal thickness as in a paper-covered cable, and these may be developed as in Fig. 3, in which the vertical scale has been purposely exaggerated to show the thickness of the layers.

Let the length of the horizontal line AB equal the circumference of the conductor of radius $r$.

Let the length of the horizontal line XY equal the circumference of the insulation of radius R.

Let the perpendicular distance between lines AB and XY equal the thickness of the insulation.

Let the perpendicular distance between the line AB and O equal the radius of the copper.

Then, if the conductor is raised to 14,140 volts and XY remains at zero volts, there will be a current through the dielectric from AB to XY, and the fall of volts from AB to XY, which is 14,140, will in each layer be proportional to the resistance of that layer in ohms.* That is, it will be proportional to the length of the lines AB, CD, &c., to XY, which are inversely as $\rho$, where $\rho$ is the distance of any layer from O.

*37/14 Cable at 10,000 R.M.S. Volts.*

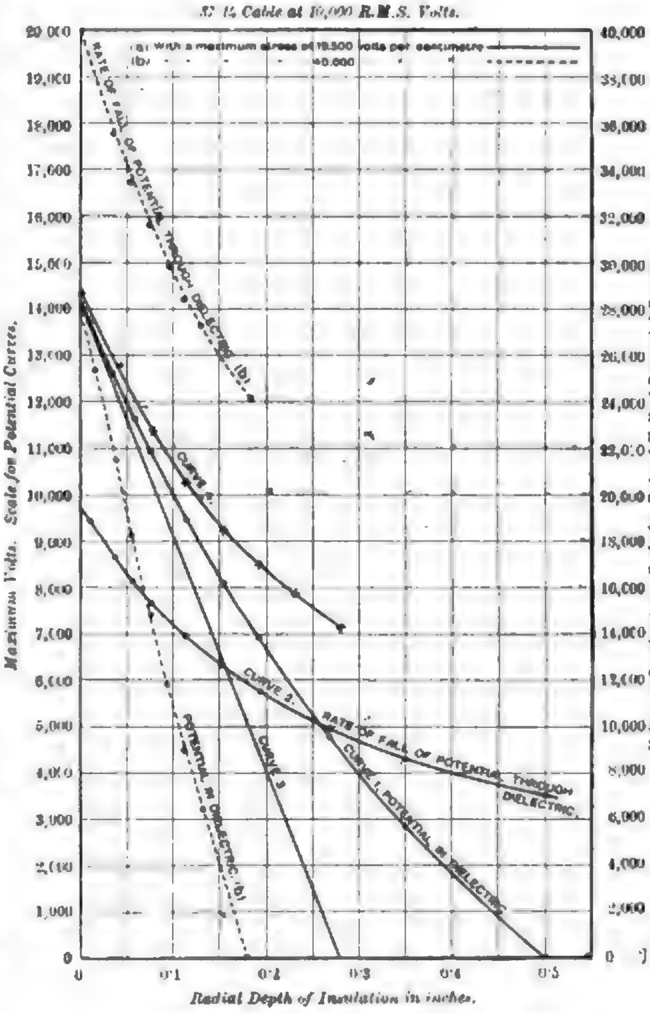


FIG. 4.

Drawing the curve of potential in the dielectric from this law† for a 37/14 with half an inch of insulation, we get Fig. 4, curve 1. The steepness of this curve or its gradient at any distance from the core is measured by the angle the tangent makes with the horizontal, and in Fig. 4, curve 2, the length of each ordinate represents this steepness.

When the fall of volts across an element of thickness is great, the disruptive stress is proportionally great,‡ and therefore Fig. 4, curve 2, shows what stress a uniform dielectric, on a cable under continuous pressure, is subjected to throughout its thickness (*i.e.*, between $r$ and R of Fig. 3). This stress is greater nearer the conductor, and diminishes from the conductor outwards.

* Fessenden's particulars of this experiment are, I think, erroneous.

* I have suggested on page 6 how far Ohm's law may be justly applied to insulators (see Naccari, *N. Cimento*, 8 4, pp. 259-260).

† The equation to this curve is No. 6 on page 14, where Vo = 14,140 volts.

‡ Not only does Maxwell appear to be satisfied as to this proportionality, but I think experimental evidence (Lombardi, T. Gray, and others) confirms it within the thickness of a continuous dielectric under strain.

If we wish to increase the working pressure without exceeding this stress, which (if the cable is properly designed) should be no more and no less than the maximum safely allowed by the specific strength of commercial insulation as used, it is at present usual to add more layers of insulation outside layer XY. This, however, is exceedingly expensive, because from the nature of the curve of gradients the depth and cost of insulation increases very much more rapidly than the voltage. Thus, in the example used for the curves of Fig. 4—

A 37/14 at 10,000 R.M.S. volts takes ½in. of insulation ;*
A 37/14 at 20,000 R.M.S. volts takes 1·89in. of insulation ;
A 37/14 at 30,000 R.M.S. volts takes 5·3in. of insulation ;

whereas there are three ways, none of which have, as far as I am aware, been suggested before for negotiating the steepest gradient while making no increase in the insulation thickness beyond that of direct proportionality between the thickness and voltage used.

The first method is obvious : It is to make the dielectric strength of the insulation in each layer proportional to the stress (or voltage gradient) in that layer. This may be done by multiplying the number of layers so as to utilise skin resistance or by using special materials, for the inner or highly stressed layers, of high strength like mica, gutta percha, &c. Only a small improvement is possible in this way, because many makers already employ for the whole of their insulation the strongest material that combines the various qualities of economy, flexibility, permanency, &c., while many others —for example, the rubber cable makers—are compelled by other considerations to put some such substance as pure rubber, which is not their strongest dielectric, into the position of greatest strain.

It is true that makers have sometimes tried introducing in the covering of a cable a layer of extra strong and proportionately expensive material, with a view to diminishing the diameter and total cost of insulation, but the attempt has generally been abandoned because the results were either inadequate or irregular. The inadequacy may be ascribed to the strong dielectric layer being usually put in some place other than where the potential gradient is steepest. The irregularity of the results is probably due to the alteration of the position of the steepest gradient by the unnoticed effect of the specific conductivity or the specific capacity of the "strong layer" displacing the strain from itself on to the surrounding weaker dielectric. The experiment of Figs. 1 and 2 gives an interesting example of the danger of introducing a "strong layer" without having regard to the effect of capacity on the gradient. The second and third methods of diminishing the thickness of insulation consist in utilising these apparently objectionable qualities of conductivity and specific inductive capacity, and adjusting or grading them in each layer of the covering of the cable.

*The Conductivity Method.*—By referring to Fig. 3, if we make the specific conductivity of the inner layers of the insulation greater than the average, the difference of voltage between the two sides of each of these layers will thereby be reduced. In fact we may so adjust the specific conductivity of all the layers that the fall of potential in each of them is a minimum and is uniform. If 20,000 volts to the centimetre may be assumed to be the maximum safe gradient in the particular material under consideration, the curve of voltage (which now becomes a straight line) is shown in Fig. 4, curve 3, the stress is uniform throughout, and is a straight horizontal line, no portion of the dielectric is more idle than another, and the total thickness of dielectric required is 0·275in., instead of 0·5in. We shall now find that a

| | | | | |
|---|---|---|---|---|
| 37/14 at | 14,140 | volts (continuous) | only requires | 0·275in. |
| ditto | 28,280 | ditto | ditto | 0·550in. |
| ditto | 42,420 | ditto | ditto | 0·825in. |

The means for obtaining this result are simple. The exact specific conductivity to be given to each layer bears a direct proportion to the ordinate of the curve of gradient plotted, as shown in curve 4, Fig. 4. This curve is in every respect similar to curve 2, Fig. 4, save that the radial depth of dielectric for which it is calculated is reduced from 0·5in. to 0·275in.

If the insulation of the cable is paper and resin oil, the conductivity of the inner layers is easily lowered 50 or 100 per cent., as required by the curve of gradients, by adding to the impregnating fluid used on the layers a very small percentage of linseed oil, which has no appreciable effect on the disruptive strength and is too small in quantity to effect any practical alteration in the specific capacity of the layers "graded" by its use thus

| No. of layer. | Thickness. | Per cent. of linseed. oil added. |
|---|---|---|
| 1st outside ...... | 0·08 n. ...... | 0 |
| 2nd next ...... | 0·05in ...... | 0·0012 |
| 3rd do. ...... | 0·05in. ...... | 0·0023 |
| 4th do. ...... | 0·05in. ...... | 0·0042 |
| 5th inside ...... | 0·05in. ...... | 0·0085 |

This method loses value (1) because of the large effect of small impurities ; (2) because of the temperature co-efficients of the oils.

(*To be continued.*)

* Chosen because this is the size and voltage of the Deptford main.

## ELECTRICITY WORKS ACCOUNTS.

### Charing Cross & Strand Electricity Supply Corporation (Ltd.).

The rise in the generating costs of supply by this undertaking last year, although regrettable, is perhaps hardly as much as might have been expected in the circumstances. Notwithstanding the embarrassment and dislocation of the system caused by the fire at the Maiden-lane station in March last year, had it not been for the greatly increased expenditure on fuel the costs would have been considerably diminished. Thus the only item of magnitude in the costs column of our analysis which shows an increase is that of fuel, and this shows a rise of no less than 0·38d. per unit as compared with the 1899 figure. From the directors' report we understand that the price paid for coal was nearly 30 per cent. over the price in 1899, thus the higher price paid for fuel was mainly, if not wholly, the cause of the increased costs. Even considering the favourable combination of an output of nearly 5,000,000 units in the year with a load factor of 18·7 per cent., the total costs at their higher figure are by no means abnormal, while the management and property charges are very low.

The year's output exceeded that of the preceding year by over 29 per cent., and at the moderate average total price of not quite 4·2d. per unit resulted in a working profit of £37,517, representing 6·77 per cent. on the mean capital expended. Out of this amount £8,000 was carried to the depreciation fund, and £1,021 paid in interest, the remainder affording again an ordinary dividend of 9 per cent.

The loss occasioned by the fire is being written off the share premium account.

During the year 22 miles of mains were laid in the West End areas and 27 miles in the City area, raising the total length to 174 miles. The Lambeth station site is now fully occupied and equipped, and motor generators to the capacity of 1,500 kw., and batteries to 400 kw., have been installed in the sub-station at Short's Gardens. Another sub-station, and also offices, are being erected in St. Martin's-lane.

For the supply of the City area motor generators and batteries are being installed at the Ludgate Hill sub-station, from which supply is already being given, while another sub-station is in course of erection at Fenchurch-street. Of the equivalent of 39,431 additional 8 c.p. lamps connected during the year, the equivalent of 36,004 were in the western areas, and 3,427 in the City area.

### Brompton and Kensington Electricity Supply Co. (Ltd.).

This company's accounts for last year, like those of the Charing Cross Company, show that the high coal prices have been bearing heavily on supply undertakings generally. At Brompton last year the fuel item was 0·126d. per unit higher than in 1899, and although substantial economies were effected in the wages item and in the management and property charges, they were insufficient to prevent a slight rise in the aggregate costs. The figure of 2·38d. for total costs is, however, a most satisfactory one with the load-factor of 13 per cent. and the output of 1,494,106 units.

Notwithstanding, however, that they have been both reduced, the wages at the station and the collective management and property charges are still too high.

The year's lamp connections increased the total by 14·4 per cent., while the year's output was higher by 20·4 per cent. than that of 1899.

The following table shows the progress made since 1889 :—

| Year. | No. of consumers. | Equiv. l'mp connections. | Output. | Plant capacity. Kw. | Max. demand. Kw. | Total revenue. | Working profit. |
|---|---|---|---|---|---|---|---|
| 1889 | 78 | 4,520 | ... | ... | ... | ... | ... |
| 1890 | 248 | 13,665 | ... | 300 | ... | £5,010 | £386 |
| 1891 | 373 | 19,388 | 247,861 | 300 | 260 | 8,328 | 2,250 |
| 1892 | 471 | 23,700 | 313,494 | 450 | 3[illegible]6 | 10,689 | 2,837 |
| 1893 | 599 | 28,429 | 358,526 | 550 | 354 | 12,054 | 4,231 |
| 1894 | 755 | 35,858 | 400,911 | 550 | 410 | 13,636 | 6,263 |
| 1895 | 932 | 44,162 | 476,714 | 950 | 520 | 15,395 | 6,811 |
| 1896 | 1,164 | 55,265 | 643,693 | 1,325 | 658 | 17,442 | 9,032 |
| 1897 | 1,416 | 66,364 | 811,255 | 1,410 | 804 | 20,811 | 12,033 |
| 1898 | 1,777 | 80,301 | 974,618 | 1,460 | 917 | 24,907 | 14,066 |
| 1899 | 2,112 | 96,303 | 1,241,369 | 1,810 | 1,105 | 30,417 | 18,181 |
| 1900 | 2,396 | 108,978 | 1,494,106 | 2,160 | 1,307 | 35,125 | 21,324 |

| | CHARING CROSS. | BROMPTON AND KENSINGTON. |
|---|---|---|
| *Undertaking Worked by* | The Charing and Strand Electricity Supply Corporation, Ltd. | The Brompton & Kensington Elec. Supply Co. Ltd. |
| *Date of Commencement of Supply* | 1890. | January, 1889. |
| *System of Supply* | Three wire continuous-current. | Alt.-curr. trans. feeding low-pressure network. |
| *Chief Engineer* | W. H. Patchell. | H. W. Bowden. |

| YEAR ENDED | Charing Cross DEC. 31, **1899.** | | Charing Cross DEC. 31, **1900.** | | Brompton and Kensington DEC. 31, **1899.** | | Brompton and Kensington DEC. 31, **1900.** | |
|---|---|---|---|---|---|---|---|---|
| **QUANTITIES—** | | | | | | | | |
| Units generated | 4,788,498 | | 6,572,739 | | — | | — | |
| „ SOLD (TOTAL) | 3,862,128 | | 4,997,181 | | 1,241,369 | | 1,494,106 | |
| „ sold to consumers | 3,837,449 | | 4,857,260 | | — | | — | |
| „ sold for public lighting, &c. | 24,679 | | 139,921 | | — | | — | |
| „ used on works | 903,142 | | 1,564,582 | | — | | — | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 34·2 | | [illegible] | | 21·9 | | 22·3 | |
| Maximum supply demanded | 2,512 kilowatts | | 3,049 kilowatts | | 1,105 kilowatts | | 1,307 kilowatts | |
| Number of public lamps | 13 arc | | 113 arc | | 7 arc, 14 (32 c.p.) glow | | 7 arc, 14 (32 c.p.) glow | |
| Number of consumers | 1,150 | | — | | 2,122 | | 2,395 | |
| Connections to mains in 8-c.p. lamps | 182,689 | | 222,120 | | 95,303 | | 108,978 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 113,000 | | 153,000 | | 56,600 | | 67,500 | |
| CAPACITY OF PLANT IN KILOWATTS | [illegible] | | 4,900 | | 1,810 | | 2,160 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | £500,000 | [illegible] | £1,133,333 | [illegible] | £249,500 | £138 | £249,500 | £116 |
| Share | 350,000 | 96·9 | 800,000 | [illegible] | 199,500 | 110 | 199,500 | 92·3 |
| Loan (including Debenture charges) | 150,000 | 41·5 | 333,333 | 68·0 | 50,000 | 27·6 | 50,000 | 23·1 |
| RECEIVED (TOTAL) | 374,200 | 104 | 510,700 | 104 | 208,305 | 115 | 208,305 | [illegible] |
| Share | 350,000 | 96·9 | 500,000 | 102 | 158,305 | 87·4 | 158,305 | 73·3 |
| Loan (including Debenture charges) | 24,200 | 6·70 | 10,700 | 2·18 | 50,000 | 27·6 | 50,000 | 23·1 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | 125,800 | [illegible] | [illegible] | 127 | 41,195 | 22·8 | 41,195 | 19·1 |
| Share (unissued) | nil | — | 300,000 | 61·2 | 41,195 | 22·8 | 41,195 | 19·1 |
| Share (uncalled) | nil | — | — | — | — | — | nil | — |
| Loan (including Debentures) | 125,800 | 34·8 | 322,633 | 65·8 | — | — | nil | — |
| REPAID (TOTAL) | — | — | — | — | — | — | — | — |
| RESERVE OR SINKING FUND | 24,267[a] | 6·72 | 40,000[g] | 8·17 | — | — | — | — |
| DEPRECIATION FUND | 28,000 | 7·76 | 36,000 | 7·35 | 11,500 | 6·35 | 17,500 | 8·10 |
| EXPENDED (TOTAL) | 498,174 | [illegible] | 609,830 | 124 | 186,212 | [illegible] | 207,701 | 96·1 |
| Lands and buildings | 181,567[b] | 50·3 | 212,941[b] | 43·5 | 20,294 | 11·2 | 21,754 | 10·1 |
| Plant | 147,172 | 40·8 | 214,411 | 43·8 | 94,404 | 52·2 | 110,026[d] | 50·9 |
| Mains | 162,481 | 45·0 | 176,772 | 36·1 | 68,113 | 37·6 | 71,926 | 33·3 |
| Miscellaneous | 6,955 | 1·93 | 5,707 | 1·16 | 3,401 | 1·88 | 3,995 | 1·85 |
| BALANCE OF CAPITAL ACCOUNT | − 123,974[c] | − 34·3 | − 99,130[c] | − 20·2 | + 22,093 | + 12·2 | + 604 | 0·280 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £70,787 | 4·400d. | £87,099 | 4·184d. | £30,417 | 5·885d. | £36,125 | 5·804d. |
| Revenue from supply | 69,701 | 4·330d. | 84,200 | 4·048d. | 28,912 | 5·595d. | 34,458 | 5·539d. |
| „ meters, &c. | 994 | 0·062d. | 1,260 | 0·061d. | 1,491 | 0·288d. | 1,659 | 0·267d. |
| „ public lighting | — | — | 1,464 | 0·070d. | — | — | — | — |
| „ sale of lamps, &c. | — | — | — | — | — | — | — | — |
| „ miscellaneous sources | 92 | 0·006d. | 175 | 0·003d. | 13 | 0·003d. | 9 | 0·001d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £35,109 | 2·182d. | £49,582 | 2·383d. | £12,237 | 2·368d. | £14,801 | 2·378d. |
| WORKS COSTS | 27,722 | 1·723d. | 41,495 | 1·993d. | 7,689 | 1·487d. | 9,866 | 1·586d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 13,766 | 0·856d. | 25,718 | 1·236d. | 3,648 | 0·706d. | 5,176 | 0·832d. |
| Oil, waste, water, stores | 929 | 0·058d. | 1,553 | 0·075d. | 434 | 0·034d. | 450 | 0·072d. |
| Wages at station | 5,616 | 0·349d. | 5,927 | 0·285d. | 2,645 | 0·512d. | 3,058 | 0·492d. |
| Repairs and maintenance at station | 4,221 | 0·262d. | 4,019 | 0·193d. | 513 | 0·099d. | 621 | 0·100d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible][h] | [illegible] | 448 | [illegible] | 562 | 0·090d. |
| Wages, &c. | 1,127 | 0·070d. | 1,145 | 0·055d. | 349 | 0·068d. | 487 | 0·078d. |
| Repairs, renewals of mains, &c. | 2,063 | 0·128d. | 1,982 | 0·095d. | 99 | 0·019d. | 75 | 0·012d. |
| *Public lighting* | — | — | 306 | 0·015d. | — | — | — | — |
| Attendance | — | — | — | — | — | — | — | — |
| Renewals | — | — | — | — | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 7,387 | 0·459d. | [illegible] | 0·388d. | 4,548 | 0·880d. | 4,935 | 0·793d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible][d] | 0·170d. | [illegible] | 0·162d. | [illegible] | 0·290d. | [illegible][e] | 0·295d. |
| *Management* | 4,657 | 0·289d. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0·498d. |
| Salaries | 3,514 | 0·219d. | 3,545[i] | 0·170d. | 1,988 | 0·385d. | 2,092 | 0·336d. |
| Stationery, &c. | 197 | 0·012d. | 243 | 0·012d. | 131 | 0·025d. | 163 | 0·026d. |
| Establishment charges | 400 | 0·025d. | 474 | 0·023d. | 300 | 0·058d. | 328 | 0·053d. |
| Law charges, &c. | 546[e] | 0·034d. | 458[j] | 0·022d. | 631[a] | 0·122d. | 519[f] | 0·083d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £35,678 | 7·86% | £37,517 | 6·77% | £18,181 | 10·0% | £21,324 | 10·8% |
| Sum carried to Depreciation Fund | 8,000 | 1·76% | 8,000 | 1·44% | 7,000 | 3·85% | 6,000 | 3·05% |
| Sum carried to Reserve or Sinking Fund | — | — | — | — | — | — | 3,000[g] | [illegible] |
| Net interest on loans (incl. Debenture charges) | 3,451 | 0·76% | 1,021 | 0·184% | 1,013 | 0·558% | [illegible] | 0·998% |
| BALANCE FROM LAST ACCOUNT | 3,292 | 0·725% | 4,542 | 0·820% | 159 | 0·088% | [illegible] | 0·116% |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 27,519 | 6·06% | 33,038 | 5·97% | 10,327 | 5·69% | 10,585 | 5·35% |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | 9% | — | 9% | — | 6 | — | 6 | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 49·6% | | 57% | | 40·2% | | 41% | |
| Expenditure per kilowatt capacity | £9. 14s. 0d. | | £10. 2s. 5d. | | £6. 15s. 2d. | | £6. 17s. 1d. | |
| REVENUE PER KILOWATT CAPACITY | £19. 10s. 10d. | | £17. 15s. 5d. | | £16. 16s. 0d. | | £16. 14s. 0d. | |
| Expenditure per 8-c.p. lamp capacity | 6s. 2½d. | | 6s. 5½d. | | 4s. 3½d. | | 4s. 4½d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 12s. 6½d. | | 11s. 4½d. | | 10s. 9d. | | 10s. 8½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 7s. 9d. | | 7s. 10d. | | 6s. 4½d. | | 6s. 7½d. | |
| Price charged for lighting, per unit | 6d. to 4d. | | 6d. to 4d.[f] | | 6d.[b] | | 6d.[b] | |
| Price charged for power, per unit | 4d. to 2d. | | 4d. to 2d.[f] | | 3d. | | 3d. | |
| Price charged for public lighting | — | | By contract | | 2½d. | | —[c] | |

CHARING CROSS.—REMARKS.—*a* Includes £19,267 balance reserve fund (capital) and £5,000 balance of leasehold depreciation fund. *b* Includes £[illegible] to purchase of generating station, mains, lands, buildings and acquisition of rights, including law charges in connection therewith. *c* Over-expended. *d* Includes insurances. *e* Includes auditing £150, law costs £[illegible] and accident compensation claims £131. *f* By discounts. *g* Inclusive of balances of reserve fund (capital) £[illegible] and of leasehold depreciation fund £[illegible]. *h* Inclusive of £545 wayleaves and licences. *i* Inclusive of directors' remuneration £1,050. *j* Includes law £277, auditing £155 and accident compensation claims £26.

BROMPTON AND KENSINGTON.—REMARKS.—*a* Includes auditing £53, law £112 and insurances £213. *b* With discounts. *c* By agreement. *d* Inclusive of £7,000 for patent rights. *e* Rates and taxes, £1,[illegible]. *f* Includes auditing £67, law £66 and insurances £263. *g* Paid in reduction of renewals suspense account.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,
1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON."

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## ELECTRIC LIGHT AND POWER CABLES.

Except for Sir WILLIAM PREECE's Paper "On the Specification of Insulated Conductors for Electric Lighting and other Purposes," in 1891, and the short supplementary Paper, "Oil as an Insulator," by the late Prof. HUGHES, until last week no Paper on cable manufacture had been read before the Institution of Electrical Engineers since the days when the only cable of interest to its members was the submarine telegraph cable. Yet, as has been repeatedly pointed out, and as was recalled once again in the discussion on Mr. O'GORMAN's Paper last week, the capital spent on cables for the distribution of electric light and power in this country probably exceeds the cost of dynamos, engines and boilers employed for the generation of electricity. Not only this, but another fact, which has also been reiterated, is that in an electric supply system the cables are the only important parts which are not duplicated, and they are hidden out of sight and not immediately accessible for repairs. Probably every apprentice at an electricity generating station knows, without hesitation, what to do in the event of the heating of a bearing or the burning-out of an armature. He has probably a fixed plan of operations which he would proceed to put into effect with the same precision and promptitude as if he had been drilled to it. After each run the engine and dynamo are overhauled, and the latter machine tested, each boiler undergoes a thorough inspection every few weeks, and switchboards are constantly under supervision. But how different is it in the case of the cable network! In many stations complete tests of the insulation are never taken at all. In others, tests, usually more or less rough and of little value, may be made daily or weekly, but as often as not no record of them is kept. In very few instances are systematic daily insulation measurements made and recorded. Then as to accidents. Not only is the apprentice, who knows his hot bearing and switchboard drill, ignorant of the methods to employ to locate a fault in the cable network, but frequently the engineer-in-chief himself is ignorant of the quickest manner in which a breakdown of this nature may be discovered and removed, and it will be very rare indeed that a definite programme has been mapped out to be acted on in case of emergency. How many charge engineers would be

able to answer the question if suddenly put to them: "What would you do if the fuse, say, of No. 8 feeder blew?" There are some, we believe, who in such a case would immediately dispatch a telegram to the manufacturer of the cable; and, at all events, if an earth were traced to the feeder itself there are many men in charge of electricity supply works who would prefer to wait the advent of an engineer from the cable manufacturer rather than rely on their own localisation test.

Mr. O'Gorman, a lengthy abstract of whose Paper is commenced in another column, does not refer much to the aspects of the mains question from this point of view, but addresses his remarks, not to cable users, but rather to cable manufacturers. He practically accuses them of not paying sufficient attention to design and scientific principles,—more than hinting, in fact, that they do not know enough about the properties of the material they are employing. He also suggests that a better and more efficient arrangement of the material at their command should be adopted, and the last part of his Paper, dealing with the calculation of the radial thickness of insulation, has a scientific as well as a practical value. The proposals to modify current ideas and practice as to the thickness of the insulating layer round the conductors of cables are fortunately, both in the case of "graded" and homogeneous dielectrics, capable of being submitted at once to the test of actual experiment. Useful results are bound to follow from Mr. O'Gorman's Paper, however, whether his anticipations are borne out on actual trial or not. Various fields of practical research suggest themselves, arising from the problems he discusses and the manner in which he discusses them. It was noticeable that the engineers attached to the cable manufacturing firms abstained from free comment on the technical parts of the Paper when it was discussed at the Institution, and this is to be regretted. Let us hope that they will realise that the open discussion of cable design should benefit the cable manufacturing industry as much as the discussion on dynamo design has benefited dynamo making, for an improvement in the quality or cost of electric light and power cables will be of advantage to the whole electrical industry. If alterations in cable practice are needed to meet the new development of this industry in the direction of large systems of wholesale electric power distribution, they must be made, not at the instigation of the consulting engineer, the dynamo maker, or even of the engineer whose task is to unite the various parts of such an undertaking into one harmonious whole. Nor can these alterations wait for a tentative relaxation of the Board of Trade regulations. The cable maker need not always confine himself to the manufacture of material to other peoples' specification. In this matter he must lead the way.

## THE SOLVAY ELECTROLYTIC ALKALI CELL.

BY JOHN B. C. KERSHAW, F.I.C.

In the issue of *The Electrician* for January 4 last, reference was made to the improved form of mercury cell which is being operated by Messrs. Solvay & Co., of Brussels, at Jemeppe, in Belgium, and by a subsidiary company at Donetz, in Russia. The works at Jemeppe were started in 1898, and they utilise 1,500 H.P. in the production of caustic alkalies and bleach, the combined output being estimated at 6,000 tons per annum. The works at Donetz will be completed early in the present year. They will utilise 1,500 H.P. and an output of 6,000 tons is expected. Both of these works are operated by steam power.

The following is a description of the principles and design of this new form of cell drawn from the French patent specification of March 5, 1898. The English patents protecting the same form of cell are Nos. 7,470 and 7,471 of 1898. The Solvay cell differs from the usual form of mercury cell in the absence of any mechanical movements for bringing about the desired circulation of the metal. Fig. 1 shows the cell in sectional elevation and Fig. 2 in sectional plan. It consists of a closed rectangular vessel A, constructed of any suitable material, provided at Z with an adjustable "bridge" or "weir." The bottom of the cell up to the level of this "weir" is covered with mercury, which is placed at R in electrical contact with the negative terminals of the dynamos, and thus functions as the cathode of the cell. The pipes O and P serve for supply and withdrawal of the mercury when the cell is at work.

The cell is charged with a fairly concentrated solution of sodium or potassium chloride as electrolyte, and into this dip a large number of carbon or platinum anodes connected in suitable manner to the positive terminals of the dynamo. Pipes are provided, as shown, for the circulation of the electrolyte, and an outlet pipe, V, is also provided for the escape of the chlorine gas produced. When the current is passed through the electrolyte the cell operates as follows:—The sodium or potassium liberated at the surface of the cathode combines with the mercury to form an amalgam. This amalgam, being lighter than the mercury, floats upon its surface (SW), and the circulation of the metal in the bottom

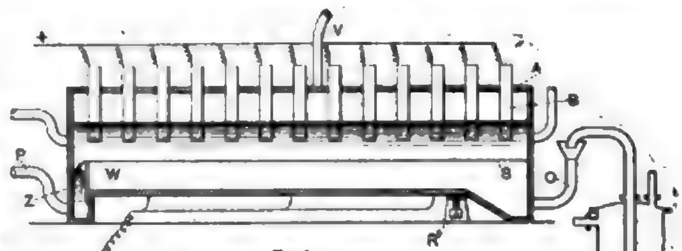


Fig. 1

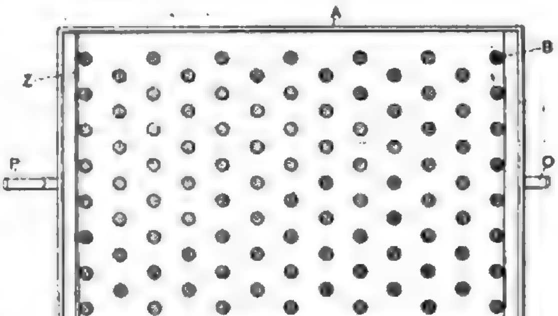


Fig 2

Sectional Elevation and Plan of the Solvay Mercury Cell.

of the cell carries it towards the "weir" Z, over which it passes. The amalgam collected at P in this way is decomposed by contact with water in a second detached cell, in which it functions as anode, and the pure mercury is returned to the decomposing cell by means of the pressure vessel T and supply pipe O. The flow or drift of the amalgam towards Z is assisted by the current of brine which is passed through the cell in the same direction, and it is claimed for this form of cell that even solid amalgam can be continuously removed without the occurrence of any stoppage or irregularity in the work of the cell. The remaining advantages are that the flow of mercury can be easily regulated to suit the current intensity; that very large cells can be used owing to the absence of all mechanical moving parts; and that the cells can be easily emptied and cleaned out when repairs are necessary.

No figures have yet been published for the work of this cell; but the writer is in communication with the firm controlling the patents, and at a future date he hopes that he may be able to present facts and data showing how it compares in actual operation with the earlier and better known forms of mercury cell.

## INAUGURATION OF THE BIRMINGHAM SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The inaugural meeting of this section took place on Wednesday, February 27, at the University Buildings, Birmingham. The chairman of the section, Dr. Oliver Lodge, presided.

Dr. LODGE, the chairman, said the inauguration of the section was due to the efforts of Mr. Henry Lea and Mr. J. C. Vaudrey. He was very glad that the branch should meet in the buildings of the University, and he hoped they would always continue to do so. It was the wish of the University and all its members to keep in touch with all the higher life of the city and surrounding district, and with none more than with the engineers.

Mr. HENRY LEA explained the beginnings of the local organisation. He said that in response to circulars sent out to the members of the Institution in Birmingham and district, including the counties of Warwick, Stafford and Worcester, 79 replies were received expressing approval of the proposed local section, and promising to render assistance. That number, exceeding, as it did, by 29 the minimum required by the parent Institution for the formation of a local section, was considered very satisfactory, and the section was at once created. The remaining meetings of the section for the current session would probably occur on March 27, April 24, and possibly May 22.

Mr. VAUDREY said the membership of the Birmingham section had now increased to 110. Birmingham and the district were rapidly becoming a very large centre of electrical industries, and the section was started with a view of bringing more nearly together those interested in electrical and kindred pursuits.

Mr. JONES proposed, and Mr. GROVES seconded, that the present officers remain in office for the session 1901-2, the object being to secure the advantages of continuity. The proposition was agreed to.

The CHAIRMAN then delivered his inaugural address. He congratulated the parent Institution on its wisdom and enterprise in forming local branches. He also congratulated them on their system of publishing and utilising Papers communicated. A multiplicity of publishing centres was bad for science. It was often as hard to discover the things that had been published as the things that had never been discovered. The more unified publication could be the better. At the same time excessive centralisation and lack of stimulus to exertion at local centres was if anything a greater evil. By the present action of the Institution of Electrical Engineers both evils were avoided. After rendering a high tribute to Prof. Perry as a great man genuinely anxious to serve humanity, Dr. Lodge spoke of the successive developments of the Institution. He afterwards proceeded to discuss the mutual compatibility of pure science and practical engineering. At the same time he expressed himself warmly in sympathy with the movement prominently identified with Prof. Perry, in favour of reforming mathematical teaching. Euclid, for its day and generation, was splendid, and its purpose as a system of geometrical philosophy admirable; but it had had its day, and for elementary and popular purposes should cease to be. We were too busy; there was too much to learn nowadays to have time to cross every river by ascending to its source and walking down the other side. Professional guides along the old river path still attempted to hide the bridges, because if they were too easily seen their occupation would be gone; but the bridges were there, and sooner or later even schoolboys would be permitted to make use of them and enjoy the country on the other side without spending all their days in a toilsome and deterrent mode of getting over a route approved by the ancients.

If there were any workers in engineering or any other branch of technology who affected to despise pure science, and say that its pursuit was needless, they were hardly worthy of notice—it must be affectation. It was to be heartily admitted that the enlarged experience, and the large-scale experiments rendered possible by the wealth of communities, who applied science to their own convenience, reacted with immense advantage on pure science itself. But those large-scale experiments were hardly like experiments proper. They should not readily be tampered with. Facts known to few with effort were science, but those same facts, when known to all without effort, were æsthetic. Meanwhile the justification for all pure dry science lay essentially in its ultimately human bearings. If a subject would be proved to be never capable of any human influence or any relation to humanity, however developed it might become, then its pursuit would be rightly condemned. But such proof could never be given. Again and again had the most unlikely channels developed into fruitful streams. We must trust the instinct of our leaders. We were in the beginning of a great era in connection with the pure science of electricity. The almost despised and neglected subject of electrostatics, as known to Franklin, was rearing its head again and pressing to the front. The experiment of a charged rod and pith balls was typical of much, perhaps typical of all that went on in electricity, and how much that meant some of them were beginning to guess. But even before they understood the nature of an electric charge they would find that the labours of J. J. Thomson had enriched the science of our times with what appeared likely to be a unifying and comprehensive generalisation such as philosophers of all time had groped after, for which some of them had strongly hoped.

At the conclusion of his inaugural address the chairman illustrated by a few simple experiments the most recent views of the passage of the electric current through liquids, solids, and gases. They had been taught, he said, that they could only have conduction of electricity with matter, and that through absolute vacuum electricity could not pass. It passed in the liquid with the atom; it passed in the solid from atom to atom; how did it pass in the gases? How did it pass in the highly exhausted gas of the Crookes tube with which he was demonstrating? Dr. Lodge showed the electric discharge in a Crookes tube, deflecting it with a magnet, and observe that that was one of the most extraordinary phenomena. They saw there the nearest approach to the electric current itself. There electricity was conveyed without matter; it was a disembodied electric charge, the pure spirit of the electric charge—the electric ghost. The atom was ordinarily associated with an electric charge, and force was required to separate them. This atomic charge, when separated, was known as an electron. Here, then, was a flow of electrons by themselves. A revolving electron was a magnet. A vibrating one started light vibrations. The electron, Dr. Lodge said, had many of the properties of matter; for himself he felt that it had all the properties of matter. Inertia, the fundamental principle of matter, had now begun to be explained. When first met with in electricity it was not called inertia; it was called self-induction. Self-induction was going to explain, he believed, the inertia of matter and the law of motion itself. It remained to be proved that the atom was composed of electrons, that the whole of matter was unified, that the different kinds of atoms only consisted of different numbers of electrons.

Prof. PERRY proposed a vote of thanks to Dr. Lodge for his address. He thanked the chairman for his references to himself, observing that, engaged in the crusade in which he was engaged, and subject to much adverse criticism, praise of the kind he had received from Dr. Lodge was of great value to him. He had got a lot of credit for what he happened to have done with regard to the new educational movement, but the fact was he hit upon the psychological moment when people's minds were moved by what had happened in the Transvaal, and were pretty much alive to the necessity for a great change in the education of everybody in the country. All the scientific world was watching to see what Dr. Lodge was going to make of the great problem that had been set before him in the Birmingham University. Dr. Lodge was a leader in science, a man much of whose laboratory work was being carried out on a large scale by engineers. Prof. Perry went on to deprecate the tendency in the parent Institution to array professors and engineers against one another, and advocated the cultivation of a spirit of mutual helpfulness, as between men whose various endowments must be inter-dependent if they were to be fully utilised. Referring to the ultimely death of Prof. FitzGerald, the speaker delivered an eloquent panegyric on his worth and his work. Prof. FitzGerald, he said, had done the most magnificent scientific work, helping everyone in their difficulties, perfectly unselfish—a perfect man. On all practical engineering questions he had not only the laboratory experimenter's point of view, but also that of the practical engineer. He had no hesitation in saying that in Prof. FitzGerald their profession had lost one of its greatest and most beneficent forces. With regard to the prospects of the local section of the Institution they were now inaugurating, it was a great advantage to the members to be working in Birmingham. Touching upon the stress of international competition, Prof. Perry said the danger which Huxley pointed out from the diffusion of education in foreign countries, and the neglect of it in England, was rapidly coming upon us. Could the men of Birmingham not raise their voices to save the nation of which they formed such an important part? Electricity had done great material things, and at second hand she had done much for the moral good of the world; but it was not electricity, it was the Institution of Electrical Engineers that was going to have the great triumph of the coming century, binding all the best thinkers together in a great association for the common good.

Prof. THRELFALL seconded the vote of thanks. He expressed his concurrence in the condemnation of the prevalent system of teaching mathematics in public schools, but said he did not endorse the perpetual tilting at their old friend Euclid. It was not so much the study of Euclid, but the setting up of algebra as a sort of puzzle for tripping lads, that was to be reprehended. They had that evening listened to an address which, like all Dr. Lodge's addresses, represented the high-water mark of the state of electrical science of the day. Dr. Lodge was now devoting himself to the development on new lines of a university untrammelled by a past age. They must all wish him "God speed" in his work.

The resolution of thanks was enthusiastically adopted.

Before concluding the meeting, Dr. LODGE, as a close personal friend of the late Prof. FitzGerald, reminded the audience that the professor was at the time of his death the chairman of the Dublin local section, and he added his testimony to the distinguished services Prof. FitzGerald had rendered to mankind, as well as to the virtues which illumined his life.

## BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

*(Continued from page 749.)*

When the enquiry into the proposed alteration of Regulation B6 was continued on Thursday, March 7, Sir Courtenay Boyle announced that, after consideration, the Board of Trade had decided that it did have power to make the proposed amendments if it so thought desirable. The legal right of the Board of Trade to do this had been challenged at the previous sitting.

Mr. ROGER WALLACE, K.C., said he was very sorry his clients could not agree to the terms offered by Mr. Littler, K.C., on behalf of the Windsor Hotel, with a view to a settlement of this portion of the opposition.

Mr. LITTLER, K.C., replied that he had done everything in his power to bring about a settlement. His clients were on the most friendly terms with the Westminster Company, and it was to their interest to be reasonable. However, he would go into the matter again and see what could be done.

Mr. MOON, K.C., then opened on behalf of the Chelsea Electricity Supply Co. In the case of this company's system there were no con-

sumers actually standing out. They had 500 consumers at 100 volts not yet dealt with, but the company was really afraid of the obstruction of persons, some of whom were ignorant of the real state of affairs, and others who did not care very much what the future generation of ratepayers would have to pay for the purchase of these various electric lighting undertakings. These persons either would not have workmen on their premises if they could help it, or else they were afraid the change involved more danger and alteration than was the case. It was on these grounds that the company supported the application, because it was of the opinion that a veto ought not to be placed in the hands of such persons. It was best in the hands of an arbitrator.

Mr. PERCY STILL, the engineer to the Chelsea Company, cross-examined by Mr. Moon, K.C., said their system was a three-wire one. They generated at a pressure of 1,000 volts, and reduced down by means of motor transformers to 200 and 100 volts. In the event of the regulation being altered, of course, the generating pressure would remain the same. They would simply double the consumers' pressure. Consequently the benefit of reduced capital expenditure in this case would be confined to the mains between the transformers and the consumers' terminals, and the granting of the alteration would not be so great a benefit to them as to the Westminster Company. However, the 100-volts consumers had the same general effect upon the system as in Westminster, for it necessitated the use of a separate set of mains and separate plant, or else they would have to use motor transformers in the consumers' premises, both of which remedies involved very considerable expense. The principle reason for the extra cost was in the fact that full advantage of the capital expenditure in the mains already laid could not be obtained. They had 2,082 consumers, and of these 1,516 were supplied at 200 volts and 566 at 100 volts, and roughly speaking 500 consumers had changed over voluntarily. No consumers had in any way been urged, and up to the present no difficulties had been met with. The present tariff was 6d. per unit for the 100 volts supply, whilst the 200 volt consumers were charged on the maximum demand system—viz., the units corresponding to the maximum demand during an average of 1½ hours per day during the quarter was 6d., and for any units consumed after that during the quarter the charge was 3d. Last year, for the same amount of light 200 volt consumers had paid £3,000 less. But in the case of the 100 volt consumer 6d. per unit was not sufficient to compensate the company for the extra cost entailed, and the greater portion were supplied at a loss. The maximum charge the company were empowered to impose under it bill was 10d. per unit, and, as a fact, they had issued a notice to all 100 volt consumers that on and after July 1 next 7d. per unit would be charged. This was rendered necessary by reason of the fact that as the number of 100-volt consumers decreased the cost would go up, and it would be necessary to go on increasing the price or supply at a loss. The installation of the higher pressure enabled the consumer to put more lamps on his existing mains, as these carried more current at 200 volts with less loss. It was a fact, he admitted, that many consumers did not take the full available load of the wiring in their houses, but the majority were increasing the size of their installation, and as they could do this without re-wiring he submitted it was an advantage. Of course, the main advantage to the customer was the question of price, but others were decreased loss of pressure in the house and more evenness of the pressure. On the question of the efficiency of 200-volt lamps, his experience from tests made periodically as new lamps were introduced was that at the time of the issue of the new Board of Trade regulations in 1896 the existing 100-volt lamps were superior.

By Sir COURTENAY BOYLE: This inferiority on the part of the 200 volt lamps was due to many things. First, there was a difference in the manufacture of the filament; secondly, there was no demand for them, and, again, manufacturers had not taken the matter seriously. Generally speaking, it would not be wrong to say that at that time they were in the experimental stage. There were none of these lamps installed on the Chelsea mains in 1896, but a gradual improvement was apparent, and it was in 1897 that he first fitted them.

By Mr. MOON, K.C.: In June, 1897, they first commenced supply at the higher voltage to new customers, and it was probably the middle of 1898 before the old customers began to be changed. He had concluded from experiments into the question of the life and efficiency of the present 200 volt lamp that there was practically no difference as compared with the latest 100 volt lamp. In fact, in some cases, the 200 volt lasted longer than the 100 volt. Beyond the difference in resistance of the two lamps, there was also a difference in the filament, which, in the case of 200 volts was twice as long and half as thick. As to the actual amount of the saving of capital expenditure on mains, he estimated this at from £2,000 to £4,000 per annum, and as the company still had 28 years to run, they could see what this absolutely wasteful expenditure would amount to. He did not claim that the system would be any more efficient, but they could do exactly what they were doing now without all this expense if they could convert the whole of their system.

By Mr. LITTLER, K.C.: The advantage was not all on the side of the company. The consumer got a cheaper supply and a better light.

By Mr. DANCKWERTS: They did not get the full advantage out of the change until the whole of the system was so changed.

Sir COURTENAY BOYLE: Why cannot you have more motor transformers for your 100 volt consumers? You have already got them in sub-stations for your 200 volt customers, and what is the objection to having two classes of transformers.

WITNESS replied that the transformer was a machine which must have constant attention. Their existing transformers were in a sub-station where a man was always in attendance, but the objecting consumers were so scattered about that it was impossible to erect a machine to supply the whole of them; therefore they would have to put them in the consumers' houses. Further, the machine had to be running all day whether the consumer used the light or not.

Mr. DANCKWERTS, K.C.: But supposing the consumers were sufficiently concentrated and numerous, I suppose that objection would disappear. If, for instance, you had a whole street of 100-volt consumers, it would be possible to erect a motor transformer in a small sub-station where constant attention could be paid to it, without any serious difficulty.

WITNESS admitted there would be no engineering difficulty in doing this, and roughly estimated the cost, if such a street of say 1,000 consumers existed, at £500. But at present the Chelsea Co. had 100 volt consumers to the full capacity of the 100 volt mains, and the loss to the company was in capital expenditure and loss of pressure, two objections which would not be removed by resorting to the expedient suggested. He did not know the actual cost per unit to the company for generating and delivering the energy which was at present charged 6d. for to the consumer, and upon which an alleged loss was incurred.

Sir COURTENAY BOYLE: This is a very important point, and it is a pity you have no figures.

WITNESS, however, stated that the generating cost was the same in the case of both 200 and 100 volts, but he could not discriminate as to the cost of distribution, because they supplied both pressures over the same mains.

By Mr. DANCKWERTS, K.C.: As he read the present regulations there was nothing to prevent him supplying at any pressure as a standard pressure.

Mr. DANCKWERTS himself also pointed out that this was so. Therefore the present application had nothing to do with any change in the standard pressure, but was for the insertion in the regulation that the company might alter the contract with the consumer without his consent.

Under further cross-examination by Mr. DANCKWERTS, WITNESS mentioned that the standard or declared pressure to all new consumers was 200 volts. The changed-over Chelsea consumers had asked for the change themselves, but the company's reason for asking for the compulsory change was that as the number of the 100 volt consumers became less, the loss in the 100 volt mains became more pronounced. If the whole of the system could be changed at once, the distributive loss in each consumer's house would average 1 per cent. instead of 4 per cent. The Chelsea Company paid nothing for the change of fittings. The consumers, having changed of their own free will, did this themselves. On the question of the mechanical strength of the filaments of the two classes of lamps he did not think there was any difference.

By Sir COURTENAY BOYLE: There was not any attraction between the two sides of the filaments which would bring them together.

By Mr. DANCKWERTS, K.C.: He had tested 200 volt lamps which had not broken down until they had burned for 1,500 hours.

By Mr. ALFRED LYTTELTON, K.C.: The tests had been made on various makes of lamps, and the makers, in supplying them, knew they were for testing purposes. Having had no complaints from the customers on the higher voltage as to any increase in their quarterly accounts, he concluded things were quite satisfactory. Assuming (counsel having stated an intention of contesting the point) that the difficulties in connection with 200 volt lamps had been overcome, he agreed it was due to the greater skill and attention of the maker; but the small demand up up to the present had been the ruling factor in keeping the prices down. In a letter, signed by himself, to a consumer announcing the increase of price to 100 volt consumers, he did not think the following sentence was in the nature of an inducement:—"The extra cost in lamps will not be considerable as your 100 volt lamps will be worn out in six months' time." He did not even think it was "soft persuasion." He supported Prof. Kennedy on the question of the efficiency of existing insulation and immunity from risk of fire. In confirming his evidence on motor transformers he said this would be contrary to the object of the application, which was to avoid extra expense.

By Mr. R. C. GLEN, on behalf of the Paddington Borough Council: Witness was not prepared to argue the merits of 5 c.p. 200-volt lamps, as he had made no tests with this size.

Re-examined by Mr. MOON, K.C.: A 5 c.p. lamp was not an economical thing to use as a rule. With motor transformers in consumers' premises there was, of course, a waste of time in the process of transformation. There was also a waste of energy which might be very considerable indeed, but the vibration need not be unpleasant if the necessary precautions were taken. His estimate of £500 for the transformer equipment did not include any premises, or erecting, or superintendence. Their present mains, at 200 volts pressure, were capable of taking double or treble their present load.

By Sir COURTENAY BOYLE: If there was a drop of a full 4 volts in any consumer's premises this would indicate that his wires were old.

Mr. SYDNEY BAYNES, electrical engineer to the St. Pancras Borough Council, was next called. Cross-examined by Mr. Balfour Browne: he said that Bradford, for which local authority he had been engineer, first supplied at 115 volts, but finding the mains becoming overloaded, and in order to avoid increasing the mains and the consequent pulling up of streets, &c., they decided to supply at 230 volts. This change was effected before the new regulations came into force, but a number of consumers asked to be supplied at the higher pressure. St. Pancras was the first to supply at the higher pressure in London, but there they had had some trouble.

Sir COURTENAY BOYLE pointed out that here again the new regulations did not apply, as the St. Pancras order was dated 1883.

Mr. BALFOUR BROWNE, however, thought the experience useful.

WITNESS, still under cross-examination, said that at St. Pancras some of the consumers wanted special terms and special expenditure in their premises if they submitted to the change. In one particular instance the vestry threatened a discontinuance of supply after repeated refusals, but the customer then gave way, and they had heard nothing of him since. Another customer, however, persisted in refusing to be changed, and the Council had been put to an expenditure of £2,500 in that district for the purpose of laying new mains.

Sir COURTENAY BOYLE: Did that consumer have a veto.

Mr. BALFOUR BROWNE: He was being supplied with 100 volts at the time of the publication of the new regulations and refused to be changed over except upon certain conditions, which were too onerous, and therefore the St. Pancras Vestry laid the extra mains.

Sir COURTENAY BOYLE: How did the consumer have a veto? The St. Pancras order is dated 1883, and he would be forced to take the higher voltage.

Mr. SYDNEY BAYNES said the altered regulations applied to St. Pancras, and as the declared pressure was 110 volts they were bound to supply it if a consumer insisted.

Sir COURTENAY BOYLE: But the St. Pancras order was the same as the Bradford order, and if the new regulations did not apply in one case they did not in the other.

Mr. BALFOUR BROWNE was of the opinion that the old regulations were subject to others issued by the Board of Trade from time to time. Thus the regulations of 1896 really became operative both in St. Pancras and Bradford.

Sir COURTENAY BOYLE: But there is no proviso to the old regulation.

Mr. BALFOUR BROWNE said that right or wrong the St. Pancras Borough Council had apparently acted upon the principle that the consumer did have a veto.

Mr. SYDNEY BAYNES said that this was so. In answer to further questions by Mr. Balfour Browne he stated that thinking themselves always bound by this proviso to the revised regulations, they had had to meet very stubborn resistance in some cases. There had been no electrical fire or accident in St. Pancras to his knowledge, and joints had been made by men in mains carrying the higher pressure without the current being switched off. The advantages to the consumer were steadier light and reduction in price. He knew of no disadvantage.

By Mr. CROIS (on behalf of the Windsor Hotel): They had met with stubborn resistance from about five people, but there were yet 200 or 300 not changed. The St. Pancras people were supporting the application as a matter of principle and not from pride or want of commercial spirit. They hoped the inquiry would cause all their consumers to change their minds. The price at present charged for the 200 volt current was a "flat" rate of 5d. per unit, or, as an alternative, the maximum demand system at 6d.—2d., which would work out at an average of something like $3\frac{3}{8}$d. The 100 volt consumers paid 6d. per unit. On the question of the higher voltage lamps, he thought that they might be a few pence per lamp more expensive, although 200 volt lamps could be obtained at the same price as 100 volt lamps. There had been no complaints from 200 volt consumers, and on the theory that a consumer would always complain if he had a chance, he thought he was entitled to consider the matter as satisfactory. He did not consider any lamp should be allowed to burn more than 700 hours. As to efficiency, he was not aware that there was any difference of opinion existing between experts as to the respective merits of 100 and 200 volt lamps. In the early days it was undisputed that the 200 volt lamp was not so efficient, but he would not admit this to hold now. However, if such a difference of opinion did exist it might be settled by official tests.

By Mr. DANCKWERTS, K.C.: The reason for supposing that the new regulations applied to St. Pancras was because the Board of Trade, on May 15, 1896, sent a copy of them to him with an intimation as to the date they would come into force. In answer to counsel's question as to whether the St. Pancras Borough Council had considered the question of this present application any more carefully than it had considered the question of the applicability of the new regulations to St. Pancras, witness gave an evasive answer, which caused counsel to retort that he could draw his own conclusions. In testing 230-volt lamps he had not tested them under the ordinary conditions of the consumer by frequent turning on and off.

Mr. A. LYTTELTON, K.C.: Did the Council know it was acting illegally in threatening to cut off a consumer if he did not agree to the change?

WITNESS: Yes.

Mr. A. LYTTELTON, K.C.: This, then, is the spirit in which these acts are worked under your Council?

Cross-examined by Mr. R. C. GLEN: Witness reiterated that no complaints had been received from 200-volt consumers.

By Mr. BALFOUR BROWNE: He did not know whether the Edison and Swan Company supplied 100 and 200 volt lamps at the same price. At St. Pancras there were some 100 volt consumers willing to be changed, but who could not owing to the obstruction of others. They had never been asked by the Board of Trade to apply the new regulations, but this had been carefully considered before deciding to support this petition.

Mr. MOON, K.C., on behalf of the Metropolitan Electric Supply Co., stated that with this company it was a question of raising the voltage from 50 volts to 100 volts. This came about through the company having a high-tension alternating-current system with transformers in all consumers' houses.

Mr. A. B. CANE, representing the City of London Electric Lighting Co., said he did not propose to call any witnesses or make any observations. The City Company, however, supported the application entirely.

Mr. W. H. MASSEY, intervening on behalf of the Crown authorities asked for protection in connection with Buckingham Palace, for which he is consulting engineer. This building was supplied at 200 volts and 100 volts, and the cost of converting the entire supply to 200 volts would be £1,500. Rather than bear the cost of this, the Westminster Electric Supply Co. preferred to go on supplying at both voltages, at the same time charging more in the case of the 100 volts supply, which he was willing should be converted. He was of the opinion that if any alteration were made in these regulations, it would merely be for the temporary benefit of the companies, as sooner or later their mains were sure to be overloaded again, and what would they do then? They were breaking the law daily now in not keeping the pressure up to the standard, and they would do the same again, or else want a still higher voltage, or perhaps they would have a five-wire system. He maintained that if there were more than one pair of 200 volt terminals in the building wired on the three-wire system it was possible to get a shock of 400 volts even if the middle wire was earthed. This made no difference whatever. And even if a transformer were fitted on the consumer's premises, why should a consumer pay for this in order to save a little copper in the supply mains of the company? He had been instructed to ask that the following clause be added to any amended regulation—viz., "Provided always that none of the cost of conversion shall be borne by the consumer." By all means let an arbitrator decided what the cost of the work should be, but for Heavens' sake they must not put the consumer to the expense of a change he did not desire. Nobody objected to 200 volts for new installations, but to change existing 100 volt circits was undesirable.

Col. CROMPTON was the last witness for the application on the general principle of the change being desirable. Cross-examined by Mr. MOON, K.C., he said that all the arguments which had been brought forward against the 200 voltage had been put forward in 1882 and 1883, when the question of raising the pressure to 100 volts was being threshed out, and the present objections were equally absurd. At the beginning of the Kensington and Knightsbridge undertaking 100 volts had been settled upon because they could only obtain good lamps for that pressure, but by reason of the fact that fairly satisfactory lamps for 150 volts could be obtained, he had contemplated that this change to 200 volts was only a matter of time. He had been continually testing 200 lamps right up to the beginning of last year, and had come to the conclusion that a certain number of makers made a 200 volt lamp equally as efficient as the present 100 volt, but other makes were not so reliable. Theoretically, the extension of the filament in a 200 volt lamp was a superiority, but practically it made manufacture slightly more troublesome. The advantage of the change was undoubted, because it did away with the continual necessity and difficulty of finding space for new mains. Consequently only the same space was taken up by the mains, whereas the variation in pressure was reduced to one half, hence the life of the lamps were increased, likewise the regularity of the light. All new enterprises were worked at the double pressure.

By Mr. LITTLER, K.C.: He did not suppose he would ever wish to adopt a pressure of 1,000 volts. Experience up to now had proved the Glasgow pressure of 230 volts to be the most economical. He knew nothing of the circumstances of the Windsor Hotel case. In reply to counsel's contention that a man who was entitled to withhold his consent ought to have something for giving it besides full compensation for loss, witness nonchalently said, "Say 10 per cent. for compulsory purchase." He denied that an 8 c.p. 200 volt lamp was not as efficient as an 8 c.p. 100 volt lamp, and further maintained that facts had proved the longer filaments to be no disadvantage.

Mr. LITTLER asked if Col. Crompton would persist in the latter declaration if he brought, say, eight witnesses to prove that this was not so.

Col. CROMPTON said yes, for he could bring 100 witnesses to prove it was so. Continuing, he said there was at present on the market lamps thin enough, long enough, and strong enough to give a satisfactory light at 200 volts. He was not aware that 100 volt lamps were 1s., whilst 200 volt lamps were 1s. 4d. He himself only paid the same price for both.

Cross-examined by Mr. W. J. WALTERS: He maintained that the benefit was to the company, to the public using the streets, and to the consumer. There would be no disadvantage to the consumer, only in the event of the mains again becoming overloaded, but the present mains would take four times the lamps for the same limit of overloading, and at present the mains were sufficient, on the higher pressure, for the districts they served. He agreed it was in the nature of a temporary benefit to the company, but the saving to the company really amounted to a very small fraction when divided over the number of units, say, about $\frac{1}{10}$d. per unit. The difference in the insulation for the two voltages was, to use counsel's own word, practically *deminimus*. If the insulation was bad in the first instance it would, of course, be altered before the new pressure was supplied. A consumer who bought his own lamps had a benefit not yet mentioned—viz., he would not have the wide range of choice he at present had with the 100 volt lamp. There was nothing more injurious to the consumer than the flood of cheap 100 volt lamps at present on the market. This flood was nothing like the same size with 200 volts, although there were necessarily some bad ones. He was not aware of any mechanical or chemical process which justified the idea that because the filaments of the higher voltage lamps were thinner, disintegration took place more rapidly. His method when tested was to select a number of lamps haphazard from a quantity, but he had never gone to a manufacturer and purchased lamps as a consumer would. It was known they were for testing purposes.

By Mr. LYTTELTON, K.C.: The majority of 200 volt lamps on the market were the same price whether good or bad.

By Mr. R. C. GLEN: It was the rule that companies did not supply current until they had made an inspection of the fittings.

By Mr. MOON, K.C.: It was generally found that any trouble with 200 volt lamps arose from the use of the cheaper article, and as soon as lamps made by an acknowledged firm were substituted all went well.

This concluded the evidence in support of the application.

*Tuesday, March 12th.*

Mr. DANCKWERTS, K.C., stating the case for the City of London Corporation, still contested the right of the Board of Trade to take upon itself the alteration of this proviso, in spite of the Board's ruling given above. Under these circumstances there were two ways out of the difficulty—viz., litigation in the law courts or the appointment of a lawyer of eminence to hear the views of both sides, and to give a final decision as to the legal position of the Board of Trade in this matter. This latter course had been followed in reference to a dispute as to the price of gas,

and he put it before Sir Courtenay Boyle as suitable in this instance. Assuming, however, for the purposes of his opposition, that the Board had the legal power, he went on to say that the companies had an unfounded case. It seemed to him that the regulation only applied to the pressure at which a consumer was being supplied, which need not necessarily be the *standard* pressure; therefore they must stick to the pressure declared to the consumer unless a change was rendered necessary by an alteration in the *standard* pressure. But they had not proved in the slightest degree that this was necessary. As the matter stood, they ought to be asked that the whole of the regulations be re-modelled; their case was illogical, unfounded, and misconceived. The present regulation (section 4) contemplated the use of more than one pressure on the circuits of an electrical undertaking. Further, it had been admitted, on behalf of the companies that by means of a transformer consumers could be supplied at the lower pressure, therefore it was apparently purely a question of convenience and saving of capital expenditure to the companies. In the case of large consumers a transformer could be placed on his premises, and for the smaller ones one transformer could supply a number. The real truth of the matter was that the companies wanted to make the alteration for their own benefit at the expense and convenience of the consumer. Even supposing they were right, ought this change to be made irrespective of the number of consumers holding out? No, certainly not. If there were, say, up to a dozen, there was a case for intervention; but there were a great many places, like the City of London, where several thousands would come within the proviso. Why should in such a case as this the change be forced for the pure benefit of the companies? There should be some limitation in almost every case by some authority as to whether the proviso should be dispensed with. Prof. Kennedy had stated with the utmost candour, for which he was deserving of credit, that to the consumer there was no benefit, but to the company there was a saving of capital expenditure, while Col. Crompton had acknowledged that it would be necessary in time to again increase the voltage. The Chelsea Company had made the change with everybody's consent. They said they felt no inconvenience from refusals, and did not anticipate any but there *might* be some resistance. Well, let them wait until it came.

Mr. BALFOUR BROWNE asked if the statement that every case should be dealt with by some authority who would state whether the proviso could be dispensed with was in the nature of a concession. This was really all he wanted.

Mr. DANCKWERTS, K.C., said no, but be could perceive extreme cases where it would be better for the Board of Trade to intervene.

Mr. BALFOUR BROWNE: Then you would not object to a regulation making that proviso?

Mr. DANCKWERTS replied, not in extreme cases, but in some cases the Board of Trade could say that the low pressure should be maintained. Then, if the Board of Trade went further, and said that in certain cases the consent of the consumer should be dispensed with, the question arose, "Upon what terms?" In his opinion, as had been done at Westminster and Glasgow, the overhauling of the installation and the supply of new fittings should be an absolute condition to the consumer's consent being dispensed with. But there might come a point when the company thought they had done enough, and in such cases it ought to be within the power of the Board of Trade or somebody else to say who was right. Then would follow the question of the cost of the arbitration, and he suggested that if the company were wrong they should pay the whole costs, and if the company were right it should be left to judicial discretion as to the amount each party should pay. In no case should the consumer pay all the costs. All the opposition were agreed upon this. He did not want such arbitrations carried out under the Arbitrations Act of 1889, because arbitrators under this act were prone to split differences in order to come to a speedy settlement. It was the custom in law courts that a person who asked for an indulgence paid the costs: in this case the companies were asking for an indulgence. Dealing with the efficiency of 200 volt lamps, he said that in face of the evidence already given that these were as satisfactory as 100 volt lamps, he had witnesses to prove that such was not a fact, and further, that they cost 20 to 25 per cent. more. Prof. Kennedy's tests had not been made under service conditions. The tests in every case were continuous, without that frequent turning on and off which would, of course, take place in a house, and they were also lamps ordered from the manufacturer for testing purposes. He contended that this did not give a fair result, and the question would have to be satisfactorily decided. The best way out of the trouble would be for the Board of Trade to have tests made under conditions approaching as nearly as possible service conditions, and this would be much better than to decide upon the conflicting evidence of experts.

Mr. BALFOUR BROWNE said he had no objection to this.

Mr. DANCKWERTS concluded by stating that the opposition failed to see any advantage to the local authorities who would have to purchase the undertaking, in keeping the capital expenditure down. The concerns would be taken over on what were known as "tramway terms," and no advantage to local authorities would accrue in this direction. He also suggested discounts on consumers' bills, in addition to a reduction in price, to pay for the increased cost of renewals consequent on the higher pressure.

Sir COURTENAY BOYLE at this stage, not on behalf of the Board of Trade, but merely as a basis to work upon, suggested the substitution of the following proviso for the one in dispute. "Provided that no change shall be made in the pressure of the supply to any premises which, on ——— were supplied with energy by the undertakers, except with the consent of the consumer: but where the consumer withholds his consent after the undertakers have offered to pay the reasonable cost of or incidental to the change, the undertakers may appeal to the Board of Trade, and that Board may, if they think fit, dispense with the consent of the consumer on such conditions as the Board impose. The Board of Trade may, if they think fit in any case, refer to the arbitration of a single arbitrator appointed by them the question of the conditions to be imposed under this provision. The arbitration shall be subject to the provisions of the Arbitration Act, 1889, as if the arbitration were pursuant to a submission, and shall also be subject to the like provisions as an arbitration in pursuance of a special act under Part I. of the Board of Trade Arbitrations, &c., Act, 1874."

Mr. BALFOUR BROWNE was willing to accept the principle of the clause, although not the actual wording.

The Hon. ALFRED LYTTELTON, K.C., thought the L.C.C. regulations inserted in the Westminster Bill would be overruled by this proviso.

Sir COURTENAY BOYLE explained that this would not be so, as it would only apply to special cases.

The Hon. ALFRED LYTTELTON, K.C., asked that the arbitration should be under the Lands Clauses Act.

Mr. DANCKWERTS, K.C., would not agree to the principle of the suggested proviso, and asked that provision should be made by which the supplier should overhaul a consumers' fittings, and put them in a fit and proper condition at the suppliers' expense. If the consumer and the company differed as to what was to be done, then the matter should be referred to arbitration, preferably under the Lands Clauses Act. The company should also make a reduction in price to all changed consumers.

Mr. CROIS (representing Mr. Littler) asked what the heads of the costs should be. If these were not decided the whole inquiry would be thrown away.

Sir COURTENAY BOYLE pointed out the words "reasonable cost."

Mr. CROIS said he had had some experience of these companies for two years, and he did not put the same faith in the words "reasonable cost" as some did. Nothing was said at present about the cost of maintaining the installation after the change, and there should be a condition which would put the consumer in the same place as he was before. Otherwise they simply took away from a man the right to refuse and gave him arbitration at his own risk and at the instance of a powerful company. As it at present stood it was not enough to offer to the individual consumer, the conditions should be much more stringent.

Mr. MOON, K.C., pointed out that the Lands Clauses Act allowed for an extra 10 per cent., which the Arbitration Act did not. Would that 10 per cent. be dispensed with.

Sir COURTENAY BOYLE said this 10 per cent. would not come into the question.

The Hon. ALFRED LYTTELTON, K.C., said that on the question of arbitration they were between two difficulties, and they must choose the lesser. It had been made evident during this short inquiry that the companies had acted oppressively to the consumer, and he instanced Chelsea and St. Pancras. These gave a very good indication of the way consumers could be treated. The suppliers of an agent like electricity always spoke about is in a perfectly obscure terminology, and the average consumer had not the slightest idea of what was going to be done. Under the circumstances he thought the company would be amply protected by a proviso that if the claimant's arbitration was not reasonable he should pay his own costs only.

Mr. ROSKILL, on behalf of the City of London Company, accepted the proposed proviso.

Mr. LITTLER, K.C., regarded it as satisfactory, although he could see some objections. This was, however, on the assumption that the Board of Trade had the legal power to make the alterations, which he did not admit.

It was eventually decided to adjourn the inquiry at once to give an opportunity for considering the proposal, and all amendments were to be sent to the Board of Trade by 11 o'clock on the 13th inst, the inquiry to be continued on Thursday.

*Thursday, March 14th.*

Mr. Littler announced that his clients had not sent in any amendment to the proposed proviso, but that they wished to be put in exactly the position they were before the change was made. The London County Council and City Corporation both sent in modifications, and after some discussion Sir Courtenay Boyle proposed that either the Board of Trade should, after having the facts of the case put before it, draft up a proviso which all parties should accept, and so close the matter, or else the evidence for the opposition should be proceeded with. Counsel asked for time to consider, but as, after nearly half an hour, nothing could be decided upon, evidence for the other side was heard. Mr. Gunyon, the electric lighting engineer to the London County Council, and Mr. Bernard Drake, both gave evidence in direct opposition to that already taken. The chief witness was Prof. W. E. Ayrton, F.R.S., who stated that he had tested 200 volt lamps, both for the manufacturers themselves and for dissatisfied consumers, but that in hardly an instance had he encountered an efficient article. In one test he found an 8 c.p. 200 volt lamp which had actually been installed in a consumer's premises only gave 1·8 candles, and that it took 15·3 watts per candle. Lord Londonderry's agent was next called and produced invoices from the Westminster Company testifying to the fact that since the change had been made in his lordship's town residence an expenditure of £238. 18s. 8d. per annum was incurred as against an average of £181. 9s. 5d. for the three years 1897-8-9.

A full report of the day's proceedings will appear next week.

**Association of Technical Institutions.—The annual general meeting of this Association, adjourned in consequence of the death of her late Majesty the Queen, will be held at the Fishmongers Hall, London, on Tuesday, April 16th. The President, Sir Surie Smith, will take the chair, and the President-elect, the Right Hon. Sir William Hart Dyke, M.P., will deliver an address.**

## ELECTRO-SILVERED v. PLAIN COPPER PLATES IN GOLD-MILLING.*

BY EDWARD HALSE.

In well-known text-books on gold-milling and metallurgy, silvered plates are recommended as avoiding the formation of the greenish-grey film† which appears on freshly amalgamated copper plates. Gold or silver amalgam is sometimes applied for this purpose, but the use of electro-silvered plates is certainly preferable, and is much more frequent. In starting as new plates they are also deemed superior, because silver amalgam has "more affinity for the gold than a copper plate simply coated with mercury."‡ John E. Hardman says :—§

"The formation of verdigris on non silvered copper plates may be permanently prevented by thoroughly cleaning and drying the plate, scraping till the copper is bright, and rubbing in mercury with canvas or chamois skin moistened with cyanide of potassium. When well coated the whole is painted over with fine gold amalgam, prepared as follows: Sweat a plate that is well coated with gold amalgam, scrape off the latter, grind in a wedgwood mortar with a little mercury, rapidly pour off the mercury, which leaves the coarse amalgam behind, while the mercury poured off is settled 24 hours, and then carefully decanted, leaving the fine amalgam at the bottom. This is of the consistency of cream, and ready to be applied."

Thus stress is laid on the utility of employing silvered plates when starting a new mill, and some millmen appear to think that their efficacy ends here. It is well known, however, that copper plates become tarnished by water containing a considerable percentage of sulphates in solution, notwithstanding the accumulation of gold amalgam on the plates, unless the discoloration be kept under by frequent washing with dilute acid—preferably sulphuric acid—or a dilute solution of cyanide of potassium. The use of the latter for this purpose is pretty general. Both permanent and temporary films appear to be due to the oxidation of the copper.

C. H. Aaron remarks that "the electro-plating of the copper surfaces does not seem to be efficient in preventing discoloration in all cases, and is not universally favoured by millmen. Some consider the silver plating as very advantageous, while others say it is void of merit." ‖ He says that silvered plates were discarded in the lower mill of the Sierra Buttes Co. on account of the rapid disappearance of the silver, while in the upper mill of the same company it was considered impossible to work without silvered plates. "The only observed difference between the two cases is that in the lower mill the rock worked contains a small portion of sulphurets, chiefly iron pyrites, while the upper mill works on surface ore with no sulphurets." This, however, does not explain the difference, as silvered plates are often used with success on ores containing a large percentage of sulphides.

An important question to the millman is whether silvered plates catch more gold in proportion than plain copper plates; if so, the latter should clearly be replaced by the former. No doubt comparison of the working of the two have frequently been made, but there appears to have been a singular dearth of records on the subject. T. A. Rickard¶ gives an instance strongly in favour of silver-plated copper which occurred in the Harrietville Mill, Ovens, Victoria :—

"At No. 5 battery the succession of plates is silver-plated copper, plain copper, plain copper; at No. 4 battery the order was silver-plated copper, silver plated copper, plain copper. After a year's working with die of identical character it is found that the plain copper from the third plate of No. 5 battery is well amalgamated, while the corresponding plate of the same material at No. 4 has not yet become whitened by amalgamation. This proves that the second plate at No. 5 (viz., copper plate) is not arresting gold amalgam so successfully as the corresponding plate (viz., plated copper) at No. 4 battery."

The writer recently had occasion to substitute silver-plated for plain copper at one of the mills belonging to the Colombian Mines Corporation (Ltd.), situated in the Remedios district, Antioquia, Colombia. The ore varies considerably in gold percentage from month to month, but it is constant in character, being invariably quartz charged with 1 to 5 per cent. of sulphides, chiefly iron pyrites, with some galena and blende. Altered granite (*mani*) country, more or less gold-bearing, frequently forms a considerable portion of the gangue. The ore contains free gold, but the greater part of the precious metal is locked up in the pyrites and galena. The latter carries silver, and is highly auriferous; the iron pyrites are less so; and the blende shows silver, but little or no gold. Arsenical pyrites sometimes occur in the altered country within or adjoining the vein, and pyrrhotite is occasionally found where the vein is wide and of low grade. A careful record was kept of the amalgam taken from the boxes, plates, mercury traps, blankets, and arrastra, in order to ascertain whether silvered plates yield a higher percentage of amalgam *in proportion to the total gold extracted* than plain copper plates. The results are given in the following notes:—The upper copper plates of each battery measured 6½ft. long by 3ft. 2in. wide, were ¼in. thick, and had been running for 18 months; below them were new plates 1ft. in length; total area 96¼ sq. ft. The electro-silvered plates (which received 1 oz. silver per square foot of surface) were 6½ft. long and ¼in. thick, and were followed by small copper plates as above; total area, 96¼ sq. ft. Along the foot of the plates were mercury traps, one for each battery, their length being equal to the width of the plates. From the latter, the pulp flowed over blanket strakes (*mesa*), the total area of these being 96 sq. ft. The blanketings (concentrates) were washed from time to time in a narrow chest (*cernidero*) and inclined table (*tablero*). The heads (*cabeceras*) of the resulting concentrates (*jaguas*) were ground in an arrastra of the ordinary type, the concentrates themselves being shipped to England. Mercury was dropped into the boxes from time to time; and unslaked lime (20lb. to 50lb. per day) to counteract the acidity of the water. The plates were laid on the floor of the mill, so that it was impossible to alter their inclination, which was about 2½deg. It should be explained here that the mill was designed for the purpose of extracting the gold in a free state on blankets. Amalgamated copper plates were substituted for blankets after the mill had been running about six months. The amalgamated copper plates, although old and fairly well saturated with gold, were constantly being tarnished by the water used in the batteries (the acidity of the water can be explained, as it had previously run through four other mills), and it was necessary to frequently wash them with a weak solution of cyanide of potassium. Before adopting silvered plates, attempts were made to get rid of this discoloration. The plates were coated with prepared silvered amalgam; this coating, however, was completely worn off in four days, and the discoloration was as bad as ever. The bad effect was somewhat reduced by putting lime in the boxes. Lumps of cyanide dropped in the boxes kept the plates clean for some time. Nitric acid was also tried, but the effect was much less marked. Iron bars were placed on the plates, in the way recommended by C. H. Aaron, but the effect was practically nil, and as they partially stopped the flow of the sulphurets they did more harm than good. In short, all nostrums signally failed, and silvered plates were ordered. These remained perfectly bright, and no stain could be detected. The use of cyanide was discarded, and the results were considered so satisfactory that electro-silvered plates were afterwards used in all the mills.

The writer has endeavoured to show that, for a certain class of ore at any rate, electro-silvered plates are highly advantageous, and that such plates not only catch more gold in proportion than plain copper plates working under similar conditions, but that such gold is of an increased fineness. Although their first cost is very high in comparison with that of plain copper plates, they soon pay for themselves in economy of labour alone, as they require much less attention than the latter.

* Abstract of a Paper read before the Institution of Mining and Metallurgy on January 16.

† Prof. Henry Louis has analysed this substance, and finds it to be "hydrated oxide of copper, with sometimes some carbonate; probably when water containing sulphates is used, a basic sulphate may also form. It is soluble in a number of substances, such as dilute acids, ammonia, and potassic cyanide." "Handbook of Gold Milling," 1894, p. 277.

‡ M. Eissler, "Metallurgy of Gold," 4th ed., p. 72.

§ As quoted by Robert H. Richards in *Mineral Industry*, Vol. VI. (1897), pp. 709, 710.

‖ *En. and Min. Jour.*, August 10, 1889, p. 118.

¶ *En. and Min. Jour.*, June 10, 1893, p. 534.

## CORRESPONDENCE.

### THE BRIGHTON CABLE CONTRACT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Enclosed are copies of correspondence on this subject which may be of interest to your readers. I think the letters fully explain the position in which the controversy stands at present.—Yours, &c., A. H. HOWARD,
Secretary Cable Makers' Association.

London, March 12.

Town Hall, Brighton, February 27, 1901.

DEAR SIR: Your letter of the 8th inst.,* the receipt of which I acknowledged on the 9th inst., has been submitted to the Lighting committee of the Corporation, and in reply thereto I am instructed to inform you that you are in error in stating that several of the recent tenders sent in for cables for the Corporation of Brighton were substantially lower in amount than the tender of the Union Cable Co., which was accepted; that when consideration had been given to the effect of the alterations made in the conditions by the persons and companies whose tenders were apparently the lowest it was found by the committee that they were in fact not so, and that the Union Company's tender was undoubtedly the most advantageous to the Corporation.

I am further directed to inform you that the Lighting committee of the Corporation are willing at any time to consider any suggestions made by the Association or any of its members for the alteration of the conditions attached to the specifications for the supply of cables for the Corporation,

* See *The Electrician* of Feb. 15, p. 560.—ED. *E.*

but they cannot consent to any alteration in the conditions, when once issued, being made by persons tendering, inasmuch as alterations so made would render a fair comparison of the tenders received exceedingly difficult and perhaps impossible.—Yours faithfully, (Signed) F. J. TILLSTONE,

A. H. Howard, hon. sec. Cable Makers' Association, Town Clerk.
2, Queen Anne's-gate, Westminster, London, S.W.

Cable Makers' Association,
2, Queen Anne's Gate, Westminster, S.W., March, 1901,
Francis J. Tillstone, Esq., Town Clerk, Town Hall, Brighton.

Re *Cable Tender.*

DEAR SIR: Your letter of February 27th has been considered by the Cable Makers' Association, and I am requested to point out that the facts of the case do not support your contention that the foreign tender accepted was undoubtedly the most advantageous to the Corporation. This is shown by the prices of the various firms, as stated below:

| | Cables. | Carriage on empties. | Total. |
|---|---|---|---|
| Johnson and Phillips ... | £13,335 0 0 ... | £30 0 0 .. | £13,365 0 0 |
| W. T. Glover & Co. ... | 13,731 13 4 ... | 89 9 2 ... | 13,821 2 6 |
| B. I. W. Co. (Rail)...... | 13,859 0 0 ... | By rail £95. ... | 13,954 0 0 |
| B. I. W. Co. (Sea) ...... | 13,859 0 0 ... | By sea £75. ... | 13,934 0 0 |
| Foreign tender accepted, including carriage | | ........... ...... | £13,952 0 0 |

The carriage on the empty drums given in the second column is obtained from the weight of the drums necessary, and the railway company's charges to each manufacturer's works; so that even taking into account this cost of carriage (which is assumed to be included in the foreign tender), there is a difference in price in favour of the lowest British firm of £587.

The only other point which might be taken as increasing the cost of the British tenders is the stipulation that if the drums are not returned, carriage paid, within three months from date of delivery, two-thirds only of the original price charged would be allowed. As presumably the extensions of the circuit are carefully planned out, and the order of laying cables arranged, three months' time should be ample for emptying and returning drums; and the probable cost of keeping some few drums beyond the three months would be very small. But even if every drum were kept more than the stipulated time, the one-third of the cost paid to the manufacturer would still leave Messrs. Johnson and Phillips's tender considerably below the accepted one. The total number of drums required would be 130. These would be of various sizes and prices; but the average price would certainly not be more than £3 per drum, or a total cost of £390. Assuming that none of these drums are returned within three months, the Corporation would have to pay £130 as a maximum charge. This would still leave Johnson and Phillips's tender £457 below that of the Union Cable Co.

Referring to your statement that the Corporation is willing to consider any suggestions for the alteration of the conditions, but cannot consent to any alteration in the conditions when once issued; it is obviously impossible for any one to suggest alterations to a specification which they have not seen; and your proposition is untenable unless it is taken to mean that all tenderers must accept the conditions, however onerous they may be, and then ask as a favour that those objected to may be modified. I would point out that this is not a sound business proceeding, and any responsible firm would object to agreeing to conditions which they could not carry out.

The conditions of the Cable Makers' Association were published in October last. Copies have been sent to all consulting engineers and station engineers; among others, to your consulting engineer at Brighton. They were, moreover, published largely in the technical Press. Therefore, so far as is possible, the suggestions which you say your Corporation is willing to consider were made to your consulting engineer, and through him, of course, to you.

As you are aware, the Cable Makers' Association, in dealing with mains for town lighting, has endeavoured to standardise the general conditions of contracts, but does not consider the question of price, so that in no sense could it be looked upon as a ring for obtaining excessive profits.—Yours faithfully.

## ELECTROLYTIC PURE ZINC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the article by Mr. J. B. C. Kershaw, entitled "The Electro-Chemical and Electro-Metallurgical Industries in 1900," the concluding portion of which appeared in your issue of January 11th, we notice on page 428 what seems to be a printer's error with respect to the test of our electrolytic pure zinc. The figure there given of 99·5 per cent. should be *99·95* per cent. zinc. We shall be glad if you will make the necessary correction in your next issue.—Yours, &c.,

For BRUNNER, MOND & CO. (LTD.)
London, March 7. Alfred Mond, Managing Director.

## BOOKS RECEIVED.

"The Complete Cost-Keeper." By H. L. Arnold. (New York and London: The *Engineering Magazine* Press.)

"Engineering Estimates and Cost Accounts." By F. G. Burton. 2nd edition. (Manchester: Technical Publishing Co.) 3s.

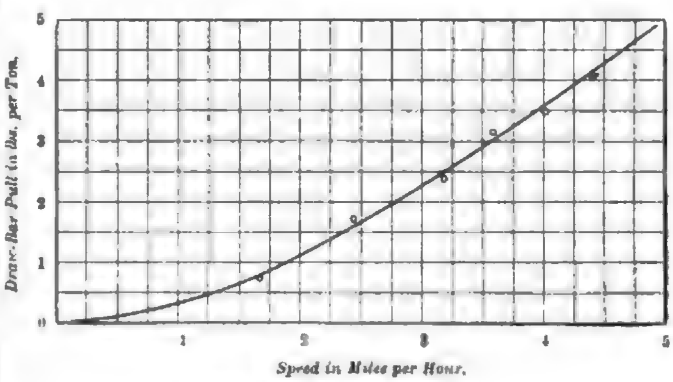
"Les Phénomènes Electriques et leurs Applications," by Henry Vivarez. (Paris: Carré et Naud.) 15f.

## ELECTRIC TRACTION ON CANALS.

The *Electrical World and Engineer* of New York for February 2 after announcing that the Erie Canal Electric Traction Co. is about to enter into contracts for the construction of a large number of electric tractors for use on canals in Europe and America, gives a history of electric traction on canals in America, and describes some interesting experiments made on April 26, 1900, on the Delaware and Raritan canal. The tractor consisted of an automobile carrying a storage battery and mounted on four steel wheels.

This tractor was worked for a considerable time, and the engineers of the Traction Company reported that it would move a freight at, in English money, $\frac{1}{20}$th of a penny per ton mile. The running gear was that of a standard delivery wagon, except that the wheels were 40in. in diameter instead of 42in., and it had 5in. steel tires instead of 2½in. solid rubber tires. The motor was built for 40 amperes, but was constantly overloaded during the test to from 150 to 200 amperes. The gearing reduction was 15·08 to 1. The vehicle was equipped with two sets of Electric Storage Battery Company's standard inverted 7 M.-V. batteries, making a total weight of 5,500lb., of which 2,700lb. was battery. The two batteries were placed in multiple. Their normal discharge rate at a three-hour rate was 33, but they were constantly worked at from 75 to 100 amperes per set.

The tests made were of two kinds. First, to determine the general behaviour of the vehicle in starting the towboats, hauling them back and forth through locks and manœuvring in general. Second, to determine the drawbar-pull per ton and its operation, with the speed and number of boats in the tow. During the test the two sand boats known as the "Admiral Dewey" and "Samuel Weller," the sand scow and a loaded coal boat were used. The "Admiral Dewey" weighed 100 tons, and "Samuel Weller" 125 tons, the coal boat 247 tons, and the sand scow 100 tons. These were towed sometimes singly and sometimes in twos.



Draw-Bar Pull, Canal Haulage.

1. *General Behaviour Tests.*—It can be briefly stated that no difficulty whatever was experienced, the tow-car picking up the boats and getting them up to speed in a very few minutes, and maintaining a uniform pull at all times. No tendency was noted towards side slipping of the wheels due to oblique pulling, although quite often pulling out of the locks the angle of draught was at least 20deg. Upon very sandy portions of the towpath a very noticeable circumferential slip of the wheels was noticed, but on the harder portions of the path this was unappreciable. In passing into and out of the locks no more difficulty was experienced than with an old and well-trained team of mules.

2. *Power Tests.*—At first both electrical readings on the tow-car and dynamometer readings on the boat were made. It was found, however, that the uneven nature of the towpath made such fluctuations in the dynamometer readings as to render them quite unreliable. The vibration of the needles of the electrical instruments, however, being very much less marked on account of their being dead beat, it was very easy to get accurate readings. The readings taken were of current only, as it was necessary only to obtain the average current in order to get the drawbar-pull developed, the speed observations being taken with a stop watch between known stations on the bank. Having the average current consumption, it was possible to obtain from the curves of the motor made from actual dynamometer tests just what torque was imparted at the motor shaft. Knowing the reduction between the motor shaft and the rear axle and the efficiency of its gearing, the latter having been obtained from dynamometer tests of the entire vehicle, and knowing the diameter of the wheel, the drawbar-pull was readily calculated.

A summary of the tests is given in the accompanying curve giving the average of 11 tests. Only the reliable and consistent tests appear

in this report. It will be seen that the curve of drawbar-pull at these loads and speeds follows approximately a straight line, the lower end of this line being probably a curve as noted by the dotted lines on the curve. It was expected that the drawbar-pull would decrease with the number of boats in tow, but the distance between successive boats required for convenient hauling was such that each boat had to make its own displacement, and consequently the resistance to each boat was approximately the same as that of the one immediately in front.

Within the range of the tests the drawbar-pull seems to follow fairly closely the general formula :—

$$y = ax - b,$$

which, after determining the constants, becomes

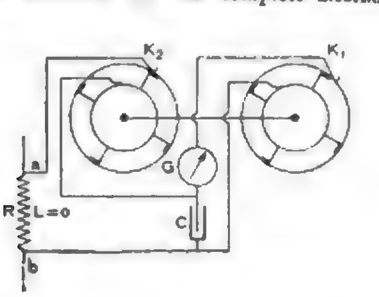
$$y = 1{\cdot}2x - 1{\cdot}3,$$

where $y$ is equal to the drawbar-pull and $x$ the speed in miles per hour. A peculiarity of the results is that the drawbar-pull for light and loaded boats seem to follow the same formula, at least within the range of speed and loads occurring in the test.

With reference to these experiments the system of accumulator traction along roads has not been successful in this country ; it may, however, prove a greater success for canal haulage, as the gradient is always of the very easiest, the stoppages very few, and the speed of the car slow, but this remains to be proved from actual works costs. The general results of these tests would also be applicable in the case of a trolley system of haulage.

## A NEW APPARATUS FOR RECORDING ALTERNATING-CURRENT WAVES.

In the *Proceedings* of the American Academy of Arts and Sciences for January there is a contribution from the physical laboratory of the Massachusetts Institute of Technology which describes an apparatus constructed at the Rogers Laboratory for recording alternating-current waves, the arrangement being a modification of the "contact method," by which the record is rendered continuous and traced photographically. The necessary electrical connections are shown in the diagram. $K_1$ and $K_2$ are two rigidly connected contact wheels of ebonite. Into the periphery of each wheel are set four brass blocks. These are accurately placed 90deg. apart. Upon each wheel a brush and collector ring give permanent contact with the blocks. Another brush resting on the periphery of the wheel completes electrical connection as the blocks pass under it. The brushes are so placed that contact is made and broken at $K_2$ before $K_1$ closes. The contact wheels are driven by a synchronous motor, which gives one revolution for four complete alternations of the



E.M.F. G is a dead-beat galvanometer, and C is an adjustable condenser. The leads $a$ and $b$ are carried to the points between which the P.D. is to be investigated. By inspection of the diagram it will be seen that once on each wave and at a definite point the condenser C is charged to the potential existing between $a$ and $b$. As the charge is determined by the breaking of the contact, the blocks may be of sufficient width to eliminate the effect of the jumping of the brushes. Also, the resistance at the contact will not be of sufficient magnitude to prevent complete charging of the condenser.

The function of $K_1$ is to discharge the condenser through the galvanometer after $K_2$ has broken circuit. The instrument would ordinarily experience a constant deflection, but $K_1$ and $K_2$ are rigidly connected and mounted on a radial arm, which is geared to the shaft so that it moves very slowly. The effect is to gradually move the contact point over the wave. The deflection of the galvanometer will at any instant be proportional to the P.D. between $a$ and $b$ at the instant of breaking at $K_2$, or in other words, the deflection follows the wave form.

The camera is also described, and several curves given which were taken with the apparatus.

# PARLIAMENTARY INTELLIGENCE.

### CAPE-AUSTRALIAN CABLE.

In the House of Commons on Monday Sir E. SASSOON asked whether, in view of the importance of the projected Cape-Australian cable as constituting a link in the All-British system, a copy of the agreement with the Eastern and Eastern Extension Telegraph Companies would be laid upon the table of the House ; whether permission had been granted for landing rights on each and all of the intervening mid-ocean stations ; and what terms and conditions had been attached thereto. In reply

Mr. CHAMBERLAIN said that no formal agreement had been signed, but landing rights had been granted at Mauritius, Rodriquez, and Cocos Islands on the condition that the sliding scale rates in force in regard to the traffic between England and South Africa were extended to these places. The landing licences contain the same conditions and stipulations in favour of the Government and the public as the licence about to be issued by the Board of Trade to the Eastern Telegraph Co. for the new cable from Madeira to Porthcurno. The Government had not required the insertion in the contract of a provision reserving the right of purchase to the Government.

### WIRELESS TELEGRAPHY.

In the House of Commons last night, Sir ROBERT PENROSE-FITZGERALD asked the President of the Board of Trade whether the Admiralty authorities have decided to put up wireless telegraph stations at Dover, Culver Cliff, Portland Bill, Rame Head, Scilly, and other places ; and whether he can now hold out hopes that this system will be adopted without delay for life-saving purposes.

Mr. G. BALFOUR : I am informed that certain stations are being erected by the Admiralty along the coast to test the value of wireless telegraphy. I regret I am not in a position to say more on the subject at present.

### UNDERGROUND TELEGRAPH LINES.

Sir JOHN LENG asked the Secretary of the Treasury whether he was aware that the commercial and manufacturing interest in Scotland complain of the frequent interruptions of the telegraph service during the storms of the past winter, and whether it was proposed to extend the underground system from Birmingham to the north of England and Scotland. What was the length of underground telegraph lines in Germany compared with this country ?

Mr. A. CHAMBERLAIN : The answer to the first part of the hon. member's question is in the affirmative, but it was a misapprehension to suppose that interruptions are unknown in Germany. On the 12th inst., the day when this question appeared on the paper, 11 out of the 22 wires between this country and Germany were interrupted, and in no case was the interruption in this country. According to latest statistics, the length of underground lines in Germany is about 3,940 miles, while in the United Kingdom there were, at the same date, 1,080 miles. The mileage of the underground wires, on the other hand, was 25,750 for Germany, and 40,600 for the United Kingdom. The Postmaster-General proposes during the ensuing financial year to begin the construction of two additional sections of underground lines in the North.

# LEGAL INTELLIGENCE.

### Cuba Submarine Telegraph Co. v. West India and Panama Telegraph Co. (Ltd.).

The Court of Appeal, consisting of Lords Justices Rigby, Vaughan Williams and Stirling, on Tuesday and Wednesday heard the defendants' appeal from a decision of Mr. Justice Farwell, fully reported in *The Electrician*, for May 25 last. The case raised questions as to the construction of an agreement of Jan. 31, 1870. Plaintiffs are the owners of certain submarine telegraph cables, and defendants own certain other submarine telegraph cables. By the agreement between the plaintiffs and a company of the same name as defendant company (predecessor of the defendant company) it was provided that the Cuba Company should hand over to and forward by the West India Company certain telegraphic messages, and that the West India Company will hand over to and forward by the Cuba Company certain other telegraphic messages, in each case with all possible expedition. Neither company was to enter into any agreement or traffic arrangement with any other company or persons, or be connected with or interested in any telegraphic line which might be prejudicial to the interests of the other company without the assent in writing under the seal of the company, but either company were at liberty to send messages over their lines at the written request of the sender of such messages, without solicitation or suggestion by any competing lines, provided that in such case the other company should share in the amount accruing in respect of such messages in proportion to the amount each company would have received had the messages gone over the lines of both companies.

Plaintiffs' case was that by means of defendants' cables they are in telegraphic communication with all places directly served by defendants' cables, and with places beyond with which defendants are in telegraphic communication, and, further, that by means of the cables from Havana to Florida, and of the land lines to New York, and of submarine cables from New York across the Atlantic, all places directly served by defendants' cables and places beyond with which defendants are in telegraphic communication with North America, and with London and other places in

Europe. A new cable had recently been laid between Bermuda and Jamaica by the Direct West India Cable Co., and by such means and the cables of companies allied with the Direct Company, the plaintiffs' case was that competition with the business of the plaintiffs and the defendants was threatened. They (plaintiffs) charged that any such arrangement as defendants threatened to make with the Direct Company whereby messages handed in by the Direct Company at Jamaica would be transmitted by defendants' lines to places south and east of Jamaica at a rate lower than that charged locally from Jamaica to such places would be an agreement or traffic arrangement prejudicial to the interests of the plaintiffs, and that any such arrangement would constitute a breach of agreement. Plaintiffs accordingly claimed an injunction to restrain defendants from committing a breach of the agreement; and also an injunction restraining defendants from forwarding any telegraphic messages received by defendants at Jamaica from the Direct West India Cable Co. for transmission to the east or south of Jamaica under an agreement or traffic arrangement which was or might be prejudicial to the interests of the plaintiffs, and for consequential relief and damages.

Defendants contended that they had never threatened or intended to do what the plaintiffs alleged, and further that the plaintiffs had claimed to do, and had for many years done, and were still doing, the very thing which they now claimed defendants were not entitled to do. In 1889 a French company (La Société Française des Telegraphie Sous Marin) opened a system of cables between Santiago de Cuba, Puerto Plata, San Dominique, Curaçoa and Venezuela, and in 1890 opened cables between Martinique and Paramaribo. In 1891 they also laid a system of cables between Paramaribo, Cayenne and Vizeo, and between Puerto Plata and Martinique, and the French company's lines therefore connected Santiago de Cuba (the eastern extremity of plaintiffs' system) with Martinique, Paramaribo, Cayenne and Vizeo, and thus it became possible to send messages from and to New York and London over plaintiffs' system. Defendants therefore counterclaimed for an injunction restraining plaintiffs from handing to the French company at Santiago de Cuba any telegraphic messages sent over plaintiffs' lines for transmission to Cayenne or Vizeo or any place south of Martinique except such messages as the sender thereof, without solicitation or suggestion, should in writing request plaintiffs to forward by way of the lines of the French company. By way of further relief defendants claimed an injunction restraining plaintiffs from entering into or continuing any agreement or traffic arrangement with the French company or any other company or persons which might be prejudicial to the interests of defendants, without their assent in writing.

Mr. Justice Farwell held that plaintiffs were entitled to succeed, and granted a declaration in the terms asked, although he left the form of the declaration to be settled by counsel. He accordingly gave judgment for the plaintiffs on the claim and counter-claim, with costs. Hence the present appeal by defendants.

Mr. HALDANE, K.C., for the appellants, said that going back to 1869 the important company in promoting telegraphic enterprise was the International Company, which had a cable from Lake City to Havana, and was connected with New York by another line. At that time the only connection with the West Indies was that of the International Company to Havana. The International was an American company which had obtained various concessions for cables in the West Indian islands, some from the Spanish Government and some through the English Colonial Office, and if it did not actually promote it took a great interest in the promotion of two companies which it was intended should enter into an agreement with it. The first company contemplated was the defendant company, the West India and Panama Telegraph Co., and this company was got up for the purpose of continuing telegraphic communication from Santiago to the West Indian islands and to the mainland. That was carried out and a cable was laid outside the island of Cuba touching at Cienfuegos to Santiago, the result being that there was now a direct line of communication between Lake City and Havana and between Havana and Santiago. He understood his learned friends on the other side to say that when the expression "telegraphic communication" was used in the agreement which was to be construed in this appeal it meant a question of rates—that in order to have telegraphic communication it was not necessary to lay the cables or to have control of the cables to a particular place, but that it was enough if they could get a message through at such a rate as would make competition possible between that and other companies. The defendants said, on the other hand, that in the agreement "telegraphic communication" meant having the cables. The words on which they relied were "effecting telegraphic communication, &c., by laying and working the cables."

Lord Justice RIGBY: You say that telegraphic communication means laying the cables?

Mr. HALDANE: Yes.

Lord Justice WILLIAMS: Are the words "telegraphic communication" in the agreement which we have to construe, or are they in an agreement which relates to the effecting of telegraphic communication?

Mr. HALDANE said that was just one of the questions. They certainly did refer to something more, and that would be one of the questions which their lordships would have to determine, whether they could limit telegraphic communication to the use of the cable of another company by making some arrangement or other. He next passed to the memorandum of association of the Cuba Company—a company which, he said, in a very large measure was an afterthought consequent upon the dangers attending the use of the existing Spanish land-line in Cuba. On July 24, 1869, there was an agreement between the International Company and the trustees for the West India Company, and six days later the last-named company was incorporated. Then, on January 21, 1870, the Cuba Company was incorporated, and subsequently, in the second year, there was entered into the agreement which was the subject of this litigation, and which was made between the Cuba Company and the West India Company.

Lord Justice WILLIAMS: Until the formation of the Cuba Company it had been proposed that communication should be by means of the Spanish lines running through Cuba?

Mr. HALDANE: Yes. In 1877 the West India Company was reconstructed, and the new company endorsed the old agreement. In 1882 lines were laid by the Western Union Company, these being the first competing lines between New York and the West Indies.

The hearing of the case had not concluded when we went to press.

## Lessing and another v. Electro-Chemical Co. (1900) (Ltd.).

In this case, before Mr. Justice Bigham, on Friday last, plaintiffs claimed £184. 11s. 1d. for carbon plates supplied. Plaintiffs carry on the business of the late Dr. Alb. Lessing, of Nuremburg, Germany, and in April, 1900, they contracted to supply defendants with 12 tons of electrolytic carbon plates at £38 a ton. The late Dr. Lessing was the inventor or possessor of a secret process which was considered to render the plates he produced of exceptional durability under heavy currents of electricity. There had been dealings between the parties previous to the contract now in dispute. The defence was that the goods delivered were not according to contract quantities and were of inferior quality. Defendants counterclaimed for damages for their works having been kept idle.

On Monday his lordship gave judgment for defendants on plaintiffs' claim with costs, and dismissed defendants' counterclaim without costs.

## Workmen's Compensation.

On Feb. 13, at the Liverpool County Court, Judge Collier decided an action in which plaintiff, a labourer in the employ of the Bootle Corporation, claimed compensation for the loss of the sight of his left eye through an accident which occurred while plaintiff was engaged in dressing road sets at Bootle, a chipping striking him in the face and causing the injury. Plaintiff's wages were £1. 1s. per week, and he had received £19. 19s.—19 weeks' wages—since the accident, and now sued for half his weekly earnings as long as the judge might direct, or for a lump sum in lieu thereof.

Judge COLLIER at the outset dealt with a technical point raised, and held that a simple intimation to the defendant Corporation that plaintiff might, under certain circumstances, proceed to law, could not be held to be a claim under the Workmen's Compensation Act, and he therefore decided that no claim for compensation had been made by plaintiff within six months from the accident, and he was consequently not entitled to compensation. He (the judge) had, however, considered the action from another standpoint, and held that sec. 7 provided that the act should apply only to employment by the undertakers "on or about railway or engineering work." There was no doubt that defendant Corporation were undertakers within the meaning of the act, but he held that the tramway lines which were to be laid down did not come within the definition of the word "railway" in the act. Plaintiff was dressing stones, which had been taken up and which were to be put down again when the tramrails had been placed in position. His connection with the tramway was, therefore, remote; but he held that the employment came within the words "on or in or about the tramway." Another point he had to decide was whether the tramway was an engineering work within the meaning of the act, and he thought the latter part of the definition given in the act to engineering work did not apply, and therefore the matter was reduced to the point—Was the tramway being constructed by the defendant Corporation a railroad within the meaning of the act? Tramlines or tramways were quite well known in 1897, and if the expression "engineering work" was intended to apply to them, he could not think that legislators would have omitted to name them, or would have taken the roundabout and unintelligible course of calling them railroads, a word seldom used in this country, and never applied to tramways. He therefore found that plaintiff's employment was not one to which the act applied, and awarded accordingly.

## Breach of Provisional Order.

At Marylebone (London) Police Court on Saturday, the Metropolitan Electric Supply Co. appeared to eight summonses, alleging breaches of the West London Lighting Order, 1889, by laying down more mains than had been sanctioned and approved by the late Marylebone Vestry (44 mains instead of 29).

Mr. BODKIN, who prosecuted, said in May last the company were desirous of laying low-tension mains from a distant station, and they deposited a plan of the proposed works with the Vestry, and, with slight exception, everything was agreed to. In November it was found the plans were being deviated from—the trenches were made wider than they should be; the mains, instead of being put under the footway, were carried into the carriage-way, and in some cases more mains were being laid than had been sanctioned, and were being laid, not one on top of the other, as agreed, but side by side.

Mr. MUIR, for the company, pleaded guilty to six of the summonses, and urged that the works shown on the plan had not been deviated from in a single instance in which the public interest was concerned. The only offence for which they were summoned was for laying five extra mains, and this was done by the engineer, under a mistaken idea of the rights of the company, in order to supply without delay a demand for continuous electric current to two customers. The additional space thus occupied, however, was exceedingly small.

The MAGISTRATE (Mr. Curtis Bennett) said the plan submitted by the company was most misleading, and nothing would have been heard of the extra mains but for the discovery made by the Council. The case was a bad one, and he inflicted the full penalty of £10, with £5. 5s. costs, on one summons, and £5, with £3. 3s. costs, on each of the remaining five, £56 altogether.

The other two summonses were withdrawn.

### Telephone Exchange Connections.

At Torquay County Court, on Saturday, the National Telephone Co. were sued for £14 for alleged breach of contract. The plaintiff, Mr. S. J. Trethewy, builder, applied to have his premises connected to the company's system. The necessary instruments were fitted up, but no connection was made. Plaintiff was subsequently sued for the rent of the telephone after several applications had been made. The rent was paid, and plaintiff became entitled to be connected up. The connection was, however, not made, and he now sued for damages. The company paid £1. 3s. 4d. into court and denied liability.

The magistrate found that plaintiff had no case in regard to the main point. The contract entered into between the parties stipulated that the rent should be paid in advance. But when he did pay the rent he was entitled to connection and was therefore entitled to damages for the period when no service was rendered by the company. Judgment would therefore be for plaintiff for £2. 2s. and costs.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Edinburgh University Patronage Curators notify that the Professorship of Natural Philosophy will be vacant from April 29 next, owing to the resignation of Prof. Tait. Applications for the professorship must reach the Secretary, 4, Albyn-place, Edinburgh, by June 1.

A principal is required for the Northern Polytechnic Institute, Holloway, London. Applications to clerk to the governors before March 30.

Coventry Electric Light committee invite applications for the position of manager of their electricity works. An advertisement contains further particulars, and applications must be delivered at the office of the town clerk (Mr. Lewis Beard) by 5 p.m., 22nd inst.

Perth Corporation require a switchboard attendant, also a junior assistant, and two improvers. Applications to the burgh electrical engineer (Mr. John Lambert) by March 27. See advertisement.

An assistant engineer for supervising outside work is required by the Tudor Accumulator Co., 16, Victoria-street, London, S.W. See advertisement.

Nelson Tramways and Electricity committee require an electrical engineer. An advertisement contains further particulars, and applications must be sent to the town clerk (Mr. R. M. Prescott), Town Hall, Nelson, by 25th inst.

The British Electric Traction Co. are prepared to admit a limited number of qualified students as pupils. See advertisement.

Lambeth (London) Borough Council require a chief engineer for their baths and washhouses, Kennington-road, S.E. Applications to town clerk by 12 noon of March 20.

The appointment by the Southport Corporation of Mr. R. S. Downe, as borough electrical engineer, in succession to Mr. C. D. Taite, who was recently appointed as chief of the Salford electricity department, has been confirmed. Mr. Downe served his time with Messrs. Simeon Bros., engine builders, Leicester, and, subsequently, joined the National Electric Supply Co., of Preston, remaining with this company until he attained the position of assistant engineer. He afterwards joined the staff of the Derby Corporation electricity works, and later served with Mr. A. Bromley Holmes, at Liverpool, where he gained promotion from station superintendent to mains superintendent, and ultimately to the position of assistant engineer.

Plymouth Corporation on Monday confirmed the appointment of Mr. E. G. Okell as borough electrical engineer at a salary of £350 per annum, increasing by annual increments of £50 to £500 per annum. The recommendation to appoint Mr. S. T. Allen as assistant engineer has been referred back.

Mr. Richard Pape, of the Sculcoates-lane station of the Hull Corporation, has been appointed resident electrical engineer at Morecambe in succession to Mr. C. F. Parkinson.

**Arbroath.**—Messrs. Mathew Buchan and Hogarth have been appointed consulting engineers in connection with the Corporation's application for a provisional electric lighting order.

**Aylesbury.**—The Council have decided to obtain terms from companies for the erection and maintenance of electricity works for a term of years.

**Barrow.**—The British Electric Traction Co. have arrived at an understanding with the Corporation on the tramway question. The present track has been condemned by the Board of Trade, and the licence to run steam engines expired on Feb. 11, but since then the Board have issued temporary licences. The company offered to sell the undertaking for about £23,000, but the Corporation declined to purchase because the conversion to electric traction would entail heavy expenditure. The company then offered to lay down a complete electric tramway system if the Corporation would extend the lease, and the Corporation have now decided to grant a lease for 28 years, the company to substitute electricity for steam and to take current from the town supply. These terms have been conditionally accepted by the company, who contemplate an expenditure of about £65,000 on the lines.

**Canada's Landline Telegraphs.**—The *Commercial Advertiser*, of New York, states that the Canadian Government is actively negotiating for the nationalisation of the telegraph land-lines in Canada. The acquisition of the Great North-Western Telegraph system with its Western Union Canadian connection are said to be a preliminary to the general scheme.

**City of London.**—At yesterday's meeting of the Court of Common Council the Streets committee announced that they had received an intimation from the Charing Cross and Strand Electricity Supply Corporation of intention to open all the principal streets in the central portion of the City, for the purpose of laying cables. The chairman of the committee said that although this meant another upheaval of the streets a stipulation had been made for day and night working.

**Clacton.**—The Council have declined the offer of a syndicate to construct electric tramways and to establish electricity generating works. The Council will retain their electric lighting powers.

**Competition.**—An international electrical accumulator competition is being organised by the Automobile Club of France to commence on June 1. Particulars of the Club, Place de la Concorde, Paris.

**Customs Tariff.**—Under the new customs tariff of British Honduras plant and material for railways, tramways, electric lighting, telegraphs, and telephones are exempt from customs dues.

The new Swiss tariff imposes a duty of £1. 0s. 4d. per cwt. on drawn platinum wire imported into that country.

From April 1st electric transformers imported into Norway, which are at present duty free, will pay an ad val. duty of 5 per cent.

**Darlington.**—The electricity works were formally opened on Monday.

**Ealing.**—The District Council have instructed Mr. B. H. Jenkinson, C.E., to inspect the neighbourhood with the chief electrical engineer (Mr. J. D. Knight) and report generally on the extension of the electricity undertaking, free wiring, &c., at an inclusive fee of £10.

**Electricity in Mining.**—In further reference to the note which appeared on p. 753 of our issue of March 8, on the subject of the application of electricity to driving the machinery at the Kolar gold mines of Mysore, it is anticipated that this work will be nearly completed within the next 15 months. In addition to the 4,000 H.P. which is, under contracts recently let, to be provided a further 4,000 H.P. is available if required. The initiative in this great undertaking has been taken by the Mysore Government, who will charge £29 per H.P. for the first year, £17 for the next three years, and £24 for the fifth year, after which the charge will be £10 per annum. The present cost of steam power is £30 per H.P. per annum.

**Farnworth.**—The Council has instructed Messrs. Lacey, Clirehugh and Sillar to prepare specifications for about 5 miles of tramway extensions.

**Folkestone.**—An inquiry is to be held this week into the application of the Corporation for powers to construct electric tramways.

**Leicester.**—The accounts of the electricity department for the half-year ended Dec. 31 show that, after paying interest and sinking fund (£1,068. 3s. 1d.), there was a profit of £1,287. 5s. 8d. The profit on the June quarter was £362. 5s. 4d., making a total of £1,649. 11s. for the year.

**Light Railways.**—The Mid-Suffolk Light Railway (Amendment) Order has been submitted to the Board of Trade for confirmation. Objections by 29th inst.

The Wakefield and District Light Railway Order has also been submitted for confirmation. Objections by 30th inst.

**Manchester.**—The Electricity committee propose to erect a temporary generating station at Stuart-street, Bradford, to provide electric power for running the tramcars over many of the routes in the city by the summer of 1902. This arrangement would enable the Corporation to meet its obligations to neighbouring authorities, and also to the Tramways committee.

**Merthyr.**—The electric tramways were officially inspected on behalf of the Board of Trade on Tuesday. The electrical equipment will be inspected on Monday next by Mr. A. P. Trotter.

**Municipal Loans.**—*Colne* Town Council have obtained sanction to a loan of £33,729 for electric lighting, but the loan of £4,000 for a light (electric) railway has been deferred. *Doncaster* Corporation have also obtained sanction to borrow £18,000, and *York* Corporation £20,000 for electric lighting. *Aberdeen* Gas and Electric Lighting committee are applying for a further loan of £81,000.

The *Arbroath* Council recently applied to the Secretary for Scotland for power to borrow under the Gas Acts a sum of £40,000 for electric lighting. The Secretary has, however, notified the Council that he cannot consent to borrowing powers for electrical purposes to a greater extent than the unexercised borrowing margin under the Arbroath Gas Act, which amounts to £11,000, but the question of amending the Electric Lighting Acts so as to remove the difficulty referred to would be considered. There was nothing in the Private Legislation Procedure (Scotland) Act, 1899, to prevent the promotion of an order for the additional borrowing powers, but the preferable course would be to apply for a provisional order under sec. 45 of the Burgh Police Act, 1892, and the Council have accordingly adopted that course.

Sanction to a loan of £12,000 for electric lighting has been obtained by the *Southampton* Corporation, but the Local Government Board has been asked to extend the period from 22 to 25 years —the period of previous loans.

*Hornsey* District Council have obtained sanction to a loan of £73,500, and tenders for plant are being invited.

Acting on the advice of their consulting engineers (Messrs. Kennedy and Jenkin) application has been made by the *Kirkcaldy* Corporation for sanction to borrow £50,000 for electric lighting, and tenders are now being invited for plant, &c. The refuse destructor portion of the scheme has been abandoned.

Application has been made by the *Morley* Corporation for sanction to borrow £7,050 for electric lighting extensions.

**Municipal Telephony.**—Eastbourne Council have decided to ask the National Telephone Co. if they are willing to dispose of their undertaking in Eastbourne to the Corporation. A deputation has also been appointed to visit Tunbridge Wells to obtain information on the question of municipal telephony, and the Telephone sub-committee has been authorised to engage Mr. A. R. Bennett to prepare a report on the subject.

Bristol Corporation have appointed a committee to consider and report as to obtaining a licence to establish a municipal telephone exchange.

**Newcastle-under-Lyme.**—Messrs. Lacey, Clirehugh and Sillar have been instructed by the Council to report on electric lighting matters.

**Poland.**—The Russian Union Electrical Co., Riga, has completed and opened for traffic an electric tramway between Pabiance, Lodz, and Zgierz, about 12 miles in length. Both passengers and goods are being carried.

**Police.**—Francis Sims, aged 34, described as a wireworker, was charged at Clerkenwell (London) police court, before Mr. Chapman, on Tuesday, with embezzling several sums of money belonging to the Electrical Trades Union. Prisoner was described as general secretary to the Union for the past four years, and the moneys embezzled were the subscriptions of the members from various branches, amounting to about £80. Prisoner pleaded guilty, and urged that he only received £2 weekly as general secretary, and out of that sum "I had to carry the Union on his back and work for 80 hours a week. He received nothing for out-of-pocket expenses, and on a salary less than the union demanded from employers, was expected to travel about the country and spend money freely." Prisoner was sent to gaol for six months.

Prisoner's statement is at variance with one sent out by the Electrical Trades Union to the effect that Sims's salary was £2. 10s. per week, his office hours 9 till 5, and, if employed on the business of the Union more than 6 miles from home, he had an allowance of 7s. 6d. per day for expenses.

**Postal Telegraph Clerks' Grievances.**—At the annual conference of the Postal Telegraph Clerks' Association, held in Manchester last week, a resolution was moved and carried unanimously urging upon the Postmaster-General the necessity for a general increase in the pay of the telegraph department. The mover referred to the disproportion between the pay of the postal telegraph clerks and the clerks in the employ of the cable companies. The maximum of the postal telegraph department clerk was in London £150, and in the provinces £146, while those in the cable companies' service received a maximum of £204.

The conference also passed a resolution protesting against the detention in the postal telegraph service of any officer beyond the age of 60 years.

**Private Bill Legislation.**—The Brompton and Piccadilly Circus Railway Co has withdrawn its proposed extensions, excepting the line between Piccadilly and Bloomsbury-square, about ¾ mile. The estimated expenditure on extensions is therefore reduced from £1,569,689 to £334,944.

The following bills have been read a second time in the House of Lords :—Harrogate Corporation, Tyneside Tramways and Tramroads, Chester Corporation Tramways, Charing Cross, Euston and Hampstead Railways (Nos. 1 and 2), Brompton and Piccadilly Circus Railway, South-Western and Isle of Wight Junction Railway, Birmingham (City) Tramways, and Wigan Corporation Tramways.

The following bills have been read a second time in the House of Commons :—Metropolitan Electric Supply, Bexley Tramways and South Yorkshire Electric Power.

Fifteen petitions have been presented against the Manchester and Liverpool Express Railway Bill, but the majority of these are for the insertion of protective clauses.

**St. Anne's-on-Sea.**—The electricity works were opened on 5th inst.

**Seaford.**—The Council have, conditionally, offered to take a transfer of the provisional order which was obtained by a syndicate in 1900.

**Sheffield.**—The Brush Co. has issued a writ against the Corporation for £1,725, balance of purchase moneys payable under a contract dated Nov. 21, 1898, for the supply of electric plant, and the Town Clerk has been instructed to enter appearance.

**Southern Nigeria.**—A great increase in the value of the exports of rubber from this district is a feature of recent trading. In the period March, 1899, to March, 1900, these exports rose more than 65 per cent.—from 874,298lb. to 1,450,567lb., valued at £105,117, compared with £60,608 in the previous annual period. The prospects of the rubber trade in the Protectorate are enormous.

It would appear from the latest reports that there is no telegraph system in existence in the Protectorate, but it is hoped that the line from Lokoja will be extended to Asaba, and ultimately across to Old Calabar. Telegrams from Bonny to Old Calabar are sent by mail steamers which call at the former place once a fortnight. Altogether the arrangements for telegraphic communication between the Protectorate and England are primitive and unsatisfactory. There is no public and only one private telephone installation in the Protectorate.

**South Wales Electricity Scheme.**—At the invitation of Mr. Mark Robinson (Messrs. Willans and Robinson) a gathering of the leading commercial and business men of South Wales dined at the Park Hotel, Cardiff, on Tuesday, to inaugurate the opening of the offices of the South Wales Electrical Power Distribution Co. in Park-place. Supporting Mr. Robinson, who is chairman of the South Wales Co., were many of the directors of the company, the leading railway and mining representatives of the district, Mr. Graham Harris, C.E. (Messrs. Bramwell and Harris, consulting engineers to the company), Mr. G. L. Addenbrooke (managing director), &c. The chairman referred to the advantages which must accrue to the district from the ready and economical application of electricity as a motive power for working mining machinery and for other purposes, and pointed out that the new company were pioneers in the district in what might prove to be one of the most important movements of the time in relation to the prosperous coalfields of South Wales.

**Sudbury.**—The Council, owing to opposition by the ratepayers, have abandoned their electric lighting scheme.

**Sunderland.**—The Corporation have decided to extend the arc lighting system at an estimated cost of £3,280, and 82 additional arc lamps are to be erected in the principal thoroughfares.

**Telegraphs in the Ottoman Empire.**—It is announced that the Turkish Government has decided to establish telegraphic communication between Medjd and Basra. The work is to be carried out by a joint corps of military and civil telegraphists. There is also to be a telegraphic line established to connect the Yemen system with that of the Hedjaz, starting from Léhi, passing along the coast of the Red Sea on to Leyt, a total distance of 1,045 kilometres. The Turkish Posts and Telegraphs Department is also said to have secured the necessary credit for the purchase in Europe of submarine cables to replace those now laid between Galata and Stamboul.

**"The Journal."**—Part No. 147 of the *Journal* of the Institution of Electrical Engineers is now ready, price 2s. ; also Part 148, price 4s. An advertisement contains particulars of contents.

**Underground Telegraphs.**—At a meeting of the Glasgow Chamber of Commerce a communication from the Postmaster-General was read, stating he was hopeful in the next financial year of extending the London-Birmingham underground telegraph line further north, and, starting from Preston, to commence another section, the object being to add to the stability and regularity of the Scottish telegraph service.

**Vibration on the Central London Railway.**—The Board of Trade inquiry into the alleged damage to property by vibration on the Central London Railway is to be resumed next week, when additional witnesses will be called. The committee's course of procedure involves the postponement of the sittings of the proposed joint committee of both Houses on the London electric railway bills.

**Wells.**—The Board of Trade threaten to revoke the Wells provisional order (obtained in 1896) unless the Council show some disposition to carry out its provisions.

**West African Telegraphs.**—In the Portuguese province of Angola telegraphic communication has recently been much extended and Loanda can now communicate with Ambriz, Kinsembo, Mussera, Ambrizette, and Quinzau, and in a short time will be in touch with Santo Antonio do Zaire, at the mouth of the Congo. To the south,

communication with Novo Redondo will soon be established. Golungo Alto, Cazengo, Dondo, Pungo Andongo, Malange, and Calullo (in the Libollo country) are all in touch with Loanda with a through-rate service to Europe. There is also a telegraph line from Mossamedes to the interior as far as Chibia.

**Concert.**—The staff of the traffic department of the Eastern and Associated Telegraph Companies gave an excellent Bohemian concert at the Great Eastern Hotel, Liverpool-street, London, on Friday last. Mr. W. Hibberdine (traffic accountant to the companies) occupied the chair. The lengthy programme was almost entirely contributed by members of the companies' staff, and the executants included the following well-known names:—Mr. A. W. Hibberdine (son of the chairman), Mr. L. B. Draper (son of Mr. George Draper), Mr. W. J. Finnis, Mr. J. F. Harrap, Mr. J. L. Verne, Mr. W. G. Calder, and Mr. W. H. Owen. The Soldiers' and Sailors' Families Association funds benefited to the extent of some pounds by the sale of tickets.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London:—*

### READY.

(Price 12s. 6d., by post, 13s. 3d.; Colonies, 14s.; abroad, 14s. 6d. United States, 15s.)

**"The Electrician" Electrical Trades' Directory and Handbook for 1901** (corrected to February 4, 1901).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. The latest developments of State and Municipal Telephone enterprise are set out from official sources, as well as the progress of the National Telephone Co.'s service. In the division of "Electric Light, Power and Traction," the valuable Digest of the Law on these subjects by Mr. A. C. Curtis-Hayward, B.A., solicitor, has been much extended; the full text of the Electric Lighting Acts and the Board of Trade Accounts Forms have been added; and Sketch Maps and particulars of the Electric "Bulk" areas are also given, together with a coloured sketch map of the Electric Railways and Tramways of the United Kingdom. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to Feb. 11. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 4, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

"LOCALISATION OF FAULTS IN ELECTRIC LIGHT MAINS."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"THE ART OF ELECTROLYTIC SEPARATION OF METALS."—A second issue of Dr. Gore's book is now ready, price 10s. 6d., post free. The author treats fully both the theoretical principles of the art of electrolytic separation of metals and the practical rules and details of technical application on a commercial scale. The work is adapted to the use of the manufacturer as well as the student.

"ELECTROMAGNETIC THEORY."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"ELECTRICAL TESTING FOR TELEGRAPH ENGINEERS."—By J. Elton Young, M.I.E.E. The scope of the book aims at furnishing a fuller treatment of the subject, from the standpoint of the Telegraph Engineer, than it has hitherto received, whilst it endeavours to facilitate a thorough comprehension of the theory of testing as applied to electrical lines in general. Demy 8vo, fully illustrated. 10s. 6d., post free.

"WIRELESS TELEGRAPHY: SIGNALLING ACROSS SPACE WITHOUT WIRES BY ELECTRIC WAVES." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"ELECTRIC LAMPS AND ELECTRIC LIGHTING," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"ELECTRICAL ENGINEERING FORMULÆ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour; price 7s. 6d.; by post, 7s. 9d.; abroad, 8s. *New Edition nearly ready.*

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Hornsey* District Council invite tenders for boiler-house and engine-house plant, condensing and water cooling apparatus, pipework, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains, and arc lamps, &c., for public lighting, meters, and workshop equipment. An advertisement contains further particulars, and specifications may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after 16th inst. Tenders to clerk (Mr. F. D. Askey), Southwood-lane, Highgate, N., by 4 p.m. of April 11.

*Ayr* Corporation invite tenders for the supply, delivery, and erection of water-tube boilers, stokers, &c., condenser and pumps, accumulators, &c., balancers, and boosters. Plans and specification may be obtained from the borough electrical engineer (Mr. Arthur J. Fuller), and tenders must be lodged with the town clerk (Mr. A. G. Young), Town Buildings, Ayr, by March 20. See advertisement.

*Stockton-on-Tees* Electric Light committee invite tenders for an additional 300kw. steam dynamo. An advertisement contains further particulars, and tenderers are to forward specifications of their standard sizes of plant and state earliest time of delivery to town clerk (Mr. Mat. B. Dodds), by 11 a.m. of 26th inst. Additional particulars may be obtained from Mr. William Ford, manager, gas and electricity works, Thompson-street, Stockton-on-Tees.

*Leith* Corporation invite tenders for the supply, delivery and erection of a 350kw. steam dynamo. Specification, &c., may be obtained from the burgh electrical engineer (Mr. J. Gray Scott). An advertisement contains further particulars.

*Colne* Electrical committee invite tenders for a 160kw. dynamo coupled to an Allen or Belliss steam engine. An advertisement contains further particulars, and specifications, &c., can be obtained from the borough electrical engineer (Mr. A. G. Cooper). Tenders to the chairman of committee, Town Hall, Colne, by March 22.

*Wigan* Corporation invite tenders for (1) cables, (2) trolley line, (3) steel poles, (4) castings. Particulars may be obtained from the borough electrical and tramway engineer (Mr. H. Collings Bishop), to whom tenders must be sent by March 27. See advertisement.

*Kircaldy* Corporation invite tenders for the supply, delivery, and erection of engines and dynamos, storage battery and overhead travelling crane. An advertisement contains further particulars, and specification, &c., may be seen at but not obtained from the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. Wm. L. Macindoe), by 10 a.m. of April 15.

*Leeds* Lighting committee invite tenders for steam, feed water, exhaust, overflow, blow-off, and other pipes, valves, hot-wells, feed-water pumps, economiser, &c., in connection with engines of 4,000 I.H.P. Specifications, &c., from the manager (Mr. Harold Dickinson), 1, Whitehall-road, and tenders to town clerk (Mr. W. J. Jeeves) by Monday, April 15. An advertisement contains additional particulars.

The *British Electric Traction Co. (Ltd.)* (on behalf of the Gravesend and Northfleet Electric Tramways), invite tenders for construction of new tramways in Gravesend and Northfleet, and reconstruction of existing lines in Gravesend; also for overhead electrical equipment. Tenders to secretary, Donington House, Norfolk-street, W.C., by 25th inst.

*Newport* Corporation invite tenders for constructional steel-work, bunkers, &c., steel flue, coal and ash conveyor, winches for outside coalhandling, overhead travelling crane, water tube boilers, mechanical stokers, fuel economiser, water storage tanks, compound condensing vertical engines, electric generators, condensing plant with cooling towers, and feed pumps. Tenders to town clerk by 5 p.m. March 26.

*Burnley* Electricity committee invite tenders for cable for their lighting extensions and tramway scheme. Tenders to chairman by March 21.

*Burnley* Tramways committee invite tenders for rail bonds and overhead equipment of tramway. Tenders to chairman by March 23.

*Burnley* Tramways committee invite tenders for steel rails, fish plates, sole plates, tire-bars, bolts and nuts. Tenders by 26th inst.

*West Ham* Corporation require high and low-tension, paper-insulated cable, boxes, &c., double-pole house cut-out boxes, recording wattmeters, transformers and transformer tanks, house wire and wiring accessories, engine-room stores. Tenders to town clerk by 4 p.m. March 22.

*Walthamstow* District Council invite tenders for wiring and supplying and fixing fittings for the electric lighting of the town hall, public

baths, public library and technical institute. Tenders to clerk by 5 p.m. March 19.

*Manchester* Electricity committee invite tenders for a switchboard for connecting four 1,800kw. generators to the lighting and traction systems, and four continuous-current motors for driving mechanical stokers and economisers. Tenders by 25th inst.

*Manchester* Tramways committee require car tools and red deal timber. Tenders by 19th inst.

*Sunderland* Corporation invite tenders for indiarubber-covered cables, stoneware casing, wrought-iron piping, cast-iron piping and cast-iron box frames and covers. Tenders to chairman of Lighting committee by noon 29th inst.

*Wolverhampton* Tramways committee require tenders for the complete overhead equipment of about 5 miles of tramway route and the supply and laying of feeders, conduits, and switch pillars. Tenders to chairman by 23rd inst.

*Brighton* Corporation invite tenders for steel and ironwork required in the construction of an electric power house at Southwick. Tenders to town clerk by 10 a.m. April 26.

*Croydon* Guardians require electrical fittings and appliances. Tenders to offices, Mayday-road, Thornton Heath, by March 18.

*Greenock* Police Board require tenders for wiring the free library. Tenders by 18th inst.

*Gorton* District Council invite tenders for electricity supply for lighting for five, seven, nine, or 12 years. Tenders to clerk by March 22.

*Shipley* District Council invite tenders for house terminals, boxes and switch-gear, motors and switch-gear, meters, wiring, cables, wires, switches, fuses, fittings, &c. Tenders by March 19 to clerk.

*Fulham* (London) Borough Council invite tenders for wiring the Central Library. Tenders to acting town clerk by 4 p.m. March 20.

*West Sussex* County Asylum Visiting committee require electric lighting sundries for 12 months from April 1. Tenders to clerk, West Pallant, Chichester, by March 26.

*Warrington* Corporation require steel rails, paving, &c., steel poles, brackets, trolley wire, insulators, &c., and electric tramcars. Tenders to town clerk by noon 27th inst.

*Colwyn Bay* District Council invite tenders for a 120kw. steam dynamo and switchboard extensions. Tenders to clerk by March 22.

*Darwen* Corporation invite tenders for feeder cables, pillars and overhead electrical equipment. Tenders to town clerk by 25th inst.

*Buxton* District Council invite tenders for an electrically driven triplex pump of approximately 17 H.P. Tenders to clerk by 23rd inst.

*Hackney* (London) Borough Council invite tenders for erection of wharf and 1 y.by for their electricity works. Tenders by 28th inst.

*Dundee* Town Council require about 1,540 tons of steel girder rails and 60 tons of fish plates. Tenders by 28th inst.

The *Portuguese* Telegraph Administration require tenders for telegraph supplies, including 10,000 zinc cylinders (Leclanché), 7,000 iron supports for insulators, and 5,000 porous and 1,000 glass Leclanché jars. Tenders by 20th inst. to Inspector-General of Telegraphs, Lisbon.

*Norwegian State Railways Administration* invite tenders, until 20th inst., for 12,000kgs. galvanised iron wire (4mm.), 4,500kgs. copper wire (2¼mm.), 5,000 insulators, and 5,000 insulator holders. Tenders to Styrelsens Expeditionskontor, Statsbanerne, Christiania.

*Piatra Neamt* (Roumania) municipality invite tenders until April 10 for an electric lighting concession for 30 years.

## TENDERS RECEIVED AND ACCEPTED.

The following tenders have been received by the Brighton Corporation for the supply of continuous current arc lamps and accessories :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Brockie-Pell Arc Lamp (*accepted*) | £1,753 | 7 | 6 | Crompton & Co. | £2,240 | 0 | 0 |
| P. R. Jackson & Co. | 2,374 | 0 | 0 | Gilbert Arc Lamp Co. | 2,080 | 17 | 6 |
| British Schuckert Co. | 2,290 | 0 | 0 | New Century Arc Light Co. | 2,012 | 15 | 0 |
| Oliver & Co. | 2,248 | 13 | 6 | | | | |

Tenders were also received from Veritys Limited, the Electrical and General Engineering Co., and Johnson and Phillips, but these firms not having sent in a sample lamp within the time specified in the specification their tenders were not entertained. The committee recommended that the tender of the Brockie-Pell Co. to supply 115 double carbon arc lamps and to fix 107 of same on standards erected by the Corporation, and to perform all other work in connection therewith for £1,753. 7s. 6d. be accepted, and this was approved.

On the presentation, on Wednesday, of the Sheffield Tramways committee's report recommending the acceptance of the Leeds Steel Co.'s tender for steel rails and fish plates at £24,156, Mr. Senior moved that the minute be referred back. One reason against contracting at present was the price of coal, which increased the cost of manufacturing steel. Mr. Senior also objected to the proposed rails because they were to be made of basic Bessemer steel. Rails of acid Bessemer would last 10 per cent. longer and would be safer. After discussion Ald. Clegg accepted the amendment, and said that the opinions which the committee had obtained were about equally divided. He though the best plan would be to consult Prof. Arnold or someone at the technical school. The saving if they had basic steel rails would be about £1,200, but that was a small matter and should not weigh against the question of quality.

Wigan Corporation have received the following tenders for the supply of two 210kw. steam dynamos, switchboards, two Korting condensers and cast-iron piping, lap-welded and welded flange steam piping, feeder boosters and battery milker :—

| | | | | | |
|---|---|---|---|---|---|
| Lister Elec. Light Co. | £6,552 | 6 | Greenwood and Batley | £4,137 | 10 |
| Brush Co. | 4,802 | 0 | Johnson and Phillips | 4,120 | 0 |
| Sunderland Forge Co. | 4,490 | 0 | Thos. Parker (Ltd.) | 4,106 | 0 |
| Crompton & Co. | 4,382 | 0 | Elec. Construction Co. | 4,101 | 16 |
| British Westinghouse Co. | 4,380 | 0 | Mather and Platt | 4,097 | 0 |
| Anchor Electric Co. | 4,329 | 0 | Siemens Bros. & Co. | 4,037 | 0 |
| E. Scott and Mountain | 4,291 | 10 | Ashton, Frost & Co. | 4,009 | 15 |
| D. Bruce Peebles & Co. | 4,262 | 0 | Bullock Elec. Mfg. Co. | 3,907 | 0 |
| Newton Elec. Works | 4,222 | 0 | Warren, Beattie & Co. | 3,821 | 0 |
| J. H. Holmes & Co. | 4,203 | 6 | General Elec. Co. | 3,760 | 0 |
| John Fowler & Co. | 4,157 | 0 | | | |

Southwark Borough Council have received the following tenders :—

*[illegible]kw. Steam Alternator.*

| | | |
|---|---|---|
| Siemens Bros. & Co. (*accepted*) (second lowest of four tenders) | £4,310 | 0 |
| Bow, McLachlan & Co. (lowest of two) | 5,500 | 0 |
| Brush Co. (only tender) | 5,270 | 0 |
| Crompton & Co. (lowest of two) | 5,034 | 0 |
| Johnson and Phillips (only tender) | 4,850 | 0 |
| General Electric Co. (only tender) | 4,813 | 10 |
| S. Z. de Ferranti (lowest of three) | 4,610 | 15 |
| Ashton, Frost & Co. (only tender) | 4,398 | 0 |
| Electric Construction Co. (lowest of two) | 4,390 | 0 |
| Dutilh-Smith, McMillan & Co. (lowest of two) | 4,379 | 0 |
| Mather and Platt (lowest of three) | 4,180 | 0 |
| Willans and Robinson (lowest of five) | 4,070 | 0 |
| British Westinghouse Co. (lowest of five) | 4,064 | 0 |
| British Schuckert Co. (lowest of three) | 4,030 | 0 |
| Bergtheil and Young (lowest of four) | 3,827 | 0 |
| C. A. Parsons & Co. (only tender) | 3,520 | 0 |

*Two Water-tube Boilers.*

| | | |
|---|---|---|
| Babcock and Wilcox (*accepted*) | £3,230 | 0 |
| J. Thompson | 3,900 | 0 |
| R. Hornsby & Sons | 3,709 | 0 |
| Stirling Boiler Co. | 3,460 | 0 |
| Dutilh-Smith, McMillan & Co. | 3,300 | 0 |

Leyton District Council have received tenders from W. T. Henley's Telegraph Works Co., the British Insulated Wire Co., Siemens Bros. & Co., Callender's Co., Western Electric Co., and W. T. Glover & Co., for 4 miles of 0·2in. and 2 miles of 0·1in. cable, and the tender of the first-named company has been accepted at £311 per mile for the 0·2in. and £196 per mile for the 0·1in cable.

Wolverhampton Corporation have accepted the tender of Messrs. Thomas Parker (Ltd.) for switchboard extensions at £374, that of the Electric Construction Co. for a new generator at £3,710, and that of Messrs. H. Willcock & Co. for alterations and additions to the generating station at £1,332. 18s. The Corporation also confirmed the acceptance of the tender of Mr. H. Holloway, amounting to £54,838. 10s. 10d., for the construction of the electric tramways from Tettenhall to the borough boundary at Bilston, and the Tramways committee were authorised to accept tenders for the construction of the Dudley-road and Cleveland-road route and the tramway between Darlington-street and Tettenhall-road, not exceeding in amount the scheduled rates included in the tender of Mr. Holloway.

The tender of Messrs. W. H. Allen, Son & Co. (Ltd.) has been accepted by the Great Yarmouth Corporation for the supply of two 300 H.P. steam engines, with dynamos by the British Schuckert Electric Co.

Walsall Corporation have accepted the tender of Mr. T. Tildesley for extensions of the electricity station building at £2,020.

West Bromwich Corporation have accepted the tender of Cowans Limited for house terminal boxes, and that of the General Electric Co. for meters.

Eastbourne Town Council have accepted the tender of the Alphons Custodis Chimney Construction Co. for the erection of a chimney shaft at the electricity station for £1,340.

The contract for the electric lighting installation at the Stalybridge Post Office has been let to Crowthers & Co.'s Electrical Industries (Ltd.).

The United Asbestos Co. has (for the 15th successive year) been awarded a large portion of the contract for the supply of asbestos goods to H.M. Navy.

Ayr Town Council have accepted the tender of Mr. W. Watson for mason work at the electric tramcar station at £1,415, and that of Messrs. D. and J. Milligan for joinery work at £395. Tenders for the extension of the electricity works, amounting to about £4,600, have also been accepted.

Wigan Corporation have accepted the tender of the Douglas Forge Co. for the supply of steam piping, condensers, &c., for the electric lighting and electric tramways department.

Bristol Electrical committee have accepted the tender of Messrs E. Bennis & Co for coal-discharging plant; that of Messrs. Babcock and Wilcox for coal-conveying plant, and that of Messrs. W. H. Allen, Son & Co., for condensing plant.

## BUSINESS NOTICES.

The Westminster Engineering Co. have removed their head offices and works from 29, Regency-street, Westminster, S.W., to Victoria-road, Willesden, London, N.W. The West-end branch office of the company remains at 16, Davies-street, W.

The Reason Manufacturing Co. (Ltd.) have now removed the offices and works from 111, Gloucester-road, to more commodious premises in Lewes-road, Brighton, where all future communications should be addressed.

Messrs. Giorgi, Arabia & Co. notify that their office in Rome has been removed from 31-33, Via Milano, to 79, Via dell'Umilta.

Messrs. Lars Bristol and Theodor Raaschou (trading as the Bristol Electric Safety Lamp Works) have dissolved partnership. Debts by Mr. Bristol, who continues under the old title.

Messrs. T. Fidge, G. Ryman, and E. H. Graesser (trading as Fidge, Ryman, and Graesser), electrical engineers, &c., 41, Ebury-street, London, S.W., and Croydon, have dissolved partnership. Debts by Mr. Fidge, who continues as Fidge & Co.

Messrs. Pritchetts and Gold, Feltham, Middlesex, inform us that they have converted their business into a company with limited liability under the title of Pritchetts and Gold (Ltd.). Particulars of the registration appear in another column. The company takes over the business as from Jan. 1, and will discharge all liabilities.

Mr. W. Boyd, A.M.I.E.E. and M.E., has severed his connection with the Central London Railway Co. Mr. Boyd was, during the construction of the line, one of the engineering staff of the Electric Traction Co., and joined the railway company when the line opened to organise the electric light department, of which since that time he has had entire control.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A first and final dividend of 5s. 3d. will be payable on 27th inst. at Messrs. Hobbs, Ravenscroft & Co., Jewry House, Old Jewry, London, E.C., in the bankruptcy of G. T. Godfrey (also trading as Godfrey Bros.), electrical engineer, &c., Boundaries-road, Balham, and 40, Trinity-road, Tooting, London, S.W.

At the Dundee Sheriff Court, on Wednesday, the public examination took place of James Matthew Hiley, partner in the late firm of Hiley and Orchar, electrical engineers, Dundee. Bankrupt stated that Mr. Orchar and he began business two years ago, the former supplying the machinery, but in February Orchar left for Hong Kong, and the machinery was sold for £76s. 10s. Total liabilities £378. 3s. 11d., assets £174. 16s. 5d. Hiley's assets were nil, while Orchar's were estimated at £121. 5s. Their liabilities as individuals amounted to £5 each.

The Morecambe Electric Launch and Power Syndicate (Ltd.) is to be wound-up voluntarily. Mr. J. Gibb, 6, Skipton street, Morecambe, is liquidator.

A meeting of the Perfect Arc Lamp and Accessories Co, Ltd. (in liquidation) will be held at 85, Gracechurch-street, London, E.C., on April 18 to receive an account of the winding-up.

A meeting of the Crowdus Accumulator Syndicate (Ltd.) will be held at 36, Victoria-street, London, S.W., on April 15, to receive an account of the winding-up. Mr. C. Scott, 66, Cannon-street, London, E.C., is liquidator.

A meeting of the St. Stephen's Electrical Syndicate (Ltd.) will be held at 1, Arthur-street East, London, E.C., on April 10 to receive an account of the winding-up.

On Saturday Mr. Justice Joyce appointed a receiver and manager of the General Engineering Co. (Ltd), on a debenture-holder's petition.

---

**Plant for Sale.**—Hull Electric Lighting committee invite offers for four Willans-Siemens direct-coupled steam dynamos, together with spare armature and other parts, switchboards and accessories. The plant is in excellent working order, and may be seen at work by appointment. The sale is due to the change to the high-voltage system, and tenders (addressed chairman of committee) must be delivered at town clerk's office, Town Hall, Hull, by noon March 21. Further particulars may be obtained from the city electrical engineer (Mr. A. S. Barnard), Sculcoates-lane, Hull. See advertisement.

**For Sale.**—An advertisement contains particulars of a 47 B.H.P. Crossley gas engine and an E.C.C. shunt-wound dynamo for sale. Applications to Messrs. Shepherd and Watney, consulting engineers, Greek-street Chambers, Leeds.

Messrs. Harry South & Co. (Ltd.), who are having new premises built, are willing to dispose of the lease of 10 and 12, Garrick-street, Covent Garden. Particulars of Mr. S. Bradford, Bloomsbury Mansions, Hart-street, London, W.C.

**For Disposal.**—An electrical engineering business in the east of England is for disposal as a going concern. See advertisement.

**Agents Wanted.**—A leading British manufacturing firm making cables and wires, arc lamps, meters, instruments, &c., wish to appoint selling agents in important industrial centres. See advertisement.

**Henley's Cables.**—A new price list of vulcanised and unvulcanised electric light cables and wires is issued by Messrs. W. T. Henley's Telegraph Works Co., 27, Martin's-lane, Cannon-street, London, E.C. The list contains a comprehensive series of tables giving diameters, carrying capacity, sectional areas, weight, resistance, &c., of a large variety of grades of cables manufactured by this firm. On p. 58 a specification is given of circular twin paper-insulated lead-covered wire.

**B.T.H. Plant.**—Pamphlet No. 89, issued by the British Thomson-Houston Co., deals with slow and moderate-speed belt-driven generators, some examples of which are illustrated.

**Electrical Testing Laboratories.**—Under the title of "Electrical Testing within Practical Limits," Mr. F. J. Warden-Stevens, A.M.I.E.E., has written a brief review of the requirements of an electrical testing laboratory for general commercial work, and this review has been published by the Electrical Testing Laboratories (Ltd.), 14, Great Smith-street, Westminster, London, S.W., annexed to a description of their laboratories and a scale of the charges for testing work. The Westminster Laboratories have been specially designed in agreement with the views expressed by Mr. Warden-Stevens, who is technical adviser to the company. The laboratories are not connected in any way with trading companies, nor is the company engaged in trade. The laboratories are provided with specially-designed plant and standard instruments for one, two, or three-phase testing work of various pressures. Copies of the pamphlet containing these particulars can be obtained free by post.

**Alternating Current Electricity Meters.**—List No. 17 issued by the Electrical Co., 122 and 124, Charing Cross-road, London, W.C., deals with the alternating-current electricity meters manufactured by the company. For this apparatus it is claimed that the absence of brushes, the simplicity and lightness of the armature, the possibility of using iron, and thus obtaining larger power with less weight, are important advantages. The motor used is constructed on the Ferraris principle, with a short-circuited squirrel cage type of armature, consisting of a single winding in bell form, made of copper. The iron armature is stationary, and the copper bell only rotates. The list, in addition to prices and illustrations, gives technical particulars, instructions for setting up and starting, &c.

**Johnson and Phillips' Cables.**—Messrs. Johnson and Phillips electric cable works, Old Charlton, Kent, have just issued a reduced price list of their vulcanised indiarubber cables and wires. The list is very compact, and neatly printed.

**"Fredennis" Price List and Wire Gauge Tables.**—Messrs. W. F. Dennis & Co. have just published (for the trade only) the second annual issue of the "Fredennis" Wire Gauge Table and Trade Price List containing prices and particulars of wires from Nos. 1 to 26 standard gauge. These wires are manufactured for a large variety of purposes. A view is given of the works of Messrs. Felten and Guilleaume, Carlswerk, for whom Messrs. W. F. Dennis & Co. are sole agents for the United Kingdom. This firm employs 4,500 hands, and the annual production of the works is 80,000 tons. A second photo shows the extensive wire stores of Messrs. W. F. Dennis & Co. at Millwall Docks. It is intended to issue the list annually, revised.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 5 to March 12, with the ports of destination:—

*Africa*—Cape Town, £758; Durban, £492 (including £352 telegraph wire). *Australasia*—Adelaide, £271; Auckland, £135; Brisbane, £274 (telegraph cable); Melbourne, £1,950; Port Chalmers, £105; Sydney, £798; Wellington, £1,429. *Belgium*—Antwerp, £21; Ostend, £25. *Ceylon*—Colombo, £244 (including £18 telegraph material). *China*—Shanghai, £62. *Denmark*—Copenhagen, £18 (telegraph wire). *Holland*—Amsterdam, £535; Flushing, £25. *Hong Kong*, £10. *India*—Bombay, £82; Calcutta, £2,559 (including £116 telegraph wire). *Japan*—Kobe, £8,650 (telegraph cable); Yokohama, £286. *Mexico*—Vera Cruz, £51. *Russia*—Libau, £20. *Spain*—San Sebastian, £85. *Straits Settlements*—Penang, £18; Singapore, £34. Total £18,987, against £129,748 in the corresponding week last year (March 7 to 13).

**Imports of Electrical Goods into the United Kingdom.**—The value of the electrical goods imported into this country during February was £97,296 against £94,317 in the preceding month, and £60,780 in February last year. The total for the two months ended Feb. 28 was £191,613, against £123,933 for the corresponding period last year.

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co. *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 8, 1900.

22,360. P. A. CAIN. London. Improvements in wireless electric telegraphic and audible signals, particularly applicable to ships and coast points.

22,362. V. I. FEENY. London. Improvements in the construction of inductors. (Allgemeine Elektricitats Gesellschaft, Germany.)*

22,372. J. G. WHITE & Co. (Ltd.) and J. G. WHITE. London. A method and apparatus for discharging electrified wool.

22,378. E. A. CLAREMONT. London. Improvements in drying apparatus for use in the manufacture of electrical insulating materials.

22,379. E. A. CLAREMONT. London. Improvements in apparatus for the manufacture of electrical insulating materials.

22,401. E. SANDER. London. Improvements in the manufacture of illuminating bodies for electric lighting.

22,403. J. WOODSIDE and F. WILSON. London. Improvements relating to electric lighting on railway trains.

22,406. J. GREENWOOD. London. Improvements in the decomposition of alkaline salts by electrolysis and in apparatus therefor.

22,411. W. B. SAYERS. London. Improvements in and relating to electric tramways or street railways.

December 10, 1900.

22,433. L. M. WATERHOUSE and THE SIMPLEX STEEL CONDUIT Co. (LTD.). Liverpool. Improvements in metallic conduits for electric light cables and the like.

22,434. L. M. WATERHOUSE and THE SIMPLEX STEEL CONDUIT Co. (LTD.). Liverpool. Improvements in metallic conduits for electric light cables and the like.

22,452. N. BROWNE. London. Improvements in automatic potential regulators for dynamos. (The Tirrill Regulator Co., United States.)

22,476. H. A. LITZ. London. Improvements in staples for electric wires.

22,484. E. SCHATTNER. London. Improvements in prepayment electricity meters.

December 11, 1900.

[illegible] J. CUSWORTH. Newcastle-on-Tyne. Electrical resistance switch.

22,515. A. B. MUDIE. Birmingham. An automatic tolling contact for electric bells.

22,542. A. RICHTER. London. Improvements in means for supporting electric lamps.

22,546. T. BERGMANN. London. Improvements in electrical interrupters for gas engines.*

22,572. K. SCHALL. London. Improvements in or relating to electrostatic machines. (Reiniger, Gebbert and Schall, Germany.)*

22,584. C. A. KELLER. London. An electric furnace with two bed-plates. (Date applied for under Patents, &c., Act, 1883, sec. 103. May 21, 1900, being date of application in France.)*

22,585. W. F. BREWSTER. London. Improvements in flexible supporting structures for electric lamps.*

22,599. A. JUST and R. FALK. London. Improvements in the manufacture of incandescence bodies for electric glow lamps.

22,605. T. MÜLLER. London. Improvements in and relating to plate-holders for electric accumulators.*

22,606. T. MÜLLER. London. A process for chemically consolidating the active material of electric accumulators.*

22,607. T. MÜLLER. London. Improuements in or relating to electric accumulator cells.*

December 12, 1900.

22,623. R. HOPE-JONES. Norwich. Improvements in electric or electro-pneumatic organs.

22,662. F. BLAU, A. SCHARF, I. LÖTI, S. LÖTI, and R. LATZKO. London. Process for the manufacture and repair of electrical glow lamps.

22,665. E. J. FARADAY. Liverpool. Improvements in trolleys for electrical locomotives, tramcars, or the like.

22,678. S. H. SHORT. London. Improved means applicable for use in transmitting energy to electrically-propelled trains or tramcars.

22,679. S. H. SHORT. London. Improved means applicable for use in operating and controlling electrically-propelled trains or tramcars.

22,680. R. P. WILSON. London. Improvements in electric current switching apparatus.

22,690. K. J. MCMULLEN and J. A. MCMULLEN. London. Improvements relating to electrical traction.

22,692. C. OSBORN and THE BRITISH MOTOR TRACTION Co. (LTD.). London. Improvements in or relating to electric ignition devices for explosion engines.

22,2698. H. A. FRASCH. London. Process of extracting and reducing metals by electrolysis.*

December 13, 1900.

22,703. S. COWPER-COLES. London. Improvements in the electrolytic refining of copper.

22,704. W. E. AYRTON and W. DUDDELL. London. Improvements in the construction of induction coils.

22,712. A. WHALLEY. Warrington. Protective device for galvanometers and the like.

22,713. A. WHALLEY. Warrington. Improvements in electric switches and fuses.

22,731. F. TUDSBURY. Newark. Increasing the efficiency of high-tension induction electrical machines of the Wimshurst, Voss, &c., type.

22,747. F. L. CLARK. London. Improvements in electromagnetic brakes. (Date applied for under Patents, &c., Act, 1883, sec. 103, May 14, 1900, being date of application in United States.)

22,748. F. L. CLARK. London. Improvements in electromagnetic brakes. (Date applied for under Patents, &c., Act, 1883, sec. 103, May 14, 1900, being date of application in United States.)

22,753. J. H. SIMPSON and E. W. H. WALKER. London. Improvements in and relating to backing or holding blocks for stereotype and electrotype plates.

22,775. CALLENDER'S CABLE AND CONSTRUCTION Co. (LTD.), and J. O. CALLENDER. London. An improved arrangement of cutouts and apparatus for the better production of electric cables and generators.

22,779. M. BYNG and F. G. BELL. London. Improvements in mounting telephonic instruments and accessories so as to admit of interchanging or renewal of the various parts.*

December 14, 1900.

22,789. S. COWPER-COLES. London. Improvements in the electrolytic production of tubes, sheets, and wire.

22,801. W. M. DOUGLAS. Liverpool. Improvements connected with electric lamps.

22,819. A. ECKSTEIN and A. J. D. KRAUSE. Manchester. Improvements in high-tension electric fuses.

22,824. E. ARNOLD, O. S. BRAGSTAD, and J. L. LA COUR. London. System of distribution for independent polycyclic electric currents.

[illegible] J. D. F. ANDREWS. London. Improvements in arc lamps.

22,851. E. L. GORDON. London. The automatic electric post.

22,872. E. BUSHE. London. A process for increasing the luminosity of electric incandescent lamps.

22,902. E. EDSER and M. WILDERMAN. London. Improvements in electrolytic methods and apparatus.

December 15, 1900.

22,910. J. B. BELCHER. Stafford. An improved means for tilting the shades and lamps of electric-lighting pendants.

22,926. A. MORRISON. Manchester. The facile electric shade remover.

22,933. A. ECKSTEIN and A. E. ANGOLD. Manchester. Improvements in combined electrical transformers and choking coils.

22,958. P. MCCULLOUGH, T. BLANEY and R. BARON. Liverpool. Improvements in or relating to safety devices applicable to trolley poles and like current collectors for electric railways and tramways.

22,972. E. M. PRESTON, of the firm of J. Stone & Co. London. Improvements in and connected with the electric lighting of railway and other vehicles.

22,982. G. CHISHOLME. Birmingham. Improvements in holders for globes, reflectors and the like for electric incandescent lamps.

22,987. C. G. FERNIE. London. Improvements in wireless electric signalling apparatus.

December 17, 1900.

23,005. D. L. REANEY. Bristol. A trolley-pulley adjuster for electric tramcars.

33,104. A. E. SHORT. London. Improved high-voltage, quick-break, single-pole, double-pole or multi-pole switch.

December 18, 1900.

23,087. S. K. REYNOLDS. Manchester. Improvements in apparatus for electrically operating keyed musical instruments.*

23,103. THE BRITISH THOMSON-HOUSTON Co. (LTD.). London. Improvements in electric railway systems. (W. B. Potter, United States.)*

23,104. THE BRITISH THOMSON-HOUSTON Co. (LTD.). London. Improvements in systems of motor control. (A. H. Armstrong, United States.)*

23,106. C. A. ALLISON. London. Improvements in galvanic batteries. (The Waterbury Battery Co., United States.)*

23,107. C. A. ALLISON. London. Improvements in galvanic batteries. (The Waterbury Battery Co., United States.)*

23,113. C. JASPER. London. Improvements in current motors.*

23,137. M. VOGEL. London. Improvements relating to plugs for electric switches.

23,146. E. SCHATTNER. London. Improvements in electricity meters.

23,148. K. HOLZMANN. London. Improvements in or relating to the connection of current conductors separated by dilation gaps, and apparatus therefor.

23,168. P. CARUS. London. Improvements in and connected with electric circuit-closing apparatus.

December 19, 1900.

23,234. R. ALIOTH, E. BERNHEIM and E. SARTIAUX. London. An electrical apparatus for operating signal and other levers.

23,240. W. COX, J. M. SMITH and A. M. SMITH. London. Improvements in motor gear-cases for electric cars.

22,242. M. DE HOOR, F. REINITZ and L. STARK. London. A new or improved regulating device for electric current generators.*

23,246. M. KALLMANN. London. Improvements in and relating to electric motors and generators.

23,254. G. B. O. SLESSOR. London. Improvements in telephone systems, the invention being also applicable to phonographs.

December 20, 1900.

23,308. THE BRITISH POWER TRACTION AND LIGHTING CO. (LTD.) and G. J. GIBBS. London. An improved process and apparatus for the manufacture of lead castings for electric batteries and the like.

23,309. THE BRITISH POWER, TRACTION AND LIGHTING CO. (LTD.) and G. J. GIBBS. London. Improvements in electrical accumulators.

23,310. THE BRITISH POWER, TRACTION AND LIGHTING CO. (LTD.) and G. J. GIBBS. London. Improvements in electrical accumulators.

23,314. J. MACTEAR. London. Improvements in electrolytic apparatus for production of chlorine and alkali.

23,322. J. WETTER. London. Improvements relating to speed regulators for electric lifts. (The Elektrizitats Aktiengesellschaft vormals Schuckert & Co., Germany.)*

23,323. J. BUSH. London. An improved controller and switch for motors for electric lifts.

23,329. T. H. BRIGGS. London. Adjustable connections for electric lamps.

December 21, 1900.

23,359. S. J. ATKINSON and W. SCHMAHL. Newcastle-on-Tyne. Improvements in insulators for electric conductors. (G. H. R. Büttner, Germany.)

23,361. G. SPERRYN and W. H. WOOD. Birmingham. Improvements in and relating to electrical fuse carriers for distribution boards and the like.

23,365. W. WHITELEY, jun. Huddersfield. Improvements in or connected with electric motors.

23,385. E. A. CLAREMONT. London. An improved machine for winding electric cables on drums or reels.

23,386. E. A. CLAREMONT. London. An improved electric dry core telegraph and telephone cable.

23,387. C. SCHÜRMANN. London. Improvements in the manufacture of braided cords or cables for electric lighting and like purposes.*

23,389. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in regulation of dynamo electric machines. (A. D. Lunt, United States.)*

23,390. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in controller casings. (C. L. Perry, United States.)*

23,391. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electrically operated switches for controlling circuits at remote points from central stations. (H. R. Sargent, United States.)*

23,392. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in means for preventing fluctuations in rotary motors. (A. L. Hadley, United States.)*

23,393. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements for preventing fluctuations in rotary motors. (J. J. Wood, United States.)*

23,394. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric brake systems. (F. E. Case, United States.)*

23,395. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in means for transmitting motion to a distant point. (D. P. Thomson, United States.)*

23,396. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in rotary transforming apparatus. (E. W. Rice, jun., United States.)*

23,397. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

23,398. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in systems of electrical distribution. (C. P. Steinmetz, United States.)*

23,408. A. POUTEAUX and A. WOLFF. London. Improvements relating to electric accumulators.

23,413. G. E. VAUGHAN. London. Improvements in or connected with the electro-deposition of metals or metallic alloys. (H. Koegel, Germany.)

23,417. A. BLONDEL. London. Improvements in or relating to galvanometers. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 6, 1900, being date of application in Belgium.)*

23,422. W. H. SCOTT. London. Improvements in or connected with controllers for use with electrically driven capstans and for analogous purposes.

23,432. W. R. LAMBERT and VERITYS LIMITED. London. Improvements in electric bells.

23,433. W. R. RIDINGS and VERITYS LIMITED. London. An improved cut-off for electric arc lamps and similar electrical installations.

23,434. P. G. EBBUTT, C. P. BROWN, H. S. SMITH, and VERITYS LIMITED. London. A new or improved watertight holder for electric lamp globes.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

466. WELLS and ALLAN and ADAMSON, LIMITED. Apparatus for facilitating the escape of gas from electric storage batteries or accumulators.

630. DICK AND REASON MANUFACTURING CO. (LTD.). Method of and apparatus for connecting electric meters in three-wire circuits.

758. WETTER (Elektrizitats-Aktiengesellschaft vorm. Schuckert & Co.). Controlling devices for the motor circuits of electrically-propelled vehicles.

859. GARDY. Electric switches.

888. PEDERSEN. Method of receiving, storing and reproducing messages, signals, and the like by magnetic influence upon magnetisable bodies.

1,024. HEYWOOD and HEYWOOD. Electrical switches.

1,267. BRODIE. Permanent way for tramways and points therefore specially applicable to electric tramways.

1,457. BARNES. Electrolytic apparatus.

1,531. HAYMAKER. Electric light dimmer.

1,704. MILLS (Vial). Electric alarm.

1,756. WEHRMANN and BASTIANS. Suspension devices for arc lamps and the like.

1,906. HAENICHEN and HAENICHEN. Electric pendulum clock.

2,231. STAMP. Telephone ear instrument holders.

2,282. DALÉN and HULTQVIST. Dynamo electric machines. (Date applied for under International Convention, July 7, 1899.)

3,031. LITTLE. Electricity meters.

3,108. JOHNSON and WUNDERLICH. Arc lamps.

3,501. HILL. Electric alarums.

5,528. GÜMIEL. Electric accumulators.

5,710. TIDDEMAN. Indicator for storage batteries.

5,764. LINDSTROM. Means for retaining the field magnet coils of electric motors and dynamos in position. (Date applied for under International Convention, October 16, 1899.)

6,261. ATKINSON. Electric switches and resistances.

7,759. DE PAUER and DE KUTSCHERA. Electrically operated submarine working devices.

8,471. RENAUD. Electrical accumulators. (Date applied for under International Convention, December 6, 1899.)

9,751. EYRE. Switches for electric tramways on sectional conductor and like systems.

10,210. DAHL. Electrical apparatus for closing steam supply valves from a distance and giving an audible signal.

10,476. BRAUN. Adjustable electric igniter or spark producer for motors.

10,606. SMITH. Electrical fuse boxes.

11,438. SIEMENS BROS. & CO. (LTD.), DIESELHORST and BUDD. Casings for the jointings of underground electrical cables.

11,944. FEENY (Allgemeine Elektricitats Gesellschaft). Switching arrangement for Nernst and vacuum incandescence lamps.

13,344. LAMBERT. Process of and apparatus for reproducing phonographic records.

13,356. THOMPSON (Tice, Urmson, Parsons and Bell). Telephonic repeaters.

13,643. MARÉCHAL, MICHEL and DERVIN. Wireless telegraphy.

# COMPANIES' MEETINGS AND REPORTS.

## City of London Electric Lighting Co. (Ltd.).

The directors' report for the year to Dec. 31 shows that the capital expenditure during the year amounted to £242,972. 11s. 3d. The total revenue was £223,776. 10s. 3d. Expenses of generation and distribution (£106,750. 16s. 4d.); rent, rates, taxes, general and special charges (£33,009. 18s. 4d.), transfer to repairs and maintenance fund (£25,000), expenses of issues of ordinary shares and second debenture stock (£2,285. 7s. 9d.), and interest on loans, &c. (£4,422. 9s. 5d.), accounted for £171,468. 11s. 10d., leaving £52,307. 18s. 5d., which, with £1,622. 14s. 5d. brought forward, gives a total available revenue of £53,930. 12s. 10d. Interest on debenture stock has taken £19,687. 13s. 8d. and interim dividend on £400,000 6 per cent. preference shares £11,500, leaving £22,742. 19s. 2d. The directors now recommend a final dividend of 6s. per share be declared (less tax) on the preference shares, making 6 per cent. for the year, absorbing £11,400 and leaving £11,342. 19s. 2d. to carry forward.

The generation and distribution expenses, including repairs and renewals, were 61·13 per cent. of the gross earnings, compared with 49·31 per cent. for 1899, 36·1 per cent. for 1898, 31·3 per cent. for 1897, 34 per cent. for 1896, 36·87 for 1895, 46 for 1894, and 54·2 for 1893. This unsatisfactory result is due to the high price of coal and to the low average price per unit received from consumers, which has decreased from 7·56d. in 1895, 7·41d. in 1896, 7·30d. in 1897, 6·22d. in 1898, and 5·16d. in 1899, to 4·09d. in 1900. A modification in the tariff has now been effected, from which a substantial increase in the revenue is anticipated. Very considerable economies in the works costs will also be possible during the current year as a result of recent capital expenditure.

The following comparative statement shows the trading position of the company at Dec. 31, 1893, and at subsequent periods:—

| — | 1893. | 1895. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|
| No. of customers... | 1,080 | 4,230 | 6,323 | 7,414 | 8,738 | 9,865 |
| No. (equiv.) 8 c.p. lamps connected | 65,341 | 195,317 | 296,012 | 365,825 | 429,628 | 511,113 |

On March 6, 1901, there were 540,389 8 c.p. lamps (equivalent) applied for and 521,651 connected, and the customers numbered 10,074. The units sold during the year 1900, excluding public lighting, were 11,272,969, compared with 7,446,703 for 1899.

The gross revenue for the year to Dec. 31, 1893, was £39,662. 17s. 9d.; for 1895, £106,999. 17s. 2d.; 1897, £175,792. 13s. 2d.; 1898, £175,607. 15s. 8d.; 1899, £187,253. 16s. 7d.; and 1900, £223,776. 10s. 3d. The net revenue in 1893 was £16,940. 14s. 10d.; 1895, £59,100. 5s. 11d.; 1897, £107,550. 2s. 4d.; 1898, £97,842. 1s. 6d.; 1899, £87,323. 18s. 2d.; and 1900, £84,015. 15s. 7d.

The City of London Electric Lighting Act, 1900, has relieved the company of the statutory obligation of setting aside a fixed percentage for

depreciation every year, and the matter is now left to the discretion of the directors. As £16,349. 6s. 6d. has been accumulated mainly out of revenue in former years, which, until the passing of the 1900 Act, could be used for any purposes of the undertaking other than for equalising dividends, has now been added to the depreciation fund (which stands at £96,045. 15s. 7d.), and as £23,486. 4s. 11d. out of £25,000 set aside from revenue for the purpose has been expended during the past year in maintaining the company's plant, buildings, &c., in an efficient state of repair, the directors have not thought it necessary to further provide for depreciation out of the past year's revenue. The act also authorised the company to acquire compulsorily certain properties essential to the development of the Bankside works. Some of these properties have been purchased since Dec. 31, 1900, and further capital liability in respect of the cost of the same will have to be provided for.

As only 10,595 ordinary shares out of the 20,000 offered to the shareholders were subscribed for, the directors to meet the commitments for capital expenditure, obtained the sanction of the shareholders to further borrowing powers of £400,000, and these powers have been exercised by the creation of second debenture stock for this amount, of which £200,000 has been issued and subscribed.

The declaration of Mr. Justice Farwell in favour of the company that the three contracts with the late Commissioners of Sewers were valid, has been varied by the Court of Appeal to the extent that two are invalid and one is valid. This decision does not affect the company's statutory right to supply electricity for private purposes throughout the City, but concerns principally the arrangements made with the Corporation, by the company's predecessors, for the public lighting of the streets in the central and western districts of the City, and the directors are giving careful consideration to the matter.

## The Potteries Electric Traction Co., Ltd.

The directors' report for the year ended Dec. 31, states that the gross profits amounted to £64,151. 4s. 7d. After deducting all expenses chargeable to revenue, including repairs and maintenance and interest on debentures, there remains as net profit £13,839. 6s. 2d. Adding £866. 9s. 7d. brought forward £14,705 15s. 9d. remains to be applied as follows: Dividend on the cumulative preference shares £10,000, dividend on the ordinary shares of 2 per cent. £4,000, depreciation £500, forward £205. 15s. 9d.

Owing to strikes throughout April and May the traffic receipts suffered considerably, and the work on the new generating station was seriously delayed, which prevented the opening of the Chesterton and Silverdale lines. During a large part of the year only a part of the total system has been in operation.

During the year the directors have issued £125,000 4½ per cent. debenture stock, part of a total issue of £200,000. This issue has been guaranteed as regards principal, interest and premium by the British Electric Traction Co., and the expenses of the issue were paid by that company in consideration of this company giving an option to subscribe for the remaining £75,000 debenture stock at par before April 27, 1901. The total capital expenditure at Dec. 31, 1900, was £363,621. 3s. 5d. in addition to £186,311, cost of debentures and shares held in the North Staffordshire Tramways Co. (Ltd.). At Jan. 1, 1900, about 12½ miles of tramways and light railways were opened for traffic; since that date nearly 16 miles of additional lines have been opened. The whole of the tramways and light railways of this company and of the North Staffordshire Tramways Co. are now worked electrically, excepting a small section under construction. The directors recommend that power be taken to increase the nominal capital of the company by the creation of 10,000 ordinary and 10,000 5 per cent. cumulative preference shares of £10 each. The Light Railway Commissioners have decided to recommend the Board of Trade to grant the company an order for further extensions of their lines.

The directors have taken steps to introduce a service for the conveyance of goods and parcels by electric cars over the company's entire system, supplemented by horse and hand vehicles, for the purpose of local distribution throughout the Potteries district, and hope this service will be in operation before the summer. An experimental service of steam omnibuses for the outlying villages has been established, and two of these conveyances will shortly be run between Burslem and Milton, a distance of about 3 miles. If the experiment gives satisfactory results the directors propose to extend the system in other outlying parts of the Potteries district.

The directors are in negotiation with some of the local authorities for the transfer of their electric lighting orders.

The miles of route open at Dec. 31, 1900, was single line 17m. 6f. 0ch.; double line 5m. 2f. 1ch.; total 23m. 0f. 1ch.; the number of passengers carried during the year was 9,841,466; average receipts per passenger, 1·32d.; average expenditure per passenger, 0·83d.; proportion of expenses to receipts, 62 per cent.; number of cars in stock 78.

## Oldham, Ashton, and Hyde Electric Tramway, Ltd.

The directors' report for the year to Dec. 31 gives the total revenue at £23,156. 3s. 7d., and the expenditure (including £1,479. 16s. 4d. debenture interest) at £18,196. 4s. 6d., a net profit of £4,959. 19s. 1d., which, with £617. 12s. 7d. brought forward, leaves £5,577. 11s. 8d. The directors propose to place to depreciation £1,000, and to pay the dividends on the 5 per cent. cumulative preference shares (absorbing £2,000) and at the rate of 7 per cent. per annum for the six months ended Dec. 31 (making 6 per cent. for the year) on the ordinary shares, requiring £2,400, leaving to be carried forward, £177. 11s. 8d. A strike of motormen and conductors seriously affected the company's traffic receipts for six weeks, and resulted in an additional expenditure of £1,482. 12s. 4d., charged against revenue. The total capital expenditure is now £127,681. 0s. 2d. The directors recommend that powers be taken to increase the nominal capital by the creation of 1,000 ordinary and 1,000 preference shares of £10 each. The appeal against the judgment in the action instituted by the Hyde Corporation to prevent the company using the feeder cables which have been laid under the footpath was dismissed, and negotiations are pending between the company and the Hyde Corporation and between the company and the contractors in regard to this matter. The company's application to the Light Railway Commissioners for an order for extensions of the lines was refused owing to opposition of the local authorities, who are now promoting tramways and light railways in the district. The miles of tramway open are 8m. 1f. 1ch. the number of passengers carried was 4,131,589, the average receipts per passenger 1·34d., the average expenditure per passenger 0·88d., proportion of expenses to receipts 65·86 per cent., and number of cars in stock 38.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**COOKE'S PATENT TRAMWAY SYSTEM (LTD.)**—Registered March 1, with a capital of £5,000 in £5 shares, to acquire certain patents granted to H. J. Cooke and P. Ehrenfeldt, and to construct and maintain rails and tramroads; to carry on business as electricians, engineers, and metal founders, producers of electricity, general carriers and agents, &c. The directors are H. J. Cooke and M. Ehrenfeldt.

**EUROPEAN McGUIRE MANUFACTURING CO. (LTD.)**—Registered Feb. 19, with a capital of £20,000 in £1 shares, to acquire patents, rights and licences in inventions relating to electric motor trucks, sweepers, fenders, stoves, life-guards, elastic brake hangers, brake handles, &c., to carry on the business of electrical engineers, electrical equipment manufacturers and suppliers of electricity for traction and light, and to act as agents in Europe or elsewhere for the electrical products of the McGuire Manufacturing Co. of Chicago. The subscribers are F. W. Dunlop (electrical engineer), J. G. Avery, F. Z. McGuire (merchant), A. Ashbee, T. J. Leith, T. L. Drimmie and J. D. Baucus (merchant). The first directors are L. Greville-Williams, W. A. McGuire, J. F. Cummings, F. C. Buxton and W. H. Booth.

**HEDGES, McKRELL & CO. (LTD.)**—Registered, March 6, with a capital of £1,000 in £1 shares, to acquire the business carried on by Hedges, McKrell & Co., electricians, ironmongers, &c. The subscribers include A. H. Sparkes (electrical engineer), T. H. Rudkin (contractor), H. E. McKrell (electrical engineer), W. Hedges (electrical engineer), and E. W. Riches (engineer).

**H. INGRAM (LTD.)**—Registered Feb. 25, with a capital of £2,000 in £1 shares, to acquire and carry on the business of electrical engineers, electricians, mechanicians, manufacturers of and dealers in electrical plant, &c. The subscribers are H. Ingram (electrical engineer), W. Bibby, R. Lees, A. W. Howard, H. Bibby (electrician), J. R. Evans and T. E. Knowles.

**C. LINDLEY & CO. (LTD.)**—Registered Feb. 11, with a capital of £60,000 in £1 shares, to acquire the business of C. Lindley & Co., and to carry on the business of manufacturers of and dealers in engineers' stores, electrical and mechanical engineers, electric railway and tramway contractors, manufacturers of and dealers in electric, telegraphic, telephonic, and other machinery and apparatus, suppliers of electricity, and manufacturers of and dealers in general electrical supplies. The first directors are Richard H. N. Lindley (chairman and managing director for life), W. L. Beken, and J. W. Gaukroger.

**NEW ELECTRIC LAMP REGENERATING CO. (LTD.)**—Registered March 7, with a capital of £80,000 in £1 shares, to carry on business as lamp manufacturers, electrical and mechanical engineers, cable and conductor manufacturers, wire drawers, carbon manufacturers, glass blowers, porcelain manufacturers, &c. The subscribers are C. W. Milne, Capt. E. I. Bax, W. J. Davy (engineer), F. Fanta, engineer, L. B. Peters (engineer), E. Cadett, and W. H. Thompson (each with 500 shares). The first directors are C. W. Milne, Capt. E. I. Bax, W. J. Davy, and F. Fanta.

**PLUMPTON BROS. & CO. (LTD.)**—Registered Feb. 4, with a capital of £100 in £1 shares, to carry on the business of electrical engineers, producers and suppliers of electricity, general engineers, merchants, &c.

**PRITCHETTS AND GOLD (LTD.)**—Registered March 7, with a capital of £40,000 in £1 shares (20,000 preference), to acquire the business carried on at Feltham, Middlesex, of Pritchetts and Gold, to enter into an agreement with Messrs. G. E. B., T. W., and C. R. D. Pritchett, and A. G. Gold, and to carry on the business of storage battery and accessory manufacturers, electrical and mechanical engineers, manufacturers of electric appliances and machinery, suppliers of electricity for light, heat, power or other purposes, &c. The subscribers are G. E. B., T. W., and C. R. D. Pritchett (electrical engineers), A. G. Gold, A. B. Bryden, C.A., F. C. G. Menzies, and J. W. Robison (electrical engineer). The first directors are G. E. B., T. W., and C. R. D. Pritchett, and A. G. Gold.

**PUBLIC UNDERTAKINGS SYNDICATE (LTD.)**—Registered March 5, with a capital of £10,000 in £10 shares, to carry on the business of constructors and controllers of public works, including railways, tramways, electric light or power, telephones, telegraphs, &c.

**ADAMS-RANDALL TELEPHONE PATENTS CO. (LTD.)**—The annual return to Dec. 26 gives the capital as £60,000 in £1 shares (10,000 preference), of which 50,000 ordinary and 400 preference have been taken up; £1 per share has been called up on 400 preference and seven ordinary shares, and £407 has been received; 49,993 ordinary shares are considered as fully-paid

**ABERDARE ELECTRIC LIGHTING CO. (LTD.)**—According to annua return to Jan. 22 the capital is £2,000, in £1 shares, 340 of which have been taken up. No calls.

**AMAZON TELEGRAPH CO. (LTD.)**—The annual return to Feb. 21 gives the capital at £850,000 in 25,000 shares of £10 each, all of which have been taken up and paid for in full. Mortgages and charges £200,000.

**BRIGHT'S LIGHT AND POWER (LTD.)**—The annual return, made up to Jan. 4, has been filed. The capital is £200,000 in 100,000 preference and 100,000 ordinary shares of £1 each, of which 100,000 ordinary shares have been taken up. £1 has been called up on each of 66,667 shares, and £66,489. 5s. has been received; 33,333 shares are considered as fully paid. No mortgages or charges.

**ELECTRIC FUR MACHINING CO. (LTD.)**—The annual return to Jan. 14 has been filed. The capital is £3 600 in £1 shares, 566 of which have been taken up. £1 has been called up and paid on each of 16. 550 shares are considered as fully paid. No mortgages or charges.

**ENGLISH ELECTRO METALLURGICAL CO. (LTD.)**—The annual return to Feb. 6 gives the capital as £700,000 in 400,000 ordinary and 300,000 preference shares of £1 each, all of which have been taken up. 15s. has been called up on each of 200,000 preference shares. All the ordinary and 100,000 preference shares are considered as fully paid. No mortgages or charges.

**NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO. (LTD.)**—The annual return to Feb. 19 gives the capital as £200,000 in 20,000 shares of £10 each, all of which have been taken up. £9 per share has been called on 10,000, and £1 per share on the remaining 10,000 shares, and £100,214 has been received. Mortgages and charges £47,080.

**RENEWABLE ELECTRIC LAMP CO. (LTD.)**—According to the annual return to Feb. 5 the capital is £150,000 in 50,000 preference and 100,000 ordinary shares of £1 each, of which 30,000 preference and 100,000 ordinary have been taken up. 10s per share has been called up on 30,000 preference and 1,074 ordinary shares. 98,926 ordinary shares are considered as fully paid. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 28$\frac{1}{16}$d. per oz. (March 14). Consols (2¾ per cent.) 96½—96⅝ for money, 96$\frac{11}{16}$—96$\frac{13}{16}$ for account; 2½ per cent. 95¾—96¼ (March 14). Consols Pay Day April 3. Stocks and Shares Continuation Days, Mar. 26 and April 10. Ticket Days, Mar. 27 and April 11; Pay Day, March 28; Mining Share Carry-over Days, Mar. 25 and April 9.

**BAKER-STREET AND WATERLOO RAILWAY CO.**—In their report to Dec. 31 the directors state that the position brought about by the failure of the contractors (the London and Globe Finance Corporation) is receiving careful attention. The company has ample assets in cash, shares and debenture stock to provide for the completion of the line, and negotiations are in progress for the transfer of the contracts to other parties. The works are in progress, and large sums have been expended upon the purchase of land.

**BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. (LTD.)**—The transfer books of this company will be closed from 16th to 26th inst. inclusive, preparatory to the payment of a dividend on the ordinary shares for the year to Dec. 31.

**BRUSH ELECTRICAL ENGINEERING CO. (LTD.)**—The directors have decided, after placing £5,000 to reserve, to recommend payment of the dividend on the 6 per cent. preference shares for the half-year to Dec. 31, and a dividend at the rate of 5 per cent. on the ordinary shares for the year.

**COMMERCIAL CABLE CO.**—The accounts for 1900 show that after transferring $150,000 to insurance reserve, and $350,000 to general reserve, the profits, including $228,063 brought forward, amounted to $2,007,730. Debenture interest requires $720,000, and dividends equal to 8 per cent. per annum have been declared and paid, leaving $221,066 to be carried forward.

**CROMPTON & CO. (LTD.)**—During the week this company invited applications for 46,000 £3 shares at 5s. premium.

**CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY CO. (LTD.)**—The meeting of the company held yesterday was, our representative was informed, a private one. The report of the directors submitted thereat was for the year ended Dec 31 last, and showed that the receipts exceeded the working expenses by £3. 4s. 1d., without any provision being made for interest on borrowed capital. The unfortunate boiler explosion in July last (see *The Electrician* for August 10, 1900) stopped completely for two months the production of current, and deranged the working for the rest of the year, besides entailing a direct loss of £573. 17s. 5d., after crediting the amounts recovered from the insurance companies. Under these circumstances the results of the year's working cannot be taken as any guide to future profits. The reconstruction of the station and installation of new plant were all but completed by the end of the year, and the company began to derive the full benefit of the improvements after March 1. The demand for current makes progress, and the consumption in 1901 will, it is expected, show a satisfactory increase over 1899.

**DAVIS AND TIMMINS (LTD.)**—At a meeting of this company, held yesterday, the following report of the directors for 1900 was approved:—The net profit for the year (including £1,633. 11s. 3d. brought forward), and after allowing for depreciation, is £11,356. 13s. 3d. The interim preference dividend absorbed £1,724. 19s. 3d., leaving £9,631. 14s. Six months' dividend on the preference and at the rate of 8 per cent. per annum on the ordinary shares for the year (less tax) absorbs £5,297. 11s. 1d., commissions to managers £343. 5s., reserve £2,000, and £1,990. 17s. 11d. is carried forward.

**DIRECT SPANISH TELEGRAPH CO. (LTD.)**—The directors have decided to pay on April 1, in addition to the dividend at the rate of 10 per cent. per annum on the preference, a dividend at the rate of 4 per cent (tax free) on the ordinary shares for the half-year ended Dec. 31 last.

**GATESHEAD ELECTRIC AND MECHANICAL SUPPLY CO. (LTD.)**—In order to provide for the extension of business it has been decided to increase the capital to £10,000, in £1 shares. The directorate will consist of Messrs. W. J. Costellos (chairman), James Davison, Robert Stewart, and J. A. M. Collier (managing).

**GENERAL ELECTRIC CO. (1900) (LTD.)**—The transfer books of the debenture stock of this company will be closed for the payment of interest from 18th to 31st inst. inclusive.

**IMPERIAL TRAMWAYS CO. (LTD.)**—After payment of the 4½ debenture interest and the 6 per cent. preference dividend, a final dividend at the rate of 8½ per cent. per annum (making 8 per cent. for the year 1900) is recommended. The reserve is increased from £69,203 to £72,789.

**LONDON UNITED TRAMWAYS (LTD.)**—After providing for debenture interest and preference dividend, the directors recommend a final dividend on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended Dec. 31, making 10 per cent. for the year. Reserve is increased from £36,199 to £39,467.

**PONTYPOOL ELECTRIC LIGHT AND POWER CO. (LTD.)**—The directors' report for the past year states that the expenses of opposing the South Wales Electric Power Bill amounted to £314. 15s. 4d. It is, therefore, proposed that the company shall not pay a dividend this year, but shall divide the balance shown on that account in payment of outstanding charges. The running of the station for the year ended Dec. 31, after carrying £100 to renewal account, has resulted in a profit of £700. 7s. 7d., which, after deducting debenture interest (£200. 5s. 4d.), with the balance carried forward from last year, leaves £512. 15s. 7d.

**STOCK EXCHANGE NOTICES.**—Application has been made to the Stock Exchange committee to appoint a special settling day in, and to grant a quotation to the scrip certificates for 4 per cent. debenture stock of the *Central London Railway Co.* The committee has appointed 21st inst. a special settling day in 19,900 £5 fully-paid 6 per cent. cumulative preference shares of the *Electric and General Investment Co. (Ltd.)*, and has ordered the same to be quoted in the official list.

**UNDERWRITING COMMISSIONS UNDER THE COMPANIES ACT, 1900.**—Sir Courtenay Boyle, on Monday, discussed an important point under the new Companies Act, as applied to a light railway order. The promoters of a light railway order in Salop desired to have sec. 8 of the Act inserted in their order, so that they might have the power of paying commissions on underwriting of shares in the same manner as a joint-stock company. Sir Courtenay Boyle, however, said he was unable to advise the Board of Trade to give one light railway company such an advantage over existing light railways, and recommended the promoters to go to Parliament to have the law amended. It was pointed out that capital could be much more readily raised when commission was offered on underwriting shares, and counsel for the promoters was unable to see why limited liability undertakings should have a power which the Legislature denied to an undertaking working under statutory powers.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | AGGREGATE. Amount. | AGGREGATE. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Mar. 2 | 560 | + 11 | 39 | 26,410 | + 3,416 |
| *Birmingham Tramways. | „ 9 | 4,216 | + 58 | 9 | 36,232 | + 500 |
| *Blackburn Corporation.. | „ 8 | 415 | + 33 | 10 | 3,809 | + 377 |
| Blackpool Corporation... | „ 7 | 209 | + 47 | 49 | 29,919 | + 7,873 |
| Blackpool and Fleetwood | „ 9 | 166 | - 16 | 10 | 1,394 | - 78 |
| Bolton Corporation ...... | „ 11 | 1,331 | ... | 49 | 66,863 | ... |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ......... | Jan. 23 | 2,830 | + 1,086 | 3 | 6,821 | + 1,519 |
| *Bristol Trams & Carriage | Mar. 8 | 3,753 | + 1,181 | 10 | 35,865 | + 9,960 |
| *Buenos Ayres & Belgrano | Feb. 10 | 2,665 | + 300 | 6 | 16,458 | + 2,300 |
| Carlisle Trams. Co. ... | Mar. 9 | 120 | ... | 10 | 1,096 | ... |
| Central London Railway | „ 9 | 5,855 | ... | 10 | 60,662 | ... |
| City & South London Ry. | „ 10 | 2,060 | + 757 | 10 | 20,133 | + 8,358 |
| Cork Elec. Trams ......... | „ 7 | 343 | + 32 | 9 | 3,190 | + 335 |
| Dover Corporation ....... | „ 9 | 159 | + [illegible] | 49 | 10,315 | + 665 |
| Dublin & Lucan Rly. ... | „ 9 | 67 | - 3 | 10 | 703 | + 162 |
| Dublin United ............ | „ 8 | 3,154 | + 323 | 10 | 21,124 | + 2,990 |
| Dublin Southern Dist.... | „ 8 | 647 | + 4 | 10 | 7,076 | |
| *Dundee Corporation ... | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation ... | Mar. 9 | 8,239 | - 121 | 10 | 83,443 | + 2,392 |
| Halifax Corporation .... | „ 11 | 776 | + 178 | 49 | 37,247 | + 7,978 |
| *Huddersfield Corpn. ... | „ 9 | 747 | + 167 | 49 | 33,748 | + 2,846 |
| Hull Corporation......... | Mar 9 | 1,555 | + 839 | 36 | 51,894 | + 28,136 |
| *Liverpool Corporation... | „ 2 | 7,789 | + 726 | 9 | 69,859 | + 10,208 |
| Liverpool Overhead Rly. | „ 10 | 1,507 | + 138 | 10 | 14,686 | + 394 |
| Portsmouth Corporation | „ 9 | 559 | + 54 | ... | ... | ... |
| *Sheffield Tramways ...... | „ 10 | 2,955 | + 1,064 | 10 | 27,678 | + 9,633 |
| Southampton Corporat'n | „ 7 | 575 | + 300 | | ... | ... |

* Partly electrical

**WOLVERHAMPTON TRAMWAYS CO. (LTD.)**—At a meeting on Monday Mr. Emile Garcke said the accounts were practically for only four months, as the lines had been taken over by the borough of Wolverhampton in April last, and as it was impossible for the company to work the lines outside the borough, which the Corporation did not purchase, at a profit, they had made a provisional agreement to sell to the British Electric Traction Co. to whom the lines had been handed over. The line had been sold to Wolverhampton Corporation for £22,500, and they had been left in the extraordinary position of having sold five-eighths of their line and being left with three-eighths, which could only be worked at a loss. He had heard the minister who was responsible for the Tramways Act, under which this compulsory purchase had been effected, take great credit to himself for having so assisted the public by the compulsory sale of tramways, but he thought it was a very far-fetched compliment. The British Electric Traction Co. had agreed to pay at the same rate as the Corporation had paid, and the result was that they received £10,020 for the line outside the Wolverhampton area. The only remaining thing now to do was to distribute the available assets amongst the shareholders, to put the company into liquidation and to appoint a liquidator. An extraordinary meeting subsequently resolved to wind up the company, and Mr. Selby was appointed liquidator.

**WESTERN UNION TELEGRAPH CO.**—The regular quarterly dividend of 1¼ per cent. has been declared.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Mch. 6 | | Price Wednesday, Mar. 13. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 13. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckb'rn & Gr'nw'ch Dist. Elec. Lt. Ord. (fully pd.) | [illegible] | [illegible] | [illegible] | [illegible] | ... | | | |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10 0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4 6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 2 6 | Brompton & Kensington Elec. Supply Ord | 7 | 8 | 7 | 8 | 3 15 0 | ... | [illegible] | 7½ |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 | 9 | 8 | 9 | 3 17 9 | March and September | [illegible] | [illegible] |
| 20,000 | 5 | 1 0 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 80,000 | 5 | 4 3 | Charing Cross & Strand Electricity Supply Corp. | 9¾ | 10¼ | 9¾ | 10¼ | 4 5 1 | February and August | 10¼ | 9¾ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¾ | 6¼ | 5¾ | 6¼ | 3 18 3 | " " | 5¾ | 5⅞ |
| 34,000 | 5 | 2 6 | Chelsea Electricity Supply Ordinary | 6 | 6½ | 6 | 6½ | 4 12 4 | March | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 111 | 4 0 4 | June and December | 110 | ... |
| $1,300,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8 0 | City of London Electric Lighting Ord. | [illegible] | [illegible] | [illegible] | [illegible] | 4 14 2 | February and August | 8 | 6½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 18 9 | June and December | ... | ... |
| £200,000 | Stock | | Do. 4½% 2nd Deb. Stock Certs. (fully pd.) | 101 | 103 | 101 | 103 | ... | ... | [illegible] | 10[illegible] |
| 40,000 | 10 | 4 0 | County of London and Brush Prov. Ordinary | 8 | 9 | 7¾ | 8¼ | 7 1 2 | ... | [illegible] | 7¾ |
| 90,000 | 10 | 6 0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock Certs. (all pd.) (red.) | [illegible] | 109 | 106 | 109 | 4 2 7 | | ... | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10 | 11 | 10 | 11 | 4 15 5 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | [illegible] | 7 | 4 5 7 | January and July | ... | ... |
| £73,000 | Stock | [illegible] | Kens. & Knights. Co. & Notting Hill Co. Jt. Deb. Stk. | 103 | 105 | 103 | 105 | 3 16 2 | ... | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 2 | ... | ... | ... | ... |
| 49,840 | 5 | 5 0 | Do. 6 per Cent. Preference | 4 | 5 | 4 | 5 | 6 0 0 | ... | [illegible] | ... |
| £380,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 65,000 | 10 | 8 0 | Metropolitan Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 4 5 11 | April and October | 13 | ... |
| 13,769 | 10 | ... | Do. (£5 paid) | 7 | 8 | 7 | 8 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 112 | 110 | 112 | 3 19 8 | June and December | ... | ... |
| £380,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 95 | 99 | 96 | 99 | 3 10 8 | ... | 95 | ... |
| 6,452 | 10 | 6 0 | Notting Hill Electric Ordinary | 15½ | 16½ | [illegible] | 15½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 5 0 | Oxford Electric Ordinary | 6½ | 6¾ | 6¼ | 6¾ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1 6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 13 5 8 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate Elec. Lt. & Tract'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| 13,000 | $100 | $2 | Royal Electric Company of Montreal Shares | [illegible] | [illegible] | [illegible] | 220 | 3 12 9 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 105 | 103 | 105 | 4 7 5 | " " | 106 | ... |
| 40,000 | 5 | 9 [illegible] | St. James's and Pall Mall Electric Ordinary | 14 | 15 | 14 | 15 | 4 10 5 | February and August | 14½ | 14¼ |
| 20,000 | 5 | 3 6 | Do. 7 per Cent. Preference | 8½ | 9¼ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 29 0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | [illegible] | ... |
| £90,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 81 | 90 | 4 10 11 | ... | ... | ... |
| 45,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5 0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 0 | March and September | [illegible] | [illegible] |
| 30,100 | 5 | [illegible] | Do. Do. | 12 | 13 | 12 | 13 | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 16,000 | 10 | [illegible] | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 8 | ... | ... | ... |
| 75,000 | 5 | | Brisbane Electric Tram. Investment Ord. | | | 2½ | 3½ | | ... | 3½ | ... |
| 75,000 | 5 | | Do. 5% Cum. Pref. | | | [illegible] | 4½ | | | ... | ... |
| [illegible] | Stock | | Do. 4½% Deb. Prov. Certs. | | | 97 | 101 | | | 100½ | ... |
| 60,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 24 | 24½ | 24 | 24½ | 3 4 0 | February and August | ... | ... |
| 25,000 | 10 | 4½ | Do. Cumulative Preference (fully pd.) | 10½ | 10¾ | 10½ | 10¾ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 115 | 118 | 3 6 1 | February and August | ... | ... |
| 20,020 | 10 | | British Columbia Electric Railway Ordinary | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 13,600 | [illegible] | [illegible] | Do. 5% Preference | 9 | 10½ | 9½ | 10½ | 4 17 7 | May and November | ... | ... |
| £250,000 | [illegible] | ... | Do. 4½% 1st Mort. Debs. | 95 | [illegible] | [illegible] | [illegible] | | ... | 99½ | ... |
| 60,000 | 10 | 6 0 | British Elec. Trac. Ord. | 14 | 15 | 14 | 15 | 5 13 1 | ... | 14½ | 14¼ |
| 60,000 | 10 | 6 0 | Do. 6% Cum. Pref. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | February and August | 12½ | 12¼ |
| £260,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 | 123 | 120 | 123 | 4 1 4 | ... | 122½ | 121½ |
| 40,000 | 5 | 3 0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 5 | 5½ | 5 | 5½ | 5 14 3 | ... | [illegible] | 5½ |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5 | | ... | [illegible] | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stock Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 0 | ... | [illegible] | 96½ |
| 400,000 | 1 | | Cape Electric Trams. Shares | | | | 1 | ... | ... | 1½ | ... |
| [illegible] | 10 | [illegible] | Central London Ordinary | 9 | 9½ | [illegible] | [illegible] | 2 19 6 | June and December | 9½ | 9 |
| [illegible] | Stock | 1½% | City and South London Railway Con. Ordinary | [illegible] | 10 | [illegible] | 10 | 3 10 0 | February and August | [illegible] | [illegible] |
| 37,500 | 10 | [illegible] | Do. Ordinary (Nos. [illegible] to 60,000) | 4 | 5 | 4 | [illegible] | | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1898) | 122 | 127 | 122 | 127 | 3 [illegible] 9 | ... | ... | ... |
| £344,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 115 | 120 | 115 | 120 | 3 18 10 | May and November | 116 | ... |
| 60,000 | 10 | [illegible] | Dublin United Tramways (1896) Ltd., Ordinary | 12 | 13 | 12 | 13 | [illegible] | ... | ... | ... |
| 53,992 | 10 | 6 0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | ... | Do. 3½ per Cent. Mort. Deb. | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 25,000 | 5 | ... | Electric Light & Traction of Australia 6% Cum. Pref. | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary | 23 | 25 | 23 | 25 | 3 12 5 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1 3 | Kidderminster & District E. L. & Tract'n 5% Pref. | ... | | [illegible] | | ... | May and November | ... | ... |
| 37,500 | 10 | 8½% | Liverpool Overhead Railway Ordinary | [illegible] | 8 | 7½ | 8 | 1 1 3 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 14 0 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debentures | 102 | 104 | 102 | 104 | 3 17 2 | January and July | ... | ... |
| [illegible] | $1,000 | 5 | London Street Ry. (Canada) 1st Mort. 5% Debentures | 100 | 102 | 100 | 102 | 4 19 0 | ... | [illegible] | 102 |
| [illegible] | Stock | [illegible] | Lond. Unit. Trams. [illegible] 5½% Prv. [illegible] | 101 | 104 | 101 | 104 | ... | ... | ... | ... |
| £80,000 | 100 | 5% | Montreal Street Railway [illegible] | 102 | 104 | 102 | 104 | 4 16 [illegible] | ... | ... | ... |
| £140,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 5 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 4 | 3½ | 4 | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | 12 | ... |
| 30,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £175,000 | Stock | 37 0 | Do. 4½ per Cent. Debenture Stock | 107 | 109 | 107 | 109 | 4 3 9 | ... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Railway [illegible] | 93 | 95 | 93 | 95 | 3 3 3 | June and December | [illegible] | 93½ |

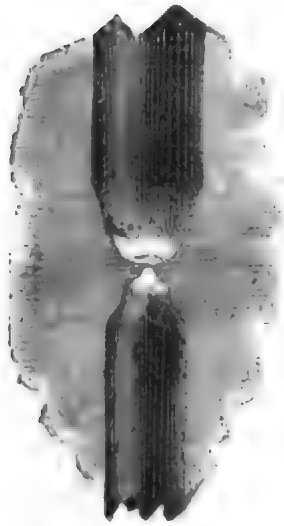
# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Mar. 6. | | Price Wednesday, Mar. 13. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During Week Ending Mar. 13. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | January and July | — | — |
| 35,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | — | — |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 55 | 65 | 55 | 65 | ... | ... | — | — |
| £637,720 | Stock | 17/6 | Anglo-American | 51 | 54 | 51 | 54 | 5 13 11 | Feb., May, Aug., Nov. | 52 | 51½ |
| £3,068,640 | Stock | 30/0 | Do. Preferred | 86 | 91 | 85 | 87 | 6 3 4 | " " | 87 | 85 |
| £3,068,640 | Stock | 5/0 | Do. Deferred | 8½ | 9 | 8½ | 8¾ | 2 14 3 | " " | 8¾ | 8⅝ |
| 13,333,300 | $100 | $1½ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 11 3 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,030 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 16 11 | " " | 103½ | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | — |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | " " | ... | — |
| 18,000 | 5 | 3/0 | Direct Spanish Ordinary | 3½ | 4½ | 3½ | 4½ | 4 8 10 | April and October | ... | — |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | — |
| £90,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | — |
| 60,710 | 20 | 5/0 | Direct United States Cable | 9¾ | 10¼ | 9¾ | 10¼ | 6 16 7 | Jan., Apr., July, Oct. | 10 | 9¾ |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | — |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary [to 1,300] (red.) | 141 | 143 | 141 | 143 | 4 11 1 | Jan., Apr., July, Oct. | 143 | 141 |
| £1,836,588 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 94 | 97 | 94 | 97 | 3 12 0 | " " | 95½ | 94½ |
| £1,433,366 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 117 | 113 | 117 | 3 9 0 | May and November | 115 | 113 |
| 260,000 | 10 | 2/6 | Eastern Extension | 14¼ | 14¾ | 14¼ | 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14⅝ | 14½ |
| 50,000 | 10 | ... | Do.(Nos. 250,001 to 300,000) £5 pd. is'd at 63pm, all pd | 13¾ | 14¼ | 13¾ | 14¼ | ... | ... | 14 | 13¾ |
| £330,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 110 | 116 | 111 | 116 | 3 9 3 | February and August | 113 | 110 |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 | 102 | 99 | 102 | 3 18 3 | February and August | 100 | — |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 17 8 | May and November | ... | — |
| 180,227 | 10 | 1/9 | Globe Telegraph and Trust | 9¾ | 10¼ | 9¾ | 10¼ | 5 2 5 | Jan., Apr., July, Oct. | 10⅛ | 9¾ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 16½ | 14½ | 15½ | 3 14 8 | " " | 16 | 15¼ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 31 | 31 | 32 | 31 | 3 12 6 | January and July | 32¼ | ... |
| £82,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (with Nos | 99 | 103 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [1 to 1,200] (red.) | 47 | 51 | 47 | 51 | 4 14 0 | May and November | 49 | 47 |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | — | — |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 16 5 | June and December | — | — |
| 11,839 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | — | — |
| 3,391 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 132 | 124 | 132 | 4 14 0 | " " | — | — |
| 14,000 | 10/0 | ... | West African Telegraph | 3½ | 3¾ | 3½ | 3¾ | 4 9 8 | December and July | — | — |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 | 100 | 97 | 100 | 5 0 0 | March and September | — | — |
| 30,000 | 2½ | ... | West Coast of America | ½ | ¾ | ½ | ¾ | ... | ... | ... | — |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | — |
| 33,211 | 10 | 6d. | West India and Panama | ½ | ¾ | ½ | ¾ | ... | May and November | ... | — |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | 6½ | 6½ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £90,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | — |
| 307,980 | 10 | 3/0 | Western Telegraph (late Brazil'n S'bm'rine) | 13¾ | 14¼ | 13¾ | 14¼ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | 14 |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 18 2 | June and December | — | — |
| £344,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 106 | 102 | 105 | 3 16 2 | ... | ... | — |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 6 14 4 | †August | — | — |
| 234,850 | 10 | 2% | Consolidated Telephone Con. and Manfg. | 2/3 | 2/9 | 2/3 | 2/9 | 10 13 2 | April and October | — | — |
| 72,000 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 5 0 0 | November | ... | — |
| 96,402 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 630,000 | 5 | 5/0 | National | 3¼ | 3½ | 3¼ | 3½ | 7 17 2 | February and August | 3½ | 3⅜ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 14 | 11 | 14 | 4 12 4 | " " | 11½ | 11 |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 13 | 11 | 13 | 4 12 4 | " " | 11½ | ... |
| 250,000 | 5 | 3/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4¼ | 4½ | 4¼ | 4½ | 5 5 3 | " " | 4⅜ | 4¼ |
| £2,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 94 | 97 | 92 | 95 | 3 14 3 | June and December | 95½ | 94 |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 19 6 | ... | ... | — |
| 171,504 | 1 | 0/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | - | — |
| 56,000 | 5 | 2/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | 4½ | ... |
| 40,000 | 5 | 2/6 | Do. 6% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | — |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 105 | 103 | 106 | 4 14 9 | June and December | 101½ | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 6% Cum. Pref. | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | — |
| 135,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | 1¼ | 1½ | 1¼ | 1½ | 7 8 2 | March and September | ... | — |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | ⅛ | ⅜ | ⅛ | ⅜ | ... | ... | ... | — |
| 50,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ⅜ | ⅝ | ⅜ | ⅝ | ... | ... | ... | — |
| £60,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 | 90 | 85 | 90 | 5 0 0 | ... | ... | — |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 6 16 4 | July and February | ... | — |
| 70,000 | 5 | 5/0 | Do. 6 per Cent. Preference | 6¼ | 6½ | 6¼ | 6½ | 4 16 0 | January and July | ... | — |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | ... | — |
| 90,000 | 2 | 1/3½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 8 8 4 | September | ... | ... |
| 15,731 | 2 | | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/3½ | Do. 8 per Cent. Pref. Non-Cum. | 2½ | 2¾ | 2½ | 2¾ | 5 9 8 | " | 2⅝ | ... |
| 15,731 | 2 | | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 101 | 105 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 5 | January and July | ... | ... |
| 90,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 | 16 | 15 | 16 | 4 13 9 | " " | 15½ | 15½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | " " | 5⅝ | 5½ |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb.(red.) | 109 | 113 | 109 | 112 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1¼ | 1 | 1¼ | 7 2 3 | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 94 | 97 | 95 | 98 | 4 12 0 | ... | 97 | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 54,000 | 2 | 1/9 | Crompton and Co. (Nos. 1 to 54,000) | 3¼ | 3¾ | 3¼ | 3¾ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 6 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | — |
| 99,261 | 3 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1½ | 2 | 1½ | 2 | 9 0 0 | February and August | ... | — |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 3½ | 4½ | 3½ | 4½ | 6 13 4 | " " | ... | ... |
| £344,028 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 85 | 90 | 86 | 90 | 4 8 11 | June and December | 88 | ... |
| £100,000 | Stock | 22/4½ | Do. 5% 2nd Deb. Standing Prov. Certs. (all pd) | 96 | 100 | 96 | 100 | ... | ... | ... | ... |
| 35,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ | 5½ | 4½ | 5½ | 6 1 10 | Half-yearly | 4⅝ | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | 103½ | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1¾ | 2¼ | 1¾ | 2¼ | 5 13 2 | January and July | 2⅛ | ... |
| 25,000 | 2 | 2/9 | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £152,300 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | — |
| 110,000 | 1 | ... | Gilfre Electro Chemical and Power Co. Ord | ¾ | | ¾ | | ... | ... | ... | ... |
| 30,000 | 5 | 4/0 | Henley's Telegraph Works Ordinary | 16 | 17 | 16 | 17 | 4 8 2 | February and August | 16½ | 16½ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 20½ | 21½ | 21 | 22 | 4 10 11 | " " | 21½ | 21½ |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 102 | 105 | 3 17 4 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 35 | 43 | 35 | 42 | 5 0 0 | March and July | 40½ | 39½ |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 17 0 | January and July | ... | — |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 | 12 | 11 | 12 | 6 5 4 | ... | 11 | ... |
| 30,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 11 | 12 | 11½ | 12½ | 4 16 0 | April and October | 12 | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6¾ | 7¼ | 6¾ | 7¼ | 4 2 9 | " " | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 107 | 103 | 107 | 4 6 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

# To obtain the best results with ARC LAMPS, use the BEST CARBONS.



# "CONRADTY" CARBONS

## are recognised throughout the World as THE BEST.

*Stock Kept by*

Messrs. CROMPTON & CO., Ld., Chelmsford & London.
Messrs. JOHNSON & PHILLIPS, Charlton, Kent.

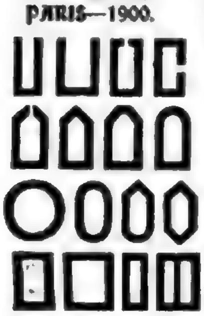
**And also the Manufacturer's Agents:**

# SLOAN ELECTRICAL CO., Ltd.,

*15, Fore Street Avenue, London, E.C.*

---

Gold Medal, PARIS—1900.



# MEIROWSKY & CO.,

WORKS: **KÖLN-EHRENFELD.**

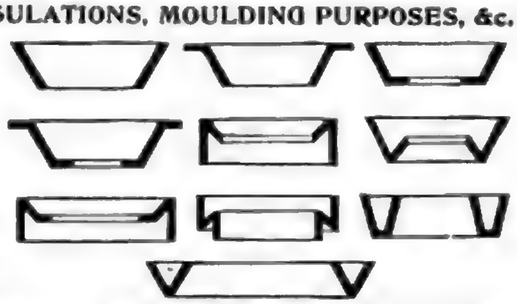
**MICA** in original BLOCKS or SHEETS or Cut to Shapes for COMMUTATORS, &c.

*MANUFACTURERS OF*

**MEGOMIT** in SHEETS for COMMUTATOR INSULATIONS, MOULDING PURPOSES, &c.

MICA COMMUTATOR RINGS and COLLARS
Of HIGH INSULATION RESISTANCE, GUARANTEED not to Exude under Heat or Pressure.

MICA INSULATION CHANNELS, TUBES, TROUGHS, &c. MICA CLOTH & PAPER.



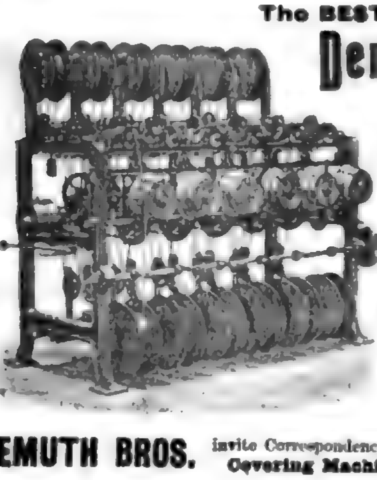
*SOLE AGENTS FOR UNITED KINGDOM:*

**GEORGE SCHULTZ & CO.,** 90, Cannon St., LONDON, E.C.

Telegraphic Address: Meirowsky London. Telephone No. 5081 Bank.

---

The BEST and MOST PERFECT WIRE-COATING MACHINE is



# Demuth Bros.' Automatic Wire-Coating Machine.

**AWARDED, Exposition Universel Paris, 1900, 2 GOLD MEDALS.**

*PATENTS:* GERMAN PATENTS, Nos. 107 and 116. AUSTRIAN PATENTS, Nos. 2,794, 2,795 and 3,040. GERMAN D. R. G. M. ENGLISH PATENT, No. 7,776.

# DEMUTH BROS.,

Foundry and Machine Works, **VIENNA**, Linzerstrasse 141-3, **AUSTRIA.**

**SPECIALITIES:** MACHINES for TWISTING WIRES, SINGLE TWIST and CABLE MACHINES for TWISTING and COATING WIRE CABLES, &c.

**ALWAYS IN STOCK.**

Wire Twisting Machines, Wire LAYING and COVERING Machines.
Indiarubber Covered Wire Twisting Machines. Armature Machines.

*Interchangeable Parts, as Spare Parts, in Stock. Installations for Wire Cable Manufacturers.*

**300 Machines supplied to the most important Factories.**

**DEMUTH BROS.** invite Correspondence, and hold Letters of Reference to many of the **first Firms** in **Europe using their Twisting and Wire Covering Machines**, and all up-to-date facilities for Wire Cable Manufacturers **of Guaranteed First-Class Workmanship.**

# The ELECTRICAL CO., Ltd.

CONTRACTORS TO H.M. GOVERNMENT.

***Head Offices: 122 & 124, CHARING CROSS ROAD, LONDON, W.C.***

Telegraphic Address. "GALVANOSCOPE."

Telephone No. 5028 GERRARD.

Fittings Department: 162, SHAFTESBURY AVENUE, LONDON, W.C.

Fittings Department Telephone No. 2133 GERRARD.

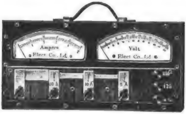
**MANCHESTER BRANCH:**
21, CORN EXCHANGE BUILDINGS, FENNEL STREET.
Telephone No. 4858 CENTRAL.
Teleg. Address: "CIRCUIT MANCHESTER."

**SOUTH COAST BRANCH:**
134, NORTH STREET, BRIGHTON.
Telephone No. 05986.

***PARIS EXHIBITION, 1900, HIGHEST AWARDS FOR OUR GOODS.***

## 6 GRANDS PRIX.

## MEASURING AND TESTING INSTRUMENTS.



**Suitable for Direct and Alternating Current at any Periodicity.**

AMMETER & VOLTMETER WATTMETER, Dead-Beat (Movable Coil) & Portable Instrument.

**DYNAMOMETRIC and INDUCTION INSTRUMENTS for Alternating Current.**

TESTING SETS. ELECTRICITY METERS (Large and Small Types).

**All our Instruments have Jewelled Bearings, and are of EXTREME ACCURACY, and suitable for ALL FREQUENCIES.**

NEW PRICE LIST, JUST PUBLISHED, ON APPLICATION.

# JOHNSON & PHILLIPS'

## ARC LAMPS.

RECENT INSTALLATION OF
J. & P's. Arc Lamps on Tramway Circuit at Bootle.

**EVERY LAMP THOROUGHLY TESTED BEFORE LEAVING THE WORKS.**

**THE GREATEST CARE EXERCISED IN THE FINISH OF EVERY PART.**

*ILLUSTRATIONS, REDUCED PRICES, and FULL PARTICULARS ON APPLICATION.*

VICTORIA WORKS, OLD CHARLTON, KENT,
**And 14, Union Court, Old Broad Street, LONDON, E.C.**

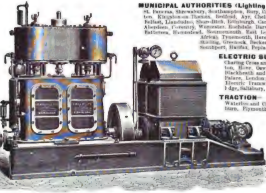
# BELLISS & MORCOM LTD.

(SUCCESSORS TO G. E. BELLISS & CO., LTD.)

**LONDON OFFICE: 9, Victoria Street, S.W.** **ENGINEERS,** **BIRMINGHAM.**

**SPECIALITY: PATENT SELF-LUBRICATING QUICK-REVOLUTION ENGINES FOR ELECTRIC LIGHT, POWER OR TRACTION.**

**OVER 190,000 H.P. SUPPLIED OR IN HAND FOR**



Representing our EC/10 STANDARD ENGINE, 250 B.H.P.
— *OVER 70 IN USE OF THIS SIZE ALONE.* —

**MUNICIPAL AUTHORITIES (Lighting & Tramways)**—
St. Pancras, Shrewsbury, Southampton, Bury, Croydon, Chester, Port Elizabeth (South Africa), Wolverhampton, Kingston-on-Thames, Bedford, Ayr, Cheltenham, Taunton, Leeds, Blackburn, Sunderland, Gibraltar, Belfast, Llandudno, Shoreditch, Edinburgh, Canterbury, Leith, Burnley, West Hartlepool, Bootle, Gloucester, Aberdeen, Coventry, Worcester, Rochdale, Darwen, Harrogate, Wakefield, Hammersmith, Woking, Newport, Battersea, Hampstead, Bournemouth, East London (South Africa), Cardiff, Buxton, Bloemfontein (South Africa), Tynemouth, Hereford, Glasgow, Bury St. Edmunds, Hastings, Govan, Ealing, Stirling, Greenock, Beckenham, Hoylake and West Kirby, Middleton, Hackney, Grimsby, Southport, Halifax, Poplar, Birmingham.

**ELECTRIC SUPPLY COS. (Lighting & Tramways)**—
Charing Cross and Strand, Winchester, Reading, Guernsey, Carlow, Northampton, Hove, Oswestry, Electricity Supply Co. for Spain (Madrid), Windsor, Blackheath and Greenwich, Colombo, House-to-House Co., London; Crystal Palace, London; Bristol Tramways, London United Tramways, Queenstown Electric Tramways, Central London Railway, Ventnor, Bromley, Alderley Edge, Salisbury, Montrose, Brechin, Newcastle.

**TRACTION**—
Waterloo and City Railway, Metropolitan and District Railway, Hull, Blackburn, Plymouth, Isle of Thanet Light Railways (Electric), Sunderland, Wolverhampton, Bury, Belfast, West Hartlepool, Bootle, Aberdeen, Rochdale, Darwen, Waterloo and Baker Street Railway, Great North of Scotland Railway, Tynemouth, East London (South Africa), Russian Railways.

Large numbers of these Self-Lubricating Engines have also been supplied to the British and other Governments, the principal Shipbuilding, Engineering and Steel Works in the United Kingdom, to Railway and Steamship Companies at home and abroad, and to many Public Institutions.

**Established 1852.**

Telegraphic Address:
"BELLISS, BIRMINGHAM."

**DEAD BEAT TYPE**

**MOVING COIL AMMETER.**

E E
C
TRADE MARK.

# Everett Edgcumbe & Co.

Head Office and Works:
22, Charterhouse Square,
LONDON, E.C.
Telephone 1052 HOLBORN.

Show Rooms:
11, Victoria Street,
WESTMINSTER.

***ACCURATE***

## WATTMETERS

***For Low Power Factors.***

ENTIRELY RE-DESIGNED.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,192. [No. 22. Vol. XLVI.] FRIDAY, MARCH 22, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

THE second Cantor lecture by Major CARDEW, on "Electric Railways," last Monday, dealt with differences between polyphase and continuous current traction, and more particularly with the Ganz system of polyphase traction, in which so much interest has lately been aroused on account of the proposal to use it on the Inner Circle. On this system, as applied to railways, very high pressures are used, the pressure intended to be employed on the Inner Circle being as high as 3,000 volts. Major CARDEW considers that this pressure can be rendered safer even than with 500 volts on a third-rail near the ground, because the polyphase conductors can be placed overhead, and they can readily be protected by short-circuit devices in the event of their falling. On the train, the engine-driver and other persons are protected from the high voltage by the use of compressed air for working all the regulating gear. Thus the trolley is raised or lowered, the switches are thrown on or off, the motors are regulated for varying speeds, and the resistances are adjusted, all by means of pneumatic controllers. Gearing is dispensed with, though not at the sacrifice of spring suspension—a matter for no small congratulation. The motor shaft is hollow, its inner diameter being much larger than the wheel axle passing through it. Flexibly-connected links convey the power from the rotor to the driving wheels. By this ingenious arrangement considerable lateral movement is possible in the rotor without interfering with its driving rate. In the next, and concluding, lecture Major CARDEW will discuss the equipment and working of a full-scale railway for suburban and main traffic on the polyphase system.

RECENTLY we have had more than one occasion to comment on the procedure of the discussions at the Institution of Electrical Engineers, and we desire once again to return to the subject, and on this occasion to address our remarks especially to those who take part in these debates. Before it was the practice to distribute advance copies of the Papers several days before the meeting, it was considered a grievance that those interested should not have the opportunity of making themselves acquainted beforehand with the author's views on the subject under discussion and his arguments in support of them. Subsequently, when the distribution of advance copies became a regular rule, it became another grievance that time should be wasted on the actual reading of these Papers at the meetings, when everybody who wished to do so might have perused them beforehand. This complaint might be considered more or less justified now that the secretary of the Institution offers on the reminder postcards to send any member copies of all the Papers regularly. The last two Papers before the Institution were on highly technical subjects, and yet, in spite of advance proofs having been sent out in plenty of time in each case, the majority of speakers in the discussion prefaced their remarks with the statement that they had not read the Paper—some speakers even seemed proud and others highly amused at the fact. The practice of sending out an advance copy of a Paper to every member who asks for it is an excellent one, and should tend to elevate the quality of the discussions, besides being a saving of time by enabling the author to let his Paper be taken as read or to deliver the briefest possible abstract or a few supplementary remarks to start the debate. But if members do not make use of their opportunity to become acquainted with the contents of Papers beforehand, the Council of the Institution, in fairness to the authors, will unfortunately have to revert to the former mode of procedure and allow the Papers to be read in full.

THE famous Berliner telephone patent has been the subject of another decision in the American law courts, and it seems likely to produce an interminable amount of litigation until it has expired or its invalidity has been affirmed by the Supreme Court of Appeal. Briefly, the history of the patent is as follows:—In April, 1877, about three months before the date of EDISON's microphone patent, EMILE BERLINER filed a "caveat" for a loose contact transmitter, and the actual application was filed in June of the same year. A delay of

14 years took place or some inexplicable cause, and the patent was only granted in November, 1891—*i.e.*, 14 years later, and according to American law the patent would not expire for 17 years after it was granted. The American Bell Telephone Co., in being owners of the fundamental Bell patent, had practically a monopoly of telephony in the United States until 1893, and since they owned the Berliner patent also it appeared as if this company's monopoly might extend until 1908. Whether on this ground, or with a view to investigating the true cause of the delay in the Patent Office, the Government brought an action against the company for the annulment of the Berliner patent, alleging fraud in the Patent Office to have occasioned the delay in the issue of the patent. After working its way up to the Supreme Court of Appeal, this action was ultimately decided in favour of the company.

In the meantime, however, the American Bell Telephone Company started an action against the National Telephone Manufacturing Co. of Boston for infringement of the Berliner patent, this suit being finally heard at the United States Circuit Court in Boston after the decision of the Supreme Court referred to above. The hearing of this new suit was concluded in November, 1899, but the decision of Judge A. L. Brown on the case was only given on February 27 last. This judgment is adverse to the patent, which it declares to be invalid because at the date of the application, June 4, 1877, the invention had not been made which is described in the patent as finally issued 14 years later. In the course of his judgment Judge Brown says:—

The original application, by changes purporting to be amendments, has been completely transformed into an application for a distinct invention. This transformation is of the most remarkable character and was made after Edison's carbon constant-contact speech transmitter was invented and described in a printed publication. Such amendment is illegal, even if Berliner had made the invention before June 4, 1877.

It appears that in this case the patent lawyer has over-reached himself, and this is a warning to patent amenders in this country. The judgment is a long and very complete review of the case and the patent, even if it does not justify that 15 months should have been required for its preparation. As the Circuit Court, however, is only a Court of First Instance, the Bell company may still not be satisfied with Judge Brown's decision, and the Berliner case bids fair to occupy an unassailable position as the Jarndyce *v.* Jarndyce of American patent litigation.

We are glad to have Mr. Hammond's explanation of the state of affairs with regard to his electricity supply scheme for Dublin. We commented on the situation in our issue of the 8th inst., and Mr. Hammond replies in our correspondence column this week. It is by no means our wish to become entangled in the complexities of party politics in Dublin; and if, in endeavouring to extricate the truth from this tangled web, we have unwittingly done Mr. Hammond any injustice, we hasten to express our regret. As a matter of fact, however, the progress of the municipal electricity scheme in the Irish capital has not been easy for those outside the circle of its promoters to follow; and judgment on Mr. Hammond's scheme in its entirety must even now be reserved until its fuller development becomes evident. Setting aside, on the other hand, all fruitless matters of past history, there are, nevertheless, several aspects of the present situation which cannot be regarded as quite satisfactory.

It is undeniable that Mr. Hammond's original estimate for buildings for the station was about £21,000. Nor can it be denied that Messrs. J. and W. Stewart's original tender for £41,674 was the lowest of the four tenders for the buildings. Mr. Hammond says that the enormous increase over his figure, in all these tenders, arose from the inclusion of items not included in his original scheme. Were the contractors asked to tender to a revised specification including those additional items? If not, whence the unanimity with which all have included them? But if they were included, why was the Corporation afterwards advised to request the contractors to carve down their original tenders; or what, in other words, can justify so enormous a reduction as £12,622 on Messrs. Stewart's original tender? With regard to the foundations, the impression that these were to be reduced, with a view to economy, may have seemed justified by the undoubted fact that Mr. Hammond includes £700 for foundations and brickwork in his revised list of items "probably not required." Certain other items, it is true, are now to be transferred from the building contract to other contracts; but we fail to see how this is going to alter the matter generally. However, as we said before, we await the course of events.

The recent address of Mr. C. Woodall, the newly-elected president of the Southern District Association of Gas Engineers and Managers, is interesting reading even for electric light engineers, who are always glad to know what their friendly rivals think of them. Mr. Woodall evidently does not love electric light, but he confesses to constantly watching its progress, and he reproaches electrical engineers for not watching as closely the progress of gas lighting. Mr. Woodall has overlooked the fact there is not the same necessity. It is electric light engineers who set the pace, and who therefore need not look behind at their rival. Gas engineers are apt to forget that before the advent of electric lighting the "archaic methods of burning gas," which Mr. Woodall thinks are the limit of the electric light engineer's knowledge of gas, were considered by gas engineers to meet amply public requirements. Only when the arc lamp showed higher possibilities of street lighting, and the glow lamp a better scale of lighting buildings, did gas engineers bestir themselves to emulate the new rivals. Mr. Woodall, nevertheless, considers London to be "the worst-lit capital in Europe," though he is blind to the real reason—the relatively small amount of street arc lighting. His one and only remedy appears to be "the high-pressure system of incandescent [gas] lighting for streets and open spaces—in short, for every purpose to which electric arc lamps were once put."

"Were once put" is too delightful; the gas engineer, forsooth, is to look on the arc lamp as being as extinct as the dodo. Thus, ostrich-like, he must bury his head in the sand to shut out the inevitable from his purview. Where, may we

ask, is this wonderful high-pressure gas system to be seen lighting streets and open places where arc lamps were once put? Mr. Woodall's son, it seems, has arranged to light part of "a southern watering place" on this system, and this "when in operation" may be "the first instance of high-pressure street lighting done directly from the works." Really, the next time Mr. Woodall attempts to frighten electric light engineers he must do better than this.

Recent great advances in the distance over which signals have been sent by Hertzian waves have raised once more the hypothesis of the feasibility of signalling to Mars. Several schemes have been put forward; Nikola Tesla, for instance, has devised a powerful etheric engine, by which he claims to be able to perform the feat. It is commonly supposed that, if there are inhabitants in Mars, and if they are intelligent, they will perceive and reply to signals from the Earth. May we suggest an elementary experiment, so absurdly simpler than signalling to Mars that our only apology for suggesting it is that it affords a ready means for testing whether highly intelligent beings are necessarily, or even probably, capable of understanding human signals. Of the remarkable intelligence of ants there can be no doubt; and it is a simple matter to determine whether any given ants' nest is inhabited. If clever ants at a hundred yards distance do not intelligently respond to Mr. Tesla's signals, why should Martians at fifty million miles do so? Let Mr. Tesla focus his wonderful etheric engine on the nearest ant-hill; let him go to the ant, consider her ways, and be wise.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 8, 1900 |
| Marseilles—Barcelona | Jan. 7, 1901 |
| Seo—Bushire | Mar. 7, 1901 |

**Radio-Active Material.**—Mr. F. Giesel, in the *Chemical News* for March 15th describes how radium rays cause skin wounds. They also cause plant leaves to acquire an autumnal yellow tint. The author states that salts, glass, paper, &c., are affected, the last-named turning brown and brittle.

**Cables Communication Committee.**—A meeting of this committee was held on Tuesday, under the presidency of Lord Balfour, when evidence was given by Mr. B. T. Ffinch, C.I.E., Director-in-Chief of the Indo-European Telegraph Department (in London), and Mr. C. H. Reynolds, late Director-General of Telegraphs (in India).

**Wireless Telegraphy in Australia.**—Mr. Jenvey, electrician to the Victorian Post Office Department, has completed the erection of the wireless telegraphy apparatus between Point Ormond and Williamstown. He will supply a report to Mr. Gurr, the Postmaster-General, as to the result of his experiments as soon as possible.

**Wireless Telegraphy and the Royal Tour.**—When the "Ophir" and her naval escort were nearing Gibraltar the "Niobe" was ordered to proceed full steam ahead and open up wireless telegraph communication with the fleet at Gibraltar. The signals, which were sent off when abeam of Tarifa Point, were received by H.M.S. "Arrogant."

**Large Two-phase Units for London.**—An advertisement in our issue this week states that the directors of the Metropolitan Electric Supply Co. are considering the expediency of adopting larger units, and are prepared to receive designs, accompanied by full specification and approximate price (erected at their works in London), for complete two-phase steam units having an output of from 3,000kw. to 4,000kw. at a pressure of 500 volts per phase, and at a frequency of 60 complete cyles per second, such units to work in parallel with the existing 1,500kw. units of the company. As an alternative, similar units generating at 10,000 volts may be considered.

**New Telephone Exchange at Hull.**—The National Telephone Co. has opened a new central telephone exchange at Hull, the equipment of which embodies the latest improvements, including the central battery system. This is the second exchange the company has fitted on this system, the first having been at Bristol. Underground wires are employed, 204-pair cables being used. We published some time ago a complete technical description of the central battery system. In this case each operator has 17 pairs of plugs and chords, and serves 100 subscribers. Power is supplied by a gas engine driven dynamo. The mileage of underground wire at Hull is about 6,000, and there are also over 1,300 miles of overhead wire in the area. In connection with this exchange there are seven exchanges.

**Electric Traction in Germany.**—The *Elektrotechnische Zeitschrift* for February 7 contains its yearly summary and full statistics of the electrically-driven tramways in Germany. On September 1, 1900, there were 99 towns having electric tramways against 83 on September 1, 1899. The total length of lines in the same time increased from 2,048km. to 2,868km., the length of track from 2,812km. to 4,255km., the number of motor cars from 4,504 to 5,991, the number of trailers from 3,138 to 3,962; the total capacity of generating plant from 52,509kw. to 75,608kw., and the total capacity of power-house batteries from 13,582kw. to 16,890kw. Besides, at the commencement of September, 1900, 28 other towns had electric tramways in progress or definitely decided, with 821km. of line and 1,053km. of track. Of these 8 had been completed by January 1, 1901.

**The late Prof. FitzGerald.**—At the meeting of the Dublin local section of the Institution of Electrical Engineers, on March 7th, Prof. W. F. Barrett, F.R.S., referred to the loss the section had sustained by the death of its chairman. In an eloquent and feeling speech he said that not only had science lost one of her most eminent and brilliant sons, but we had all lost a dear personal friend. His was one of the most gifted and highly-trained yet modest and unselfish natures, closely resembling both intellectually and in character the great Englishman, Clark Maxwell, who also passed away at the same age and in the prime of his intellectual power. Dr. F. T. Trouton, in seconding the resolution, said that what rose up most clearly in his memory was the infinite sympathy Prof. FitzGerald had always evinced with others in all their ideas and plans. He had never spared trouble in assisting those who sought his advice, and he had ever placed his brilliant genius at the service of all serious students of science. Dr. A. Trail, who had known Prof. FitzGerald as a personal friend ever since he came to Trinity College, Dublin, having also spoken, the resolution was carried in silence.

**The Institution of Junior Engineers' Annual Dinner.**—The sixteenth anniversary dinner of the Institution of Junior Engineers was held last Saturday at the Westminster Palace Hotel, when, owing to the unavoidable absence of Sir E. J. Reed, the chair was taken by Prof. John Perry. The engineering and colonial world were both in force, no less than four colonies being represented by their agents general. Most of the speakers especially referred to the future of British engineering, the general tone being optimistic. Sir Horace Tozer, K.C.M.G., agent-general for Queensland, was even able to state that the colony he represented had not bought a pennyworth of engineering material outside the United Kingdom. Sir Walter Peace, K.C.M.G., agent-general for Natal, in proposing the toast "British Engineering," was more critical, complaining from a business point of view that it was impossible to obtain goods of a given quality, and that he had often to place orders with the United States owing to the fact that they could deliver quicker and at a lower price. Prof. Perry, in acknowledging the toast, said that we were now going to standardise everything, but our chief handicap lay in the over-capitalisation of industry in England; and we should educate our capitalists to trust the young engineers.

**Humours of the Wireless Telegraph.**—Three ships of the King's navy, fitted with wireless telegraphs—viz., the "Alexandra," "Sans Pareil" and "Melampus"—have recently been anchored near Bournemouth, in the direct path of the Marconi signals between Bournemouth and the Isle of Wight. Notwithstanding all that has been said in scorn of the suggestion that Marconi signals can be intercepted, it occurred to someone on one of these ships to see whether the thing could be done. The special correspondent of a daily contemporary describes the results as follows:—

They were kept busy, and entertained by taking in the messages which passed from time to time between Mr. Marconi's private stations on the coast. It was, for instance, pleasant to know that the operators at one of the stations had enjoyed a cake for their tea, and their generosity in offering the paper which surrounded it to their fellow labourers at another station, was duly appreciated.

Sunday, March 10th.—Quiet day at anchor. . . . Marconi's people were busy again in the morning. We hope that the gentlemen mentioned in the despatch really did "get on well with the girls," but from the time of the message there seemed to be some little doubt about it. By the way, until Mr. Marconi can invent a machine that will promise not to tell tales out of school, he can hardly expect the public to take enthusiastically to the "new telegraphy." As it is now, all that a gentleman of an inquiring turn of mind need do will be to pay a royalty, set up a wireless installation in his back garden, and in a week he would be in possession of all the secrets of the neighbourhood for 50 miles around.

**Obituary.**—We regret to record the death of Mr. William Henry Axworthy, which took place suddenly, from heart failure, at his residence, "Wallasea," Barnes Common, on Sunday, 17th inst. Mr. Axworthy was born on June 7, 1845, and, after completing his education, entered the accountants' department of the Wallasea Local Board. On the formation of the Brazilian Submarine Telegraph Co., in 1873, he entered its service as accountant, and afterwards was also traffic manager. In 1898 he became manager of the Brazilian Submarine and Western and Brazilian Telegraph Companies, which were merged in the Western Telegraph Co. in 1899, and was manager of the London Platino-Brazilian Telegraph Co., and secretary of the Pacific and European Telegraph Co. from its formation. He represented the Brazilian Submarine Telegraph Co. at the International Telegraph Conference held at Budapest in 1896, and was one of the trustees for the staff in connection with the Pension Fund of the Eastern and Associated Telegraph Companies. Mr. Axworthy was universally respected and will be greatly missed by a wide circle of colleagues and friends. The funeral service was held at Barnes parish church and the interment took place in Barnes Cemetery yesterday. In addition to the relatives the following, amongst others, were present:—Mr. John Denison-Pender, the Hon. A. G. Brodrick, Mr. Frank Dawes, Mr. Briscoe, Mr. R. T. Brown (West India and Panama Telegraph Co.), Mr. F. L. Robinson (West Coast of America Telegraph Co.), Captain Woodcock (Telegraph Construction and Maintenance Co.), Mr. Slater, Messrs. G. Draper, A. R. Hardie, T. A. Bullock and H. St. L. Smith (Eastern Telegraph Co.), Mr. W. R. Lyne (Eastern Extension Telegraph Co.), Mr. John Cambrook (West African Telegraph Co.), Mr. W. Hibberdine, jun., Messrs. E. Steer Hodson, Dover, Cliffe, and Beach (Western Telegraph Co.), Mr. S. Collett (Globe Telegraph Co.), Mr. F. Preddle (Direct Spanish Telegraph Co.), Mr. H. E. Plank (African Direct Telegraph Co.), and Mr. G. R. Neilson (Europe and Azores Telegraph Co.) The floral tributes were very numerous and beautiful.——The death is announced of Mr. Frank Jarvis Patten, whose name will always be associated with the invention of the multiplex telegraph system and the use of the gyroscope for giving the position of a vessel in mid-ocean.

**Atmospheric Limits to the Propagation of Sound.**—At the Royal Institution last Saturday Lord Rayleigh, in the fourth of his course of lectures on "Sound and Vibrations," began by considering the velocity of the propagation of sound in air. With regard to the discrepancy between the determinations of that velocity made by Newton and Laplace, says *The Times*, he showed the reason to be that the former assumed the density of air to vary with the pressure asserted by Boyle's law, while the latter perceived that it did not. It was not very easy to answer the question whether sound was propagated without loss, the word loss not being here understood as referring to the diminution of the intensity of a sound with increase of distance from its source. The difficulty of making sounds carry at sea was well known; yet it had been calculated that, according to the law of inverse squares, a sound absorbing 60 H.P. should be audible across the Atlantic. That it was not so proved that some factors had been left out of account in the calculation. A reason advanced by Tyndall to explain why sounds were not freely propagated was the non-homogeneity of the atmosphere; he held that it might assume a "flocculent" condition, which was a distinct obstacle to sound, and he devised an experiment in which the presence of portions of air of different densities was seen to have an effect of the kind. But Lord Rayleigh found it hard to decide whether or not the "acoustical refraction" discussed by Stokes and by Henry was not a more important cause. If the higher layers of the atmosphere were colder than the lower, as was often the case, the waves of sound would be retarded as to their top portions, and since the direction of their propagation was at right angles to their vertical height, they would be deflected up over the head of the observer. If, on the other hand, the air was colder below than above, as happened at night, the path of the vibrations would be deflected down, and this partly explains why sounds were heard better by night than by day. Normally, also, the wind blew more strongly above than below, and, again, owing to the retardation of the tops of the waves, the effect would be to deflect a sound overhead if it was going upwind, but downwards if it were going downwind. Perhaps, however, these causes did not afford a sufficient explanation, and recourse must be had to considerations involving the kinetic theory of gases.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), March 22nd.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the Chemical Lecture Theatre of the University College, Gower-street. Agenda: (1) "On the Expansion of Silica," by Prof. Callendar, F.R.S. (2) "The Spectroscopic Apparatus at University College," by Dr. E. C. C. Baly.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Engineering Question Night, at the Westminster Palace Hotel.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse, by H. T. Brown, F.R.S. Subject: "Some Recent Work on Diffusion."

**SATURDAY, March 23rd.**

ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture V. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

**MONDAY, March 25th.**

INSTITUTION OF ELECTRICAL ENGINEERS—NEWCASTLE SECTION.

Ordinary Meeting at the College of Science, Newcastle-on-Tyne.

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture III.: "Electric Railways," by Major P. Cardew.

**TUESDAY, March 26th.**

INSTITUTION OF ELECTRICAL ENGINEERS—MANCHESTER SECTION.

*7:30 p.m.* Meeting in the New Physical Laboratory, Owens College. Paper to be read: "Direct Current Generators," by S. H. Short.

**WEDNESDAY, March 27th.**

INSTITUTION OF ELECTRICAL ENGINEERS—BIRMINGHAM SECTION.

*7:30 p.m.* Meeting in the Physical Theatre of the Birmingham University. Paper to be read: "Polyphase Equipment in Factories," by W. Wyld.

**THURSDAY, March 28th.**

THE ROYAL SOCIETY.

*4:30 p.m.* Ordinary Meeting at Burlington House, W.

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Papers to be read: (1) "The Electrical Transmission of Power in Coal Mines," by H. W. Ravenshaw. (2) "Portable Electric Lamps," by S. F. Walker.

**FRIDAY, March 29th.**

ELECTRO-HARMONIC SOCIETY.

*8 p.m.* Concert at the St. James' Hall Restaurant, Regent-street.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by the Right Hon. Lord Rayleigh, F.R.S. Subject: "Polish."

**SATURDAY, March 30th.**

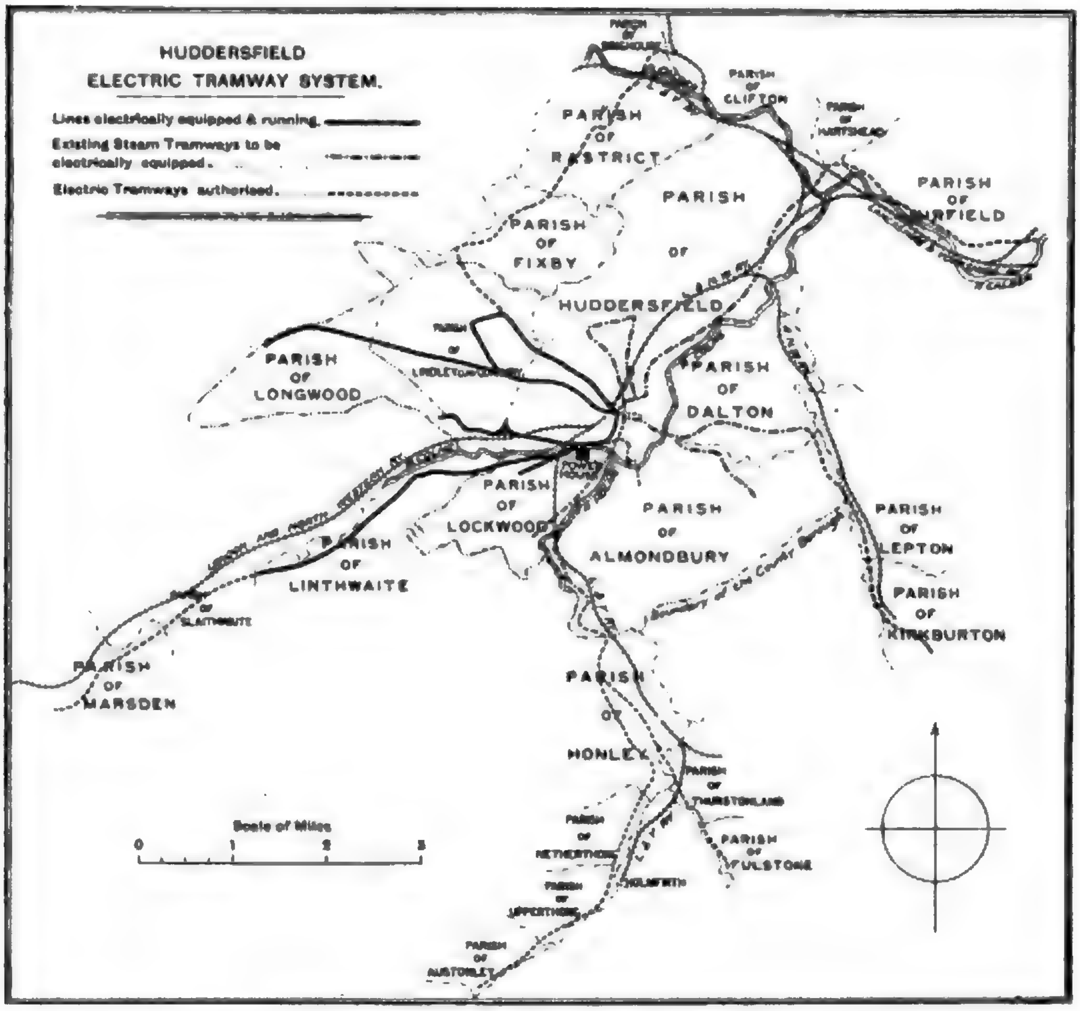
ROYAL INSTITUTION.

*3 p.m.* Afternoon Lecture VI. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

# HUDDERSFIELD CORPORATION ELECTRIC TRAMWAYS.

The borough of Huddersfield has had a system of tramways for many years, but only last month it inaugurated electric traction on these lines. The Corporation of Huddersfield is to be congratulated on the result, especially as it is a second change of system, and such an alteration is more difficult than establishing a completely new installation.

Huddersfield started with a horse system of traction in 1882, when 10 miles of track had been completed, but changed this to steam in 1893, and by 1898 28 miles of track had been laid. In the latter year the question of electric traction was considered by the Corporation, and in September the borough engineer, Mr. K. F. Campbell, M.Inst.C.E., was instructed to prepare a full report on the proposed undertaking.



Huddersfield: Map of Tramway System.

The report was presented to the Tramways committee on December 12, it was adopted by the Council on February 24, 1899, and it was resolved to proceed forthwith to electrically equip the Lindley and Outlane routes. It had been proposed to equip at first only a small section and generate the necessary power at the Corporation electric light station, but Mr. Campbell, the borough engineer, was strongly opposed to this, as he considered the existing station not suitable for the complete scheme, and electric traction was too far advanced to necessitate its trial on a small scale. Under the Act 1899-1900 powers were obtained for the construction of 19½ miles of track outside the borough, and 8½ miles within the borough, making an aggregate of 51 miles; at the same time the Corporation obtained running powers over about 8 miles in the Linthwaite district. The necessary plans and specifications were prepared by Mr. Campbell, with the assistance of the Corporation's able tramways manager, Mr. J. Pogson, M.I.M.E.; they were then submitted to Mr. H. F. Parshall, M.Inst.C.E., and after having been approved by him the work was immediately put in hand.

The site of the power-house is about 1 acre in extent, and it stands on the River Colne, from which water is obtained for boiler and condensing purposes, and this water is found very suitable on account of the soda from dye works along the river; it will be in a most central position for the completed system; it was already the property of the Corporation, used previously for a refuse destructor, and the chimney is utilised for the new tramway station.

The buildings, which have been erected from the designs of the borough engineer, are constructed in Yorkshire stone, with ashlar facings, with roofs of Welsh slates, and sufficient glazing to thoroughly light every part of the buildings. They are free from embellishment, but have a substantial and workmanlike appearance.

The boiler-house has its entire frontage to a new street constructed between St. Thomas's-road and the River Colne; it is 107ft. in length, 59ft. wide, and 28ft. high to the square, and provides accommodation for eight boilers. Opposite to each boiler is an arched opening in ashlar, with wrought label mould over, and formed of sufficient width to permit of additional boilers being introduced without interfence with the structure. The inside is lined throughout with double-pressed bricks; the roof is of slate, in two bays, with skylights 6ft.

wide on both sides of each bay. The apex of each roof is finished with continuous louvred openings for ventilation; the flues, &c., are lined with firebrick, and the front of the boilers is walled in white glazed brickwork. The flooring to the front of the boilers is finished in cement with polished granite face. The chimney shaft is circular in plan and 225ft. high, built in brickwork and finished at the top with a neat moulded stone cornice, supported by shaped and moulded corbels.

The engine-house is built alongside of and parallel with the boiler-house; it is 180ft. long, 42ft. 6in. wide, and 85ft. high to the square; it is lighted by 12 windows, each 5ft. wide and 15ft. high. The building is faced inside with white glazed bricks, with three courses chocolate coloured at dado height, and the projecting buttresses and arches which support the moulded stone string carrying the travelling crane have bull-nosed angles. The roof is of steel construction, with a skylight running along each side for the full length of the building, three ventilators are fixed in the ridge, and the roof is covered on the inside with dressed boards, with mouldings planted round to form panels between the principals.

HUDDERSFIELD: VIEW OF COMBINED PLANT.

The car sheds, which practically occupy the remainder of the site, provide accommodation for some 25 cars, and are constructed entirely of steel, the roof being in four bays, supported on wrought-iron posts and neat lattice girders. They are entirely lighted from the roofs by means of skylights, and the ceilings are boarded; an inspection pit has been formed between each set of rails to allow for a thorough examination of the cars when necessary.

Stand-pipes and connections have been arranged at convenient points to facilitate the washing and cleaning of cars, and the whole of the sheds and yard have been paved with 8in. local stone setts laid to proper falls and suitably drained.

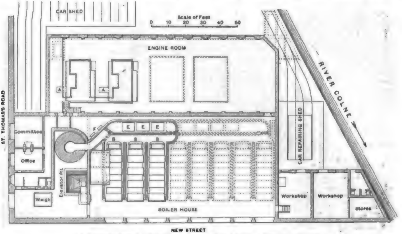
The engineering equipment was undertaken by Messrs. Greenwood and Batley, except for the electrical equipment of the Paddock and Crossland Moor routes, which were carried out by Messrs. R. W. Blackwell & Co.

Three boilers have already been fixed. They are of the Lancashire type, and were supplied by Messrs. Taylor & Co., of Marsden, and they are 8ft. 6in. in diameter and 30ft. long. The flues are 3ft. 5in. diameter, each being fitted with five Galloway tubes, and are constructed for a working pressure of 180lb. per square inch. The furnaces are fitted with Vicar's mechanical stokers with special clinkering nozzles to allow the clinker to be broken while the furnaces are working. The coal is at present carted to the power station three times a week, but a coal shed to hold about 600 tons is going to be built shortly as a stand-by in case of emergency. About 42 tons are consumed per week, the trams not running on Sundays. After weighing it is tipped into a pit from which it is raised by an elevator and deposited in the conveyor, each boiler being fitted with hopper and automatic gear. The whole arrangement is driven by a Greenwood and Batley 10 B.H.P. motor, the motor also driving the economiser scrapers; it is arranged so that it can be driven either from the main generators or the station set. Each boiler is fitted with a 88-tube Musgrave superheater, and a 96-tube Green's economiser, and the feed water is supplied through duplicate piping by means of two Blake and Knowles pumps, each pump being capable of supplying 3,000 gallons of water per hour.

The whole of the steam piping is in duplicate, and is arranged that any part of the steam range can be cut out without shutting down a boiler; it is lagged with magnesia sections and drained by Lancaster steam traps, Geipel steam traps being used on the engines. The pipes from boilers are 7in. diameter, the main range pipes are 10in. diameter, and Hopkinson's valves are used throughout.

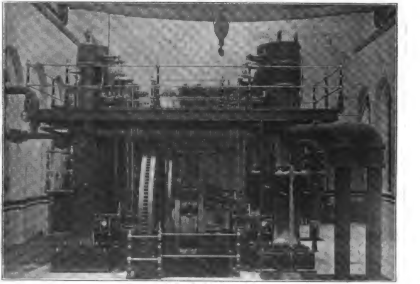
Two vertical inverted cross-compound condensing engines have been erected; they were manufactured by Messrs. Musgrave & Sons, of Bolton. The high-pressure cylinder is 17½in. diameter, the low-pressure 35in., with 3ft. stroke. The engines are rated for 520 I.H.P. with a maximum of 650 I.H.P. at 90 revs. per min. and 150lb. steam pressure; they are fitted with Musgrave patent automatic cut-off gear, and are designed for working condensing or non-condensing. They are provided with adjustable forced lubrication, and all the parts are supplied by two ram pumps on each side of the engine. One pump is coupled to the neck and eccentric rings, the other to the crank-pin, crosshead-pin, and side block; but, if necessary, both pumps can be coupled to pump the oil through one main pipe to the various parts. The valves are of the Corliss type, double ported, the high pressure only being coupled to the governor, which can be regulated to vary the speed whilst running. The fly-wheel is 18ft. diameter, with 10 tons of metal in the rim; on starting up an auxiliary engine is employed to bar it round, the barring engine making 1,055 revolutions to one of the main engine, and is fitted with automatic throw-off gear. The air-pump is 24in. diameter, with 14in. stroke, the suction pipe dipping into an open culvert which runs the full length of engine-house in the basement. The condensers are of the injector type, giving a vacuum of from 26in. to 27in., and the injection water return pipes are laid alongside of the exhaust steam pipes at the top of the culvert, and discharge to the river at a lower level than the intake, the whole arrangement being made sufficiently large for a total flow of 3,000 gallons per minute when the station is completed.

The dynamos are of Messrs. Greenwood and Batley's multipolar pattern, over-compounded so that the pressure is 500 volts at no load and 550 volts at 375kw.: the armatures have slotted core, internally ventilated, and is situated between the high and low-pressure cylinders of the engine. The winding is of barrel type, parallel wound, the armature conductors being laid in slots principally insulated by micanite troughs. The armature is mounted direct on the engine shaft, the armature hub being belted direct to the fly-wheel, thus relieving the shaft of any strain. The machines are designed to carry an overload of 25 per cent. for half an hour and a temporary overload of 40 per cent. without sparking. They stood a test of 3,500 volts alternating, and after a 12 hours' test on full load and overload the greatest rise in temperature did not exceed 30°F. on any part.



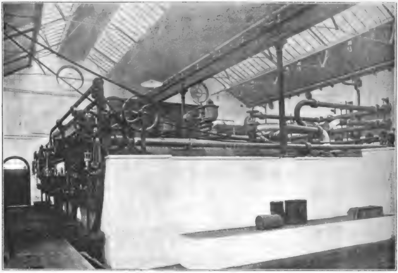
A.A. Starting Engines. E.E.E. Economisers. F. Feed Pumps. S.S.S. Superheaters:

Huddersfield: Plan of Generating Station.

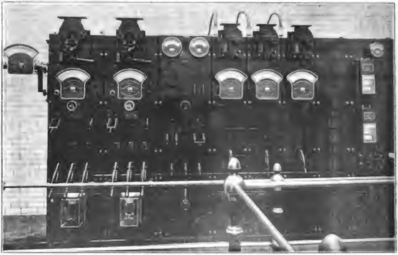


Huddersfield: Side View of Combined Plant.

Besides the above, there is a 25kw. direct-coupled set, which is used for lighting about 100 16 c.p. glow lamps, and 5 arcs on the station premises. It is also used for shunting



HUDDERSFIELD: INTERIOR OF BOILER HOUSE.

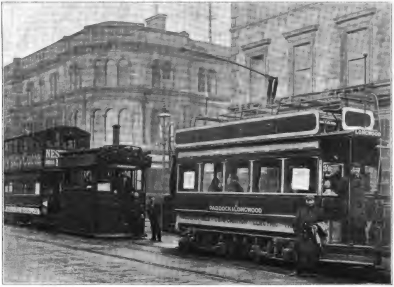


HUDDERSFIELD: VIEW OF SWITCHBOARD.

purposes when the large sets are shut down. It was supplied by the British Thomson-Houston Co., and consists of a Reavell engine coupled to a dynamo made by the General Electric Co. of America. A 25-ton overhead traveller, made by Messrs. Broadbent & Sons, of Huddersfield, and placed 27ft. above the floor level, runs the whole length of the engine room, and is operated by handles from an overhead platform. The switchboard, of which we give an illustration, was supplied by the British Thomson-Houston Co. It is mounted on a gallery 12ft. 9in. above the floor level, the gallery being connected to those round the engine cylinders, and consists of two generator panels, three feeder panels, a

Board of Trade panel, and a station lighting panel. The switchboard is made of enamelled slate, and is mounted with the usual complement of switches and instruments. Mounted on a hinged bracket at the end of the board are two illuminated dial voltmeters, one for the generator the other for the 'bus bars.

They were made by Messrs. Russell & Co. and erected by Messrs. Greenwood and Batley. There is an efficient system of two or more guard wires where the telegraph wires pass over them, the poles being earthed to the rails; and in one case where the telegraph wires pass under the tramway wire trolley wire suspenders are used.

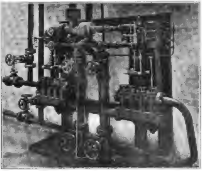


Huddersfield: The Old Steam and the New Electric Cars.

The British Thomson-Houston Co. have also supplied the whole of the overhead line equipment except that already mentioned, which was supplied by Messrs. R. W. Blackwell & Co.

Huddersfield: Exterior of Power House and Car Sheds.

It is of their well-known standard type, which is used in Sheffield and other towns. The trolley wires are of hard-drawn copper No. 00 B. and S. gauge, carried on tubular steel poles, of which we give illustrations, suspension poles being mostly used. The poles are placed about 120ft. apart.



Huddersfield: View of Feed Pumps.

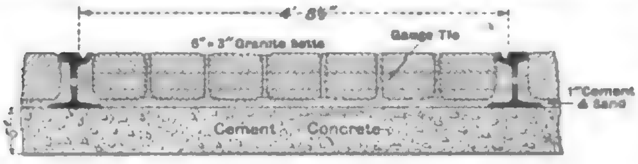
Four feeders and three rail returns have at present been laid. Three of the feeders are paper insulated, and made by Messrs. W. T. Henley's Telegraph Works Co.; the fourth was made by the St. Helens Cable Co. They are drawn into three and four-way earthenware conduits laid in cement. The feeders are respectively:—

| | | | |
|---|---|---|---|
| Lingthwaite ... | 2 miles ... | 0·35 sq. in. go ... | 0·25 sq. in. return. |
| Outlane ......... | 2 miles ... | 0·45 ditto ... | 0·4 ditto |
| Manchester-road | 1 mile ... | 0·4 ditto ... | 0·4 ditto |

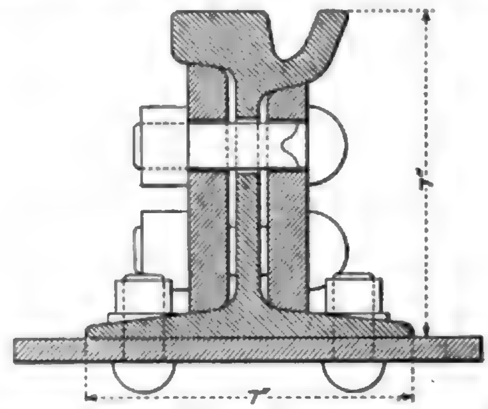
The maximum drop under the worst circumstances between feeding points and the furthest point on the line is not more than 20 volts. The maximum drop on the rails in the town is about 8½ volts and on the outlying routes not quite 5 volts, the leakage current being about ⅓th of an ampere. Section boxes are fixed about half a mile apart, with switches for cutting out any section, and two main switches for disconnecting rail and line feeder. Telephone cables are brought up to small cast-iron boxes fixed to the feeder pillar, and each driver carries a telephone of the Western Electric Co.'s make.

The cars number 25, of which 16 are at present running; they were built by Messrs. G. F. Milnes & Co., of Hadley, and are mounted upon Brill maximum traction trucks. The length of car bodies outside is 18ft. 7in., the length over end platforms 29ft. 1in., the height inside (clear) 6ft. 8in., and they have a total carrying capacity of 57 passengers—*i.e.*, 24 passengers inside and 33 outside. The cars have vermilion waist panels and cream-coloured rocker panels, emblazoned with the Corporation arms. The interior is very neat, the roof having sycamore veneer panels, from which hang the incandescent lights. The pillars are of ash, and the doors have curved oak moulding. The inside seats have stuffed cushions trimmed with crimson Utrecht velvet; the top deck seats are Callender's patent rain-proof type. The cars are heated electrically by four heaters of the Heating Company's make, placed beneath the seats, with perforated grids through the kicking board, and they are fitted with post office pillar box, these having been in use on the steam trams for years. The postal authorities pay £800 per annum for this and allowing postmen and telegraph boys to travel on the cars free of charge. The electrical equipment of each car consists of two Thomson-Houston GE-58 electric motors of approximately 27 B.H.P., two B18 controllers, MQ circuit breakers, and lightning arresters. The motors are of special soft steel, cast into two bowl-shaped halves, known as the "top" and "bottom" frames. The frame is thus divided into a horizontal plane, and the two parts bolted together, completely encasing and protecting the machine. The motor is supported in the rear on the car axles, power being transmitted to the axles from the armature by means of cut steel gearing working in a practically water-tight iron case. The two types of car, steam and electric, are clearly shown in our illustrations, and we think that there is no doubt which is the superior. Messrs. G. F. Milnes & Co. have also supplied a number of their 6-ton lifting jacks, patented by Mr. Busch, which have several novel features. Their chief characteristic is that the spindle is in tension and is suspended on ball bearings; the load to be lifted is carried by a beam between the two jacks, this is of H section fitted with a claw at each end which engages the nut of the jack.

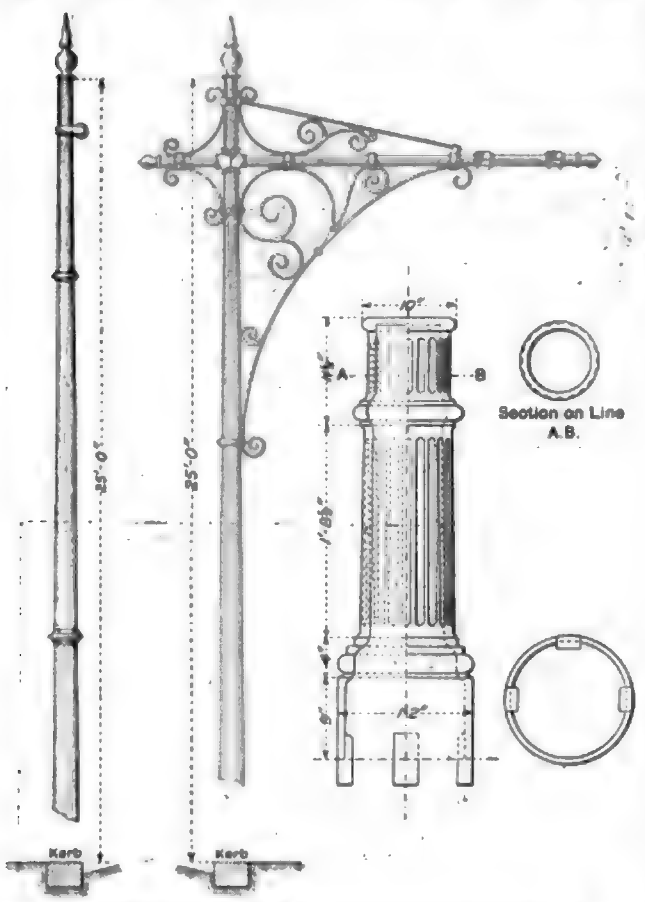
The permanent way, of which 16 miles has been electrically equipped, is divided into two sections, that laid between 1898



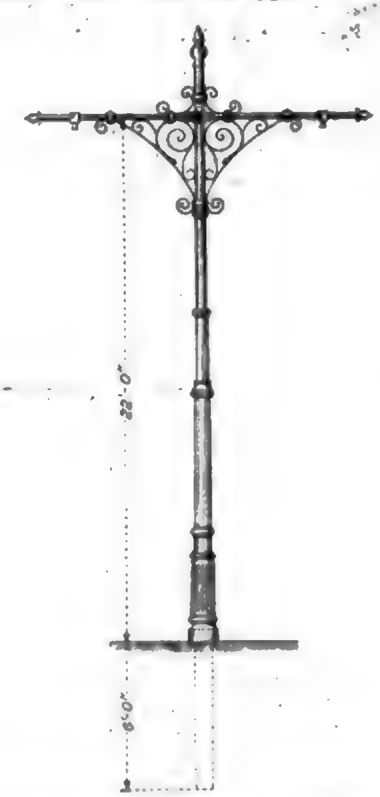
HUDDERSFIELD: CROSS-SECTION OF TRACK.



HUDDERSFIELD: SECTION OF RAIL. SOLE PLATE AND FISH PLATES. ¼-Scale.



HUDDERSFIELD: DETAILS OF SPAN WIRE POLE AND SIDE POLE.



HUDDERSFIELD: DETAILS OF CENTRE POLE.

and 1898 for steam traffic, and that which has since been put down from the design of the borough engineer. The rail weighs 98lb. per yard, and whilst the old section had a groove ⅞in. in depth the new rail has a groove $1\frac{1}{16}$in. deep. The fishplates are made especially strong as great trouble was experienced with the old rail from springing at the joint. We show details of rail and fishplate in an illustration. Each joint is bonded with double 0000 copper Felten and Guilleaume "Neptune" bonds supplied by Messrs. W. F. Dennis & Co., fitted by hydraulic pressure, cross bonds being fitted at intervals of 120ft. All the special work for the permanent way, consisting of crucible cast-steel automatic points and crossings, drain rails, &c., were supplied by Messrs. Askham Bros. and Wilson, of Sheffield. This firm have supplied the Corporation with this class of material, as well as a large quantity of the steel incidentals for the rolling stock, for the last 20 years. The town district is very hilly and some of the gradients are very trying, the steepest gradient being about 30 yards of 1 in 11, and the sharpest curve has a radius of 80ft. The service in the town is every 10 minutes, and outside 20 minutes.

In conclusion, we may add that the chairman (Mr. Ald. Haigh) has presided over the electrical tramway department, assisted by the deputy-chairman (Mr. Councillor T. A. Cockin). Mr. K. F. Campbell, the borough engineer, has had charge of the carrying out of the scheme, assisted by Mr. J. Pogson, the tramways manager, and Mr. H. N. Thomas, who has acted as clerk of the works and is now resident engineer. Great credit is due to all these gentlemen, and we must express our thanks for much of the information from which this article is compiled.

## M. GUARINI'S WIRELESS TELEGRAPH EXPERIMENTS IN BELGIUM.

Having satisfied himself that successful wireless telegraphic communication could be maintained between Malines and Brussels on the one hand, and between Malines and Antwerp on the other (see *The Electrician* of March 1, p. 706), M. Guarini has now tested his repeater with the object of re-transmitting automatically to Antwerp the signals received at Malines from Brussels. Unfortunately this trial has not been eminently successful. Individual letters and signals were received, but some failed to actuate the repeater at Malines, and others, although received at Malines, did not register themselves at Brussels, so that the transmission of actual messages was found to be absolutely impossible. Sample records which M. Guarini has sent us are very poor. As, however, M. Guarini's experiments were conducted on a large scale it is of interest to describe briefly the apparatus he employed. A communication on the same subject from Lieut. Poncelet, who assisted M. Guarini, appears in our correspondence columns.

The repeating apparatus set up at Malines is shown diagrammatically in Fig. 1. It included one air-wire, serving equally for the transmitter and receiver. Two relays were employed, as seen in the diagram. The relay in the coherer circuit was extremely sensitive, the distance between the contacts being but a fraction of a millimetre, and the maximum current it could carry through its secondary terminals was 0·4 ampere at 30 volts. On the other hand, for working a 25cm. spark coil (1cm. spark-gap was employed in the actual experiment) 3 amperes was necessary. The same relay which closed the induction coil circuit broke the connection between the air-wire and the coherer. Instead of connecting the air-wire directly to the coherer, however, it was connected to earth through the primary of a small transformer with a glass core. A condenser was added in series with the secondary of this transformer, the circuit being completed by the coherer, and the usual coherer, choking coil, relay and battery circuit was made up as in the diagram.

The coherer was enclosed in a metal box, and a self-induction coil, surrounded with crumpled tin and placed in a second metal box, protected one of the connecting wires to the coil of the second relay. The other end of this relay coil, as well as the metal boxes and crumpled tin, were earthed. This second relay was placed outside of the metal box. Its tongue was divided into three parts by ebonite plates. One part opened and closed the circuit of the induction coil; the second constituted the armature of the coil; and the third served to break and close the connection between the air-wire and the coherer-transformer according as the coil circuit was closed or open. The latter portion was again subdivided, so that the break occurred at three contacts in series instead of by a single spark. The terminal pillar and the wire connecting the relay contact and the coherer-transformer were insulated and surrounded by an earthed iron pipe. A relay of the Siemens type was employed, with the modification that the north pole was connected to the cores, while the south pole was insulated from the armature. One-twentieth of a milliampere sufficed to work it.

M. Guarini had also constructed a special form of coherer. The gap between its electrodes was 1mm. and was completely filled with coarse nickel filings with traces of silver. A vacuum was employed as usual. As it is easier to de-

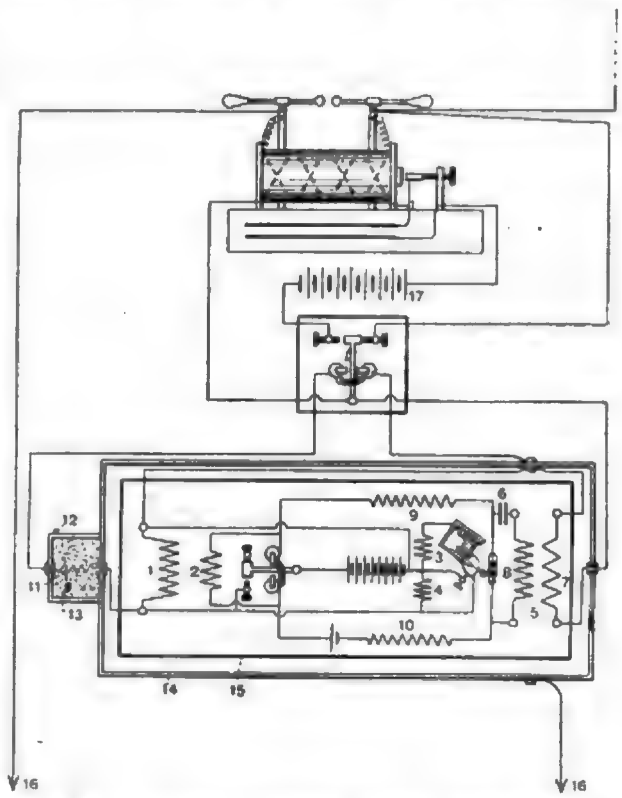


Fig. 1.—Diagram of Guarini Repeater Connections.

1, 2, 3, 4. Shunts.
5. Transformer.
6. Condenser.
7. 0·25 ohm.
8. 11,000 ohms.
9, 10, 11. Self-induction Coils: 40 ohms and 25 henries.
12. Iron Box.
13. Crumpled Tin in connection with box and earth.
14. Iron Box.
15. Board on which the apparatus is mounted.
16. Earth Connection (gas pipe).
17. Accumulators.

cohere the coherer the smaller the current passing through it, M. Guarini introduced a resistance in connection with the tapper-relay, so that as the tapper is about to strike the tube a supplementary resistance of 2,000 ohms is introduced in the coherer circuit.

It is to be regretted that, with all his ingenuity, M. Guarini has not been more successful. The idea of a repeater for wireless telegraphy has always been a fairly obvious one, and should merely be a question of working out the necessary detail to put it into practice. It must not be forgotten, however, that to be of utility a repeater must be absolutely automatic and absolutely reliable. If a skilled attendant has always to be present to keep it in order, the messages may just as well be received in the ordinary way and re-transmitted with a Morse key.

## THE USE OF STORAGE BATTERIES IN CONNECTION WITH ELECTRIC TRAMWAYS.*

BY G. A. GRINDLE, M.I.E.E.

(*Concluded from page 782.*)

*The Saving to be Made in the Cost of Operation* is self-evident, the high load factor on the engine ensuring the highest economy in the cost of production of energy, and if it is possible to reduce, as before

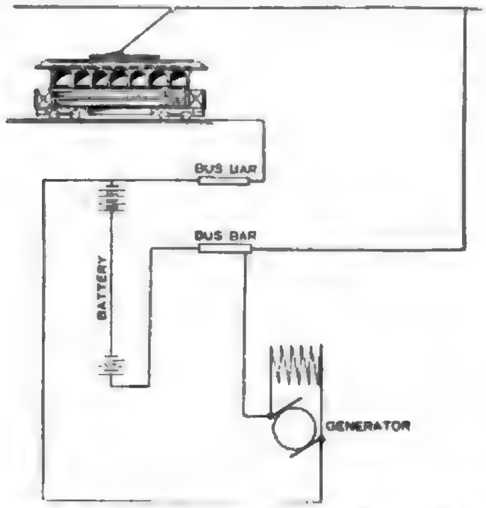
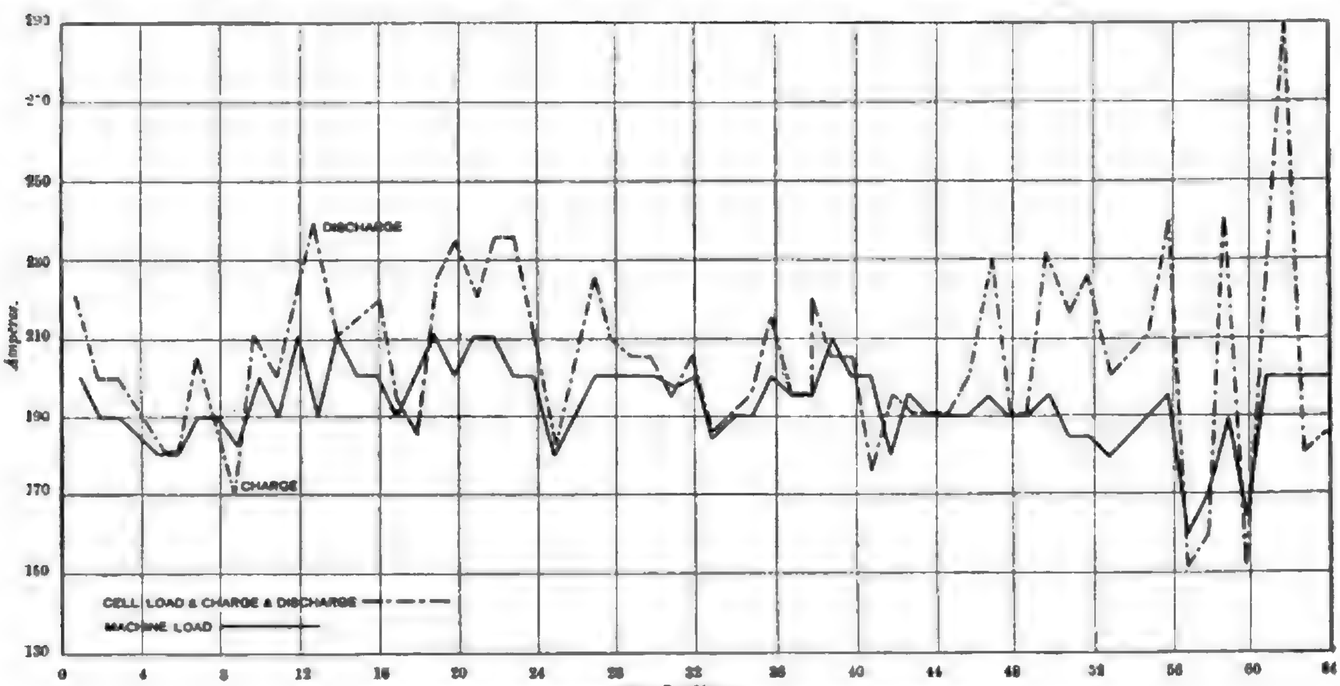


DIAGRAM 4.—Showing arrangement of Generator and Battery (at Power House). No Booster employed.

mentioned, our coal consumption 75 per cent., almost on this score only the cost would be justified, apart from the saving, in many instances, of an entire shift and the decreased running hours of machinery.

The question will naturally arise here as to what the battery losses will amount to on that portion of the load that is dealt with by the battery. These are very considerably less than are generally estimated to be the case. The actual result of four consecutive months'



Hour Discharge. Rate of Battery, 190 amperes. Battery at Power House.

DIAGRAM 5.—Curves from Generator and Battery without Booster or Tramway Load.

working of the plant from which the curves on Diagrams Nos. 9 and 10 are obtained show that out of 234,072 units generated 8,240 were absorbed by the booster, or 3·5 per cent., and the efficiency of used to generated units worked out to 91 per cent. The next point to consider will be what relative proportion the battery should bear to the station capacity. To effectively instal a battery—this is a point requiring careful consideration, and will vary considerably under different existing conditions. As a general rule it may be taken that the battery should be capable of dealing with from twice the mean load in the case of small stations to half the load at large stations; a very considerable range, it will be noted, due to the fact that with the increase in the number of running cars the relative variations of load will decrease, and also to a considerable extent by the size of generators employed in the case of large stations. No more definite

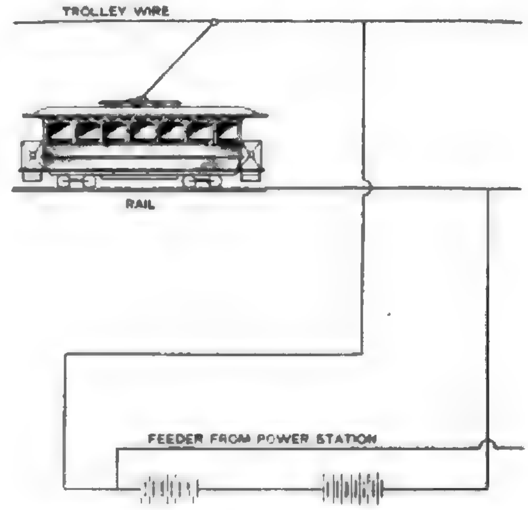


DIAGRAM 6.—Battery across Main at Sub-station.

rule can well be formulated to deal with the question, each case requiring to be dealt with on its own merits. The question will be further influenced to a considerable degree by the exact

*Method of Employing the Battery.*—There are several methods of employment, which may be generally divided into two main heads, namely, (*a*) where the battery is employed at the power station, (*b*) where the battery is employed at an outlying sub-station. Each of these two main divisions can be again subdivided into, first, where the battery is coupled as a whole across the mains or 'bus bars; second, as the first, but with a portion of it employed as regulating cells; third, where it is employed in conjunction with an ordinary booster; and fourth, where it is used in conjunction with a differential or reversible booster. The function of the battery under these different conditions will vary considerably.

* Abstract of a Paper read before the Manchester Section of the Institution of Electrical Engineers, Feb. 26.

Let us, in the first instance, take the case where a simple battery is installed at the power station without any special apparatus for its control, its two extremities being coupled direct to the 'bus bars. Under these conditions a certain portion of the fluctuations of load must fall on the generator, and a certain variation of voltage must be permissible at the 'bus bars in order that the battery may take its proportion of the load. This is easily understood if we first consider a condition of no external load, have the battery standing at a potential of 500 volts, and the potential of the generator at 500 volts; it is now very evident that the two will balance and nothing will result. If, however, by adjustment of the governors of the engine, or by the field windings of the generator, we so arrange that the generator potential shall rise, then, as can easily be followed, the generator will charge into the battery. The load next comes on the line, which should be dealt with by thegenerator up to the point of its full output being reached, after which, should the load still continue to increase, the generator voltage should commence to drop, the battery voltage predominate, and the battery commence to discharge to line. As the load falls the reverse conditions will take place. This method of working must of necessity require a certain amount of voltage variation on the 'bus bars, and consequently on the line, and it also requires a very careful predetermination of the precise characteristic of the generator. The results generally obtained cannot be deemed to be satisfactory, though greatly improving matters as compared with the case in which no battery is employed; they are, nevertheless, far behind what can be obtained with other methods of employment.

This system has, it is to be regretted, been rather widely adopted not only at home but also abroad, and the modicum of success obtained with it has, I am afraid, resulted in rather discouraging and disappointing those adopting it. Diagram No. 4 shows the general arrangement of a battery employed on this method, and Diagrams No. 5 and 12 the results obtained. From these will be noted the extremely small amount of work done by the battery and the wide range of machine load—in No. 5 the machine load varying no less than from 160 to 210 amperes and the battery practically getting no charge at all, with the working under best conditions. The voltage curve shows a variation of over 50 volts, which cannot be deemed satisfactory. The method of adoption at the sub-stations, where the battery is simply placed across the mains, as shown in Diagram No. 6, is possibly the simplest adaptation, but the results are as equivalently unsatisfactory. Here everything does and must depend on the rise and fall of the line voltage. At times of heavy load the volts will go down and the

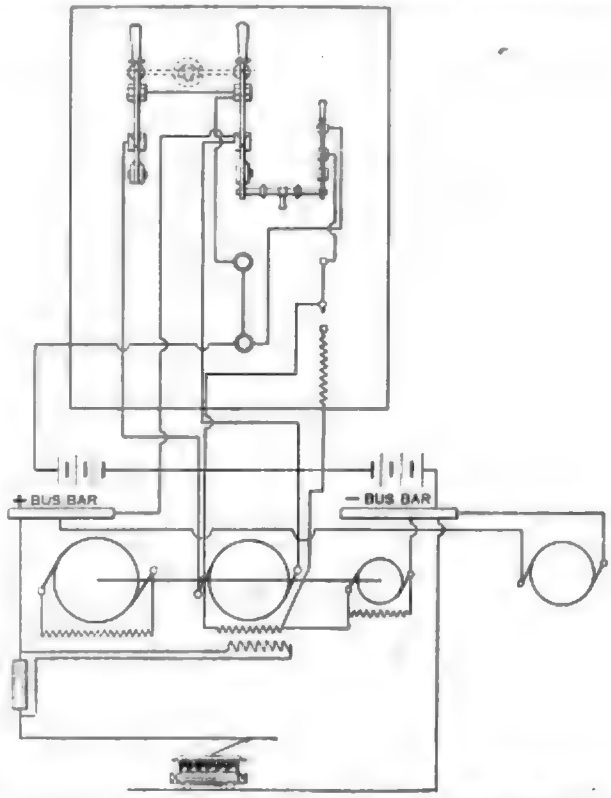


DIAGRAM 7.—Showing General Arrangement of Reversible or Differential Booster.

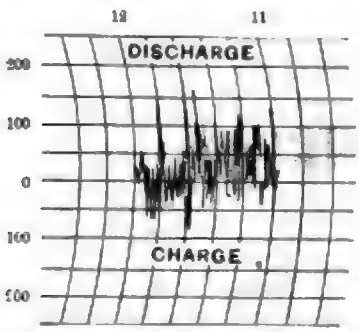
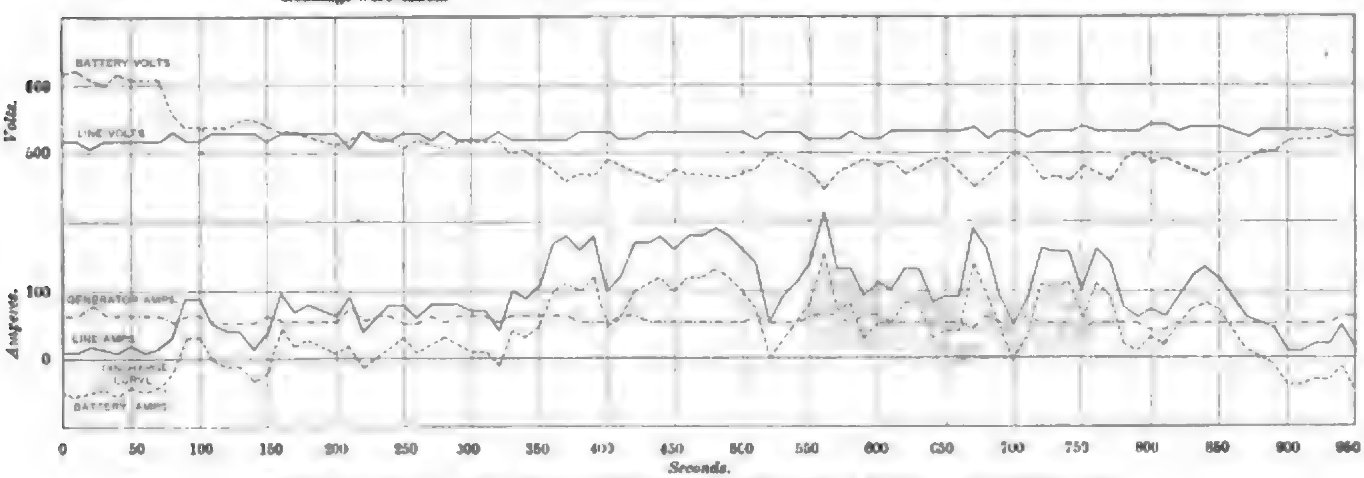


Diagram showing Curves taken by Recording Ammeter during Time the Readings were taken.

battery discharges, while when the load is light the voltage rises and the battery charges. As can be easily gathered the result cannot give satisfaction, nor is there any possible chance, within reasonable limits of variation of voltage, of the battery ever doing very much, the operation of the battery being entirely dependent on the variations of the line voltage, which must of necessity have a wide range



Eight Cars on Line. 100kw. Shunt-wound Generator. Battery, 1-hour discharge. Rate, 110 amperes.

DIAGRAM 8.—Curves from Generator, Battery and Special Booster on a Tramway Load.

result that it would either have to be charged by special means during slack time or after running hours—under these conditions the battery is of little real value, and is certainly working under very bad working conditions to itself. Diagram No. 12 shows very much the same, the generator practically following the load throughout, the battery being induced to assert itself very occasionally. These readings were taken soon after charge and may therefore be assumed to be to ensure any effectual work being got out of the battery. To be perfect a storage battery should be without internal resistance so that, however great the current passing through it, the fall or rise of volts across the terminals due to that current, whether charging or discharging, should be negligible—unfortunately, no storage battery has been made which show these qualities, nor, I am sorry to say, does it appear likely there ever will be.

P

In quite a number of cases that have come to my personal knowledge where batteries have been installed under these conditions they simply lie little less than "dead" on the line. A recent instance I have in mind where a battery which had been installed with adequate boosting arrangements at a power station was, on being replaced at the power station by a considerably larger battery, itself removed to an outlying sub-station, and employed there in this way pending arrangements for boosting. The battery, which has a one-hour discharge rate of 150 amperes, under its old methods of working frequently discharged up to 175 amperes and over, while under the new conditions it has never been known to exceed 40 amperes. Diagram No. 5 also demonstrates the same poor result. The battery in this case has a one-hour discharge rate of 190 amperes, and it will be noticed that the highest point ever reached is only 90, and that quite an exception. It is certainly not worth while installing a battery under these conditions if an effective result is desired from it, and further the working conditions are distinctly detrimental to the battery.

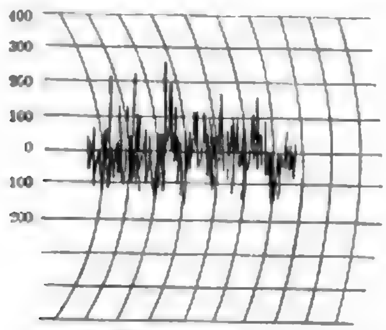
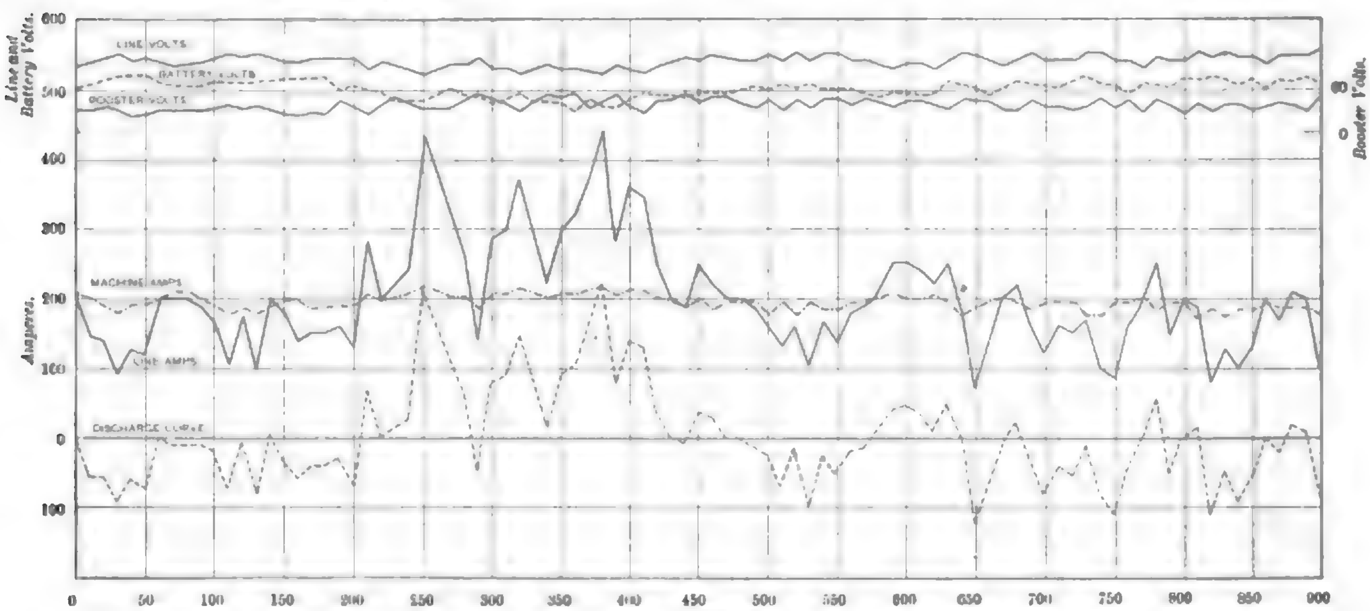


Diagram showing Curve taken by Recording Ammeter during the Time the Readings were taken.

afraid that the strongest feature about it will be the pyrotechnic display which will in all likelihood accompany its operations.

The third system, namely, the employment in conjunction with an ordinary booster has met with a certain amount of success. In this method the battery is more usually employed as a store or reservoir of energy, the charging being effected for definite periods by means of the booster current being added to that of the line, or more generally special feeder, and the battery discharged by being placed across the line either with or without regulating cells at times of very heavy load when the generators are running or when the load is as light as not to justify the generators being kept running. Under both these conditions a battery can often be employed with great advantage and material saving of running expenses, but the work generally is heavy on the battery and very liable to abuse. Except to meet very special circumstances this system has no special advantage to recommend it.

The fourth method, namely, when employed in conjunction with a differential or reversible booster is undoubtedly, at any rate as far as our present knowledge is concerned, the correct and proper way of operating a battery on a traction system, irrespective of whether it is installed at the power house or at an outlying station. Diagram No. 7 shows the general arrangement of plant at a power station. The arrangement may be thus shortly described :—In series with the battery is connected the booster, which is provided with a variable field. The field is automatically controlled by the battery pressure, and the booster pressure varies exactly as the battery pressure departs from the desired constant, so that the pressure across the terminals of the battery and booster combined is constant, the whole being perfectly automatic and controlled absolutely by the windings of the booster and the battery pressure. In the case of a battery and booster of this description employed on a traction system or any system where the load is of a rapidly varying character, the battery controlled by the booster serves to take charge of practically the whole variation, whether above or below the normal or mean load, so that the generator works at practically a steady constant load, the difference between



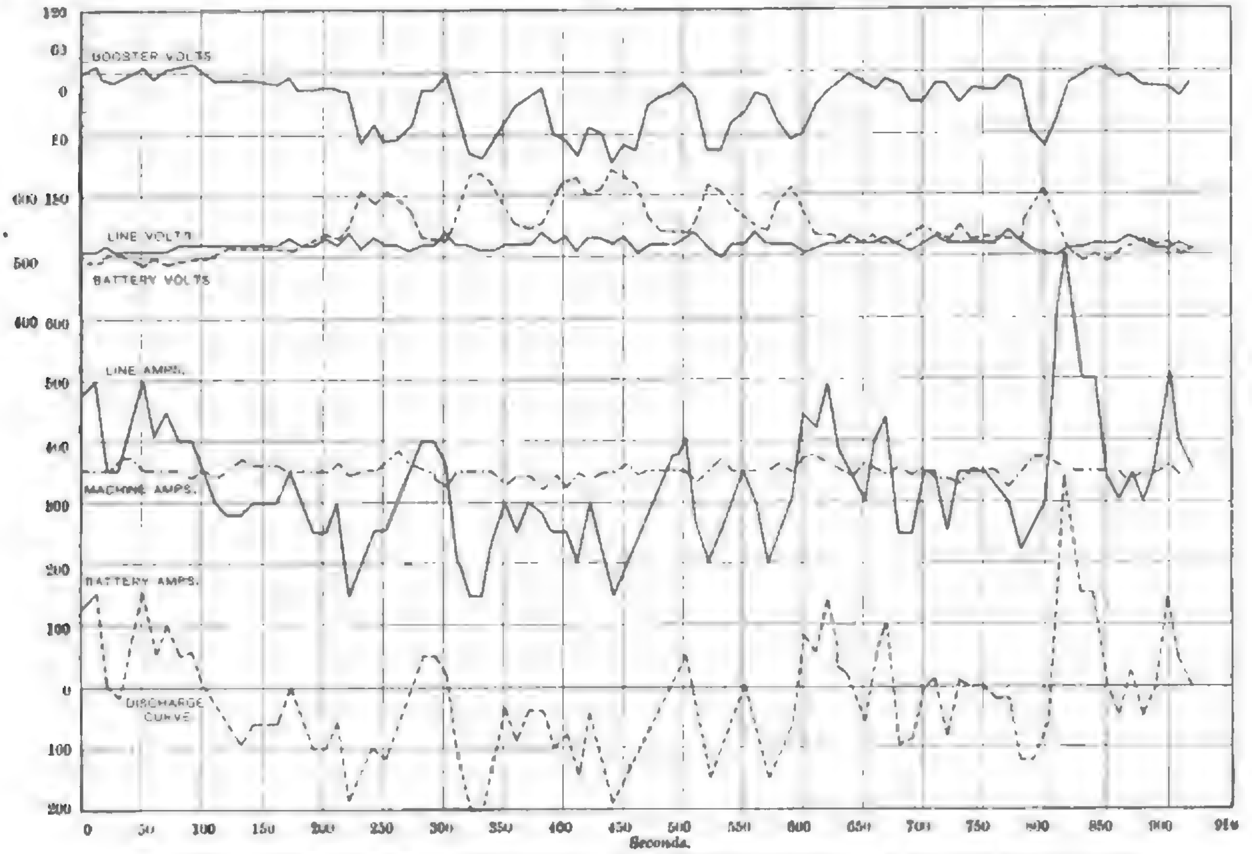
125kw. Shunt-wound Generator. Battery, 1-hour. Rate of Discharge, 450 amperes. Cars on Line, 20.

DIAGRAM 9.—Curves from Generator, Battery and Special Booster on a Tramway Load.

In the second method mentioned above, namely, the adoption of regulating cells, various attempts have been made from time to time to increase the effectiveness of batteries installed either at power stations or at outlying sub-stations by employing a portion of them as regulating cells. Automatic apparatus for cutting cells in or out as the line potential falls or rises with variation of load has in several instances been adopted, the general result, however, has been a conspicuous failure. The method is an extremely expensive one, particularly in the case of large batteries necessitating the use of a great number of costly regulating leads and expensive switch gear to keep in order. It is almost impossible to charge the regulating cells correctly, and hence they deteriorate rapidly and become a constant source of trouble ; the suddenness and rapidity of the current fluctuations being such as to make it impossible to follow them, at any rate by any automatic switches that have so far been devised. If anything at all in this direction is to be accomplished, I am of opinion that it will be by means of some automatic and interlocking rocking apparatus with mercury contacts, but I am very much

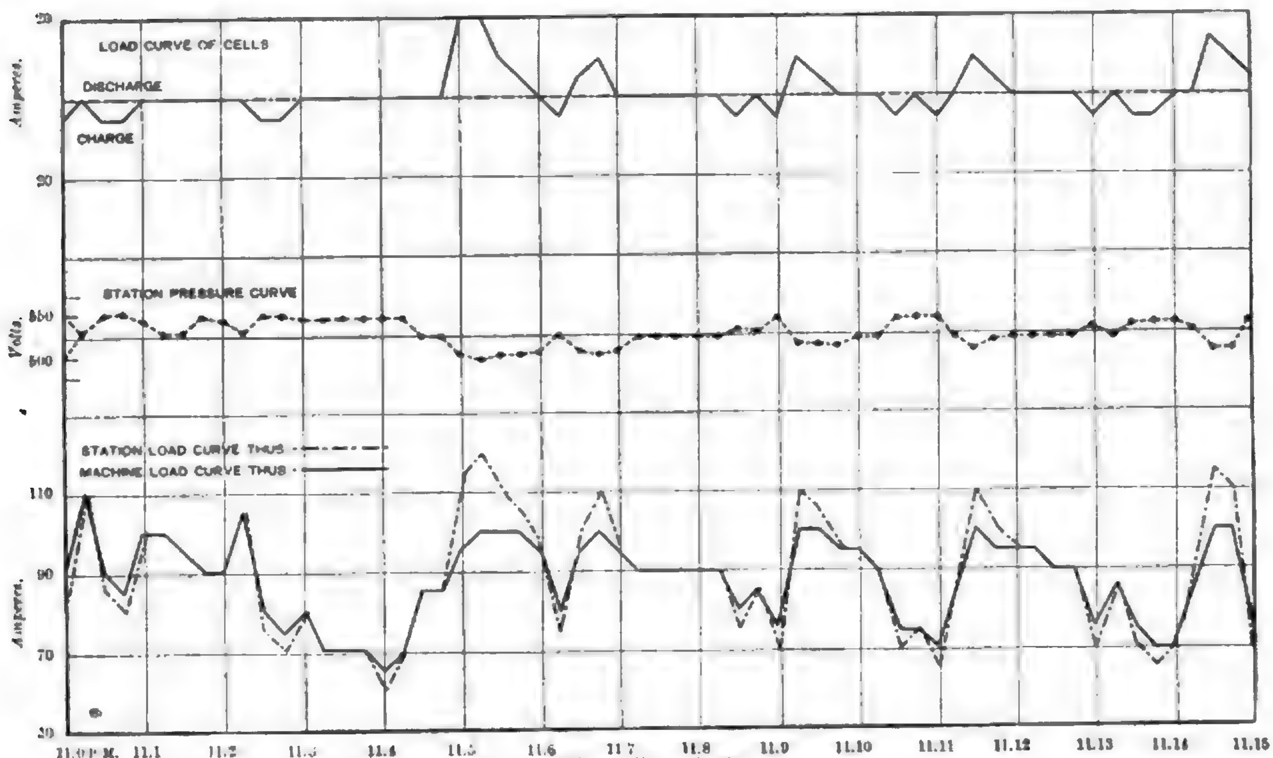
the load and the mean charging into the battery when the line load falls below the mean, and the battery discharging to line whenever the load exceeds the mean. The generator load will naturally be adjusted to be the mean load required to generate the total average output for the usual period of work. The general features of this arrangement which commend it as being of special value on a tramway system may be summed up as follows : The first cars run out in the morning and under the precisely similar conditions of energy supply can be worked entirely from the battery, thus obviating the necessity of starting up the power station for a few early workmen cars some two or three hours before the general load comes on. During the day the battery will be intermittently charging and discharging, the output of the generator or generators being fixed at such an amount that at the pre-determined time of shutting down the battery is fully charged. Should the battery be found not to be in its normal state of charge at shutting down, owing to an abnormal demand, the running time can be prolonged, or the loss compensated for, by slightly increasing the generator output the next day, *vice*

*versa* if the battery is overcharged, the output may be decreased. The power station can be shut down on the heavy load falling off, the remaining late cars being run, as the early morning ones, off the



220kw. Shunt-wound Generator. Battery, 1-hour. Rate of Discharge, 450 amperes. 21 Cars, heavy load, greasy track.

DIAGRAM 10.—Curves from Generator, Battery and Special Booster on a Tramway Load.



Hour Discharge Rate of Battery, 160 amperes. Conditions. Readings taken soon after Charge; 240 Cells in parallel with 1 Generator; Voltage of Cells at commencement, 500

DIAGRAM 12.—Curves from Generator and Battery, without Booster, on Tramway Load.

battery only. The advantages of working a plant under these conditions are self-evident.

Working at full constant load, the greatest possible economy can be ensured. The actual running hours shortened, and the most uneconomical and unprofitable hours in every sense of the whole day's work avoided. The minimum of plant running necessary for operating the load. Wear and tear on the plant generally will be much less, the load on the generators being practically constant. Ordinary shunt wound machines may be used, though the system

works as perfectly with compound wound machines. The switching gear is of the simplest description, and is reduced to a minimum, and the whole arrangement absolutely automatically controls itself. The general working conditions are most favourable to the life of the battery, the latter being kept constantly fully charged, and immediately charged after discharge. Diagrams Nos. 8, 9, and 10 give some highly interesting curves obtained under different conditions with a tramway system, in which a battery and booster of this description form part of the power station equipment. The steady generator load is particularly noteworthy, also the range of the total load curve, the variations of which are taken almost entirely by the battery. Diagrams No. 9 and 10, further, are interesting examples of how a load on the same system may vary, due principally to conditions of traffic and weather, practically the same number of cars running in both cases, while the mean load differs widely.

The actual recorder curves, which I regret to say I have not been able to get reproduced, show very clearly the result which can be obtained on a system equipped with a battery and booster. The battery must, of course, be properly adapted for the work it has to perform. It must be capable of being charged at very high rates without injury, and of the minimum possible internal resistance, so as to ensure the least possible range of voltage. These conditions are best met with in plates of the Planté type, and with such the battery losses amount to but a small percentage of the total load.

As can readily be understood, a great deal depends on the design and construction of the booster necessary to properly carry out these functions. Up to quite recently the differential or reversible booster has been practically unknown, and those machines which did exist can scarcely be looked upon as being either highly effective or highly efficient. The extended adoption of batteries in connection with power plants has, however, created a demand, and of late considerable attention has been paid to the construction of this type of machine, and various methods and arrangements have been designed to meet the necessary requirement; in many instances the results have left very much to be desired, and in cases where the working may have been passable, the efficiency has been such as to preclude their being considered. There is very little doubt but that the most successful machine that has so far been introduced is that for which Mr. J. S. Highfield is responsible. By this machine all the functions above mentioned are attained to a remarkable degree, and with the highest efficiency. The booster is a distinctly novel departure, in that it consists of three distinct machines, namely, a motor, generator, or booster and exciting controller, by means of which the unwieldy and waste windings, which have prevailed in all other machines, and which have seriously impaired their efficiency, have been avoided. The function of the third machine is to control the excitation of the booster, and runs in direct opposition to the battery current, by this means the requisite field reversals are obtained. Operating a traction or power system with a machine of this type practically results in the battery becoming, as it should do,

*The Real Regulator of the System.*—The extent to which a battery should control or regulate a system is an interesting factor. Personally, I am of opinion that it should take the sole and entire charge and control of the whole, even to the extent of not excluding the engine—in other words, the engine should be run without a governor on a constant steam pressure and constant valve admission. This will doubtless by many be considered to be a bold departure, but I am convinced myself that the best curves on the accompanying diagrams or any hitherto obtained might be still better under these circumstances, and that the small generator variations that do occur are due to the governor attempting to follow the load instead of leaving it entirely to the battery to compensate for, as should be the case. The abolition of the governor on a power station engine is the consummation of an ideal devoutly hoped for, but I am certain in many instances, with a proper equipment of battery and booster, it is perfectly feasible.

In closing this Paper, I must express my thanks for the kind assistance rendered me, both by information and curves, by Mr. McMahon, of Bispham, and Mr. Highfield, of St. Helens.

## BOOKS RECEIVED.

**Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.**

"*Proceedings* of the Royal Society." No. 442. Vol. LXVIII. (London: Harrison & Sons.) 1s. 6d.

"Esperimento di Trazione Elettrica sulla Linea Ferroviaria Bologna—San Felice sul Panaro." Lecture by Pietro Lanino. (Turin: C. E. and N. Bertolero.)

"Prime Nozioni Fondamentali di Elettrochimica." By Alfonso Cossa. (Milan: U. Hoepli.)

"Impianti di Illuminazione Elettrica." By Emilio Piazzoli. 5th edition. (Milan: U. Hoepli.)

"L'Electricité à l'Exposition de 1900." By E. Hospitalier and J. A. Montpellier. No. 5. (Paris: Vve. Ch. Dunod.)

## ELECTRICITY WORKS ACCOUNTS.

### Liverpool Municipal Electric Supply Works.

As the result of a combined traction and lighting load, the Liverpool undertaking is now the largest in the provinces, its output last year having exceeded 11½ million units sold. The city is to be congratulated, moreover, not only on the huge output of its supply undertaking, but also on the character of the load as evidenced by the load factor of 20·8 per cent.—another beneficient influence of the tramways as a customer.

In the following tables are given figures showing the growth of the undertaking since 1896, when it was acquired by the Corporation:—

| Year. | No. of con-s'mers. | Equiv. No. of lamps. | Units sold, total. | Load factor. | Total costs | Works costs. | Gen. costs. | Total rev. | Working profit, to mean cap. |
|---|---|---|---|---|---|---|---|---|---|
| 1896 | 1,200 | 104,980 | 1,452,511 | 8·19 | ... | ... | ... | ... | ... |
| 1897 | 1,779 | 135,222 | 2,187,594 | 9·18 | 2·07d. | 1·32d. | 1·01d. | 5·67d. | 6·64 % |
| 1898 | 2,279 | 184,648 | 2,915,695 | 9·17 | 1·78d. | 1·17d. | 0·97d. | 4·77d. | 6·54 |
| 1899 | 2,[illegible]42 | 237,962 | 5,729,4[illegible] | 12·7 | 1·36d. | 0·91d. | 0·77d. | 3·04d. | 6·11 % |
| 1900 | 3,34[illegible] | 298,99[illegible] | 11,5[illegible]4,335 | 2[illegible]·8 | 1·25d. | 0·95d. | 0·89d. | 2·28d. | 5·44 % |

| Year | Output. | | | | | | Revenue, pence per unit. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Public lighting | % of tot. | Private lighting. | % of tot. | Traction supply. | % of tot. | Public. | % of tot. | Private. | % of tot. | Traction. | % of tot. |
| 1898 | 210,492 | 7·27 | 2,600,378 | 89·2 | 104,815 | 3·59 | 3·00 | 4·54 | 4·67 | 87·2 | 1·00 | 0·75 |
| 1899 | 201,574 | 3·52 | 3,644,175 | 63·6 | 1,883,728 | 32·9 | 2·29 | 2·65 | 3·93 | 82·0 | 0·94 | 10·1 |
| 1900 | 211,7[illegible]2 | 1·83 | 4,676,951 | 40·5 | 6,675,682 | 57·7 | 2·[illegible]0 | 1·61 | 3·70 | 65·5 | 1·10 | 27·9 |

As might have been expected from such a great advance in the nature and extent of the business done, a general and substantial reduction was effected in the various items of cost, excepting fuel. This item shows a rise of nearly 42 per cent. on the 1899 value, and we learn from the engineer of the Liverpool undertaking that the average price paid for coal was 60 per cent. higher. In these circumstances to have kept down the generating and works costs to the values shown in our table, and to have reduced the total costs, are most satisfactory results.

The other three items of generating costs and the collective management and property charges present figures worthy the magnitude and character of the undertaking.

The management and property charges at 0·29d. and the total revenue per unit are the lowest we have yet come across in our analyses.

With the low average prices charged for current for various purposes, as shown in the subsidiary table given above, the working profit of 5·44 per cent. of the mean capital expended is a most gratifying result, and enabled £17,8[illegible]8 to be placed to the sinking fund and £3,497 to the renewal fund, leaving £2,000 for the benefit of the rates.

### Chelsea Electricity Supply Co. (Ltd.).

The last year's accounts of this company indicate satisfactory results. The lamp connections increased during the year by 12·4 per cent., and the advance of 17 per cent. in the output was attended by a slight improvement in the load-factor, which was 10·38 per cent.

The inevitable increase in the fuel item here, as elsewhere, prevented a reduction being shown in the costs. As it is, all the other important items except those of distribution costs have dropped.

With the moderate total revenue of 5·45d. per unit from all sources the working profit was barely 5 per cent. of the capital. In 1899 a sum of £1,096 was set aside in view of the increase expected in the coal bill of last year. It may be noticed that this amount was really insufficient to meet the whole increase. In our analysis we have kept this amount from entering into the ordinary revenue account, and therefore, in the present table it appears debited in 1899 and credited in 1900 to the net revenue account. The net balance afforded a dividend on the 6 per cent. preference shares and one of 5½ per cent. on the ordinary shares, leaving £122 to carry forward to next year.

| | LIVERPOOL. | CHELSEA (LONDON). |
|---|---|---|
| *Undertaking Worked by* | Liverpool Corporation. | Chelsea Electricity Supply Co., Ltd. |
| *Date of Commencement of Supply* | 1893. | September 1889. |
| *System of Supply* | Con. curr. two and three-wire, with batteries. | Con.-curr. with dynamotor sub-stations. |
| *Chief Engineer* | A. B. Holmes. | Percy Still. |

| YEAR ENDED | Liverpool DEC. 31, **1899.** | Liverpool DEC. 31, **1900.** | Chelsea DEC. 31, **1899.** | Chelsea DEC. 31, **1900.** |
|---|---|---|---|---|
| **QUANTITIES** | | | | |
| Units generated | — | — | — | — |
| " SOLD (TOTAL) | 5,723,477 | 11,564,335 | 1,428,323 | 1,672,026 |
| " sold to consumers | 5,527,903[a] | 11,352,633[j] | 1,428,323 | 1,672,026 |
| " sold for public lighting, &c. | 201,574 | 211,702 | — | — |
| " used on works | — | — | — | — |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 25.9 | 33.3 | 14.7 | 17.25 |
| Maximum supply demanded | 5,165 kilowatts | 6,352 kilowatts[k] | 1,580 kilowatts | 1,840 kilowatts |
| Number of public lamps | 142 arc | 142 (tramp) arc, 25 10-c.p. glow.[l] | nil | nil |
| Number of consumers | 2,842 | 3,340 | 1,690 | 2,082 |
| Connections to mains in 8-c.p. lamps | 237,552 | 298,930 | 129,000 | 145,000 |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 221,000 | 347,000 | 96,900 | 96,900 |
| CAPACITY OF PLANT IN KILOWATTS | 7,090 | 11,110 | 3,100 | 3,100 |

| CAPITAL— | L 1899 Total. | L 1899 Per kilowatt capacity. | L 1900 Total. | L 1900 Per kilowatt capacity. | C 1899 Total. | C 1899 Per kilowatt capacity. | C 1900 Total. | C 1900 Per kilowatt capacity. |
|---|---|---|---|---|---|---|---|---|
| AUTHORISED (TOTAL) | — | — | — | — | — | — | — | — |
| Share | — | — | — | — | £400,500 | £129 | £400,500 | £129 |
| Loan (including Debenture charges) | — | — | — | — | —[a] | — | —[a] | — |
| RECEIVED (TOTAL) | £350,000 | £49.4 | £817,819 | £73.6 | 338,430 | 109 | 370,645 | 120 |
| Share | — | — | — | — | 200,500 | 64.7 | 220,645 | 71.1 |
| Loan (including Debenture charges) | 350,000 | 49.4 | 817,819 | 73.6 | 137,930 | 44.5 | 150,000 | 48.4 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | — | — | — | — | — | — | — | — |
| Share (unissued) | — | — | — | — | 200,000 | 64.5 | 150,975 | 48.7 |
| Share (uncalled) | — | — | — | — | — | — | 28,880 | 9.31 |
| Loan (including Debentures) | — | — | — | — | — | — | — | — |
| REPAID (TOTAL) | — | — | 18,500 | 1.67 | — | — | — | — |
| RESERVE OR SINKING FUND | 55,069[b] | 7.78 | 58,068[i] | 5.23 | 48,605 | 15.7 | 56,623 | 18.3 |
| DEPRECIATION FUND | 23,720 | 3.35 | 24,431 | 2.20 | 10,270 | 3.31 | 11,570 | 3.73 |
| EXPENDED (TOTAL) | 769,589[c] | 109 | 1,048,559 | 94.4 | 389,835 | 126 | 425,545 | 137 |
| Lands and buildings | — | — | 66,399[n] | — | 114,960[b] | 37.1 | 125,835 | 40.6 |
| Plant | — | — | 90,981[l] | — | 157,659[b] | 50.9 | 169,347 | 54.6 |
| Mains | — | — | 121,593[l] | — | 102,155[b] | 32.9 | 115,372 | 37.2 |
| Miscellaneous | — | — | 3 | — | 15,081 | 4.86 | 15,093 | 4.87 |
| BALANCE OF CAPITAL ACCOUNT | −419,589[d] | −59.2 | 230,740[l] | −20.8 | −51,405[c] | 16.6 | −54,900[c] | −17.7 |

| REVENUE— | L 1899 Total. | L 1899 Per unit sold | L 1900 Total. | L 1900 Per unit sold | C 1899 Total | C 1899 Per unit sold | C 1900 Total. | C 1900 Per unit sold |
|---|---|---|---|---|---|---|---|---|
| TOTAL | £72,696 | 3.044d. | £109,651 | 2.276d. | £34,988 | 5.881d. | £38,012 | 5.456d. |
| Revenue from supply | 67,016[e] | 2.806d. | 102,608[m] | 2.130d. | 33,449 | 5.624d. | 35,975 | 5.163d. |
| " meters, &c. | 1,687 | 0.071d. | 2,029 | 0.042d. | 1,440 | 0.242d. | 1,703 | 0.244d. |
| " public lighting | 1,925 | 0.081d. | 1,764 | 0.037d. | — | — | — | — |
| " sale of lamps, &c. | 2,068 | 0.087d. | 2,545 | 0.053d. | — | — | — | — |
| " miscellaneous sources | — | — | 705 | — | 99 | 0.017d. | 334 | 0.048d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £31,161 | 1.305d. | £60,175 | 1.249d. | £14,881 | 2.500d. | £17,693 | 2.538d. |
| WORKS COSTS | 21,813 | 0.914d. | 45,994 | 0.955d. | 10,104 | 1.697d. | 12,690 | 1.821d. |
| *Generation of electricity* | 18,313 | [illegible] | [illegible] | 0.888d. | [illegible][d] | 1.301d. | [illegible][d] | 1.290d. |
| Fuel (including cartage, &c.) | 10,116 | 0.424d. | 22,944 | 0.601d. | 4,152 | 0.698d. | 6,366 | 0.914d. |
| Oil, waste, water, stores | 1,676 | 0.069d. | 3,173 | 0.065d. | 594 | 0.100d. | 705 | 0.101d. |
| Wages at station | 4,542 | 0.190d. | 7,951 | 0.165d. | 1,709 | 0.287d. | 1,671 | 0.240d. |
| Repairs and maintenance at station | 2,046 | 0.086d. | 2,717[n] | 0.056d. | 1,295 | 0.218d. | 1,419 | 0.204d. |
| *Distribution of electricity* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Wages, &c. | 1,371 | 0.057d. | 1,262 | 0.026d. | [illegible] | 0.145d. | 1,169 | 0.168d. |
| Repairs, renewals of mains, &c. | 2,099 | 0.088d. | 1,987 | 0.041d. | 906 | 0.153d. | 1,140 | 0.164d. |
| *Public lighting* | — | — | — | — | — | — | — | — |
| Attendance | — | — | — | — | — | — | — | — |
| Renewals | — | — | — | — | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 9,348 | 0.392d. | 14,181 | 0.294d. | 4,777 | 0.803d. | 5,003 | 0.718d. |
| *Royalties* | — | — | — | — | [illegible] | [illegible] | [illegible] | [illegible] |
| *Rent, rates, taxes* | 2,878 | 0.120d. | [illegible] | [illegible] | [illegible] | [illegible] | 2,057 | 0.295d. |
| *Management* | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Salaries | 4,947 | 0.207d. | 5,621 | 0.117d. | 2,137 | 0.359d. | 2,151 | 0.309d. |
| Stationery, &c. | [illegible] | 0.017d. | 433 | 0.009d. | [illegible] | 0.024d. | 91 | 0.013d. |
| Establishment charges | 449 | 0.019d. | 492 | 0.010d. | 260 | 0.044d. | 331 | 0.047d. |
| Law charges, &c. | 679[i] | 0.028d. | 962 | 0.020d. | 297[e] | 0.050d. | 373[i] | 0.054d. |

| FINANCIAL RESULTS— | L 1899 Total. | L 1899 % to mean cap. expended | L 1900 Total. | L 1900 % to mean cap. expended | C 1899 Total. | C 1899 % to mean cap. expended | C 1900 Total. | C 1900 % to mean cap. exp'nded |
|---|---|---|---|---|---|---|---|---|
| WORKING PROFIT FOR YEAR | £41,536 | 6.11% | £49,478 | 5.44% | £20,107 | 5.57% | £20,319 | 4.98% |
| Sum carried to Depreciation Fund | 5,200 | 0.765% | — | — | 3,132 | 0.867 | 3,000 | 0.756% |
| Sum carried to Reserve or Sinking Fund | 17,723 | 2.61% | 21,330 | 2.34% | 1,096[f] | 0.303 | −1,096[f] | 0.269% |
| Net interest on loans (incl. Debenture charges) | 18,582 | 2.73% | 26,145 | 2.88% | 4,802[g] | 1.33% | 7,045[g] | 1.75% |
| BALANCE FROM LAST ACCOUNT | 1,555 | 0.229% | — | — | 928 | 0.256% | [illegible] | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 1,000 | 0.147% | 2,000 | 0.22% | 12,000 | 2.32% | 11,371 | 2.79% |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | — | — | — | — | 6 | — | 5½ | — |

| | Liverpool 1899 | Liverpool 1900 | Chelsea 1899 | Chelsea 1900 |
|---|---|---|---|---|
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 42.9% | 54.9% | 42.5% | 46.5% |
| Expenditure per kilowatt capacity | £4. 7s. 11d. | £5. 8s. 4d. | £4. 16s. 0d. | £5. 14s. 2d. |
| REVENUE PER KILOWATT CAPACITY | £10. 5s. 0d. | £9. 17s. 5d. | £11. 5s. 7d. | £12. 5s. 0d. |
| Expenditure per 8 c.p. lamp capacity | 2s. 9½d. | 3s. 5½d. | 3s. 0¾d. | 3s. 7½d. |
| REVENUE PER 8-C.P. LAMP CAPACITY | 6s. 7d. | 6s. 4d. | 7s. 2½d. | 7s. 10d. |
| REVENUE PER 8-C.P. LAMP CONNECTED | 6s. 1½d. | 7s. 4d. | 4s. 5d. | 5s. 3d. |
| Price charged for lighting, per unit | 4d. | 4d. | 6d. to 3d.[h] | 6d. to 3d.[h] |
| Price charged for power, per unit | 2d. to 1½d.[h] | 2d. to 1d.[h] | 3d. | 3d. |
| Price charged for public lighting | 2d. per unit. | 2d. per unit. | — | — |

LIVERPOOL.—REMARKS.—a Includes [illegible] for tramways. b Inclusive of [illegible] balance of renewals fund account. c Concern was purchased in [illegible] for [illegible] in addition to £80,471 being capital spent by the company but not included in the share capital. d Over-expended. e Includes £7,362 from tramways for energy supplied. f Includes £[illegible] for insurance and £[illegible] certification of meters. g Contributed to city fund. h On maximum demand system [illegible] per quarter and 1d. per unit in excess of [illegible] units to April 1 [illegible] per unit in excess of [illegible] units. For tramways the charge is [illegible] per unit [illegible]. i At [illegible], 1900. j Of which [illegible] units were sold to tramways. k Includes [illegible] balance of renewal account. l For year 1900 only. m Inclusive of [illegible] for tramway supply. n Buildings [illegible], plant [illegible]. o Insurance £[illegible], certification of meters £[illegible], cost of [illegible] stock [illegible], stamp duty £[illegible].

CHELSEA (LONDON).—REMARKS.—a [illegible] of unsubscribed share capital. b These items do not include any fraction of [illegible] paid for works, machinery and mains of the Cadogan Co. and included under "Miscellaneous." c Over-expended. d Includes "sundry costs," £[illegible] in 1899 and £[illegible] in 1900. e Auditing £[illegible], law £[illegible] and insurance £[illegible]. f Provision for extra cost of coal in 1900. g Includes [illegible] fees to trustees of debenture stock holders. h On maximum demand system to house scale. i Auditing £52, law £[illegible] and insurance £[illegible]. j Taken from reserve to meet, as provided, extra cost of coal.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

ublished every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON
*Telephone:* 949 Holborn. *Telegrams:* "ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | | HALF-YEAR | | QUARTER | |
|---|---|---|---|---|---|---|
| United Kingdom | 26s. 0d. | ... | 13s. 6d. | ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | ... | 16s. 0d. | ... | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## CONDUIT AND TROLLEY.

The application of electric power to the working of tramways and light railways is a modern engineering problem that has resulted in a considerable number of proposed methods of solution. These resolve themselves into four classes:—(1) Accumulator cars, (2) the overhead conductor, (3) slotted conduits beneath the track, and (4) surface contacts on the track. A fifth, the so-called third-rail system, is not applicable to ordinary tramways and has been used hitherto exclusively on railways. Ideally, the first-named system is the one that best solves the problem; but practically it is handicapped by the absence of a really suitable accumulator. Progress in battery design, however, is making rapid strides, and the advocates of accumulator traction are encouraged each year to higher hopes for its complete success. With regard to surface-contact systems, of which there are innumerable varieties, it has hitherto been found that the complicated arrangements necessary to ensure safety and to secure regularity of working have been prohibitive. There are numerous workers in this field, and a large section of the electric tramway fraternity does not despair of arriving ultimately at a practical solution of the problem on these lines. For the present, however, there remain for consideration only the overhead trolley and the slotted conduit systems.

At the Institution of Mechanical Engineers, on Friday last, an important Paper was read by a well-known American traction engineer, Mr. A. N. CONNETT, on "Combined Trolley and Conduit Tramway Systems." Pressure on our space, owing to the large number of important Papers which have lately been read at various engineering societies, as well as on account of unusual activity in other directions, prevents us from reprinting any portion of Mr. CONNETT's Paper in the present issue, but we hope to do so at a later date. Meanwhile we will briefly summarise the contents of the Paper and offer some comments thereof. The main purpose of the Paper is to call attention to the suitability, in certain very common circumstances, of a combination of the overhead trolley with some form of conduit system. The circumstances to which this particular combination is adapted arise where

the tramway or light railway passes, over a portion of its route, through crowded city thoroughfares, and over the remaining portion through less crowded suburbs or sparsely populated rural districts. For the city part the conduit system is proposed, while the overhead trolley system is considered to be the better adapted to the country portions. Inasmuch as, from an engineering point of view, both the overhead trolley and the conduit system are successful beyond dispute, the chief problem of a novel character which this proposal presents to engineers relates to the junction between the two systems, at which point cars passing in either direction would have to undergo some effective and rapid process of conversion from one system to the other. Perhaps it is scarcely correct, however, to describe this as a novel problem, for it has long been solved at Washington, and more recent methods of solution are to be found on the combined systems at Paris, Berlin, and Brussels. In a very real and practical aspect, however, the junction point does present a novel problem, inasmuch as none of the existing arrangements can be considered to adapt themselves perfectly to English conditions of tramway construction, more especially with regard to the narrow slot which English requirements render necessary. Mr. CONNETT describes in considerable detail the arrangements in use on existing combination lines. The Washington system of conversion is clumsy and costly, while the ingenious system of almost automatic conversion used in Berlin is not adapted to conduits having narrow slots. We do not believe that the wide slots found on some of the Continental lines would be tolerated in the United Kingdom. If, as is alleged, these 1¼in. and even wider slots are essential to the side-slot conduit, then there can be little doubt as to the fate of side slot schemes in this country; we may expect to see nothing but the centre-slot. Difficult as it may appear to provide sufficient conductivity, insulation, and mechanical strength in the connection between car and plough with a ¾in. slot, the thing can be done—it was done with perfect success by Mr. HOLROYD SMITH in 1885 on his pioneer conduit tramway at Blackpool.

Dealing with the general question of combination lines, from the point of view of English practice, the engineer must face the question as to the need for such a complication. Why cannot the conduit system be extended from the city streets to the most remote rural point in the tramway system; or why cannot the overhead trolley be taken into the city streets? The well-informed electric traction engineer may have a ready and convincing answer to these questions, but tramway managers, local authorities, and the public generally frequently demand an answer to them. It is easier, perhaps, to give a satisfactory answer to the first than to the second question: the reason why the slotted conduit system cannot be extended into rural portions of the tramway is simply that it would not pay. The traffic receipts would be insufficient to justify so large a capital outlay. Mr. CONNETT's estimate for a mile of single track equipped on the slotted-conduit system, for average English conditions, is £16,498. 13s., exclusive of any proportion of power-station and sub-station cost. A rural trolley line need not cost £5,000 per mile of single track. In the face of so great a difference of cost, many engineers would advocate a trolley system throughout, even in crowded thoroughfares; nor would this be contrary to the accepted practice in many large and densely-populated cities in America, on the Continent, and in this country. Chicago, in America; Hamburg and Frankfort, on the Continent; and Liverpool, Bristol, Glasgow, nearer home, are cases in point. There is a strong and growing feeling in many quarters, however, that this practice should be discontinued, and that the overhead trolley should be excluded from the principal streets of cities and large towns. Alleged æsthetic defects in the trolley system are least among the objections that can be urged against it, for English designers have shown that these imperfections are by no means inherent in it. Even such alarming occurrences as the recent fatal accidents in Liverpool and Vienna are not to be counted against the overhead trolley so much as against the overhead telegraph and telephone wires, which would be much more properly placed underground. Undoubtedly there is potential danger in a 500 volt wire suspended, like the sword of DAMOCLES, over the heads of citizens; yet the number of accidents from actual personal contact with such a wire has been extremely small, whether here or in other countries. The one outstanding objection raised against the trolley is the fact that the return current ostensibly passes through the track rails, but in reality largely passes through the soil and any metallic pipes that may be laid in it. Electrolytic corrosion of the pipes is the mischief that chiefly renders this objectionable. At the same time uninsulated returns are by no means essential to the trolley system, though as a rule they accompany its use; we have already described a system of insulated return surface-contacts which would entirely obviate this difficulty, and at far less cost than a slotted conduit. Nevertheless, where the volume of traffic is sufficiently large and steady to justify the extra capital outlay, the slotted conduit provides an admirable method of equipping city tramways; and where these tramways are connected to suburban and rural lines the subject of Mr. CONNETT's Paper is directly applicable, and the information contained in that Paper will serve as a valuable guide to the tramway engineer.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Ions Produced by Collision.*—J. S. Townsend has already described some researches which led him to the conclusion that negatively charged ions, moving through a gas, produce other ions, although the force acting on them is very small compared with the force necessary to produce the ordinary vacuum tube or spark discharges. He now gives a more complete account of these experiments, and shows that at low pressures the current may be considered to pass through three stages as the E.M.F. is increased. In the first stage, the current increases with the E.M.F.; in the second stage, the current remains practically constant and shows only small variations for comparatively large changes in the force; in the third stage, the current rapidly increases with the E.M.F. It is the negative ions which produce the large increases of conductivity. The velocity acquired by a negative ion in travelling freely between two points differing in potential by 4 volts is 10 times as great as its velocity of agitation at ordinary temperatures. The number of collisions made by an ion in going through a centimetre of air at 1mm. pressure is 21. At atmospheric pressure, each ion would produce some 10,000 other ions per centimetre, and the same number would be produced by a particle conveying "Becquerel rays."

[J. S. TOWNSEND, *Phil. Mag.*, February, 1901.]

*Secondary Radium Rays.*—It is known that any substance placed in the neighbourhood of a radium preparation becomes radio-active itself. Not only that, but it retains its radioactive powers for some time, which in the case of an actinium preparation may extend over several months. P. Curie and A. Debierne have recently made some experiments which shed much light on the manner in which this secondary radioactivity is induced. It appears that only the most easily absorbed rays enter into this phenomenon. They are absorbed by the air, and in the process of absorption they impart some property to the air which is diffused by convection, and eventually reaches the body exposed. That the process is not one

of direct radiation is shown by the fact that if the preparation is separated from the body to be influenced by a long capillary tube bent at right angles the influence is exerted all the same. The maximum radio-activity is induced in a time which varies greatly with the amount of free space surrounding the radiant body. If it is a small space, the maximum is reached very soon. The authors do not attempt to frame a theory, but suspect a close connection between magnetic deviation and the absorption of rays.

[CURIE and DEBIERNE, *Comptes Rendus*, March 4, 1901.]

*The Electric Effluvium.*—Under this somewhat antiquated name S. Leduc describes some further remarkable properties of the silent electric discharge whose physical and chemical effects he has latterly been investigating. He produces it by rapidly charging and discharging a condenser consisting of a metallic sphere on the one hand, and a sheet of aluminium with a central perforation on the other hand, separated by a plate of glass or celluloid. The central portion of the plate is on both its faces the origin of violet and ultra-violet rays, which can be concentrated by a quartz lens. These rays produce an intense fluorescence on a platino-cyanide screen without concentrating the beam. Photographic effects are obtained which surpass in intensity those produced by sunlight. The rays are particularly valuable for Finsen's treatment of anæmic tissues. These are compressed by means of a quartz plate contained in an ebonite frame, which directly adjoins the aluminium sheet forming one armature of the condenser. The diseased tissue is thus exposed to rays which have only to traverse a thin plate of quartz. The apparatus may be worked with an induction coil or an influence machine.

[S. LEDUC, *Comptes Rendus*, March 4, 1901.]

*Propagation of Electric Waves in Water.*—When the electric and magnetic properties of an insulator only depend upon its dielectric constant, the wave-length of a resonator remains the same when measured first in air and then in the insulating medium in question. This proposition was deduced by Blondlot from considerations of homogeneity, and verified in the cases of castor oil and ice. If the medium is magnetic or conducting, or if it shows considerable absorption for electric waves, its properties are no longer completely defined by its dielectric constant, and the equality of wave-lengths of a resonator in air and in the medium cannot be certain. This is the case with ordinary spring water, which shows a decided conductivity and consequent absorption of electric waves. C. Gutton therefore measured the wave-lengths of a simple resonator in air and in water, and found that they were practically the same when resonator and wires were either out in the air or immersed in water. He also found that the path traversed by the waves during one period of the resonator oscillating in air is 8·3 times smaller in water than in air. This implies that when a resonator is plunged into water its period of oscillation becomes 8·3 greater than in air.

[C. GUTTON, *Comptes Rendus*, March 4, 1901.]

*Magnetic Effect on Discharges.*—It is well known that if a discharge is passing through a tube containing rarefied gas, the effect of a transverse magnetic field is to increase the potential difference at the terminals and to diminish the current passing through it, while a longitudinal field renders the passage of the discharge easier. While working with tubes in which the pressure varied from 0·1mm. to 1mm., R. S. Willows noticed that under certain conditions the imposition of a transverse field caused a large increase in the current passing and a decrease in the potential difference of the terminals, just the opposite of what generally occurs. Further experiments showed that at a pressure of 1mm. the effect of the field was to diminish the current, but as the pressure was lowered this effect became less and less, until at a certain pressure no effect at all was produced on the current or the potential difference between the terminals, although the discharge itself was distorted. As the pressure was still further lowered the current was increased by putting on the magnetic field. The effect is probably due to some action of the electrodes, which has not yet been fully unravelled.

[R. S. WILLOWS, *Phil. Mag.*, February, 1901.]

*Elementary Quantities of Matter and Electricity.*—Boltzmann has represented the entropy of a monatomic gas by the logarithm of the probability of its state, and shown that

$$\int\frac{dQ}{T}=\frac{2}{3}\Omega=\frac{2}{3}\log P,$$

where $dQ$ signifies the heat introduced from without (in mechanical units), T the mean kinetic energy of an atom, and $\Omega=\log P$ the natural logarithm of the probability of the stationary distribution of velocities among the atoms, measured by the number P of possible "complexions." M. Planck adds that in his own electromagnetic theory of radiation he obtains for the entropy of a large number of linear resonators oscillating independently in a steady-radiation field the expression

$$\kappa\log R,$$

where R is the number of possible "complexions," and $\kappa$ the number $1{\cdot}346\times10^{-6}$ erg-degrees. Combining these two principles, he finds the following values: Weight of the atom $1{\cdot}64\times10^{-24}$ gramme; number of gas molecules in 1cc. at 0deg. and 1 atmosphere, $2{\cdot}76\times10^{19}$; mean kinetic energy of an atom at absolute temperature 1deg., $2{\cdot}02\times10^{-16}$; charge of a positive monovalent electron $4{\cdot}69\times10^{-10}$ electrostatic units. These values, if the theory holds, are very much more definite than anything yet given, and the constant $\kappa$ is the weakest point in the calculation.

[M. PLANCK, *Ann. der Physik*, No. 3, 1901.]

## INSULATION ON CABLES.*

BY MERVYN O'GORMAN.

(*Continued from page 786.*)

*Capacity Method.*—The specific capacity K of any one quality of insulation can be obtained from a cable covered with it by using the well-known formula

$$K=\frac{M\log_{10}\frac{R}{r}}{0{\cdot}038839}$$

where M is the capacity of an immersed (or lead-covered) cable per mile in microfarads, and R and $r$ are respectively the outside radii of the insulation and conductor. Mr. Mordey made experiments on a particular rubber cable for which M was the same when obtained at any alternating voltage V from the formula $M=10^6A/2\pi nV$, and this result coincided with the direct-current ballistic measurement. It is probable that the formula is approximate enough with sine curve alternators of any frequency $n$ ("A" being the alternate R.M.S. current in amperes).† For accurate measurements it must be remembered that the results depend on the particular dielectric. Arno has found as much as 3 per cent. difference, and Lombardi, H. V. Carpenter, and others have independently come to similar conclusions.

When the capacity is required of a powder, or a gum in the rough, or an oil, or has a difficult shape to deal with like paper, jute, cotton, or hemp, the specific capacity may be obtained according to a method which I think is due to Nernst. The specific capacity of a volume of oil (which does not re-act on the powder, &c.) is measured, the powder is added and the mixture measured again. If the capacity of the mixture is not altered by the added substance, its specific capacity is found. If not, another known oil is used and its process repeated. In the case of roasted manilla paper the method gave the approximate result of 1·8 (air = 1)‡ for one sample of paper and 2·6 for another.

Among innumerable methods of finding specific capacities may be mentioned that of C. B. Thwing, who obtains it from the chemical composition, density and molecular weight of a substance and its components.§ Briefly he showed that the specific capacity $K=D\,M\,(a_1k_1+a_2k_2+a_3k_3+\&c.)$, where D = the density and M the molecular

* Abstract of a Paper read before the Institution of Electrical Engineers, March 7.

† An extension of Mr. Mordey's test [I.E.E. *Journal*, January 10, 1901] was made on 3 miles of 25,000-volt cable at the St. Croix Co., Wisconsin, U.S.A., on October 14, 1900, after laying and jointing. The frequency was kept constant and the charging current and voltage curve was a straight line through the origin, thus showing that the capacity was constant at all voltages. Mr. Mordey's test was on rubber; this was on paper cable.

‡ A. Gray, "Absolute Measurements," gives the precautions to be taken in experimenting on capacity. The dearth of results giving S.I.C. at known temperatures of substances having a known chemical constitution is astonishing.

§ *Zeitschrift für Physik. Chemie*, Vol. II., p. 297.

weight of the substance, and $a_1 a_2 a_3$, $k_1 k_2 k_3$ the number of atoms or atom groups and their dielectric constants respectively.

| Substance. | Formula. | D. | M. | K calculated. | K measured. |
|---|---|---|---|---|---|
| Water............ | HOH | 1 | 18 | 75·5 | 75·5, 78·5 |
| Glycerine ...... | $C_3H^5(OH)_3$ | 1·26 | 92 | 57·17 | 56·2 |
| Petroleum ...... | ... | 0·8 | ... | 2·08 | 2·06 |
| Paraffin ......... | ... | 0·87 | ... | 2·26 | 2·28, 1·99, 2·32, &c. |
| Turpentine .. | $C_{10}H_{16}$ | 0·87 | ... | 2·23 | 2·23 |
| Chalk ............ | $CaO\ CO_2$ | 2·65 | ... | 6·89 | 6·14 |

The utilisation of specific capacity deserves to be considered because its economic importance has not yet been fully realised by cable makers, many of whom have perhaps overlooked the fact exemplified by the experiment of Figs. 1 and 2 that across a composite insulation the potential gradient divides itself inversely as the specific capacity of the various separate layers. Substances of dissimilar specific capacities can be utilised in much the same way as those of dissimilar conductivities for grading the layers of insulation and obtaining a uniform stress in all parts of the coating of a cable under alternating pressures. Even with continuous currents the specific capacity of the insulation is of importance when the cable is first switched on, and because the maximum stresses are frequently of a rapidly alternating character.

Consider a homogeneous insulation to be made up of elementary condensers in series (Fig. 5), and disregard the conductivity of the dielectric for the moment. As all the condensers receive the same charge and are of the same material and thickness, the P.D. between the plates of each elementary condenser is less as its area is greater. That is, the gradient or fall of volts across the element of thickness is inversely as the area—that is, inversely as the radial distance $\rho$ of any elementary condenser from the centre. This gives us, again, the curve of potential (Fig. 4, curve 1) on the 37/14 cable.

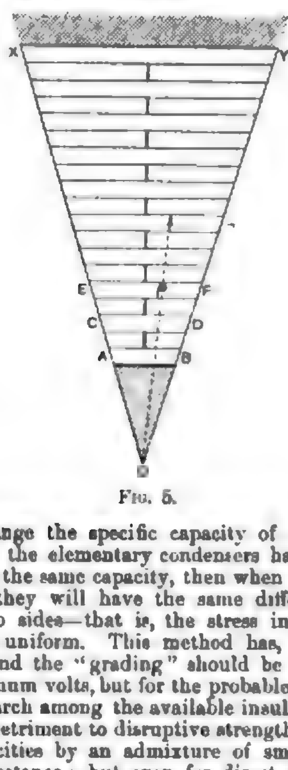


FIG. 5.

If now we arrange the specific capacity of every layer of the insulation so that the elementary condensers have, in spite of the difference of area, the same capacity, then when they are all given the same charge they will have the same difference of pressure between their two sides—that is, the stress in every part of the dielectric will be uniform. This method has, I think, a serious practical utility, and the "grading" should be calculated, not for the working maximum volts, but for the probable greatest maximum volts. A brief search among the available insulators shows that it is easier, without detriment to disruptive strength, to adjust conductivities than capacities by an admixture of small quantities of a less insulating substance; but even for direct currents there is a theoretical advantage to be gained by choosing that substance with a higher specific capacity than the matrix or insulation proper. Substances of any specific capacity immersed in a dielectric of a lower capacity tend to move slowly towards the place of steepest potential gradient. If there should remain after careful "grading" a slightly steeper potential slope near the inner conductor, for example, of a concentric cable, a tendency is thereby established which will oppose diffusion, and will tend to maintain or improve the pre-arranged disposition if the order of both conductivities and capacities is properly chosen.*

When the outside of an insulated conductor is not exactly circular, but is either a number of small part circles, as in a strand of round wires, or sector-shaped and therefore offering two or more approximately flat surfaces and corners, which are usually rounded off, the electric intensity† will be greatest in the insulation which is nearest to the most protruding portion of the smaller curvatures of the conductor, and the potential gradients will be proportionately steep and will tend to disrupt the insulation unless correction is made by either increasing the thickness of total insulation, as is done at present, or increasing the dielectric strength locally, or increasing the specific inductive capacity so as everywhere to correspond with the steepness of the potential gradient.

The curve of gradients for any usual arrangement of conductors may be graphically obtained with sufficient approximation for practical purposes, and for this we shall utilise the apparently unimportant similarity between the curve of potential obtained by considering first conductivity, and, secondly, capacity. The following suggestion which Prof. Perry kindly made to me is of special assistance in the somewhat difficult case of a three-phase or two-phase cable. An enlarged section model of the cable is made and the conductors and sheath (if any) are maintained by accumulators at potentials proportionate to the instantaneous value of their potentials when in use; say 4 volts, 2 volts and zero volts for a three-phase cable. A thin sheet of high resistance metal is laid across the section, and the equipotential lines are then plotted by pricking holes with two needles connected to a galvanometer, at those places where no deflection is obtained. Such an arrangement clearly takes no account of capacity. But an alternating potential takes no account of conductivity, and so we thus get the curve which we require. We can then confirm it mathematically by following out Mie's work on Poynting's theorem.‡

When the dielectric matrix can be made sufficiently fluid by heat, and is free from interposed solids, the grading might conceivably be effected by maintaining a difference of potential between the conductors. To prevent the substances from reverting, when the potential difference is cut off, to any other undesired arrangement of capacities, they might be so chosen that they should solidify or become highly viscous with time or by cooling, &c. Such a method would not only be slow, but might be imperfect owing to the forces being possibly smaller than the effects of diffusion.

Example of 37/14 "graded" cable to stand 14,140 volts maximum:—

| No. of layer. | Thickness. | Spec. capacity. | Per cent. of castor oil. |
|---|---|---|---|
| 1st outside ............. | 0·06in. | 2 | 0 |
| 2nd next .................. | 0·05 ,, | 2·27 | 9·5 |
| 3rd ,, .................. | 0·05 ,, | 2·57 | 20·5 |
| 4th ,, .................. | 0·05 ,, | 2·93 | 33·0 |
| 5th inside.................. | 0·05 ,, | 3·40 | 50·0 |

As now made cables are often inversely "graded." A large class of fibre cables are given their final impregnation by immersing them in their entirety in a tank full of a mixture of an oil and some solid hydro-carbon, which, as in the case of resin, frequently has a higher specific capacity than the oil and paper, as well as a greater disruptive strength. During the process of this impregnation the fibres of the outer layers have the effect of filtering the solute from the solvent, and although the oil reaches and fills up all the pores of the innermost layers of paper, the solid is filtered away and only reaches the outer portion of the dielectric, which consequently has the greater dielectric strength and capacity where they are not wanted. That the dielectric strength should be greater in this particular position is of little consequence, but that the capacity should be greater is a danger, because it tends to make the potential gradient steeper even than it would be in a homogeneous insulation close to the conductor. On the other hand, it would be worth trying to utilise this fact to graduate the conductivity or capacity by choosing the oil and solid to have a suitable viscosity at the temperature of the impregnating tank.

A similar faulty arrangement is met with in ordinary vulcanised rubber cables. The pure rubber which is placed next the conductor has a specific capacity of about 2·3. The high-class compound which comes next to this may have a capacity of 2·6, and is 50 per cent. stronger, and the outer layers, which are almost invariably made of lower-grade material have often a specific capacity of 3 and more, a very poor insulation resistance, and strangely enough up to three times the strength in some samples. The layers of insulation on such cables are arranged in the opposite order of capacity to the most efficient, and are only enabled to stand because the vulcanised com-

* Some such words as the following are to be found in Heaviside's "Electromagnetic Theory":—"A sphere of uniform permittivity in a uniform electric field causes the external lines of electric force to be symmetrically distorted fore and aft, and therefore it has no tendency to move."

If, however, the body be a very small piece in a field which is not uniform it tends to move in the direction in which the energy or stress in the field increases most rapidly, independent of the direction of the electric force when the permittivity of the body exceeds that of the medium. It will move in the opposite direction when the permittivity is less than that of the medium.

† This is a measure of the gradient, and therefore of the stress.

‡ See a Paper on "Poynting's Theorem," by G. Mie, in *Zeitschr. Phys. Chem.*, 34, pp. 523, Sept. 7, 1900, which is briefly abstracted, translated, and followed out for practical use in Appendix VII. of Mr. O'Gorman's complete Paper.

pound rubber has a sufficiently uniform texture and a high dielectric strength. I think there is no question that, bulk for bulk, the best vulcanised rubber is stronger than the best impregnated paper, and the day will come when really high pressures are used, but just now it needs all its dielectric strength to compete in cost at present prices. It is chiefly on armoured cables that their lesser diameter results in such a saving of steel tape as to allow rubber cables to win in the price competition.

It may be possible to grade paper cables by "loading" the paper with barytes, clay, gypsum, &c., but it is not safe to prophesy whether or not the dielectric strength of loading materials, applied as they would be in powder form, would allow allow of their utilisation with advantage. A few simple experiments will solve this, however, and I have made arrangements with the courteous proprietor of the Hele Paper Co., S. Devon, to obtain a large number of samples of known composition.

At present it will be found that rubber-covered H.T. cables have as much as double the capacity of fibre cables. This is due (1) to the specific capacities being as 3 to 2, and (2) to the superior dielectric strength of rubber, which allows the conductors to be placed nearer together. In non-concentric cables this capacity can be diminished by adding, if required, a bed or worming of jute, &c., and the reduction can be more cheaply done with rubber than if there is to be a coat of lead over each wire, which is the safest way with three-phase hygroscopic cables other than feeders.

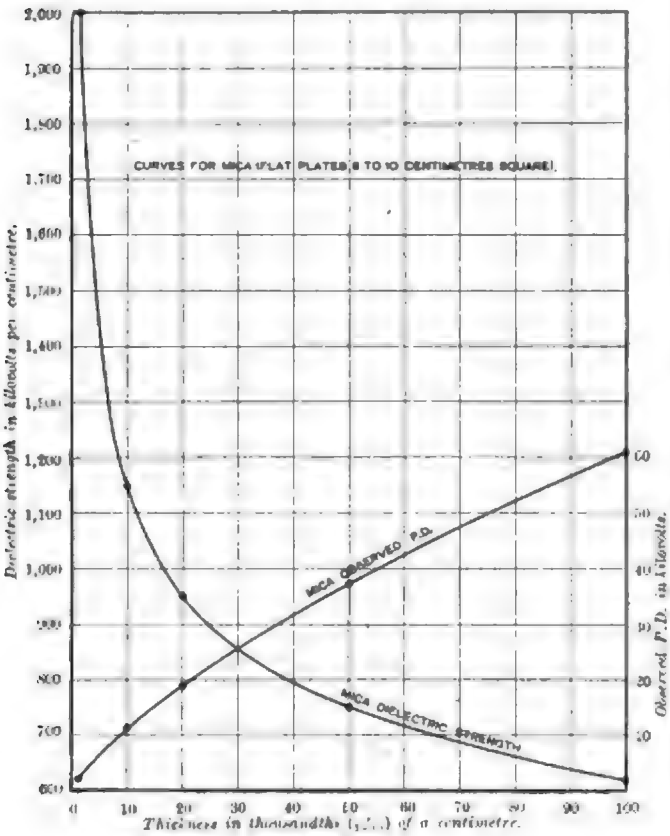


Fig. 6.

*Capacity of a Three-Wire Cable.*—I do not think there is any simple manner of calculating the capacities of lead-covered, three-wire, non-concentric cables.* In a particular experiment an approximation was got as follows:—

The capacity of two parallel wires laid on a solid system, if not lead covered but buried in the insulator, is per unit length

$$= K \div 2\log(a + \sqrt{a^2 - 1}),$$

where K is the specific inductive capacity of the insulator, and

$$a = (d^2 - R^2 - R'^2) \div 2RR',$$

and where $d$ is the distance between the centres of the wires, whose radii are R, R'.† Where there is a lead sheath at a distance equal to the distance between the surfaces of the wires, and, further, a third wire in the solid dielectric, 10 per cent. must be added to get the capacity between any two. Lastly, the capacity-current for all these wires will be approximately 33 per cent. greater than the capacity-current calculated for two wires as above.

*Capacity of a Two-Wire Cable* is given by G. W. Patterson* as follows:—

If the radius of each wire be R;
If the least thickness between wires be $d$;
If the specific dielectric capacity = K;
Then the capacity in microfarads per centimetre length is

$$= (1.206 \times 10^{-12} K) \div \log\left(\frac{\sqrt{(4Rd + d^2)} + d}{\sqrt{(4Rd + d^2)} - d}\right).$$

It is interesting here to point out that the capacity of the lines of an overhead three-phase system may, according to Perrine and Braun, be considered as that of three condensers connected between the wires in a star and not a mesh pattern. If the centres of the wires are at the corners of an equilateral triangle whose side is $d$, and if $r$ be the radius of the wires whose length is L, the charging current can be calculated by supposing three condensers, each of capacity C, where—

$$C = \frac{0.0388\,L}{\log_{10}\frac{d}{r}}$$

microfarads connected starwise between the mains. If the capacity be considered as mesh connected, then the charging current would be $\sqrt{3}$ times the charging current of a single phase; if star connected, the current is $\sqrt{2}/3$ of current on a single-phase line.

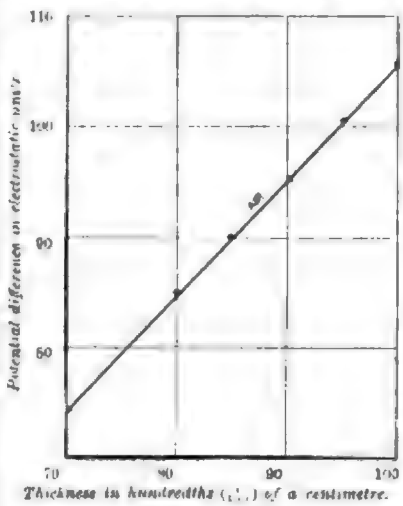


Fig. 7.

*Radial Depth of Dielectric.*—Knowledge of this is practically the foundation of the power-cable makers' art, just as in telephone cable making the amount of elbow room to give any size of wire with any given number of neighbours is the cardinal fact which is so rarely discussed outside of the manufacturers' circle. It is interesting to consider the subject of "radials" at some length, not from the point of view of small conductors and small voltages, but in the case of large conductors and high pressures, both of which will be of interest in the immediate future. If we double the radial depth, can we double the applied pressure between conductors? If we increase the size of conductor, must we increase the radial thickness for the same volts? The tendency has up to the present been to answer both questions affirmatively, though with hesitation; the curve of gradients points to an opposite conclusion. How, then, does the price vary?

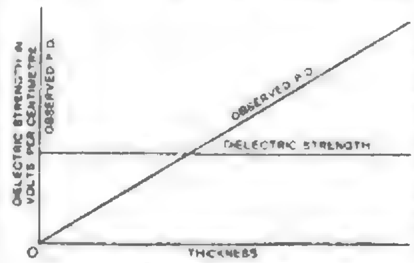


Fig. 8.—Paraffined Paper.

We must commence by giving the values which practice has fixed to a number of variables. We may suppose the insulating material has a *constant volt-resisting quality* per centimetre thickness measured between plane surfaces. Trowbridge (1898) has proved this true for large thicknesses of air, and T. Gray (1898) for all thicknesses of paraffined paper. It is not true for small thicknesses of substances like paper impregnated with oil, empire cloth, mica, &c., but the law is known, having been investigated by T. Gray and others. Some idea of the law is given by the curves in Figs. 6 to 8. With the exceptions of paraffined paper and air, the disruptive strength is great when the testing plates are near together, and diminishes according to an approximate hyperbolic law with increasing thickness, reaching after a certain thickness a nearly constant lowest value. One would think that this lowest value might be taken as safe for cable-making, but on referring to practice we find that a factor of safety of 10 to 20 is used, and this brings us well on towards the flat part of the curves.

* *Capacity.*—G. Breisig (*Elektrotech. Zeitschr.*, 20, pp. 127-131, 1899. Now that multiphase work is making the concentric cable less prominent than heretofore in H.T. transmissions a formula for the capacity of twisted wires is of value, even though it only gives an approximation. A two-wire cable may be regarded as three condensers in parallel, and Breisig gives an expression for more wires. The capacity K is approximately given by the formula— K [illegible] + 1 K [illegible].

† J. B. Pomey, *Ecl. Electr.*, 13, pp. 131-133, 1899.

* *Phys. Rev.*, 3, pp. 309-315.

It is unnecessary to say that every nerve has been strained to reduce the factor by seeking for cleanliness, uniformity of material, absence of metal particles, &c. The effect on price of reducing this factor of safety, or what eventually comes to the same thing, increasing the available disruptive strength of the material applied, is given by Fig. 9, which takes the example of a 37/14 at various voltages from 3,000 upwards, and shows, for example, that halving the factor of safety will make a thirtyfold economy of insulation at 30,000 volts and a fivefold economy at 10,000 volts. Had the effect of thickness in weakening the dielectric been considered the advantage of a strong dielectric, which is not weak for any thickness, would have appeared greater. Until we are quite clear that such phenomena as Mr. Duddell showed us in his admirable Paper on December 13, 1900, do not, as I believe they do not, often occur in practice, we should be rash to diminish our factor of safety much below 10, as it is difficult to secure that carbon-break switches and other precautions shall be universally used.

*(To be concluded.)*

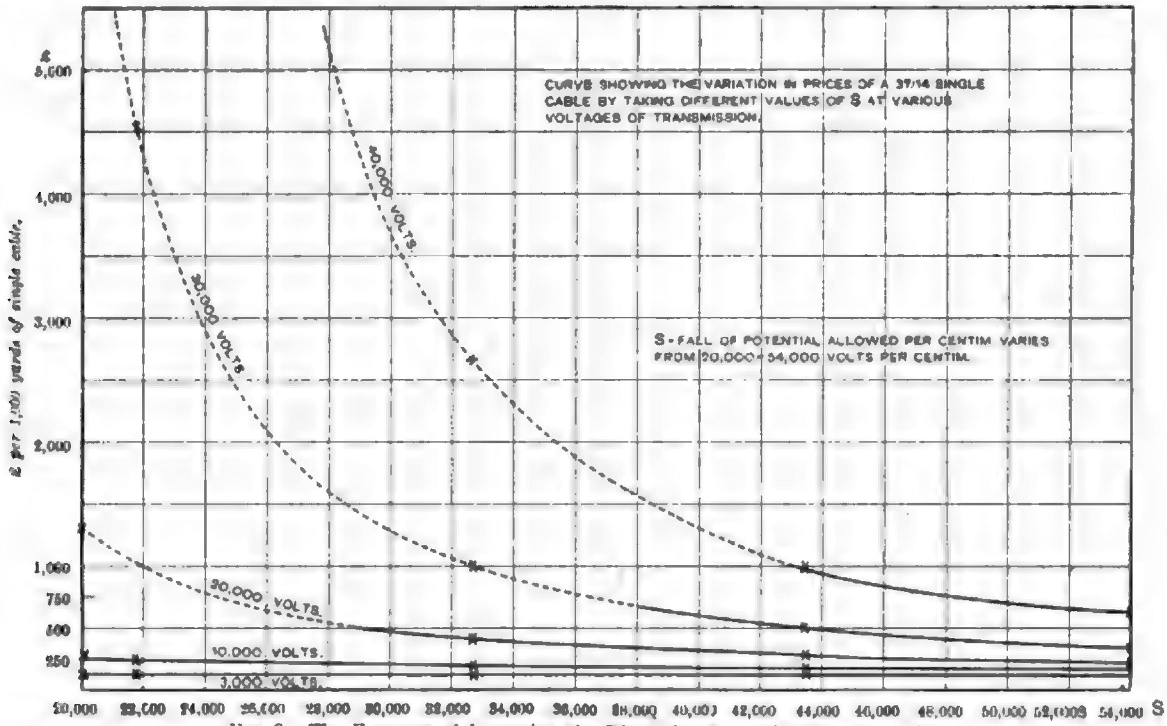


FIG. 9.—The Economy of Increasing the Disruptive Strength of Insulation.*

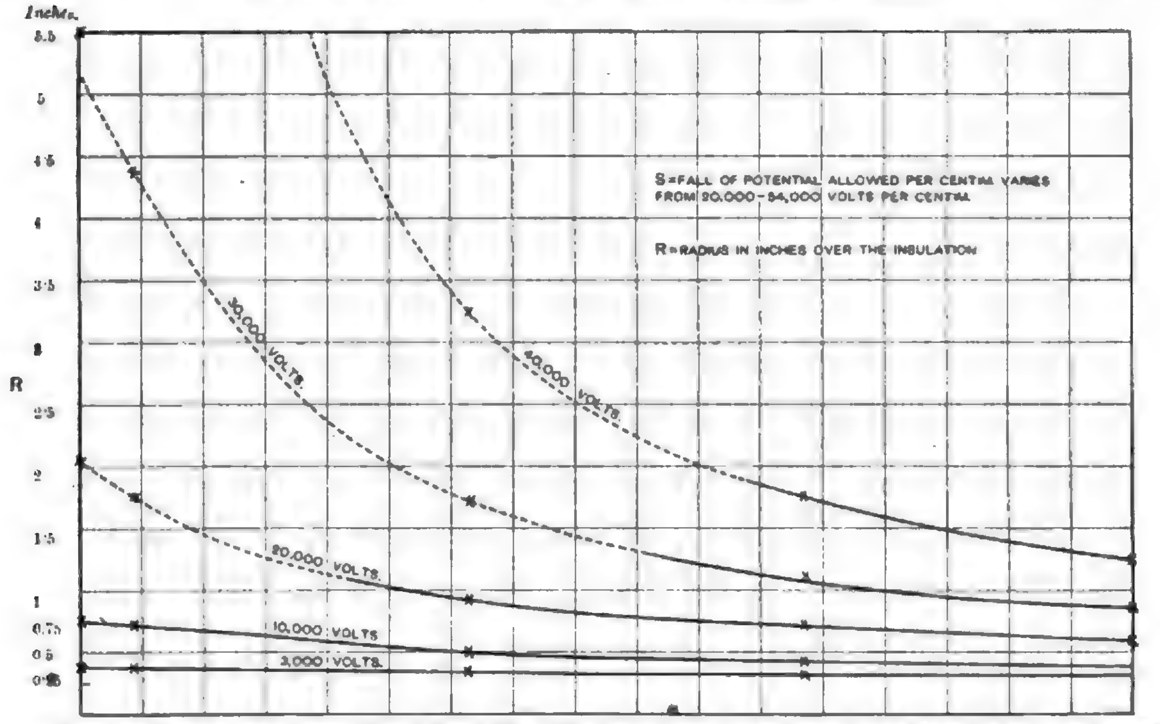


FIG. 9A.—Curve Showing the Reduction of Depth of Insulation on a 37/14 when the Dielectric Strength is Increased but kept Homogeneous.†

* Fig. 9.—The section of copper being constant, we may take the power which may be transmitted as proportional to the square of the voltage. It is to be noted that were a high value of S allowable (say 50,000 volts per cm.) at *d*, the price of an insulated 37/14 cable for different voltages increases much less rapidly than the voltage, and therefore very much less rapidly than the power which such a cable could transmit. Therefore, where S is high, it pays to use high-pressure cables up to say 30,000 volts. When S may not exceed 20,000 volts per cm. the price rises prohibitively with the voltage—that is, at a greater rate than proportional to the power.

† Fig 9A shows that if 30,000 or 40,000 volts is likely to be the limit of pressures for structural reasons in alternators, switchboards, &c., there is no great economy on cables to be made by increasing the dielectric strength alone beyond 50,000 volts per cm., and experiments need not be made in that direction beyond that limit.

## BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

(*Continued from page 793.*)

*Thursday, March 14th*

It will be remembered that the previous sitting was adjourned early to admit of the consideration of a proviso suggested by Sir Courtenay Boyle, and which was published last week.

Mr. LITTLER, K.C., said he had sent in no amendment, but he had a communication from his clients in which they stated their wish to be placed pecuniarily in the same position after the change that they were at present.

The Hon. ALFRED LYTTELTON, K.C., was of the opinion that any clause presented should be on behalf of objectors generally, and with this object in view, on behalf of the London County Council, he suggested the following:—"Provided that no change shall be made in the pressure of supply to any premises which on ——— were supplied with energy by the undertakers, except with the consent of the consumer, but where the consumer withhholds his consent after the undertakers have offered to pay the costs of the damage caused by the change, the undertakers may appeal to the Board of Trade, and that Board may, at the request of both parties finally settle the matter in difference between them, and failing such request, may dispense with the consent of the consumer on the following conditions, that is to say: The Board of Trade shall in such case refer to a single arbitrator, to be agreed upon betwen the parties, or, failing agreement, appointed by the Board of Trade, the settlement and due execution of such terms as shall recoup the consumer all reasonable costs, charges, expenses and loss incurred in consequence of the change of pressure, and to place the consumer in at least as beneficial a position as if the change had not been made. The costs of both parties to the arbitration, to be settled in case of difference by the arbitrator, shall be paid by the undertakers, provided always that if the arbitrator certifies that the consumer has vexatiously withheld his consent, the consumer should pay his own costs of the said arbitration."

Mr. W. J. WALTER, on behalf of the City of London Corporation, submitted the following, which is substantially the same as that given above:—"Provided that no change shall be made in the pressure of supply to any premises which on ——— were supplied with energy by the undertakers except with the consent of the consumer, but where the consumer withholds his consent after the undertakers have offered to pay the costs of and damage (including a reduction in the price of supply of energy) caused by or incidental to the change, the undertakers may appeal to the Board of Trade and that Board may, if the parties agree, finally settle the matters in difference between them and failing such agreement, may dispense with the consent of the consumer on the following conditions, that is to say: The Board of Trade shall in such case refer to the arbitration of a single arbitrator, to be agreed upon between the parties, or failing such agreement, appointed by the Board of Trade, the question of the condition under which the change shall be allowed and the due fulfilment of the same by the undertakers. Such conditions shall include those imposed by the London County Council or local authority, as the case may be. Under these regulations the reasonable cost of both parties to the said arbitration shall be paid by the undertakers."

Mr. ROSKILL, K.C., strongly opposed the suggestion that the companies were asking for an indulgence in this matter. The change was imperative for the necessary development of the electrical industry, but the two clauses suggested by the London County Council and City Corporation were practically invitations to the consumer to resist the change.

Mr. D. WARMINGTON refused to consent to the provision that the undertakers should pay the cost of both parties in the arbitration.

Mr. R. C. GLEN was prepared to support the London County Council and City Corporation, but was inclined to make the regulation as to costs more stringent.

Mr. MOON, K.C., said that this claim for the indemnity of the consumer as to costs was based on an entirely erroneous idea of what the 1896 regulation was intended to, and did, effect. In 1896 it was clear that there was an idea—not more—that it might be advisable to increase the pressure at which electricity was supplied by the companies. In order that this might be done it was necessary to alter the provisions of the regulation which was accomplished by the Board of Trade inquiry, adding the proviso at present under discussion. At that time it was admitted that there was no satisfactory 200 volt lamp on the market, and therefore 200 volt supply was practically in its experimental stage. Under these circumstances the Board of Trade had, in effect, said they would not commit themselves, but left it open to the company to try to get its standard of pressure altered either by the London County Council or themselves, and so alter the consumer's pressure without his consent. This they were now trying to do. He submitted that the proviso in dispute was not a permanent decree of the Board of Trade, but was a regulation justified and necessitated at the time it was made by the condition of the industry. If this argument was, as he maintained it was, right, the attempt to indemnify the consumer against all costs of arbitration had no sound foundation. The undertakers were now asking to be put back in the position they were before 1896, a position in which they could have applied to the Board of Trade for their consent to an alteration in pressure, and which could have been granted upon such terms as seemed to them to be fitting as regards not only the particular consumer but also in the public interest. It was in the public interest that the company, being able to double or treble the load on their mains, did not require to pull up the streets, and although there might not be any very great advantage to the consumer in the change, it was not true to say there was no evidence of any advantage, because at any rate he was able to increase the load on the installation in his house.

Mr. LITTLER, K.C., objected to the last statement, as he had not put forward his opposition evidence.

Mr. MOON, K.C., continuing, said he was merely giving this as an illustration. On the question of arbitration, these proposed clauses invited every consumer to say he would not consent to the Board of Trade settling the matter, but would want arbitration. It had been done before. The consumer would then probably go to the supply company and say, "It will cost you a great deal if we go to arbitration. You will have to pay in any event. Had not you better give us something extra to avoid the cost of arbitration?" They would ask for this or that improvement in addition to an increase in pressure.

The Hon. A. LYTTELTON, K.C., speaking for the whole of the opposition, said Mr. Moon's argument had been based upon the evidence of such a witness as Col. Crompton, who held the most extreme views, and had entirely disregarded the evidence of Prof. Kennedy who had stated that the consumer should be indemnified. He opposed Mr. Moon's view at some length.

Mr. ROGER WALLACE, K.C., preferred to accept the clause proposed by Sir Courtenay Boyle, which he thought would meet any reasonable circumstances.

Sir COURTENAY BOYLE said he had heard sufficient to enable him to advise the Board of Trade in such a manner as would result in the drafting of a clause which both parties must agree to accept and so close the inquiry. Otherwise the evidence for the opposition must be heard.

An adjournment was made with a view to the various counsel coming to an agreement, but after something like half an hour the Hon. Alfred Lyttelton informed Sir Courtenay Boyle that it had been decided to examine the further witnesses.

Mr. T. P. GUNYON, of the London County Council electrical testing department, cross examined by the Hon. A. Lyttelton, K.C., did not consider any benefit accrued to the consumer by changing to 200 volts, and in many cases the consumer lost as regards price and efficiency of lamps. He had obtained quotations from six well-known lamp makers as to price and life, all of which came out unfavourably as compared with 100 volt lamps. His tests on these lamps resulted generally in a lesser degree of efficiency. He then enumerated various complaints of fire, many of them having arisen after a change to the higher pressure had been made. At the same time, if extra precautions were taken, as had been stated by Prof. Kennedy, there was not a greater danger, but such extra pains were absolutely necessary. He agreed with Col. Crompton that supply companies in the early days were very lax as to inspection, but although an improvement had been made some bad wiring was still passed, and he handed a specimen taken from a house quite recently to the President. Generally speaking, however, he maintained that with 200 volts the lamps cost more, had a lesser efficiency and shorter life, besides a somewhat increased danger of fire.

By Mr. ROGER WALLACE, K.C.: Witness admitted that about one-half of his list of fires were in buildings supplied at 100 volts. All his information connected therewith was obtained from assistants, and he had never personally inspected any of the places. At the same time he had seen a good many places where fire was quite possible owing to the bad wiring. He was of the opinion that the present regulations were quite sufficient if supply companies exercised to the full the powers they had. Questioned as to his qualifications, he said he had not had any theoretical training electrically, and it was only since he had been with the London County Council that he had taken up electricity. He had never tested lamps for life, but usually relied on what the makers told him, and, further, stated that he was aware that some of the makers whose lamps were included in his list did not encourage the sale of 200 volt lamps.

By Mr. MOON, K.C.: He had not tested 100 volt lamps of the same make in order to compare with the 200 volt. He could not explain the remarkable disparity which existed in price between the various makes of 200 volt lamps.

By the Hon. A. LYTTELTON, K.C.: In obtaining the lamps he had simply ordered them without stating what they were wanted for, and he did not think a message of that description would convey the idea that they were for testing purposes.

Mr. BERNARD DRAKE substantially agreed with the last witness, and further stated that numbers of his clients had complained of increased quarterly bills, or else that less light was obtained for the same money.

Sir COURTENAY BOYLE: Is that increased expense at the same rate of charging for the current?

WITNESS said that lamps with less efficiency would increase the bill for current for the same amount of light.

By the Hon. A. LYTTELTON, K.C.: He had sent round communications to people who had changed over, asking if, from their present experience, they would agree to change again and nearly all agreed that they would not.

Mr. R. WALLACE, K.C., objected to this on the ground that it was not evidence.

WITNESS replied that no doubt the Board of Trade preferred facts to theories.

Sir COURTENAY BOYLE thought it unnecessary to press this matter.

By the Hon. A. LYTTELTON, K.C.: If the opposition, however, wished to test the point he had the material ready. Although his firm did not make lamps, his experience was that more expense attached to the manufacture of 200 volt lamps and the results of tests he had made on large quantities proved they were less efficient. The life was certainly less and there would be a decided increased danger of fire if the supply companies were allowed to bring the full 400 volts into one house. There was practically no benefit to the consumer as the question of loss in the house wiring was a negligible quantity.

By Mr. R. WALLACE, K.C.: Although he felt very strongly on this question of 200 volts, he did not agree that he had imbued his clients with the same ideas. Tests on single lamps either for life or candle-power were useless, and he had never made any. He could not agree with Prof. Kennedy's evidence that there was not less light because he was

constantly receiving complaints that there was less light. Most of the lamps used by his clients were supplied by the Westminster Company to Prof. Kennedy's specification and they seemed to be the worst of the lot. Such complaints he considered more valuable than laboratory tests. Personally he felt he would have no difficulty in making a satisfactory 200 volt installation in the first instance, but there was danger in converting a 100 volt system.

By Mr. MOON, K.C.: He was not satisfied with the present 200 volt lamp. They were not reliable as, for one thing, the thin filaments shook together. No doubt in time they would be overcome.

Re-examined by the Hon. A. LYTTELTON: The question of successfully overcoming the difficulties in lamps should be left to arbitration. He did not regard tests as valueless but as fallible. As a practical man he placed more reliance in the results of a very large practical experience.

Mr. JUSTUS ECK followed, and stated that he had been connected with something like 1,000 installations both during the time that he was engineer to Messrs. Laing, Wharton and Down, and since acting for himself. A 200 volt installation in some cases cost 15 per cent. more than a 100 volt under similar conditions. The percentage difference in the cost of lamps varied from 32 to 57 per cent., and was less efficient. In his opinion to make up for this a consumer ought to have a reduction of about 28 per cent. in the price of current.

By Mr. R. WALLACE, K.C.: About 250 to 300 of the 1,000 installations mentioned were at 200 volts, and although he had passed them he had not been satisfied himself, as he considered they were more liable to fire. Asked as to why he had not reported this either to the supply company or the insurance company, he replied that it was not his duty. The Laing, Wharton and Down company simply did what the supply company asked them to do, and in that way he had passed the installations, as the best that could be done under the circumstances had been done. In a new installation and properly done, there was no danger from fire. He disagreed with Mr. Drake that individual tests were no good. Tests made by himself with a greasepot photometer had shown a consumption of 4·1 watts per candle from 110 volts and 5·2 watts per candle from 200 volts.

By Mr. MOON, K.C.: It was quite possible to get lamps at a less increased price than he had mentioned, but he not think his evidence exaggerated.

By Mr. ROSKILL: Personally, he was indifferent on the matter of the change. Possibly the only advantage to the consumer was in uniformity of light.

Re-examined by the Hon. A. LYTTELTON, K.C.: It depended on the company as to whether its mains were overloaded, and this would have a great influence on the regularity of the light. His tests' figures were the mean of several tests. Testing the voltage from time to time, he found an average variation of 5 or 6 volts. These tests were made at home, using current supplied by the Aberystwyth and Chiswick Company.

Prof. W. E. AYRTON, F.R.S., cross-examined by the Hon. A. Lyttelton, said he did not agree with Col. Crompton that if lamps made by well-known makers were installed complaints ceased. Practically speaking, the highest priced 200 volt lamps on the market were extremely bad, and the makers of very good 100 volt lamps made extremely bad 200 volts lamps. He had tested lamps under two sets of circumstances—viz., either because manufacturers had asked him to do so in their interest, or for consumers themselves who had found that after the change the light had been so much diminished. In one instance he tested 20 lamps of a very well-known manufacturer, but the results were surprisingly bad. Had they been good he would not have brought them forward. Both 8 c.p. and 16 c.p. lamps were included. He would not state the exact price, as that would give a clue to the name of the maker, but they were priced at over 1s. 8d., and marked 200 16 c.p. The average illumination, tested for over 1,000 hours, was 9·8, 8, 11, 10 candles, and so on, and the expenditure of power 9·3, 7·3, 5·1, 6·0, &c., watts per candle. The average watts per candle of some 100 volt lamps of the same make, tested for 1,820 hours, was 4·35. He had made many other similar tests. For a consumer he had tested some 200 volt 8 c.p. lamps which had been running for some weeks, and these gave 6, 1·8, 3·1, and 5·1 candles, and in expenditure of power 6·0 15·3, 10·8 and 7·5 watts per candle. At first he himself had thought there was a mistake in the tests, but it was not so; and, in case it should be imagined that he was dealing with some absurd lamps supplied by some small mushroom firm, he mentioned that these were the kind of lamps which he found himself had been put into offices by the Westminster Company in Victoria-street. From the above figures it was obvious that the life would be diminished. These results were quite in conformity with the information which had been given publicly by lamp manufacturers, and in support of this he read an extract from a Paper by Mr. Binswanger Byng, of the General Electric Co., on Feb. 24, 1898, in which was given what he thought an extremely fair account of the difficulty of making glow-lamps. He disagreed with Prof. Kennedy that because the number of units consumed for the same number of lights remained the same after the change there was an advantage. He found it was quite true that the bills in some instances had not altered in amount, despite the fact that the light was less, and the reason was that these inefficient 200 volt lamps were made to take just about as much power as the relatively efficient 100 volt lamp. If the change was carefully carried out he did not think there was increased danger of fire, but extra trouble must be taken. However, in the case of all the three wires coming into the building there was a certain risk of shock which did not exist before. The middle wire was earthed at the station, which prevented the potential of either of the outers having more than 200 volts difference from the other, but it still left the two outers differing by 400 volts. Supposing there was a piece of metal running upstairs, such as an electric bell wire or metal stair rail, which would be fairly insulated from the ground but not from the electric light wire, there would be a possibility of a 400 volt shock if this came in contact with one outer of the system, and therefore there was a risk which did not exist before. If two wires only were taken into the house there was not so much fear of shock. On the question of the advantage to the consumer, he said it was more easy for the company to keep the pressure within Board of Trade limits at 200 volts, but if two companies were supplying equally well in one district, one at 100 volts and the other at 200 volts, there was no advantage to the consumer.

By Mr. MOON, K.C.: He was of the opinion that manufacturers were making large numbers of high-priced inefficient 200 volt lamps, and although improvement was going on, he would neither say that manufacturers would not or could not turn out a better article. Neither would be say that within a short distance of time there would not be an efficient lamp. The question of the undesirability of the consumer standing in the way depended on what his financial position was to be after the change as compared with before. If he would be in an absolutely good position it would be desirable for him to have the change. As long as any extra expense was caused he should be indemnified. Of course, the time at which the extra expense was not apparent should be decided by an arbitrator or the Board of Trade. The cost of copper in a private house was a very small fraction of the total cost of installation, and he was inclined to think that a respectable firm would charge slightly more for wiring an absolutely new installation at 200 volts.

By Mr. WALLACE, K.C.: He had no knowledge that one particular manufacturer had come to him for tests because he had had trouble himself in making the thing satisfactory. Reliance was better placed in the results of long tests, but he preferred his own tests to any others.

Re-examined by the Hon. A. LYTTELTON, K.C.: The tests he had mentioned had been made during last year and this year, and he had quoted them because they were made on lamps which were being installed by supply companies in London. It would be quite right to say that if the 200 volt lamp improved with time there should be a corresponding improvement in 100 volt lamps, as the former suffered from certain disadvantages which the latter did not. Broadly speaking, they would improve together. The main disadvantage of the 200 volt lamp was the necessity for using unflashed filaments and the extra molecular discharge owing to the higher pressure.

By Sir COURTENAY BOYLE: The molecular discharge took place from one limb of the filament to the other. There was no regular ratio of change in insulating material as the gauge of the copper increased. One insulation was sufficient for several gauges of copper. Given a reasonable amount of copper and a reasonable amount of good insulating material there would not be more risk of breakdown with 200 volts on a circuit previously carrying 100 volts. The switches, however, were made differently and the fuses were rather longer, and these would in most cases have to be changed.

Mr. APPERLEY, Lord Londonderry's agent, cross-examined by the Hon. Alfred Lyttelton, K.C., gave some non-technical evidence as to the unsatisfactory nature of the supply since the change had been effected in his lordship's town house. Further, the average amount paid for the 100 volt supply during 1897-98 99 was £181. 9s. 5d., but during 1900, which time a 200 volt supply has been taken, the yearly bill amounted to £288. 18s. 8d. As evidence that no more light had been used, he mentioned the national mourning, and consequently there had been less balls, parties, &c.

By Mr. ROGER WALLACE, K.C.: He had made complaints to the Westminster Company as to these troubles and read some of the letters. He had had no difficulty with the insurance companies in connection with the change. The reason why his lordship had been changed was because he had been told the price of current would be 8d. per unit if he did not. There had been decidedly more trouble with renewals of lamps since the change was made, and, generally speaking, he considered more money was paid for a less efficient light. He had the company's own invoices to substantiate his charges as to increase of the quarterly bills.

By the Hon. ALFRED LYTTELTON, K.C.: The increase in the bills was notwithstanding the lower tariff, and the company had even charged for the extra light burned whilst the workmen were in the place.

By Sir COURTENAY BOYLE: He considered the extra renewals of lamps due to the fact of the filaments not being strong enough touched the sides of the globe, and so broke down.

*Monday, March 18th.*

On resuming on Monday morning Mr. Littler complained that one of his witnesses, a librarian under the City of Westminster Corporation, had been refused permission to give evidence of his experience. Considering the City of Westminster were represented at the inquiry, he thought this a rather startling thing, and appealed to Sir Courtenay Boyle.

Sir COURTENAY BOYLE: I am afraid I cannot do anything in the matter.

The Hon. ALFRED LYTTELTON, K.C., then summed up his case for the London County Council. He thought it had been recognised that the Board of Trade was willing to make the change, and the question was, "Upon what terms"? The argument of Mr. Balfour Browne had originally been that the change was to the advantage of the industry, the company, and the consumer, but that the very few consumers who refused to allow the change had taken advantage of their position, and had endeavoured to extract terms which they were not entitled to. This latter statement was manifestly not a correct one, and nobody who had heard the evidence could deny that there was a substantial case for the consumer who cared to stand out. It was perfectly true that the majority of the Westminster Company's consumers had been captivated by the sanguine statements made by the company, and that a few less credulous ones had held out; but he considered the very sanguine statements of the company to be questionable. Further, Mr. Moon had practically abandoned the buoyant argument of the case, and had fallen back upon far more temperate ground. His argument was, in substance, that the 1896 proviso was introduced as a temporary estoppel during an experimental stage, and that the condition of the industry really

remitted, at present, to the period before 1896, which would give to the company the right to ask the Board of Trade to do away with the proviso in question. But this was a fallacious argument, because the premises upon which it depended were not borne out by facts. There was not a word in the proviso as to its being a temporary one, and it seemed as permanent as any in an Act of Parliament. But even supposing that it was in the nature of a temporary measure, which he did not admit, he challenged Mr. Moon's statement that the state of things existing previously to 1896 was substantially the same as at present. The evidence put forward by the London County Council had established unquestionably that the experimental stage had not gone, and that the matter was still in a state of acute controversy. To illustrate this he took the Westminster Company's evidence, in which it was claimed that an advantage accrued to the consumer, and put against it the statements by Mr. Bernard Drake, who was particularly experienced in the Westminster district. This witness was prepared to show the specific nature of the numerous complaints he had received, and Lord Londonderry's agent had been an example of them. It was safe to say that a company like the Westminster Company would put their best leg forward in dealing with such a person, and the result of their best was seen by this evidence. Even on Mr. Drake's evidence alone he could claim that the 200 volt system had been proved to be still in the experimental stage as compared with 100 volts. Mr. Gunyon's and Prof. Ayrton's evidence supported this. Even Col. Crompton had not claimed for the consumer anything more than a greater regularity of light, and then they had Prof. Kennedy's admission that any disadvantage to the consumer ought to be made good. Therefore there was only the question of the arbitration to be settled. But he did not suggest that this should be done on the footing that no efficient 200 volt lamp would ever be made. A state of things existed which might be reasonably expected to be cured in the course of time, and it would not be beyond the power of the arbitrator to adjust this matter. But if the change were made in accordance with the company's wishes, the fact that the latter could enter a consumer's house at will would be a dispensation of the ordinary law of trespass of the country. This might or might not be very serious; but, on the other hand, surely it would not be right for the consumer to be forced into such an unequal contest. The company would have the power to enforce arbitration, but let it be at their own expense, unless the consumer had shown himself to be unreasonable. If this were not done nineteen-twentieths of the consumers would be obliged to have the change without a murmur, simply because they could not afford to go to arbitration. The company was amply protected under the proposed clauses by the fact that between them and the expense of arbitration there was the mediation of the Board of Trade, and further, there was the provision that the arbitrator could make the consumer pay his own costs if he had not been reasonable.

Mr. LITTLER, K.C., next called his witnesses.

Major CARDEW, examined by Mr. Crois on behalf of Mr. Littler, confirmed the previous evidence as to the undesirability of the change, and considered the clause submitted by the London County Council a very fair one under the circumstances. He considered the supply company should be called upon to pay all the expenses of the change, and, further, to put the consumer in all respects in as good a position as he was before. The fittings would certainly have to be changed if they had been at work with 100 volts for some years. The wires in every case ought to be overhauled by opening up the casing, as in his opinion, ordinary insulation tests were not sufficient. Flexibles in most cases would have to be replaced. In the case of trade premises the operations in connection with the change might be an appreciable inconvenience. He agreed with Prof. Kennedy that there was no essential difference between the two classes of lamps; probably only a small difference in price which favoured the 100 volt. However, although he had not carefully tested 200 volt lamps, he did not think it possible, with the smaller sizes, that they were as satisfactory as regards life.

By Mr. ROSKILL: It would not be a judicious policy on the part of the Board of Trade to absolutely veto the use of 200 volts, but at present he did not see how it was to the benefit of the consumer. He did not go so far as Mr. Chamen and say definitely that greater regularity of light was ensured, although, naturally, the company could for the time being comply better with the Board of Trade regulations as to constancy of pressure. Summing the whole matter up, it would be injurious to the consumer to have the change, on account of the slighter all-round efficiency of the lamps, and the probable greater risk of fire and shock. Nevertheless he had never recommended a change back from 200 to 100 volts.

Mr. ALFRED ROSE, of the amalgamated firms of Messrs. Rose and Bird and the Crystal Electric Lamp Co., entirely dissented from the view that 200 volt lamps were as good as 100 volt, for it was impossible for them to last 1,000 hours and not have more than 25 per cent. drop in candle-power to the same number of watts per candle. If an improvement took place in the 200 volt lamp it would still be behindhand, because a similar improvement would be apparent in the 100 volt lamp. At present there was about 25 per cent. difference in cost, and they took ½ watts per candle more.

By Mr. BALFOUR BROWNE, K.C.: The life of the lamp depended on the disintegration of the filament, and was mostly confined to the surface. He admitted there was the same proportion of surface in both lamps.

Mr. V. B. D. COOPER gave evidence of the state of things which existed between the Westminster Company and the Windsor Hotel and Junior Constitutional Club. He said he had asked well-known contractors for tenders for effecting the change at the above two places, and the figures quoted included nothing for internal re-decoration in any shape or form. The lowest tender for the Windsor Hotel was £966 and for the Junior Constitutional he quoted two amounts, viz., £700 and £530. In his view this was about the price he would expect to pay a respectable firm for doing the work. The re-decoration, which would, of course be absolutely necessary, would amount to a considerable sum. The change would be no benefit to his clients in either case, and the company ought to put them, if anything, in a slightly better position. At the same time, he repudiated the suggestion that on his advice his clients had attempted to blackmail the Westminster Company. It was not to his interest to retard the progress of the electrical industry, and his letter to the company, dated July 19, 1900, proved this. In this letter it was stated that he had no wish to prevent the company from increasing the earning capacity of its mains, and would be disposed to accept 200 volts provided slightly more light was given for the same amount of money. It was further pointed out that as the change was for the company's benefit and not his clients, all alterations must be carried out at the expense of the former. The Windsor Hotel's bill, which was paid monthly, averaged £1,250 per annum, and the Junior Constitutional slightly more. There was sufficient ground available in the case of the first named upon which they could erect their own generating plant.

By Mr. BALFOUR BROWNE, K.C.: Witness admitted that the company had offered to instal a transformer on the premises at the Windsor Hotel, but he had objections to it. He did not suggest that the company should pay any amount which a contractor selected by him liked to name for the alterations. He asked that the lowest tender out of four good contractors should be accepted, but did not seem to favour the idea of putting this to arbitration. If an installation was thoroughly wired, say yesterday, for 100 volts he did not think any change would be necessary except in flexibles.

By Mr. SYDNEY MORSE for the Chelsea Company: A building thoroughly wired for 100 volts would take an additional number of 200 volt lamps.

By Mr. ROSKILL: He could not make a definite statement as to the durability of the hotel 100 volt lamps, but was quite certain it was more than 600 hours.

By Mr. LITTLER, K.C.: The Windsor Hotel had been perfectly wired for 100 volts except in one or two places, but to-day there was no alteration wanting whatever.

Sir COURTENAY BOYLE: Why is it necessary to re-wire flexibles? Why is a distinction drawn?

WITNESS said that flexible wire for 100 volts was not so efficient as 200 volt flexible. It was a question of insulation.

Sir COURTENAY BOYLE: Do you say that the insulation for 100 volt flexible is inferior to that necessary for 200 volts.

WITNESS: Yes, that is so. In answer to further questions he said that if the necessary alterations were not carried out the fuse would go, and if it did not, then the wires would become so heated that they would burn up, with consequent danger to the building.

Mr. LITTLER, K.C., summing up on behalf of his clients, said he did not want his money spent or his time wasted in arbitration when he was in a position which he regarded as being perfectly reasonable. It would be different if they were asking for some ridiculous sum, say £20,000. The only terms they asked was that they should be placed in exactly the same position after the change as they were at present, and therefore the clause as to being vexatious or unreasonable could not apply in his case. Suppose when a consumer went to arbitration and the Board of Trade happened to select an electrician with extreme views, what would his position be then?

Sir COURTENAY BOYLE: I cannot admit that, necessarily.

Mr. LITTLER, continuing, said that with, say, Prof. Kennedy, the consumer would get no compensation, while according to Col. Crompton, he would be bound to give all that was asked and 10 per cent. besides. He was, however, perfectly prepared to abide by a decision of Sir Courtenay Boyle made on the spot, but this was not permissible. It was true that the Westminster Company had suggested that his clients should go to another company, but they would not be any more satisfied. But, further, it was useless to think that a company like the Westminster Company would offer to give up a large consumer like the Windsor Hotel if they did not know it was practically impossible for them to go elsewhere. He challenged the statement that the consumer got any advantage. Indeed, by coming to this inquiry the company had clearly accepted the position that the consumer was master of the situation. Much has been made of the purchase price which would have to be paid by local authorities, but, as far as he could see, the only interest the local authorities had in the matter was as to the pulling up of the streets, and, considering that this was done for six months at a time by those same people, it would not appear to matter much. He traversed the whole of the evidence on the question of saving, and denied in toto that this was so, and concluded his speech by extracts from the correspondence both between the Windsor Hotel and the Westminster Company and the Junior Constitutional Club, from which he said it was apparent that the company had attempted to tyrannise over his clients. A few of these extracts are noteworthy. One letter to the Junior Constitutional intimated that it would be necessary to terminate all original contracts with consumers after a certain date, and that the higher price would be charged if the change were not carried out, and another stated that having obtained the consent of the London County Council it would be necessary to make the change. A matter which Mr. Littler drew particular attention to was the fact that under its act the Westminster company had the right to obtain a deposit before supplying a consumer. Here was a customer spending £1,250 a year with the company, paying it monthly, absolutely regularly, when, in consequence of his refusal to submit to this change, he had been asked for an advance of some hundreds of pounds, or the company could not continue to supply. It was an insult to his clients. This, he said, was contained in the correspondence which was handed in to the Board of Trade, as also was the fact that the money had been paid under protest. Under all these circumstances, he maintained that, whatever the action of the Board of Trade in the matter, it should say, with regard to his clients, that arbitration should not be enforced, but that they should be put in a position absolutely to their own satisfaction.

Mr. BALFOUR BROWNE, K.C., replied both on the general points and the particular case of the Windsor Hotel. His company was not by any means alone in this application to the Board of Trade. The whole of the seven metropolitan boroughs supported the Westminster Company, besides 25 local authorities and 14 companies in the country. Altogether there were 68 applicants, and yet Mr. Littler came and bothered them about a squabble between a hotel, a club, and a company, which could be settled by an arbitrator in half an hour. These people were certainly trying to get more than they were entitled to, and although they were standing on what they called their "rights," this meant the right to extort as much as they could out of the company. He maintained what he had already stated—viz., that there was a benefit to the consumer, to the company, and to the public. But supposing there was no direct benefit to the consumer, was not a benefit to the company an indirect benefit to the consumer? The companies were not the enemies of the consumers. They had a right to charge 8d., but only charged 4d., because it was greatly to the benefit of the company as well as the consumer that electricity should be supplied at a cheap rate. The sliding scale in connection with the gas industry, by which as the profits went up the price went down and vice versa, was an endeavour to make the consumers partners in the undertaking, and this was what the electric supply companies were trying to do. Who were going to pay for the extra loss in mains? Not the company, but the consumer, and the consumer would get as much benefit out of it as the company. He admitted the company had a benefit, and they expected it. Mr. Littler had given the question of opening up the streets the go-by, but this should not be so. The public were directly interested in keeping down the capital account of his company. Every penny put into the ground in the shape of additional mains would have to be paid back by the public. Local authorities had to buy at the standing value of the undertaking. It might be possible, if all the 100 volt consumers lived in one street, for the company to supply them without any great expense, or if half the consumers in a district wished for 100 volts, there might be a case for the old regulations. But where there were only eight, as in his particular case, all distributed over the area, it was possible for the company to be blackmailed, and he did not hesitate to say that the Windsor Hotel had attempted to blackmail. Mr. Cooper had even asked to be put in a slightly better position than he was now. Why should the Windsor Hotel, or anyone else, object to arbitration if they had the truth and right on their side? Even Mr. Danckwerts suggested arbitration, and on this account Sir Courtenay Boyle had put in his clause, which was perfectly fair in principle. The only alteration he would suggest, but which he would not insist upon, was the insertion of the following, in the early part of the clause, immediately in front of the words "the undertakers may appeal to the Board of Trade"—viz., "and the consumer and undertakers have failed to come to an agreement within one month." As it at present stood a consumer could hang the company up for 20 years. He would further suggest that the undertakers should only offer to pay "what in their opinion was" the reasonable costs, &c., of the change. With these two exceptions Sir Courtenay Boyle's proposal was perfectly reasonable. The London County Council and City Corporation had asked for the Lands Clauses Act in preference to the Arbitration Act, which was the last deliverance of Parliament as to arbitration. He asked Sir Courtenay Boyle to leave his own clause, with the two corrections above, as it stood, or even leave his suggested alterations out, and he would be willing to accept it. He considered the question of lamps was covered by the words "incidental to."

The inquiry was adjourned until to-day (Friday).

With reference to Mr. Sydney Baynes' evidence on March 7, reported in our last issue, and in which he said that the present proviso did not really apply to St. Pancras, there appears to have been a misunderstanding between the witness and counsel. The facts of the case are as follows:—The St. Pancras order of 1883 contained a proviso only allowing a change of pressure subject to the approval of the Board of Trade, and in accordance with such conditions as they might see fit to impose. The Vestry wrote for these conditions, and in reply received the letter referred to of May 15, 1896, imposing the terms of the clause now under discussion. Under these circumstances, of course, the criticisms made by the counsel for the opposition do not hold good.

# CORRESPONDENCE.

## THE DUBLIN ELECTRICITY SUPPLY SCHEME.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have to day returned from Dublin, and venture to trouble you with a communication in reference to your remarks contained in your issue of the 8th instant. *The Electrician*, as you are no doubt aware, reaches Dublin regularly, and is treated as an authority on electrical matters, as its information is usually so correct, and my Dublin friends, therefore, have read with great surprise your references to what you describe as "the singularly unfortunate arrangements for the erection of a large electricity station for the supply of Dublin."

I have a great admiration for the way the technical press perform their weekly function of keeping the members of the industry acquainted with what is going on in every part of the kingdom, and I have hitherto been under the impression that, as far as municipal electricity works were concerned, they usually drew their inspiration from the reports of the Lighting committees or from the discussions in the Councils. May I, in the case of Dublin, refer you to these documents?

In a "Report of the Whole House, 1898," No. 36, page 292, Prof. Kennedy says, in reference to the Pigeon House Fort:—"From the electrical point of view, however, there is, of course, no difficulty whatever in making a good station at Pigeon House Fort, and in working economically from it, and if you have practically no alternative, I have no doubt the scheme can be carried out successfully. I may fairly say, however, that if the matter were in my hands, I would rather spend money on land nearer the city than on mains coming into the city, and believe that if the alternative exists at all, this would be the wiser one to adopt, but I quite realise that there may be circumstances which render it impossible for you to adopt it."

In consequence of the above expression of opinion, the Electric Lighting committee of Dublin advertised for sites, but the result of the responses not being favourable, they decided to proceed with the Pigeon House scheme and invited Prof. Kennedy to carry it out. When the application was made to Prof. Kennedy, however, he was on the point of starting to the United States under a retainer from the London County Council, and he expressed his regret at it being impossible for him to take up the work. This was the sole reason of my being appointed to carry it out rather than he.

With regard to the buildings, you state that in respect of my estimate of £20,000 for the buildings, "not one of the firms tendering offered to do the work for less than double Mr. Hammond's figure." May I refer you to Report 1,901, No. 36, page 225, in which I summarised the items embraced in the £41,000 tender which were not included in the original scheme, as follows:—

| | |
|---|---|
| Increased size of engine and boiler-house | £4,261 |
| Coal store (extra) | 2,500 |
| Overhead bunkers | 3,400 |
| Glazed brick lining to engine-house | 1,252 |
| Additional setting for Lancashire boilers | 500 |
| Excavation of engine-block to prepare for future engines | 400 |
| Provisional items | 1,175 |
| | £13,488 |

As compared with the above figure of £13,488, the excess in the figure of the tender is £16,300 as already set out, and there is, therefore, a difference between my original estimate and the actual tender figure of £2,812, which, considering the rise in the price of iron and especially of cement since I gave evidence before the local Government Board in February last, I do not consider can be deemed a very great divergence.

From the report of the committee which I enclose herewith, you will notice that including the small excess figure upon the buildings, the contracts given out to date in Dublin will amount to £184,550, against my total estimates of £185,549, in respect of the corresponding work.

I should also like to add that your leader writer is under a misapprehension in supposing that I have in any way departed from my original requirements with regard to substantial buildings and suitable foundations. The list of items which have been eliminated from the £41,000 tender, and which are set forth on p. 226 of the enclosed document, will show you that the building stands absolutely as substantial as that for which I laid plans before the Local Government Board.—Yours, &c., ROBERT HAMMOND.

London, March 18.

## WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

(*Translation.*)

SIR: During the experiments which I have just made with M. Guarini between Brussels, Malines and Antwerp, I was able to make some observations which I think it useful to point out to you. In all our laboratory experiments the Guarini repeater had always acted well even when, as in Fig. 1, the air-wire was connected to the coherer through the intermediary of the armature of an electromagnetic interrupter, whose object is, as is known, to break automatically the connection between the coherer and the air-wire when the latter is to be employed for radiating. But when we tried this pattern of repeater in our actual long-distance experiments, the following curious occurrence took place each time. As soon as an

electric wave transmitted from Brussels actuated the repeater at Malines, the latter continued to work by itself. Yet we had taken all possible precautions to prevent the sparks produced in the repeating apparatus, especially those of the

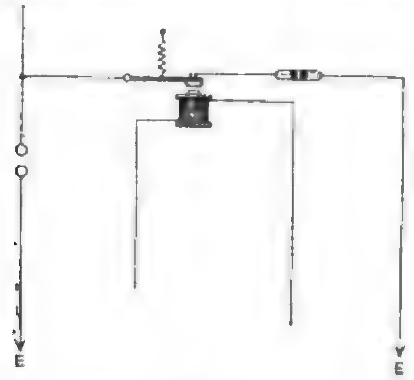


FIG. 1.

oscillator, from influencing the coherer. The metallic box enclosing the latter and the sensitive parts were carefully put to earth. After having assured ourselves that the cause of this phenomenon could not be from the apparatus itself, we

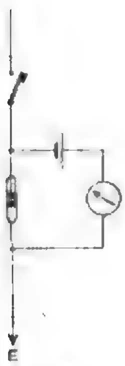


FIG. 2.

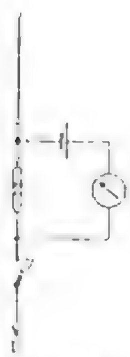


FIG. 3.

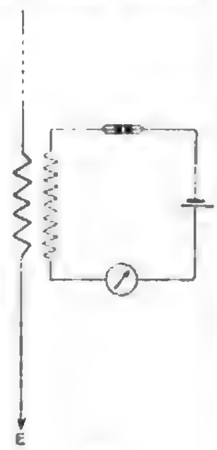


FIG. 4.

supposed that it must be attributed to atmospheric electricity. To-day I have verified this opinion by the following experiments.

I connected the air-wire at Malines, which is 70 metres high, directly to one electrode of a coherer, the other electrode

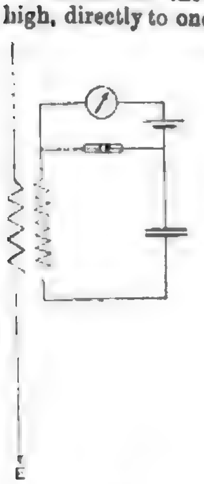


FIG. 5.

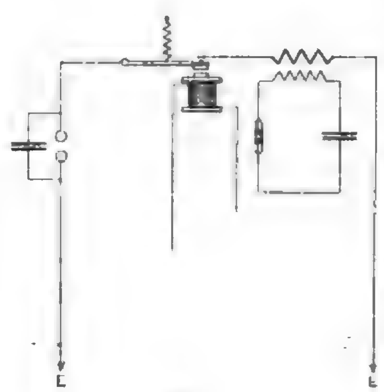


FIG. 6.

being put to earth. Each time that I broke or re-made the connection either between the air-wire and the coherer (Fig. 2) or between the latter and earth (Fig. 3), I observed a deflection of the galvanometer needle. I attribute this effect to the atmospheric electricity which traversed the air-wire—an actual lightning conductor; by breaking or re-making the connection I produced extra currents which put the coherer into action. I then connected the air-wire to one of the terminals of the primary of an induction coil, whose other terminal was earthed (Fig. 4). In the secondary, a very sensitive Blondel coherer was connected in series with a cell and a galvanometer, and the needle of the latter showed a constant deflection. Finally, I put a condenser in parallel with the coherer (Fig. 5), and I no longer noticed the least deflection of the galvanometer needle. This arrangement was then adopted in connection with the repeater, and the phenomenon of "self-impression" mentioned above no longer occurred.

One word with regard to the employment of alternating currents instead of Hertzian waves, of which M. Guarini has already informed you (see *The Electrician*, March 1, 1901). At the Brussels station, transmission is now being made exclusively by means of alternating currents and the result which we obtain is perfect. At Malines the repeater still includes an oscillator, but between the balls of the latter there is only a gap of 1mm. A condenser is put in parallel with the two balls (Fig. 6). This allows the spark-gap to be diminished, and thus reduces the travel of the armature of the electromagnetic interrupter.—Yours, &c.,

Brussels, March 16. LIEUT. PONCELET.

# PARLIAMENTARY INTELLIGENCE.

## SHEFFIELD CORPORATION BILL.

A question of making special provision for dealing with electrolysis was once more raised before the House of Lords Committee which had this bill under its consideration yesterday. The members of the Committee were Lord Newton (chairman), the Earl of Lathom, Viscount Falmouth, and Lord Sinclair. The bill is of an omnibus character, and the only part of it that was opposed related to electric tramway extensions. The Sheffield United Gas Co. petitioned against the bill.

The case for the promoters was opened by Mr. BAGGALLAY, K.C., who stated that the Sheffield United Gas Co. raised a question of considerable importance by asking that provision should be made in excess of the present protection given to gas companies against the possible effect of the electrolytic action of electricity escaping from tramway mains. The promoters contended that the general regulations of the Board of Trade were sufficient to protect the petitioners, and that so long as the Corporation carried out the Board's regulations they were entitled to the same protection as other local authorities who worked tramways by electric power. If they said these regulations were not sufficient, it was for the Board of Trade to amend them. It was most desirable that legislation on this subject should be general and should not be varied by local acts. No doubt Lord Camperdown's Committee on the London County Tramways Act of last year inserted a special clause on the subject of electrolytic action, but the promoters urged that it was unnecessary to insert a similar clause in this bill.

Mr. A. L. FELL, electric engineer and general manager of the Sheffield Corporation Tramways, stated that every proper precaution against electrolytic action had been taken in the construction of the tramways. The rails were laid in a solid bed of concrete and were plastered up with Portland cement and sand on each side so that they were practically insulated from the general body of the earth. Every joint was bonded and the tracks themselves were cross bonded. Under the Board of Trade regulations the Corporation had to keep certain records and these records showed that the amount of current working back to the power station otherwise than by the rails was very small. Witness had seen an old water pipe taken up in Sheffield before the tramways started running and it was so much corroded that it had actually burst. He had also seen pipes which had only been laid down for three years in made ground but which were corroding rapidly. He thought this was due to chemical action arising from the cinders in the ground. Under these circumstances if the Committee inserted a clause making the Corporation liable for damage caused by corrosion, the Corporation might have to pay for damage which they had never caused. The Sheffield rails were not insulated in a technical sense.

Mr. FREEMAN read the following proviso which, he said, the gas company desired to have inserted in the bill:—

> "Provided that, notwithstanding anything contained in the said acts or this act, if it be proved that any injury or damage to any mains, pipes or apparatus of the Sheffield United Gaslight Co. shall have resulted from fusion or electrolytic action caused by any currents generated or used for the purpose of electric traction on any of the tramways for the time being belonging to the Corporation, nothing in the said acts or this act shall relieve the Corporation from any liability to make compensation for such injury or damage which would have existed but for the passing of the said acts and this act."

Asked whether he saw any objection to such a proviso, Witness said it would cause endless litigation.

Mr. HORACE F. PARSHALL said he had had American experience, and could state that in the United States there were no regulations like those of the Board of Trade in this country. A tramway company was allowed to adopt any system of traction it wished; if the company did damage it had to fight it out in the Courts. Electrolysis did occur in the United States, but not to the extent that might under these circumstances have been expected. It was a very easy thing for a company that had a worn-out system of water pipes to discover suddenly when a tramway was laid that a new system of pipes would be convenient. He had examined the Dublin Tramway Company's system particularly, with a view of ascertaining whether there had been any deterioration of the company's property through electrolysis, because where the current strayed from the rails it necessarily took with it some of the metal. He found no deterioration in the Dublin rails, and there was no talk of electrolysis in any of the numerous installations with which he was connected. In Sheffield the electrical arrangements were the usual ones, and complied with the Board of Trade regulations. Those regulations afforded all the protection that was necessary to the owners of gas and water pipes. This was shown by practical experience. He did not think that even if tramways were defectively laid electrolytic action might ensue to a considerable extent. If the Board of Trade regulations were carried out there was no risk of electrolytic action whatever, and he had not found any difference of opinion on the point among electrical engineers who had been associated with practical systems.

Mr. ROBERT HAMMOND expressed the opinion that if electric tramways were properly constructed there was no risk whatever of electrolytic action. Last year he visited three times every large city on the Continent in which electric traction was employed, and in not one of them was he told anything about electrolytic troubles. He was consulting engineer to the Corporation of Dublin, and he was perfectly certain that the Dublin people, who loved a quarrel, would have gone to him before this about electrolysis if they had had any trouble of that kind. In Sheffield, even though the pipes were situated in ashy and damp ground, the Board of Trade regulations furnished sufficient protection. The electrolytic scare had been imported from America, and was not based on anything that had been seen in this country.

This closed the promoters' case.

Mr. H. THOMAS, general manager and secretary of the Sheffield United Gas Light Co., stated that they had about 100 miles of mains under the streets of the city, and at present they were in a very good condition. The company regarded it as a dangerous thing to have an electrical tramway running close to their pipes. He thought it only a matter of justice that, if the pipes were damaged by electricity escaping from the Corporation's wires, the Corporation should make good the damage.

Prof. J. PERRY, President of the Institution of Electrical Engineers, said he had examined the electric tramway at Sheffield, and was aware that it was worked under the regulations of the Board of Trade. He did not consider it a mere scare to anticipate that electrolytic action might be caused to the pipes which were laid near electric tramway lines; in his opinion it was a serious danger. When electricity left the metal and entered a liquid or damp soil a certain amount of metal was carried away with it. Under Board of Trade rule 5 per cent. of leakage might take place, but a single ampere of current continuing for one week to leave metal and enter soil of a certain kind would remove 1 cubic in. of iron or 2 cubic in. of lead. In some cases it would remove very much more than this and in other cases much less. Witness produced and placed before the Committee examples of pipes from South London which he had been assured by the local engineer had been damaged in consequence of leakage of the current from the City and South London Railway. He had not taken up the pipes himself, but had no doubt that in two of them the corrosion had been caused by electricity. These two were fitted in a way they would not have been if it had been a case of ordinary corrosion. It was fair to say that until about 14 months ago the City and South London Railway was not working under Board of Trade rules. He had no doubt whatever, however, that damage might be caused by electricity from the Sheffield Tramway, though it was working under Board of Trade rules. It was possible that one of the fitted gas-pipes he had produced had been laid since 1825.

Mr. WARNINGHAM, electrical engineer, said he had given very careful attention to questions of electrolysis. Theoretically the Board of Trade regulations did not afford protection, and there had not be sufficient time to see whether in practice they did or not.

Prof AYRTON stated that he was generally in accord with the views expressed by Prof. Perry. The London County Council plans of electric traction so far as they had been settled had been submitted to him and the return conductor was to be as wholly insulated as the going conductor. This would afford an absolute safeguard to the pipes in the roads through which the tramways would be laid. Various plans were now in course of development for preventing electrolytic action in the case of tramways, and many schemes had been patented during the last few months to prevent the anticipated electrolytic action that might be caused by the ordinary overhead trolley wire and the uninsulated rails employed as a return. Witness was inclined to think that the Board of Trade rules were drawn up under a misconception. He thought the Board, when the rules were made, had an idea that if the difference of potentials between a rail and a pipe was less than a certain value, which they specified definitely, there would be no electrolytic action, while if it was greater than that value there would be such action. That misconception existed in various books written in previous years. It was stated in those books that unless there were an electromotive force of about $1\frac{1}{2}$ volts there could not be electrolytic action. Greater knowledge had shown that this was not correct and that, whatever was the difference of potentials, electrolysis would take place.

Mr. Freeman having addressed the Committee in favour of the insertion of the clause he had already placed before them, and Mr. Balfour Browne having replied,

The CHAIRMAN announced the Committee's decision as follows: We are of opinion that the bill may proceed subject to the addition of the clause asked for by the Gas Company.

The unopposed portion of the bill was then proceeded with.

## KING'S NORTON AND NORTHFIELD TRAMWAYS BILL.

On Wednesday this bill came before a select committee of the House of Lords, over which Lord Stanmore presided.

For the promoters, Mr. BALFOUR BROWNE, K.C., said the bill empowered the District Council of King's Norton and Northfield to construct railways and tramways in the district. It was practically an ordinary tramway bill, and, like most tramways, was to be worked by electricity on the overhead system. The main object was to connect the lines which exist in Birmingham with the district, and the principal proposal was to make two great main thoroughfares for traffic, one along the Pershore-road, and the other along the Bristol-road from Northfield. The Council had come to the conclusion that tramways were essential for the district. The total length of the proposed tramways was $11\frac{1}{2}$ miles, and the cost £130,000. The petition against the bill was on behalf of certain property owners, and, as frontagers, they did not want the tramways.

Mr. Edwin Docker, clerk, Mr. Thomas Gibbins, chairman, and Mr. A. W. Cross, engineer of the King's Norton and Northfield Council, gave evidence in support of the bill.

Mr. C. H. GADSBY, consulting engineer, said he approved the route selected for the trams. He thought a 15 minutes' service would be adequate for the district. The total estimated cost was a little over £129,000, and on that outlay he believed the trams would pay.

Mr. S. R. Locock, civil engineer, also gave evidence in support of the bill, after which witnesses for the opposition were called, and the inquiry was adjourned.

## CHINESE CABLES.

In the House of Commons on Monday Sir CHARLES DILKE asked the Chancellor of the Exchequer a question on the subject of the laying and working of submarine cables in China.

In reply, Sir MICHAEL HICKS-BEACH said: The cable between Shanghai, Chifu, and Taku (which does not touch at Wei-hai-wei) has been laid by the Eastern Extension and Great Northern Telegraph companies for the Chinese Telegraph Administration under an arrangement which the British Government fully recognises and supports. The cable is leased by the Chinese Administration to the companies for a minimum period of 25 years, and the companies will work and maintain it. Wei-hai-wei will be served by a branch line from Chifu. It is stipulated in the agreement between the Eastern Extension Company and the British Government that this branch line shall be worked by a British staff, and that all traffic between Wei-hai-wei, Chifu, Shanghai, and Hong-Kong shall also, as far as practicable, be transmitted exclusively by British operators.

## STANDING ORDERS AMENDMENT.

In the House of Commons on Friday, on the motion of Mr. J. W. Lowther, it was agreed to amend Standing Orders 134 (c) and 170 (a) in order to give county councils a locus standi to appear against tramway schemes when the tramways proposed were to run along roads for which the county councils are responsible, and of extending from 21 years to a maximum of 42 years the period at which the local authority may purchase a tramway undertaking. The alterations apply to the whole of the United Kingdom.

# LEGAL INTELLIGENCE.

### Cuba Submarine Telegraph Co. (Ltd.) v. West India and Panama Telegraph Co. (Ltd.).

On Thursday, March 14th, the hearing was resumed in this appeal.

Mr. HALDANE, K.C., continuing his arguments in support of the appeal, contended that the defendants had never threatened or intended to arrange with the Direct West India Cable Co. to transmit messages from London handed by the Direct Company at Jamaica to the defendants for transmission to places south and east of Jamaica at a lower rate than the local rate, or to arrange terms with the Direct Company which should enable messages handed in by the Direct Company to the defendants at a rate greater than the through rate which had been fixed in respect of messages from London to places south and east of Jamaica, via New York and Havana. The defendants further alleged that plaintiffs claimed to do and had for many years done, and were still doing, the very thing they now claimed defendants were not entitled to do.

Mr. YOUNGER, K.C., followed on the same side. He said if the plaintiffs' contention was correct it would involve this, that plaintiff company must be taken to be in telegraphic communication with every place on the defendant company's system. The result would follow that if a message was handed in at any one station on the defendant company's system for transmission to another place on the same system that inasmuch as the place of destination was in telegraphic communication with the plaintiff company, that company would be entitled to a proportion of the receipts for that message, inasmuch as the only obligation under the third clause of the agreement upon the West India Company was to hand over to or forward by the Cuba Company all the telegraphic messages received by or sent through the West India Company for such places as the Cuba Company might be in telegraphic communication with. That in itself amounted to what might be called a limitation. It was put to him that there would

be no handing over to the Cuba Company of a message which was to be transmitted from one station on the defendant company's system to another. He ventured by way of reply to say that the wording of the agreement as it stood, as it was construed by the learned judge and by the plaintiffs, was that they might be entitled to some portion of the rate paid in respect of a message which never in any sense of the word reached the terminus of the defendant company at the beginning of the Cuba Company's line. In other words, that the plaintiff company claimed to be entitled to participate in messages which were dealt with by the defendant company, although under no possibility could these messages in the course of their transit ever reach Santiago. He had to contend that in the drawing up of the judgment there had been a grave error. According to his decision the learned judge for the purpose of arriving at the conclusion of what places where in telegraphic communication made the rates of the rival routes the standard. The declaration of the Court as drawn declared that the plaintiffs were, according to the true construction of the agreement of January 31, 1870, in telegraphic communication with every place with which the plaintiffs should be able to communicate by telegraph, or of which the defendants should also be able to communicate by telegraph in such manner and at such rates as to enable defendants or any other person or company to compete for traffic with the plaintiffs. The order had been transposed and the effect of the declaration was to lead to the extraordinary result that the more exorbitant the plaintiff company's rates were the more easy it was for the defendants with a lower rate to compete with them. It was the amount of the plaintiff company's rates not the smallness of them which, according to the formal declaration, constituted telegraphic communication, whereas according to the learned judge's decision telegraphic communication depended upon the plaintiffs' being equal to or not greater than the rates of other routes.

Mr. SWINFEN EADY, K.C., for plaintiffs (respondents) submitted that the judgment of Mr. Justice Farwell was correct, and ought to stand. The telegraph companies had agreed between themselves on a through rate between London and Jamaica at 3s. a word. Before the time of those disputes the through rate to St. Croix, as agreed by the plaintiffs and their allies, was 5s. 5d.—that was to say, a message might be sent from London to Halifax, Santiago, Jamaica, and thence to St. Croix. The through rate for that was 5s. 5d. Supposing a message was handed in at Jamaica for St. Croix the local rate was 4s. 1d. That was an agreed figure. So that supposing a person wished to telegraph from London to St. Croix by the Direct Company's route, apart from any preferential arrangement, the Direct Company would charge 3s. per word for going to Jamaica, and there they would have to hand it on to the West India Company, and if the latter charged the Direct Company what they charged others—viz., 4s. 1d.—the public would have to be charged 7s. 1d. for the message. The through rate was only 5s. 5d. by the plaintiffs' system. The plaintiffs' complaint was that the defendants, in order to enable the Direct Company to compete with the plaintiffs instead of treating them as strangers, as they were bound to do, did not require the Direct to pay 4s. 1d., but had entered into an arrangement with the Direct Company which enabled the latter company to compete with the plaintiffs' system in the St. Croix messages. In other words, the defendants announced themselves willing to work with the Direct Company at through rates, and had arranged to charge them not 4s. 1d. per word, but to charge them such a sum as would enable them to compete with the plaintiffs in the St. Croix messages.

Lord Justice WILLIAMS: Do you say that it is impossible for them to say that for all the world their transit rates are 25 per cent. less than their local rates? Might they say: "For all the world we charge for transit rates 25 per cent. less than for local rates"? You say that that would be a contravention of paragraph 5 of the agreement.

Mr. SWINFEN EADY: If that was the rate they gave to us, I think it would be a breach of the agreement with us so far as regards competing cables. Take Jamaica. They are not to enable any new company to compete with us by reducing their rates. They allowed the Cuba Company and their allies a reduction of 25 per cent. to get a working tariff. For them to say "We will allow your competitors a similar reduction in order to enable them to compete with you," I say that is an agreement prejudicial to us, and which the defendants have agreed not to enter into. The learned counsel, continuing, said that the real dispute was with the Direct Company, because that company went to Jamaica. There was not much competition between the plaintiffs and the French company. He submitted that Mr. Justice Farwell had come to a proper conclusion on the matter, and that there had been a clear breach of the agreement by the defendants, and that the plaintiffs were entitled to an injunction as asked.

Mr. HALDANE having replied,

Lord Justice RIGBY, in giving judgment, said: The main question to be decided is as to the meaning of words apparently most easy of interpretation. His lordship briefly reviewed the early history of the establishment of telegraphic connection in the West Indian islands. The Cuba Company (the plaintiffs in this action) having been formed, and the West India Company having also been incorporated, on the 31st January, 1870, these two companies entered into the agreement in question in this case. By that agreement it is provided, by clause 1, that the Cuba Company will hand over to the West India Company all telegraphic messages received by or through the lines of the Cuba Company for any part or parts of the world with which the West India Company were in telegraphic communication. Then clause 3 provides that the West India Company will hand over to and forward by the Cuba Company all telegraphic messages received by or through the West India Company for such places as the Cuba Company may be in telegraphic communication with. That phrase "telegraphic communication" has got to be dealt with, and it is the main question in this action. The contending points are that a company cannot be in telegraphic communication with any part away from its own system. It must be in telegraphic communication by means of a cable of its own. Now, prima facie, that certainly is not the meaning of the words "telegraphic communication." I think that, with the ordinary parlance so far as the agreement is concerned, the Company may be in telegraphic communication with a place which is not reached by its own cable or telegraphic lines. I hold that according to the meaning of the agreement Jamaica was in telegraphic communication with London, and I hold that telegraphic communication must mean everything which can be, in the ordinary acceptation of the word, treated as telegraphic communication. I hold then that under this agreement the words "telegraphic communication" are to have their general effect, and that when you find a practically established system of communication, especially where there are through rates, you have really telegraphic communication. But then there is another part of the agreement—clause 5, which says:—"Neither company parties hereto shall enter into an agreement or trade arrangement with any other company or persons, or may connect with any telegraphic line or any cable at these points which may be prejudicial to the interests of the other company party hereto without the assent in writing of the other company," and an injunction was asked for restraining breaches of that contract. In the case for an injunction you must see that the party complaining suffers damage; not that there has been a mere breach of the agreement but that it is one practically tending to inflict damage upon the party complaining, and for that purpose it is necessary to consider whether there was a practical reason for granting an injunction. And of course it at once becomes evident that there might be cases in which there was communication to a certain place, but where no damage could possibly arise by what was being done because there would be no competition at all. There might be cases in which the rates necessary to be charged were so high that there would be no competition, and therefore an injunction would be unreasonable. The learned judge sought to limit the injunction he was about to grant to practical cases. In his reasoning judgment—as distinct from the formal judgment—the learned judge seemed to say that unless there was competition practically there was no damage and no injunction could be granted. There must be competition by the plaintiffs and competition by the defendants. The words of the formal judgment had left the matter not so clear as it ought to be, and I think that those words as to damage by competition ought to be reconsidered, and that we should not leave the matter open to any doubt at all. In my judgment the plaintiffs are entitled to the declaration as to the words "telegraphic communication" practically as extensive as that which has been put upon the words by Mr. Justice Farwell, and that they are entitled to the injunction practically to the extent to which the learned judge has granted it. The result will be that the appeal will be dismissed.

Lord Justice VAUGHAN WILLIAMS: While concurring with everything that Lord Justic Rigby has said, I wish to point out for myself that I think the formal judgment given in the Court below requires a very substantial correction. My view is that the words "telegraphic communication" in the agreement must be construed in their ordinary meaning, and the limitation which appears at the end of the formal judgment is not regular and is not accurate. I should like to point out, however, that, according to my view, that which is claimed by the plaintiffs in the statement of claim is altogether too wide. The plaintiffs claim an injunction without any restriction or limitation at all, which injunction I am not ready to grant, and, as I understand from Lord Justice Rigby's judgment, he was not ready to grant. The injunction claimed is altogether too wide. I think the words "telegraphic communication" in the agreement must receive their natural meaning, and I wish to heartily assent to what Lord Justice Rigby has already said, that, although a wide interpretation was put upon the words in question, it does not follow that the plaintiffs are entitled to an injunction as wide as that claimed. The plaintiffs certainly could not get damages wider than the injury they have sustained.

Lord Justice STIRLING: I am of the same opinion as regards the phrase which has been so much considered in argument, namely, being "in telegraphic communication." There are two different interpretations advocated, one on behalf of the appellants and the other on behalf of the respondents. The construction which is advocated by the appellants is that the words "being in telegraphic communication" means that when one or the other can communicate telegraphic communication has been effected. To my mind that construction is far too narrow. The construction advocated on behalf of the plaintiffs—that two places are, in ordinary parlance, put in telegraphic communication when a telegram can in the ordinary course of business be sent from the one to the other—is the ordinary meaning which it ought to receive on this occasion. I think that the contract the defendant company has entered into has such a tendency that the judgment of the Court below is correct, with the suggested modification.

It was left to counsel to arrange the terms of the order, with leave to apply to the Court if necessary.

The appeal was then dismissed with costs, leave being given to appeal to the House of Lords.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

The Guardians of St. George's Union, London, W., require a chief engineer for their infirmary, to take entire charge of the heating and electric lighting plant, &c.; also two drivers for the electric lighting plant. Further particulars will be found in an advertisement.

The British Electric Traction Co. require a manager to superintend the erection of 7 miles of overhead construction for electric tramways in Scotland. See advertisement.

A mechanical and electrical draughtsman is required at the Lancaster Corporation electricity works. Applications to borough

electrical and tramways engineer (Mr. W. A. Tester), by April 1. See advertisement.

The Professorship of Natural Philosophy at Edinburgh will be vacant from April 29 next, owing to the resignation of Prof. Tait. Applications to Secretary, 4, Albyn-place, Edinburgh, by June 1.

A principal is required for the Northern Polytechnic Institute, Holloway, London. Applications to clerk before March 30.

Nelson Tramways and Electricity committee require an electrical engineer. Applications to town clerk by 25th inst.

---

Mr. Teed Owen, of Huddersfield, has been appointed traffic assistant to the Electric Lighting and Tramways department of the East Ham District Council.

Dr Kohn, of Liverpool University College, has been appointed principal of the Sir John Cass Technical Institute, London, at a salary of £500 per annum.

---

**Bath.**—At the Council meeting on Monday, on the motion o Ald. Taylor, the Electric Lighting committee's report was adopted, except so far as it related to the appointment of Mr. Francis Teague as city electrical engineer. Mr. Teague has been appointed for three months at a salary of £29. 3s. 4d. per month. The object of the motion, Ald. Taylor explained, was to enable the committee to make inquiries which they had not yet been able to make.

**Burton-on-Trent.**—Last week the Council decided, on the motion of Councillor Lowe, to rescind the resolution passed on Sept. 13, 1899, relating to the fixing of the charges for electric energy for heating and power, and fixing the future charges as follow:—For the use of a motor or heater for 117 hours (or less) per quarter, 3d. per unit; for any additional number of hours' use (during daylight) per quarter, 1d. per unit. Mr. Lowe explained that there was an all-round charge of 2½d. per unit for power or heating, and it had been thought advisable to revise this charge. Most of their expenses were the same whatever the consumption. They had found that the consumption of electricity for motive power had proved a fruitful source of income in other towns, and this revision had been made with a view to inducing local firms to take current for motive power. Those who so took current would find the cost compare favourably with either steam or gas. They had to create a market for electric energy.

**Cardiff.**—At the next meeting of the Electric Lighting committee the borough electrical and tramways engineer (Mr. Arthur Ellis) will submit a revised tariff for current for lighting and power.

**Electricity in the Navy.**—In presenting the Navy Estimates in the House of Commons on Monday, Mr. Arnold Forster explained that the rating of electricians was a new rating for which the Admiralty hoped to obtain 100 men during the present year and 100 more at an early date. The enormous growth in the use of electricity on board ships of war had caused the rating. The men, after undergoing an examination, would be passed into the Navy, and it was hoped they would form a most valuable addition to the staff of the torpedo department. They would rank as petty and chief petty officers.

**Glasgow Exhibition.**—It has now been definitely arranged that the Duke and Duchess of Fife will in the King's name perform the opening ceremony of the Glasgow Exhibition in May.

**Islington (London).**—The salary of the borough electrical engineer (Mr. Albert Gay) has been increased from £500 to £600, and that of the chief assistant (Mr. C. Yeaman) from £250 to £300.

**King's Lynn.**—The electrical engineer's salary has been increased from £150 to £200 per annum, and a bonus of £105 has been voted to Mr. Pilling in connection with the completion of the extensions at the electricity works.

**London County Council.**—At Tuesday's meeting the following motion was agreed to:—

That it be referred to the Local Government committee to report (*a*) whether any means at present exist of ascertaining the names and addresses, and nature and extent of interest of debenture stock and shareholders in the companies supplying gas or electricity, or water or hydraulic power or undertaking, tramway or telephone service, or owning docks or wharves within the County of London, and, if not, (*b*) as to the desirability of the Council seeking parliamentary powers to bring all such companies, whether incorporated by private act of Parliament or otherwise, under similar obligations in that respect as would be the case had they been incorporated under the Companies Acts, 1862 to 1900.

**Lowestoft.**—On March 1 there were 68 consumers, representing an equivalent of 3,500 8 c.p. lamps connected. On the recommendation of the consulting engineer (Mr. W. C. C. Hawtayne) considerable extensions of the mains are to be carried out principally for public lighting, and sanction to a further loan of £30,000 has been applied for.

**Merthyr.**—The electrical equipment of the tramways was officially inspected by Mr. A. P. Trotter on Tuesday.

**Municipal Loans.**—*Heywood* Corporation have received sanction to borrow £15,000 for electric lighting.

*Bradford* Corporation have been authorised to borrow £140,000 for electric lighting and tramways.

**Municipal Trading.**—The Shoreditch Borough Council has received a letter from Messrs. Aublet, Harry & Co. (Ltd.) drawing attention to an estimate for wiring certain premises recently unsuccessfully submitted by that company. Greatly to their surprise (the letter states) they found that the accepted tender was sent in by the electricity department of the Shoreditch Council, and that the price quoted was 50 per cent. below that of the company's tender. The letter also referred to a second case, and stated that the company were forced to the conclusion that it was the intention of the Council to compete against electrical engineers in the borough and elsewhere, which was an unfair proceeding. The writers submitted that in the first instance referred to the actual cost price of the work was more than the amount of the Council's estimate, and that the authority was exceeding its powers under the Electric Lighting Acts, and was acting beyond the province of a borough council. The letter has been referred to the Lighting committee for consideration.

**Pembroke (Dublin).**—A recommendation by the electrical engineer (Mr. Price) to reduce the charge for electric current to 4d. per unit has been referred to the consulting engineer (Mr. R. Hammond).

The Council have approved the Scalp and Enniskerry tramway project.

**Police.**—At Stratford Police Court last week Kenneth Ling, hosier, of Leyton, was summoned by the Leyton Council for making a connection with the electric light mains of the Council without consent, and also for using current generated by the Council. The clerk (Mr. R. Vincent) prosecuted for the Council, and said that the proceedings were taken under the Electric Lighting Act, 1882, wherein the provisions of the Gasworks Clauses Act, 1847, were incorporated. Defendant pleaded guilty and was fined £5.

**Presentation.**—On Saturday evening last, at the Coach and Horses, Greenwich, Mr. J. Swaisland was presented with a cheque and an address on vellum on the occasion of his retirement after 35 years' service with Messrs. Siemens Bros. & Co., at Woolwich. Mr. G. Taylor presided over a large gathering of past and present employés of the firm. For 28 years Mr. Swaisland has held the important post of principal foreman of the instrument department. Mr. J. Hodgson, who made the presentation on behalf of nearly 100 subscribers, spoke in feeling terms of the great respect in which Mr. Swaisland was held. Mr. Swaisland, in responding, referred to the unexpected character of the presentation and the pleasure he felt to find so many of his old boys holding such good positions in the electrical industry in various parts of the country.

**Private Bill Legislation.**—The Charing Cross and Hammersmith Electric Railway and the King's-road Railway, and the South Lancashire Tramways Bills have been read a second time in the House of Lords.

**Salford.**—A brisk and edifying correspondence has been a feature of the past few issues of the Salford *Reporter*, in which journal has appeared communications from a number of city councillors and others on the subject of recent statements and charges made against Mr. Councillor Haworth by certain of his fellow members on the Council and others. The correspondence lets in a flood of light upon recent events at Salford, one important result of which, it will be remembered, was the resignation of Mr. C. L. Turner, late electrical engineer to the corporation.

A Board of Trade inquiry was held here last week into the application of the Corporation to borrow £8,771 for electric lighting. It was stated that the present generating station had been in operation four years, but the demand for current was so great that it had been decided to erect a large generating station at Pendleton capable of supplying all demands for current in the borough. Of the loan, £3,771 was for additional plant, and part of this amount had been spent. The electrical engineer *pro tem.* (Mr. F. A. Wilkinson) said they had already 450 customers, and anticipated making 250 additional connections this year. The proposed additions would carry them on till the new station was completed.

**Sheffield.**—The Tramways committee have set aside a further £5,000 out of the tramway receipts for relief of the rates.

**Tunbridge Wells.**—An inquiry was held here on Wednesday into the application of the Council to borrow, among other sums, £10,000 for the erection and maintenance of a municipal telephone service for Tunbridge Wells, Tonbridge and Southborough, and the outlying parishes of Ashurst, Bidborough, Brenchley, Buxted, Capel, East Peckham, Frant, Goudhurst, Hadlow, Hartfield, Hildenborough, and other Kent villages, and also on the Sussex side of Tunbridge Wells to Mayfield, Rotherfield, Ticehurst, Wadhurst, and Withyham.

The Town Clerk (Mr. W. C. Cripps) said that since the Postmaster-General's licence had been obtained, the posts had been erected, and the scheme was being carried out with a view to the early opening of the exchange. It was proposed to extend into Sussex as well as into Kent. That was the first inquiry of the kind under the Telegraph Act of 1899, Tunbridge Wells being one of the first towns to secure the licence for a municipal telephone service. With regard to the laying-down of underground wires in the main streets, no consent was needed by the Corporation, but for overhead wires, not through the streets of the borough, consent might be needed, as some of the latter would be over and on private property. This point was discussed at length by the inspector and Mr. Cripps.

The latter cited clauses in the acts dealing with the questions of rights of way, maintaining that the question of the £10,000 loan was a first consideration, to allow of other applications for consent in the development of the scheme. In the borough no railways or canals had to be crossed by the overhead wires, but outside the boundary it would be necessary twice to cross railways. In Tunbridge Wells the wires would in many cases go over, or on private land, &c., but no objection by owners within the borough had so far been received. Mr. A. R. Bennett, consulting telephone engineer to the Council, said the Local Government Board had sanctioned a loan of £121,000 to the Corporation of Glasgow before any consents had been obtained from property owners. Mr. Cripps further explained that on the Kent side consent had been obtained to twice cross the S.E. & C. Railway at a point near Tonbridge. The question of wayleaves, &c., having been discussed, and maps, plans and diagrams illustrating the districts affected by the scheme submitted, Mr. Cripps said the Corporation became a competitor against the National Telephone Co., and it was most important to the Council to secure the loan. The clerk to the Tonbridge District Council (Mr. W. A. Williams) supported the application, and Mr. Cripps said the Southborough Council also favoured the scheme. It was explained that at present 286 persons in Tunbridge Wells had promised to become subscribers and 129 outside the borough, and this list would be much increased as soon as the system could begin to serve the town and district. Mr. Bennett said they did not at first expect to make a profit, but would be satisfied if the scheme covered working expenses. In a few years, however, there would be a substantial profit. Mr. Cripps pointed out that Tunbridge Wells Council passed a resolution as long ago as June, 1896, in favour of a municipal telephone system, and subsequently all the leading public bodies in Tunbridge Wells (the Trades' Association, Farmers' Club, &c.) supported the proposal. Mr. G. F. Carell (clerk to the Sevenoaks Council), said if his council were assured as to the overhead wires and posts on roads they would not oppose the scheme. Mr. Bennett said in all main streets in the borough there would be cables underground, but not in the rural districts. The tender of Henley's Telegraph Works Co., for supplying and laying the cables had been accepted, and various other firms had received orders for goods required in the construction of the lines. The whole scheme was estimated to cost £9,136, and the tenders came under that amount. There was no opposition.

In reference to the statement which appeared yesterday (Thursday) in one of the London halfpenny papers to the effect that a breakdown occurred in the electricity supply on Wednesday, we are authoritatively informed that there is no truth whatever in the report.

**Tynemouth.**—The electric tramways were opened for traffic on Monday.

**Vibration Committee.**—The Board of Trade Committee appointed to enquire into the alleged vibration and damage to structures above the course of the Central London Railway resumed its sittings on Monday. Much evidence was given alleging variations in the vibrations at different times of the day according to the amount of traffic. Prof. J. A. Ewing suggested to Mr. Basil Mott that there might be a difference in the speed of the trains at various parts of the day, and Mr. Mott, in reply, said there was no difference in speed, but the trains were more numerous in the morning and evening. At the busiest time of the day trains were run about every 2min. 50sec., and at the slackest every 3½min. He had examined the road and the rolling stock and had found nothing that would account for the alleged aforesaid vibration. The Committee again adjourned.

**Watford.**—Messrs. Preece and Cardew were recently called in to report upon the present condition of the electricity undertaking, and in their report they state that the generating station has evidently been designed too much with the view to keeping down capital. There were no coal bunkers, and there was no system of weighing and checking the coal from the railway company's trucks to boilers, except a small weighing machine, which was quite insufficient. Feed-water was taken from a surface well in the boiler-house; the town's water was also available as feed water, but as it produced a harder scale in the boilers it was not often used. There were no water meters, no arrangement of feed-water heaters other than the economiser. The arrangement of steam pipes in the boiler-house was good. The present boilers scale up with the hard water used, and in consequence one boiler was always being cleaned while the other boiler was doing the load, and for that reason there was insufficient steam to do more than drive one 150kw. and one 30kw. alternator. The alternators seemed to work well, but the engine governors were unsatisfactory and were a constant source of trouble. The means provided for lubrication of the engines was reported to be wasteful, and they noticed that the oil was being thrown about. At present there were connected the equivalent of 2,000 8 c.p. lamps for street lighting, and 6,400 8 c.p. lamps for private lighting. The existing plant and works are not sufficient to meet the demand for current, and the whole supply may be at any time interrupted by a breakdown in any part of the high-pressure system of mains which it would be difficult to localise. In order to meet urgent requirements they recommend the following additions—viz.: (a) Another Babcock and Wilcox boiler; (b) a Chevalet feed-water heater and detartariser; (c) another 150kw. set; and (d) means for sectioning the high-pressure mains so as to admit of isolating any defective portion, or for testing, &c., and they would recommend that a switch room should be provided at or near Bank-corner, into which the two different high-pressure trunk should be taken and from which all branch mains should proceed. Accommodation might also be provided in the same building for office requirements and testing room if a suitable building could be acquired. If not, an underground switching chamber should be constructed near this point. After providing the main switch room, disconnecting boxes should be introduced in the branch mains, which should as far as possible be connected up to form a system of ring mains; (e) proper coal bunkers and weighing apparatus, and a system of working introduced which will admit of an exact check on the coal paid for, received, and consumed. This should cost approximately £250. As regards the provision of means for condensing, it appeared to them that there would be no difficulty in making a pond of suitable size close to the station. They do not recommend a dust destructor.

**Woolwich.**—The Borough Council are inquiring the terms upon which the Woolwich District Electric Light Co. will dispose of its undertaking to the Council.

**Workhouse Lighting.**—The Kensington (London) Guardians have been again informed by the Local Government Board that they cannot sanction a loan for establishing independent electricity works for lighting the workhouse.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Leeds* Lighting committee invite tenders for steam, feed water, exhaust, overflow, blow-off, and other pipes, valves, hot-wells, feed-water pumps, economiser, &c., in connection with engines of 4,000 I.H.P. Specifications, &c., from the manager (Mr. Harold Dickinson), 1, Whitehall-road, and tenders to town clerk (Mr. W. J. Jeeves) by Monday, April 15. An advertisement contains additional particulars.

*Dublin* Lighting committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane and workshop equipment. Specifications, &c., after 23rd inst., from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., and tenders to the clerk (Mr. Henry Campbell), City Hall, Dublin, by 4 p.m. April 22. An advertisement contains additional particulars.

*Metropolitan Asylums Board* invite tenders for the supply and erection, at the Tooting Bec hospital, of electrical generating and heating plant, particulars of which are set out in an advertisement. Specifications, which have been prepared by Messrs. Handcock and Dykes, consulting engineers, 1, Victoria-street, Westminster, S.W., can be obtained at the offices of the Board, Embankment, London, E.C., where tenders must be delivered by 10 a.m., April 24.

*Bradford* Corporation invite tenders for a combined motor balancer and boosters, with switch gear for same, for their Bolton-road electricity works. Specifications from the city electrical engineer (Mr. R. A. Chattock), Town Hall, Bradford, and tenders to the town clerk (Mr. Frederick Stevens) by April 3. An advertisement contains further particulars.

*Salford* Corporation invite tenders for wiring for motors, dynamo leads, engine room and switchboard connections, &c., at Strawberry-road generating station. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh and Sillar), 2, Queen Anne's-gate, Westminster, London, and 78, King-street, Manchester; but can be obtained only from the latter office. Tenders to the town clerk (Mr. L. C. Evans), Town Hall, Salford, by noon April 9. See advertisement.

*Sunderland* Corporation invite tenders for 104 arc lamp pillars and 104 arc lamps and accessories. Specification, &c., can be obtained from the borough electrical engineer (Mr. J. F. C. Snell), Dunning-street, and tenders, addressed Chairman of Lighting Committee, Town Hall, Sunderland, must be sent to the town clerk (Mr. Fras. M. Bowey) by noon of April 3. See advertisement.

*Sunderland* Corporation also invite tenders for indiarubber-covered cables, stoneware casing, wrought-iron piping, cast-iron piping and cast-iron box frames and covers. Tenders to chairman of Lighting committee by noon 29th inst.

The directors of the *Lancashire and Yorkshire Railway* require tenders for the supply of the company's stores during the 12 months ending April 30, 1902. Among the requirements are signal, telegraph and electric light wires, signal and telegraph fittings, wire, screws, steel sheets, tubes and tubing, reflectors, oil, copper, iron castings, &c. Further particulars and forms of tender may be obtained at the stores department, Osborne-street, Manchester, and

tenders must be lodged with the secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. of April 8. An advertisement contains further information.

The Directors of the *Metropolitan Electric Supply Co.*, 16, Stratford-place, London, W., are considering the expediency of adopting larger units, and are prepared to receive designs, accompanied by full specification and approximate price, for complete two-phase steam units having an output of from 3,000kw. to 4,000kw. at a pressure of 500 volts per phase, and at a periodicity of 60 complete cycles per second, such units to work in parallel with the existing 1,500 kw. units of the company. As an alternative, similar units generating at 10,000 volts may be considered.

*Aylesbury* District Council invite tenders for the construction and maintenance, for a term of years, of electricity supply works. An advertisement contains further particulars, and tenders, addressed o the clerk (Mr. Percy Wright), must be in by 4 p.m., April 22.

*Kircaldy* Corporation invite tenders for the supply, delivery, and erection of engines and dynamos, storage battery and overhead travelling crane. Specification may be seen at but not obtained from the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. Wm. L. Macindoe) by 10 a.m. April 15.

*Hornsey* District Council invite tenders for boiler-house and engine-house plant, condensing and water cooling apparatus, pipe-work, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains, and arc lamps, &c., for public lighting, meters and workshop equipment. Tenders to clerk by 4 p.m. April 11.

*Bradford* Corporation invite tenders for castings, forgings and turned work required for slipper brakes for the electric tramcars. Tenders by 30th inst.

*West Sussex* County Asylum Visiting committee require electric lighting sundries for 12 months from April 1. Tenders to clerk, West Pallant, Chichester, by March 26.

*Warrington* Corporation require steel rails, paving, &c., steel poles, brackets, trolley wire, insulators, &c., and electric tramcars. Tenders to town clerk by noon 27th inst.

*Stockton-on-Tees* Electric Light committee invite tenders for an additional 300kw. steam dynamo. Tenders to town clerk by 11 a.m. 26th inst.

*Wigan* Corporation invite tenders for (1) cables, (2) trolley line, (3) steel poles, (4) castings. Tenders to borough electrical and tramway engineer (Mr. H. Collings Bishop) by March 27.

*Farnworth* District Council invite tenders for supply of electricity meters. Tenders to clerk, Council Offices, Farnworth, R.S.O., by 29th inst.

*Partick* Corporation require tenders for steam, feed, exhaust, and drain pipes, feed pump water storage tank, feed water heater, and sundry ironwork. Tenders to town clerk, 97, West Regent-street, Glasgow, by April 9.

*Leith* Corporation invite tenders for a 350kw. steam dynamo Specification from burgh electrical engineer (Mr. J. Gray Scott).

*Wallasey* District Council invite tenders for tramway points and crossings. Tenders to clerk, Public Offices, Egremont, by 26th inst.

*Norwegian* State Telegraph Department (Christiania) invite tenders until April 6 for the supply of telegraph wire, bronze wire and telephone cables; also until March 30 for porcelain insulators, iron angles, brackets, top coverings, top plates and telephones.

*Palencia* (Spain) municipal council require tenders for the erection and working of a telephone exchange. Tenders by April 21.

## TENDERS RECEIVED AND ACCEPTED.

Burnley Corporation have received the following tenders for a traction switchboard :—

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S. Z. de Ferranti (Ltd.) (*accepted*) | £1,040 | 0 | 0 | Brook, Hirst & Co. | £898 | 0 | 0 |
| Walsall Elec. Co. | 1,657 | 0 | 0 | E. F. Moy (Ltd.) | 894 | 0 | 0 |
| S. H. Heywood | 1,140 | 0 | 0 | Do. | 844 | 0 | 0 |
| Brush Co. | 1,123 | 0 | 0 | Veritys Limited | 892 | 0 | 0 |
| Do. | 1,120 | 0 | 0 | Simpson Bros. | 886 | 15 | 0 |
| Brit. Westinghouse Co. | 1,055 | 0 | 0 | Williamson and Joseph | 875 | 0 | 0 |
| Do. | 955 | 0 | 0 | R. W. Blackwell & Co. | 871 | 10 | 0 |
| Siemens Bros. & Co. | 1,023 | 0 | 0 | Dorman and Smith | 862 | 0 | 0 |
| Do. | 1,013 | 0 | 0 | Bertram Thomas | 759 | 0 | 0 |
| General Electric Co. | 967 | 0 | 0 | Crompton & Co. | 750 | 0 | 0 |
| John Fowler & Co. | 919 | 0 | 0 | Do. | 739 | 10 | 0 |
| Kelvin & James White | 910 | 18 | 6 | Cowans Limited | 740 | 0 | 0 |

Bradford Corporation have accepted the tender of the Leeds Steel Works for the supply of steel girder rails and fishplates required for relaying the Manchester-road tramway at £7. 5s. and £8. 15s. per ton respectively. The following tenders have been accepted for works required at the Valley-road electricity station :—Messrs. Thomas Obank & Sons (excavators', masons', and bricklayers' work), £14,549; Roberts & Co. (smith and ironfounders' work), £5,295; Wilkinson and Dawson (joiners' and carpenters' work), £898; Hill and Nelson (slaters' work), £150; R. Townend (plumbers' and glaziers' work), £829; Bradley, Krischke & Co. (plasterers' work), £44. 13s.; and T. H. Hewitt (painters' work), £171. 17s.

Middleton Corporation have received tenders for the supply of a traction switchboard from the Brush Company, Cowans Limited, Crompton & Co., General Electric Co., Mechan & Son, Bertram Thomas, John Fowler & Co., W. J. Fryer & Co., Walsall Electrical Co., Robert W. Blackwell & Co., and Dorman and Smith.

Walsall Council have accepted the tender of Messrs. Tangyes (Ltd.) for an 8-ton travelling crane for the electricity works at £840.

Great Yarmouth Corporation have accepted the tender of Babcock and Wilcox for the supply of two boosters at £1,810.

Croydon Corporation have accepted the tender of Messrs. E. Danks & Co. for two water-tube boilers, at £1,630.

Wigan Corporation have placed an order with the General Electric Co. for an additional steam dynamo on the same terms as the last unit supplied.

Llandudno District Council have accepted the tender of the National Electric Wiring Co. for the wiring of the Town Hall at £482.

Aberdeen Gas and Electric Light committee have accepted the tender of Messrs. Gall and Walker for the erection of a chimney stalk at the Dee village electricity works at £2,897.

Dundee Corporation have accepted the tender of Messrs. Doulton & Co. for underground electric conduits at £1,823. 5s. The tender covers all deliveries during 1901.

British Electric Traction Co. have placed an order with Messrs. Frank Suter & Co. for two 440kw. "Helios" tramway generators for the Maybank power station of the Potteries Electric Traction Co.

Islington (London) Borough Council have accepted the tender of Messrs. John Grover & Sons, for water tower, tanks, &c., at the Elengrove electricity works at £5,782.

A 1,000 H.P. steam dynamo for the extension of the electricity generating station at Brussels is on order from Compagnie Internationale d'Electricité, Liége.

## BUSINESS NOTICES.

Mr. A. H. Hunt, who has been for the past 12 years with the Edison and Swan Co. has severed his connection with that firm. We learn that Mr. Hunt was for three of four years in the incandescent lamp manufactory at Ponder's End, and for the last eight years has had control (under the general manager) of the estimating, buying, pricing, catalogue and advertising departments in London. For some years previous to his association with the Edison and Swan Co. Mr. Hunt was connected with the electrical industry. He has now taken offices and warehouse at 59, Gresham-street, London, E.C., and will shortly open a showroom for electric light fittings at that address for supply to the trade only. Mr. Hunt's retirement from the Edison and Swan Co. to start on his own account is a perfectly friendly arrangement, and we wish him every success in his venture.

The firm of Woods & Co., electric light engineers and manufacturers, 2, Gray's Inn-road, London, has been changed to Marshall and Woods.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of the Macroom Electric Lighting Syndicate (Ltd.) will be held at the Conservative Club, Higher Ardwick, Manchester, on April 16, to receive an account of the winding-up.

A meeting of the Phæton Electrical Co. (Ltd.) will be held at 6A, Austin Friars, London, E.C., on April 23, to receive an account of the winding-up.

A receiving order has been made against A. I. Greenberg (trading as Midland Electrical Co.), 30, Arthur-road, Erdington, and 20, Caroline-street, St. Paul's, Birmingham.

Claims against Geo. Stegmann, electrical engineer, 46, St. John's-hill, Clapham Junction, London, S.W., who has executed a deed of assignment, must be in by April 2. Mr. F. W. Davis, 95, Finsbury-pavement, London, E.C., is trustee.

---

**Sale by Auction.**—Messrs. Percy Huddleston & Co. have been instructed by the receiver for the debenture holders in Messrs. Sax, Slatter & Co., Ltd. (in liquidation) to sell by public auction at the Foresters' Hall, Clerkenwell-road, London, E.C., on Thursday and Friday, March 28 and 29, at 10 for 11 a.m. precisely, a stock of electric supply stores, some particulars of which are set out in an advertisement. Catalogues from the auctioneers, 72, Finsbury-pavement, London, E.C., and on the premises, of Mr. A. A. Yeatman, C.A., Gresham-buildings, Basinghall-street, London, E.C., and Messrs. Ellis, Munday and Clarke, solicitors, 23, College-hill, London, E.C.

**For Sale.**—An advertisement contains particulars of a 47 B.H.P. Crossley gas engine and an E.C.C. shunt-wound dynamo for sale. Applications to Messrs. Shepherd and Watney, consulting engineers, Greek-street Chambers, Leeds.

**Agents Wanted.**—A leading British manufacturing firm making cables and wires, arc lamps, meters, instruments, &c., wish to appoint selling agents in important industrial centres. See advertisement.

**Catalogues, &c.**—By a trade list dated March, 1901, issued by the London Electric Wire Co., Playhouse Yard, London, E.C.,

all former price lists are cancelled. The new list contains a number of useful tables of sizes, weights, resistances and working currents of copper wires and cables. Prices are given of a large variety of cables, flexibles, instruments and line wires, fusible wires and brushes, telephone cords, and sundries, and special tables are devoted to particulars and prices of Martino's platinoid wires, for which the London Electric Wire Co. are exclusive agents, and of "Eureka" wire, an alloy manufactured by the company especially to give high resistance with a temperature co-efficient practically nil. The list is very complete and compact.

Messrs. John Spencer, Globe Tube Works, Wednesbury, Staffs., have just issued a revised trade list of tubes and fittings. By an error, we presume, the list is dated July 15, 1899.

**"Excelsior" Enamelled Steel Conduit Tubes.**—The New Brotherton Tube Co. (Ltd.), Commercial-road, Wolverhampton, in sending their new list of "Excelsior" enamelled steel conduit and fittings, advise us that, for the convenience of their London and South Coast customers an office has been opened at 66, Victoria-street, Westminster, London S.W., where large stocks will be kept. The specialities of the firm include conduit and fittings, of which the new list gives particulars and illustrations.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 13 to March 19, with the ports of destination:—

*Africa*—Durban, £551; Port Said, £26. *Argentina*—Buenos Ayres, £204 (including £120 telegraph cable). *Australasia*—Adelaide, £27,544 (including £27,518 telegraph material); Auckland, £60; Melbourne, £259; Perth, £180; Port Chalmers, £126; Rockhampton, £54; Sydney, £1,654 (including £149 telegraph cable). *Brazil*—Pernambuco, £15,500 (telegraph cable). *British Guiana*—Demerara, £398 (including £82 telegraph material). *Ceylon*—Colombo, £60. *China*—Shanghai, £249. *Denmark*—Copenhagen, £51 (telegraph wire). *Germany*—Cologne, £1,102 (telegraph cable). *Gibraltar*, £1,750 (telegraph cable). *Holland*—Amsterdam, £76. *Hong Kong*, £1,000. *India*—Calcutta, £1,823; Madras, £135. *Japan*—Nagasaki, £747; Yokohama, £180. *Malta*, £1,760 (including £1,750 telegraph cable). *Russia*—St. Petersburg, £34 (telegraph material). *Spain*—Huelva, £680. *Straits Settlements*—Penang, £115; Singapore, £618 (including £346 telegraph material). *Zanzibar*, £107. Total, £57,048, against £52,666 in the corresponding week last year (March 14 to 20).

## COMPANIES' MEETINGS AND REPORTS.

### City of London Electric Lighting Co. (Ltd.)

The ordinary general meeting of this company was held yesterday, Sir David L. SALOMONS, Bart., presiding.

The MANAGER and SECRETARY (Mr. J. Cecil Bull) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN said: The main point which calls for remark in the report is the table of figures given on page 7 under "Average price per unit obtained." You will observe that the average price for 1900 has been lower than in any previous year, being 4·09d. per unit. This figure, combined with two other circumstances, has rendered it impossible to pay a dividend to the ordinary shareholders. The other two circumstances are the price of coal and the working cost. The increase in the gross revenue for 1900 was £35,031, but the increased expenses amounted to £39,830, made up as follows: £34,100 for coal, £3,000 for wages and other details, £1,100 for rates and taxes and £1,630 for various other items. Consequently, although the business of the company had enormously increased, there was an actual loss in the net revenue as compared with 1899 of £4,799. The amount of coal used last year exceeded 75,000 tons, at an average price of £1. 0s. 9d. per ton. In 1899 the average price was 14s. 10d., and it should be borne in mind that a drop of 5s. per ton is equal to rather more than 23 per cent. on the ordinary shares. That is for the same amount of coal, of course. We asked you to enable the directors to raise further capital, and permission was granted, and it has been duly acted upon. This money has been expended in the most careful manner, and, we believe, I may say we know, that a very large economy has resulted in consequence. Of course that money has been expended comparatively recently, and the advantages from it will come in in this current year. It is well, therefore, to look a little ahead and see what our prospects are for the year ensuing. Coal has begun to fall, and the economies now being effected will considerably reduce the working costs, and with the new tariff a considerable increase in the receipts should ensue; 1d. per unit in working costs, or in any other direction, is equivalent to £50,000 for 12,000,000 units, and our last year's output approached very closely to 12,000,000 units, so that it is not very difficult to calculate, on the shares issued, that that represents about 7 per cent. But you must not accept these figures absolutely as I put them because, in face of competition which is bound to arise very shortly, perhaps in a serious form for all we know, we shall have to strengthen the funds of this company, and, providing the shareholders get a proper amount of the profits which we trust will come in, a portion will have to be set aside for contingencies in the future so as to make us a strong concern. I should like once more to refresh your memory respecting the contracts made between this company and the City of London. No question was raised about the validity of the contracts until many years after they had been made, and when prosperity had followed our footsteps. Then certain members of the Corporation started the hare and tried to declare that the contracts were invalid. I would point out, to show how unjust their action was, that only three gentlemen, I believe, held shares of a most nominal sum. One, I think it was shown, had purchased 200 shares before the contract was made and took them up afterwards, another had purchased 100 shares, and another 50. The shares were, I think, at that time £3 nominal, and not at any premium at all. (A voice: In the Brush?) I think in the Brush Company, so that because three of their own members had held 350 shares, worth under £1,000, they tried to upset these large contracts in a great wealthy city like this. (Shame!) They sought to declare them invalid, as you know, and thought to take advantage of their own wrong, which, according to the first principle of English law, no British subject can do, but there happens to be a certain act or acts which abrogate this national piece of justice in favour of the Corporation of the City of London. I will not attempt to criticise the action of the City authorities, as probably if I did so I should be using language which I might regret hereafter. We applied to the Courts to declare our contracts with the City Corporation valid, as it was simply impossible that two parties, ourselves and the City authorities, could go on working when one side was declaring that our contracts were valid and the other side declaring that they were waste paper. In the Courts, in the first instance, Mr. Justice Farwell took what we considered the right point of view, and declared for us all along the line. Naturally the City, having once been made defendants, and finding the case against them, were bound to appeal. In the Court of Appeal the decision, as is probably known, divided the honours between us. We gained the eastern part of the City, which is rather more, or about equal, to the whole of the City, and therefore they cannot under any circumstances enter into competition with us there, either by buying up the Charing Cross Company or by obtaining an order for themselves. In the circumstances, and after taking proper advice, the board have decided up to the present not to appeal against this last decision. We do not know yet what the City will do, whether they will appeal or not. But this decision complicates matters very much in regard to public lighting. We had a contract with the City of London for the public lighting at so much per lamp. Owing to the recent decision, there is now no contract in existence with regard to the western and central districts, though in the eastern district the contract stands good. At the present time we are in communication with the City authorities, and we hope that some arrangement which will be satisfactory to all parties interested in regard to the lighting of the western and central districts will be come to. There is one point which may arise in your minds and cause some alarm. It is that you may think that in consequence of the recent decision we have lost the right to supply current in the western and central districts of the City. Therefore, I ought to tell you that our provisional order is in no way touched by what has happened in the Law Courts. We shall be in the City in the same way as the other electric lighting companies are in their respective districts—the electric lighting companies that have made no contracts with the local authorities. The general business of this company is not touched. It is simply a question of public lighting and similar questions which are not vital from any great point of view. But it is important to this extent: If we are not to have the City competing with us, with the ratepayers' money, it is important that we should have a contract binding in some portion of the City, if possible, and as far as matters go we have that now for the eastern part of the City, and I believe in the event of appeal and we lost, and we must consider that as a possibility because the law is very funny, I do not believe Parliament would be so unjust, after what has happened, as to permit the City of London to compete with this company when it had placed before it the fact that the Corporation had broken their contracts because three of their body held a few pounds' worth of shares in it, or, rather, in connection with the company which preceded this one, because the contracts were transferred to this company by another. From my own point of view, the worst enemy the shareholders of this company have had to encounter all through the piece is that the public placed complete confidence in the honesty and integrity of the City of London, and it is only natural that the shares of the City of London Company should have been regarded as a first-class holding. I have now told you, in an unvarnished way, why no dividend is payable on the ordinary shares for 1900, also what may be the condition of things, and what we hope will be the condition of things, at the end of this year; and also the complicated position with the City authorities, brought about by the decision of the Courts respecting our contracts. On the rating question, I consider we have been dealt with in a very unfair manner. In Southwark, where our rating ought to be the heaviest, as it is, in the year 1895 we were assessed at £6,348, in 1896 at £8,000, in the following year it was raised to £11,092, and for the past year to £18,225. When you remember that something like 6s. or 7s. in the pound has to be paid on that assessment you will see that it means a considerable item to the company when their coffers are not too well filled with coin. We have appealed against this increase. The additional machinery which has been placed in our works is for the production of continuous current, which simplifies the working to a great extent, and is also very efficient. A considerable sum has been expended on cables for extending our net-work, and upon feeders to equalise the pressure throughout the City. At the present time, perhaps, within a few thousand our number of lamps applied for may be taken as the equivalent of 540,000 8 c.p. lamps. The directors deeply sympathise with you, and are also sorry on their own account. We have a large stake in the undertaking. I now move the adoption of the report and accounts.

Col. MARTINDALE, C.B., in seconding the resolution, said that he considered the outlook for the present year to be more favourable than the results of last year's working would seem to indicate.

Mr. HICKS asked why the board had come to the conclusion not to go to the House of Lords with the company's case?

Mr. FITCH enquired who was responsible for the reduction of the rate charged per unit by which the company had lost about £50,000. The shareholders could have had a dividend of 8 per cent. if that had not happened.

Mr. YOUNG said the present position of affairs was really due to the shameful action of the Corporation against this company. The Corporation had broken contracts that were solemnly made, and had set an example, not only to other corporations, but to the whole business community, which, he thought, ought not to be passed over without comment. The corporations were very glad, when electric lighting undertaking meant a risk, for the company to come forward and do the work, and so long as moderate profits were being earned nothing was said about the contracts, but so soon as the company became prosperous the Corporation swooped down on them. If he were to sell his holding in this company to-day he should lose £1,000 in hard cash, and he got no dividend on his investment this year. This was not because the company had been mismanaged, but because the Corporation had broken the solemn pledges on the faith of which he, for one, put his money into the concern.

Mr. JACKSON asked if the expenses in connection with the litigation were paid.

Mr. BAILEY would suggest as a way out of the difficulty that the Corporation should reconsider the position. He thought that the least that they could do was to enter into fresh contracts with the company on similar lines to the old ones, and so afford the company an opportunity of earning that which they were entitled to.

Mr. CANDLER asked for an explanation of the following paragraph in the report, which he considered somewhat obscure, namely, "your directors in view of these circumstances have made a modification in the tariff, which it is believed will result in a substantial increase in the revenue."

Mr. MARTIN, referring to the statement that the Corporation had been receiving an advantage in the past equal to £8,000 a year out of the public lighting by the company, asked whether the board proposed to proceed against them for obtaining that money under false pretences?

The CHAIRMAN: I think shareholders have covered pretty well the whole ground with their questions and I will now reply to them to the best of my ability. Mr. Hicks has asked why we do not appeal. We are advised it is not desirable to do so, after reading what the judges had said in their judgment. We have 12 months before us in which we can do so—12 months, that is, from the date of the judgment. If the Corporation cannot come to any reasonable terms with us it may be necessary to appeal, but up to the present it is thought desirable that we should not do so. In the Court of Appeal there were three judges who gave a unanimous judgment. We have, therefore, to think twice before we appeal. If we are ultimately misused in such a way that we cannot help ourselves we must then go to the House of Lords, which would cost us between £2,000 and £3,000. With regard to the reduction in the rate of charge per unit of current, after careful discussion we decided to make this reduction. It is one of those cases where you make a move in the hope of doing the best, but it does not always turn out to be so. He agreed that it was a mistake, and the rates had, therefore, been increased at the earliest possible moment to one that he believed would pay the company, and this new rate was now in force. It is more than likely that if the previous rate had been maintained their customers would have handed themselves over to the Charing Cross and Strand Company by contract for long periods, and in this way the City of London Company would have irretrievably suffered. They had, by the course pursued, kept most of their customers. With regard to the cost of the litigation, these had been paid excepting those for the appeal action, which had not yet been rendered to the company. With regard to future arrangements with the City of London Corporation, we have called the Corporation's attention to the present condition of affairs, especially in regard to the public lighting in the western and central districts of the City which, so far as contracts are concerned, have lapsed. We are asking them for new contracts, and the answer so far received is that our communication is receiving attention. With regard to the past, we cannot make any claim against the Corporation on the points raised by Mr. Martin. There may, however, be other grounds upon which such claims may be made. Before concluding I should like to say on behalf of the board that we recognise the loyal service of our secretary and manager, Mr. J. Cecil Bell, of our engineer, Mr. F. Bailey, our second engineer, Mr. Jackson, our accountant, Mr. Foye, and the whole of our staff from the highest to the lowest. The resolution was then carried unanimously.

The resolutions approving the dividends set out in the report were also carried.

The resolutions bringing the Articles of Association into line with the new Companies Act were then submitted and approved.

The retiring directors (Mr. J. B. Braithwaite, Mr. H. S. Leon, and Mr. Edward Lucas) having been re-elected, Mr. J. B. BRAITHWAITE returned thanks for his re-election, and said there was no doubt they had a splendid property, and that the result of the present year's working would be very different from that of the past year. The shareholders should not be frightened by the threatened competition of the Charing Cross and Strand Co. or of any other bodies which were set up to frighten them. The retiring auditors were then re-appointed.

The CHAIRMAN said: I have now to ask your attention to a personal matter. It is absolutely essential that I should have several years rest free from all anxieties and responsibilities as far as possible, and I have, therefore, to announce to you that I am on the eve of resigning the position which you have honoured me with for so many years. I should have taken this course at an earlier time but for the rocks and difficulties I saw ahead, but now that the difficulties seem to me upon the point of being overcome, I feel that the time has arrived when I must place my resignation in your hands.

Sir DAVID then entered into a lengthy personal explanation of his views in regard to the future of the company, and gave sincere praise to the manager and secretary and the engineers of the company for their persistent and skilful work in the past to make the company the success which it had unquestionably become. He expressed his views strongly on the advantage of continuous over alternating-current machinery for such a service as the City of London Company was called upon to render, and referred to the fact that all new plant that was being put into the station was for continuous-current working.

On the conclusion of Sir David's remarks, Mr. Jackson moved, and Mr. Tessier seconded, a cordial vote of thanks expressing on behalf of the shareholders their unfeigned regret at the retirement of their chairman.

Sir DAVID SALOMONS having responded, the proceedings terminated.

## Notting Hill Electric Lighting Co. (Ltd.).

The fourteenth ordinary general meeting of this Company was held on Tuesday, under the presidency of Sir WILLIAM CROOKES, F.R.S.

The SECRETARY (Mr. R. G. Rawkins) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, it gives me pleasure again to have the opportunity of presiding at your annual general meeting and presenting the Directors' report and the accounts for the past year. A copy has been sent to each shareholder, so I presume you will take them as read. We all regret that the accounts do not show a corresponding increase in the profits as compared with the previous year. The explanation I will deal with presently. The share capital account has undergone considerable change and has been increased by the addition of £100,000, of which £22,000 were issued to the shareholders, leaving an unissued balance of £78,000. The whole of the preference and founders' shares have been issued and are fully paid. The remaining £19,000 of loan capital has been issued, bringing the total amount of 4 per cent. mortgage debentures up to £50,000. On the expenditure side is seen an increase of £27,639. 9s. 4d., raising the total expenditure from £137,350. 13s. 7d. to £164,990. 2s. 11d., the largest two items being expenditure on new mains and on machinery to meet the increasing demand for current. The cost of the new mains amounted to £12,198, mainly for constructing the three high-tension mains from the joint works at Wood-lane to the distributing stations, one being at the back of the offices, another in Lancaster-road, Notting Hill, and a third to the Addison-road district in readiness for the distributing station to be erected in that neighbourhood. Numerous other small extensions also have been made to connect up further consumers. Additional expenditure on fixed machinery, amounting to £8,282, represents the cost of the motor generators and accessories used in the distributing stations, these being required to enable us to utilise the current generated at the Wood-lane works. The sum of £6,514 spent on land and buildings is represented by the site and buildings at Lancaster-road and the new building at the rear of this office. The receipts side of this account shows that during the year £41,000 additional capital was received, bringing the total up to £172,000, or £7,009. 17s. 1d. in excess of the capital expenditure. But we had £18,250 in hand unspent, and this sum I expect will be required during the present year for completing the equipment of the distributing stations and the purchase of a site for one in the Addison-road district. Our profit amounts to £9,856, and, comparing this with last year's profit, a reduction is seen of £504. This is more than accounted for by two items—the extra cost of coal and the cost of renewing the accumulators. But for these the profit would really have shown an increase of about 10 per cent. With regard to the price of coal, this remains high, but we may now look forward to some reduction. With regard to the £1,200 spent on accumulators, we do not anticipate a repetition of this expenditure for a long time, representing, as it does, the renewal of about half the cells. The only other item I need refer to in this account is the sum of £111. 10s. 9d. for electricity supplied from the Wood-lane works. This represents cost of the current received from the joint works, and no doubt, in future years, this item will increase largely, as now we receive a considerable quantity of current from Wood-lane, and, sooner or later, we expect to obtain our main supply from that source. The net revenue shows a balance of £7,444. 14s. 8d., after deducting depreciation and interest on debentures and new ordinary shares, &c. The depreciation and renewal account has been raised from £6,000 to £11,000 by the addition of the premiums received on the issue of the new shares and debentures, and by setting aside out of the profits £742. 2s. 5d. Another large reserve fund is being created year by year in the shape of the Wood-lane joint works, as in accordance with the trust deed securing the stock issued to provide capital for these works, a certain sum, at present £2,000, has to be invested each year as a sinking fund, so that in the year 1931, when the local authority has the option to purchase, the joint station will revert to the two companies free of cost, and will be divided according to the amount contributed by each company to the sinking fund. The balance-sheet shows that the cash on deposit at the Company's bankers at the end of the year amounted to £18,250, and most of this will be required to pay contractors for completing the buildings and equipment of the distributing stations, and the necessary additions to the mains required for the current supplied from the joint works at Wood-lane. It is rather a matter of conjecture what amount of capital we must spend this year, as it depends to a large extent on when we are able to obtain a site for the distributing station in the south-west portion of our area of supply. I may perhaps, here refer to a serious difficulty the Company has had to contend with—viz., the overloading of the present mains and the inability of the plant and machinery adequately to meet the demand for current during the winter months. To this is due the fact that during some of the dark days of winter we had complaints as to inadequacy of pressure. This was due to our being compelled, almost against our will, to take new customers when in reality we were only able properly to supply those to whom we were already bound. The result was that our machinery was overworked,

and some of it was put temporarily out of gear, but as far as our customers were concerned all they suffered from was an occasional dimness of light. We are able now to send out a considerable quantity of current from Wood-lane, but unfortunately it will not be available in the Addison-road district until we can erect machinery to distribute it in the area. We are therefore in the unsatisfactory position of having to refuse further customers in that locality until we can fix a date for the erection of the distributing station. To supply the northern part of the district in Notting Hill a distributing station has been erected and will soon be in operation in Lancaster road; it is now being equipped with the machinery necessary to utilise the current received from the Wood-lane works. The other distributing station in the rear of these offices has been working satisfactorily for some time. The engineer advises that these arrangements, as soon as they are complete, will enable us to resume connecting new customers in all parts of our area of supply, and very largely to increase our business, and from the number of applications already received it is evident that much business awaits us. It only now remains for me to refer to the manner in which we recommend you to divide the profit of £7,444. 14s. 6d. For the information of new shareholders I may explain that after payment of 6 per cent. on the preference and ordinary shares the balance remaining is divisible, in accordance with our articles of association, into two moieties, one being credited to the founders' shares, and the other to the preference and ordinary shares pro rata. The amount thus standing to the credit of the founders' shares, including the undivided amount of £19. 14s. 9d. brought forward from the previous year, is £907. 2s. 1d., which will allow a distribution of £1. 12s. per share. The total profit available for distribution on the preference and ordinary shares is £6,622. 2s. 1d., and out of this we recommend you to pay a dividend of 7 per cent. for the year on both these classes of shares. In addition to these dividends the fact should not be overlooked that the shareholders received a bonus last year by the issue of the new ordinary shares, which were allotted pro rata at a premium of £2 per share, while many of them have changed hands since at a premium exceeding £5 per share. I now move the adoption of the report and accounts.

Mr. J. W. SWAN seconded the resolution, which was carried.

The retiring directors, Mr. J. W. Swan, and Mr. A. Howden were unanimously re-elected, as were the retiring auditors.

A hearty vote of thanks to the Chairman, Directors, Secretary, Engineer and other officials of the Company was then moved and the proceedings terminated.

## Potteries Electric Traction Co (Ltd.).

The third ordinary general meeting of this company was held on Tuesday, under the presidency of Mr. Emile Garcke.

The SECRETARY (Mr. B. Kingsford) having read the notice convening the meeting,

The CHAIRMAN said: I trust the statement I shall make of the progress achieved during the past year will be as satisfactory to you as it is to the board. I move the adoption of the report and accounts, and in doing so will say a few words in explanation. You will observe that the accounts this year are presented in a very much more simple form than last year, when I explained to you that owing to a large section of the company's system being worked by the North Staffordshire Tramways Co., we were obliged to keep the accounts distinct, but you, on that occasion, sanctioned an agreement between the Potteries Electric Traction Co and the North Staffordshire Company which has enabled the accounts to be presented in the present much simpler form. The agreement with the North Staffordshire Company was that we should guarantee the interest on their debentures and a fixed dividend on their shares in consideration of our taking over the whole of the working of their system, we receiving the whole of the traffic receipts and paying the expenses. The profit and loss account, therefore, shows on the debit side a sum of £11,425, the amount we have paid the North Staffordshire Company for fixed debenture charges and fixed dividend on their shares; and on the other side there is £9,799, the proportion we have received on the debentures and shares which we hold in that company. The progress we have made during the past year is very much greater than is, perhaps, apparent from the net results shown in the profit and loss accounts, and it is somewhat unfortunate that I am not able, by reason of the different way in which the accounts are presented, to make a correct and complete comparison between the accounts of this and last year. Nevertheless, I can give a few figures to show what a great work this company is carrying on, and how great are the potentialities for improvement I think we may fairly look for. Only five years ago the total passengers carried by the North Staffordshire Company were a little over 3,000,000, and we carried last year nearly 10,000,000. The total receipts of the North Staffordshire Company five years ago were £18,600 odd, while ours for last year were over £54,000. There have also been a combination of circumstances during the past year which have had an adverse effect on the net results—the high price of fuel alone has made a difference of something like £1,000, and the rate of wages in the district has been rather high. The wages item cannot be reduced, but there are one or two other items which we think it should be possible to reduce somewhat. A strike of potters and bricklayers in the district has reduced receipts, and we suffered a loss of business due to delay in opening the Chesterton and Silverdale route and the exceptional charges of the year, all of which, brought into debit of our profit and loss accounts, make our net result smaller than would otherwise have been the case. The net profit is £13,139, and, adding £866 brought forward, we have a balance of £14,705 to deal with. The 5 per cent. cumulative preferential dividend amounts to £10,000, a dividend at the rate of 2 per cent. for the year on the ordinary shares takes £4,000, depreciation takes £500, leaving £205 to be carried forward. The amount placed to depreciation fund is, I think, ample, having regard to the fact that the line and the whole of the rolling stock and power-house are kept in first-class condition and in a high state of efficiency out of revenue. The board think, and hope the shareholders concur, that it is better the line should be maintained in the fullest state of efficiency out of revenue, and that the surplus, after paying a reasonable dividend, should be applied to building up a strong reserve to protect us against the risk of expiring tenure, and, possibly, in years to come, the replacement of either the permanent way or some of the plant. I would here emphasise the fact that the £54,000 which we have from traffic receipts on this occasion has been in respect of only a small portion of the total system which the company is now operating. At the present time we are running 28½ miles of line in the Potteries, and when the Blythe Bridge piece is completed, we shall be running over 30 miles. On the profit and loss account it is not necessary for me to say anything further. Turning to the balance-sheet, during the past year we have issued £125,000 4½ per cent. debenture stock. The subscriptions did not come up to our expectations, so that it was necessary to withdraw the first issue and to make a second issue under improved conditions. The British Electric Traction Co. saw their way to assist us in the matter, and agreed to guarantee the principal, interest and the premiums on these debentures, and with that very improved guarantee of course we were able to establish a really gilt-edged security, and there was no difficulty then in raising the £125,000. The British Electric Traction Co. from this and other sources obtained the option to take up the remaining £75,000 of debenture stock at par at any time before April 27 this year, an arrangement distinctly favourable to our shareholders. Now, as to new developments. First I should like to speak of the proposed extensions of a line for which we have applied for a light railway order. These proposed extensions include two lines between Stoke and Newcastle, and similar lines between Newcastle and Trent Vale, and then at Hanley, lines going from Hanley to Sneyd Green, and from Hanley to Bucknall, and at Longton two short lines. The lines at Blythe Bridge are already authorised under our original order, and we are now constructing them. All the other lines applied for under the order are light railways, which we are now promoting under the Light Railways Act. You will see by a glance at the map accompanying the report how desirable it is that these extensions should be granted, and how very important will be the effect on the net result of the working if we get these intercommunications effected. Then we have been in negotiation with some of the local authorities for the transfer of their electric lighting orders. Most local authorities acquire these orders and then consider what they shall do with them, and many of them find it difficult to do anything whatever with the order because their districts are not sufficiently populous or are not of a character justifying the installation of electric light, and we have felt, therefore, that we might, in conjunction with our power station for the tramways, enable these local authorities to obtain the electric light on a basis which they could not themselves afford to adopt, and I think we can do them good service and be able to make an additional profit for the shareholders by taking over these lighting orders. Then a more important development, and one to which I am anxious to obtain your approval, is the establishment of a service for the carrying of parcels and goods in small bulk throughout the Potteries district. At present there is not a thoroughly satisfactory system in operation for handling the parcels traffic expeditiously, and it has occurred to us that we can, by means of our service, arrange for the collection and delivery of parcels throughout the district on terms which will compete with existing carriers.

Sir JOSEPH SAVORY asked for particulars as to the administration expenses, and the amount in dispute with the contractors.

Mr. CROFT asked if further information could not be published with regard to the traffics.

The CHAIRMAN, in reply, said: With regard to administration expenses which appeared in the accounts at £4,767, these items were: Rates, £1,209; insurance, £645; directors fees, £500; head office and legal expenses, £970; sundry rents, £325; printing, stationery, &c., £280; travelling expenses, £270; sundry expenses, £141, and so on. That made up the total to within a few hundred pounds. The amount in dispute with the contractors is between £5,000 and £6,000.

The motion for the adoption of the report and accounts was then carried unanimously.

A resolution increasing the capital of the company from £400,000 to £600,000 by the creation of 20,000 new £10 shares was then approved.

Mr. C. Drummond and Mr. J. V. Kitchener, the retiring directors, were re-elected, as were the retiring auditors.

Resolutions amending the articles of association in accordance with the provisions of the new Companies Act, were then approved by the extraordinary general meeting which followed, and a cordial vote of thanks to the chairman, directors, and staff brought the proceedings to a close.

## South London Electric Supply Corporation, Ltd.

The directors of this company report for the year 1900, that on Dec. 31, 1899, the company were supplying current to the equivalent of 26,625 lamps of 8 c.p. On the same day in 1900 this number had increased to 43,322. At 19th March there were on circuit the equivalent of 45,432 lamps of 8 c.p., and applications have been received for a further 2,890 lamps, with a consequent large increase in revenue. The company has now reached a profit-earning stage.

The length of roadway in which mains have been laid is now 41 miles, equal to 48 miles of high tension and 38 miles low tension ways, in which 32½ miles of the former and 33 miles of the latter class of cable have been laid, not including service connections. The erection of the remaining plant provided for under the various contracts has satisfactorily progressed during the year. At the end of October last the dust destructor had to be shut down, in consequence of proceedings taken by the Lambeth Vestry for alleged effluvia from the chimney.

## Direct Spanish Telegraph Co. (Ltd.).

The directors' report for the year to Dec. 31 last, states that, after providing for interest on and redemption of debentures, there is a credit balance of £10,817. 18s. 9d. After adding the usual £5,000 to reserve, the directors recommend the declaration of dividends for the year 1900 of 10 per cent. on the preference and 4 per cent. (free of tax) on the ordinary shares, absorbing £5,448. 11s. 8d. Half this amount was distributed on Oct. 1 last. The balance (£369. 7s. 1d.) is transferred to contingencies account, bringing this up to £566. 2s. 6d. The traffic receipts show an increase of £1,029. 8s. 4d., and the ordinary working expenses a decrease of £210. 4s. 9d. compared with the year 1899.

On Nov. 17 the Falmouth-Bilbao cable broke about 70 miles from the Spanish landing. The Eastern Telegraph Co. s.s. "Amber" was engaged to effect the repair, but owing to the exceptionally bad weather in the Bay of Biscay, was only able to complete the work on Dec. 18, the cost being £6,975. 13s. 3d., which has been taken from the reserve. The Bilbao cable again broke down quite close to the Spanish coast on Dec. 27, having been severed by a ship's anchor. This repair was effected on Jan. 23, and the cable has worked well since. On Jan. 6 the Barcelona-Marseilles cable was found to be broken, and owing to a continuance of very bad weather in the Mediterranean, it had not been possible to repair it up to the date of the report (March 15). The considerable expenditure occasioned by these breaks amply justifies the board in not distributing more than a 4 per cent. dividend on the ordinary shares, and in building up a reserve fund.

It was found necessary to re-lay and deviate a considerable portion of the underground lines connecting the company's Bilbao office with the landing-place of the cable. With the alterations previously made, there are now practically two new underground cables at Bilbao. The cost of this work (£1,539. 14s.) has been taken from reserve.

## Brush Electrical Engineering Co. (Ltd.).

The directors' report for the year ended Dec. 31 states that the profit and loss account shows a gross profit of £61,732. 8s. 9d. After deducting maintenance, general charges, debenture interest and interim preference dividend for half-year to June 30 last, there remains a net profit balance of £24,070. 0s. 8d. The directors recommend the payment of the 6 per cent. preference dividend (taking £5,948. 3s. 6d.), and a dividend at the rate of 5 per cent. per annum on the ordinary shares for the year (taking £9,521. 8s. 9d.), also a bonus to the employés under the profit-sharing scheme, of £2,098. 1s. 7d., and the placing to depreciation reserve of £5,000, carrying forward £1,502. 6s. 10d. Capital expenditure to the extent of £68,067. 2s. 11d. has been incurred during the year.

The extensive additions to the company's works and plant at Loughborough are now virtually complete, and the directors anticipate that the company will reap the benefit of the large expenditure that has been made on capital account in the increased facilities for economical manufacture which the works now afford. Complete electric cars, comprising trucks, motor equipments, controllers and car bodies are now being manufactured at the works, and the directors continue to look forward for a large and increasing business in connection with electric traction.

In order to provide for the expenditure on capital account the directors have decided to offer for subscription 12,500 preference and 20,000 ordinary shares of £2 each.

The offer of the British Electric Traction Co. to issue ordinary shares in exchange for ordinary shares of the Brush Company, on the terms of the agreement of Jan. 3, 1901, has resulted in that company acquiring 15,581 Brush ordinary shares.

## County of London and Brush Provincial Electric Lighting Co. (Ltd.).

The report of the directors for the year ended 31st Dec. states that the capital expenditure on account of the Company's London districts amounted to £174,481. 3s. 4d., making the total in respect of those districts £892,677. 2s. 3d. This expenditure was met in part by the issue, in July last, of a further £100,000 4½ per cent. debenture stock at a premium of £8 per cent. The premium has been placed to reserve for depreciation, repairs and renewals. The balance from last account was £12,594. 2s. 8d., and the balance from revenue, after payment of standing charges, is £27,367. 19s. 7d., making £39,962. 2s. 3d., from which must be deducted debenture interest (£9,606. 14s. 10d.), interim preference dividend (£5,750), and interim ordinary dividend at 4 per cent. per annum for half-year ended June 30 (£7,666. 13s. 4d.); together, £23,023. 8s. 2d., leaving for further distribution £16,938. 14s. 1d. The directors now recommend the payment of the balance preference dividend (less tax), and that a further dividend on the ordinary shares for the half-year to Dec. 31 at the rate of 4 per cent. per annum (less tax), absorbing £13,300, and leaving £3,638. 14s. 1d. to be carried forward.

Notwithstanding the high price of fuel during the greater part of the year, the profits derived from the City-road station have risen from £8,707. 7s. 9d. in 1899 to £17,239. 0s. 3d. in 1900, an increase of 98 per cent., while at the Wandsworth station the profits have risen from £11,136. 10s. in 1899 to £15,624. 8s. 5d. in 1900, an increase of 40 per cent. The equivalent number of 8 c.p. lamps applied for during the year was 102,003, against 58,523 for 1899, and the units sold were 2,990,138, against 1,766,515. As a result of this satisfactory progress, the directors are able to recommend a dividend out of the carnings of the company's London stations without assistance from the further realisation of any of the company's investments. These results reflect great credit upon the chief engineer, the secretary, and the company's staff.

London Stations.—*St. Luke and Clerkenwell, Eastern Holborn, Western Holborn and St. Giles.*—In these districts, the total applications to Dec. 31, including power, represented the equivalent of 143,195 8 c.p. lamps, of which 119,076 were then connected to the mains. The applications for the year represented an increase of 62,272, and the connections an increase of 57,888. At the same date 165 users of motors, aggregating 1,171 H.P. were supplied from the company's mains, an increase of 798 H.P. for the year, and further applications have since been received, raising the total to 214 applications, representing 1,941 H.P. The special plant erected for the generation of continuous current for power will shortly be insufficient, and further machinery has been ordered to meet the rapidly increasing demand. Additional plant for the lighting supply has also been ordered for delivery in time for next winter. The Board of Trde granted a competing order, which was confirmed in the last session of Parliament, to the local authorities in the company's East-end districts, and the directors have lodged the company's claim for compensation, as provided for under the order referred to.

*Wandsworth* (including Putney, Wandsworth, Clapham, Streatham, and Tooting), *Camberwell, and St. George-the-Martyr, Southwark.*—The total applications to Dec. 31 represented the equivalent of 96,607 8 c.p. lamps, of which 90,472 were then connected to the mains. The applications for the year represented an increase of 39,731, and the connections an increase of 35,825. In order to meet the increasing demand in these districts, additional plant has been erected.

Investments in Provincial Companies.—*Bournemouth and Poole Electricity Supply Co. (Ltd.).*—This company continues to make satisfactory progress. A dividend on the ordinary shares at the rate of 6 per cent. for the year ended Dec. 31 (less income tax) has been declared, against 5 per cent. for the previous year.

*The Dover Electricity Supply Co. (Ltd.).*—This company has made good progress. A dividend has been declared on the share capital at the rate of 3½ per cent. per annum, against 3 per cent. for 1899.

*Scottish House-to-House Electricity Co. (Ltd.).*—Satisfactory terms have been arranged for a transfer to this company of the electric lighting order for the adjoining borough of Airdrie, and an agreement has been entered into with the Airdrie Corporation for both public and private lighting. The company has also acquired the interests of the Airdrie and Coatbridge Tramways Co. in the Airdrie and Coatbridge Tramways Act, 1900, and is promoting a provisional order under agreement with the Coatbridge Corporation for the construction of tramways in Coatbridge.

## Bournemouth and Poole Electricity Supply Co. (Ltd.).

The report of the directors for the year ended Dec. 31 last shows that the capital expenditure during the year in respect of the Bournemouth provisional order, 1890, amounted to £26,342. 2s. The issue in March last year of £70,000 4½ per cent. debenture stock was over-subscribed, and the premium received, after deducting expenses, has been carried to reserve. The balance from revenue, with the balance forward, amounted to £12,579. 13s. 2d., from which is deducted interest, depreciation, &c., leaving £8,052. 10s. 5d. to credit of net revenue, against £6,799. 13s. 5d. for 1899. The full year's preference dividend has been paid, and the directors now recommend a dividend on the ordinary shares at the rate of 6 per cent (less tax) for the year, absorbing £7,391. 5s. 9d., leaving £661. 4s. 8d. to be carried forward.

The equivalent of 53,379 8 c.p. lamps were connected to the company's mains in Bournemouth at Dec. 31, an increase of 9,283 lamps for the year, and applications representing a further 1,896 8 c.p. lamps were then awaiting connection.

The construction of the tramways between Bournemouth and Poole is practically completed, and the company will shortly be supplying electric power for the working of the line.

Baker Street and Waterloo Railway Co.—At the meeting on Monday the chairman (Mr. T. J. Hare) explained the position of the company under the agreements with the London and Globe Finance Corporation. On Nov. 4, 1897, the company entered into a contract with the corporation for the construction and equipment of the railways authorised by the acts of 1893 and 1896. The contractors were to pay for all land and compensation, preliminary and construction expenses, &c., in consideration of a lump sum in shares and debentures, payable on engineers' certificates, subject to a 10 per cent. retention up to £50,000. With the approval of the railway company, Messrs. Perry & Co. became sub-contractors. It was one of the terms of the contract of Nov. 4, 1897, that if the corporation should be wound up, and the works in consequence be stopped, or if the engineers should certify that the works had practically stopped for one month, the company should be entitled to take the works out of the contractors' hands and employ others, and that then the contractors should only be entitled to further payments out of any ultimate balance, if any, of the contract price. At the end of last year the company were informed that the corporation were in default with the sub-contractors, and that, unless some arrangement could be come to, the works must be stopped. Since that time the works had been carried on by Messrs. Perry under agreements in pursuance of which the company had paid them the amount of engineers' certificates, less retention, direct. The position now was that the railway company was entitled to enter upon the works and employ Messrs. Perry, or other contractors, direct, in which case the London and Globe Finance Corporation would have a claim only for the difference, if any, between the contract price and the sums already paid, plus the future cost. If, on the other hand, the company was able to show damage by reason of default of the corporation, they were entitled to have such damage estimated, and to prove for the amount of the estimate in the winding-up. The company had ample assets to provide for the completion of the line, and negotiations were in progress for the transfer of the contracts to a strong financial syndicate.

The works on the Waterloo and Baker-street section were in an advanced state, and all the station sites were arranged for. At the south end, and following on the direction of Waterloo Station, they came to the site of the Indigent Blind School. This had recently been purchased by the company for nearly £150,000. That was where the generating station would be. At Waterloo the South-Western Company had been arranged with as regarded communication. The station shafts had been sunk, and from within about 130yd. of this point the western running tunnel had been driven under the river, and up Regent-street a little to the north of Vigo-street. The eastern tunnel had been driven from the staging in the river to the north of Vigo-street, with the exception of a small gap in Cockspur-street and the Haymarket. One of the station tunnels at the interchange station on the Embankment, and both at Trafalgar-square and at Piccadilly-circus, had been constructed, also the station shafts and subways at Piccadilly. At Oxford-circus the site was being cleared and the sinking of one of the shafts was about to be commenced. The station shafts at Baker-street had both been sunk, and the western running tunnel had been driven to the top of Portland-place, while the up tunnel had reached a point in Regent's Park about 600yd. from Baker-street. The works on the section between Baker-street and Paddington had not yet been commenced. The Central London Railway was now earning over £6,000 per week, and carrying over 100,000 passengers a day. The high rate of working expenses on the Central London during the first five months was not to be taken as any criterion of what the rate of working electric railways would be in the future, and their company would have the advantage of profiting by the experience of the Central London. A committee was now inquiring into the cause of the vibration, and there was little doubt that their engineers would be able to obviate this.

**CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)**—The directors' report for 1900 states that the profit for the year amounts to £69,654. 8s. 5d., an increase of £986. 3s. 8d. over last year, to which has to be added £2,083. 6s. 8d. set aside out of last year's profit to meet dividend accrued on preference shares from Oct. 15 to Dec. 31, 1899, making a total of £71,737. 15s. 1d. After paying debenture interest (£12,000), preference dividend (£10,000) and interim dividend on ordinary shares at 5 per cent. per annum to June 30 (£2,104. 14s.), there was a balance of £46,956. 13s. 11d., out of which the directors propose to carry forward £2,083. 6s. 8d. to meet the preference dividend to Dec. 31 last (£6,314. 2s.), to pay a 5 per cent. dividend and a bonus of 5 per cent. (making 10 per cent. for the year on the ordinary shares to Dec. 31, and to carry £38,559. 5s. 3d. to reserve. Terms have been arranged with the Birmingham Corporation and the King's Norton and Northfield District Council for the equipment of the Bristol-road line on the overhead system. The work of reconstruction, commenced on October 1 last, is rapidly approaching completion, and the line is expected to be opened for traffic in a few weeks. A bill is being promoted for extending the Bristol-road line through Selley Oak, for constructing short lines within the city, so as to afford better terminal facilities for the electric cars, for constructing a tramway from the existing line at Small Heath to Hay Mills, &c.

**HOVE ELECTRIC LIGHTING CO. (LTD.)**—The directors' report for 1900 states the company's revenue has suffered through the increased cost of coal, but that the increased consumption of electricity more than compensated for this. At the end of the year 802 houses, representing an equivalent of 52,919 8 c.p. lamps, were connected to the company's mains. The units sold were 539,208. The gross revenue amounted to £13,828, and the net profit to £7,715. 14s. 5d., which with £345. 17s. 9d. from the previous year, makes £8,061. 12s. 2d. After deducting debenture interest and the interim dividend at the rate of 7 per cent., there remains £5,161. 19s. 1d. The balance of the preliminary expenses (£126. 12s. 1d.) has been written off, and £2,250 placed to reserve, a dividend at rate of 9 per cent. per annum for half-year on the share capital, making 8 per cent. for the year, is declared, and £545. 14s. 1d. carried forward. During the year the directors issued 1,000 additional shares at £7. 10s. per share, the premium being added to reserve, which now amounts to £17,037. 17s. The £600 annually set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, has proved insufficient to meet outlay on this account, in consequence chiefly of the renewal of the company's battery of accumulators, and £315. 12s. 5d. has been taken from this reserve account, which now amounts to £945. 14s. 11d. The expenditure on capital account during the year was £6,862. 9s., the total expenditure to Dec. 31 being £100,523. 3s. 9d. The site for a second generating station has been acquired and it is intended to commence erection at an early date.

**OXFORD ELECTRIC CO. (LTD.)**—The annual meeting of this company was recently held at Oxford, when the directors' report, which appeared in our issue of March 8 was adopted. The chairman said that the capital expenditure in 1900 amounted to £6,020. A new E.C.C. Willans set of 225kw. capacity and an Economic boiler by Davey, Paxman & Co. had been put down. The capacity of their station was now equal to supplying 45,000 or 50,000 8 c.p. lamps installed, and at present they had 34,000 8 c.p. lamps connected. There had been an expenditure under the heading of mains of £3,027 for extensions to their system. The cost of coal per unit delivered had risen from 0·63d. to 0·76d. The maintenance charges were, with the exception of the items of mains, generally below those of 1899. This was due principally to the fact that the dynamos, transformers, engines and boilers had cost them less to keep in order. The wages at the distributing stations were slightly lower, but their high-tension mains had given trouble, necessitating a good deal of labour being expended upon them. The net revenue from street lighting was somewhat less by reason of the increased cost of materials especially of carbons. The reduced amount of gross profit had been occasioned by the reduction in the maximum price from 7d. to 6d. per unit. The units sold had been 13 per cent. more than last year. The number of consumers added had been about 80, and the total number of lamps added had been 3,722, against 3,638 in the previous year. The past had been an exceptional year, and they had, he thought, reason to congratulate themselves that, notwithstanding dear coal and reduced prices, they had been able to maintain their dividend.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27⅛d. per oz. (March 21). Consols (2¾ per cent.) 95⅝—95¾ for money, 95⅞—96 for account; 2½ per cent. 95⅞—96 (March 21). Consols Pay Day April 3. Stocks and Shares Continuation Days, Mar. 26 and April 10. Ticket Days, Mar. 27 and April 11; Pay Days, March 28 and April 12; Mining Share Carry-over Days, Mar. 25 and April 9.

**ARON ELECTRICITY METER (LTD.)**—The transfer books of the preference shares are closed from 25th to 30th inclusive, for the preparation of dividend warrants.

**BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)**—A meeting will be held on 25th inst. to authorise the raising of further capital for the purchase of additional rolling stock and generating plant.

**"ELECTRICAL UNDERTAKINGS."**—This is the title of a new fortnightly financial journal issued by the Manual of Electrical Undertakings (Ltd.), of which Messrs. Emile Garcke and W. L. Madgen are the directors. The price of the new journal is 1d.

**W. T. GLOVER & CO. (LTD.).**—The preference and ordinary share transfer books are closed from 18th to 30th inst. inclusive.

**IMPERIAL TRAMWAYS CO. (LTD.)**—The report of the directors of this company deals with the finances of the Middlesbrough, Stockton and Thornaby electric tramways. The gross receipts of these lines for the year 1900 amounted to £47,218. 17s. 9d., and the number of passengers carried to 8,782,970, compared with £45,372. 13s. 8d. and 8,307,322 respectively in the preceding year. The net profit for the year amounts to £14,637. 10s. 9d., slightly in excess of the previous year, and representing a return of about 6 per cent. upon the capital employed. The extension of the Middlesbrough line to Clarence Ferry is in course of construction, and this branch will be opened in time for the summer traffic.

**MERSEY RAILWAY CO.**—The directors' report for half-year ended Dec. 31 states that the arrangements for working the railway by electricity are under consideration.

**NATIONAL ELECTRIC WIRING CO. (LTD.)**—A dividend of 4 per cent. for 1900 is recommended.

**NEWMARKET ELECTRIC LIGHT CO. (LTD.)**—At a recent meeting of this company the directors' report, which stated that steady progress had been made during the year, was adopted. The equivalent of over 2,000 8 c.p. lamps had been connected. The profit on the year's working, added to £47. 8s. 9d. from last account, amounted to £581. 14s. 2d., which, after providing for debenture interest (£375. 19s.), left £205. 15s. 2d. to be carried forward. At present there were connected to the mains the equivalent of 7,431 8 c.p. lamps, representing 101 consumers, and applications had been received for a further 1,415 lamps. They were putting down plant for the supply of 6,000 additional lamps.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Mar. 16 | 577 | + 60 | 41 | 27,556 | + 3,518 |
| *Birmingham Tramways. | „ 16 | 4,169 | + 94 | 10 | 40,401 | + 594 |
| *Blackburn Corporation.. | „ 15 | 446 | + 25 | 11 | 4,255 | + 3,850 |
| Blackpool Corporation... | „ 14 | 242 | + 73 | 50 | 30,162 | + 7,946 |
| Blackpool and Fleetwood | „ 16 | 180 | - 32 | 11 | 1,574 | - 110 |
| Bolton Corporation ...... | „ 17 | 1,271 | ... | 50 | 68,139 | ... |
| Bradford Corporation... | „ 17 | 826 | + 456 | 50 | 31,027 | +11,936 |
| Brisbane Trams ......... | Jan. 30 | 1,918 | + 174 | 4 | 8,739 | + 1,695 |
| *Bristol Trams & Carriage | Mar. 15 | 3,542 | +1,123 | 11 | 39,703 | +11,083 |
| *Buenos Ayres & Belgrano | Feb. 17 | 2,669 | + 255 | 7 | 19,127 | + 2,555 |
| Carlisle Trams. Co. ... | Mar. 16 | 124 | ... | 11 | 1,220 | ... |
| Central London Railway | „ 16 | 6,157 | ... | 11 | 66,819 | ... |
| City & South London Ry. | „ 17 | 2,021 | + 569 | 11 | 22,151 | + 8,927 |
| Cork Elec. Trams ........ | „ 14 | 357 | + 41 | 10 | 3,557 | + 377 |
| Dover Corporation ...... | „ 16 | 156 | + 21 | 50 | 10,472 | + 687 |
| Dublin & Lucan Rly. ... | „ 16 | 72 | - 18 | 11 | 774 | - 144 |
| Dublin United ............ | „ 15 | 3,169 | + 175 | 11 | 24,295 | + 3,236 |
| Dublin Southern Dist.... | „ 15 | 711 | + 41 | 11 | 7,787 | |
| *Dundee Corporation ... | „ 13 | 569 | + 219 | ... | ... | ... |
| *Glasgow Corporation ... | „ 16 | 8,501 | + 144 | 11 | 91,944 | + 2,537 |
| Halifax Corporation...... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | Mar 16 | 714 | + 132 | 50 | 34,462 | + 2,978 |
| Hull Corporation ........ | „ 16 | 1,539 | + 798 | 37 | 53,434 | +28,931 |
| *Liverpool Corporation... | ... | ... | ... | ... | ... | |
| Liverpool Overhead Rly. | Mar. 17 | 1,574 | + 234 | 11 | 16,269 | + 623 |
| Portsmouth Corporation | „ 16 | 544 | + 17 | | ... | ... |
| *Sheffield Tramways ...... | „ 17 | 2,975 | +1,121 | 11 | 30,653 | +10,754 |
| Southampton Corporat'n | „ 14 | 578 | + 305 | | ... | |

* Partly electrical

**ROBEY & CO. (LTD.)**—After writing off £6,671 for depreciation, the directors recommend a dividend of 6 per cent., adding £10,000 to reserve (making this £50,000), and carrying forward £3,422.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed 27th inst. as a special settling day in 13,363 6 per cent. cumulative preference £5 full-paid shares (Nos. 6,638 to 20,000) of *Edmundson's Electricity Corporation (Ltd.)* and 37,398 £5 (£3 paid) shares (between Nos. 20,008 and 59,807) of the *Johnson-Lundell Electric Traction Co. (Ltd.)*. The committee has also ordered the further issue of 30,000 £5 fully-paid ordinary shares (Nos. 40,001 to 70,000) and 30,000 6 per cent. cumulative preference £5 fully-paid shares (Nos. 40,001 to 70,000) of the *British Insulated Wire Co. (Ltd.)* to be quoted in the official list.

**TELEGRAPH MANUFACTURING CO. (LTD.)**—The transfer books of the preference shares of this company are closed from 18th to 30th inst. inclusive, for the purpose of paying preference dividend due on 1st prox.

**VICKERS, SONS AND MAXIM (LTD.)**—The directors, in their report to Dec. 31 last, announce that the company has acquired the sole right for Europe for the carriage-lighting system of the Consolidated Railway Electric Lighting and Equipment Co. of the United States, and for the construction and equipment of the Holland submarine boat. The British Government has placed an order with the company for five of these boats, the construction of which is already far advanced at the Barrow works. The capital of the company is to be increased to £3,700,000 by the issue of 200,000 new ordinary shares of £1 each.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | NAME. | Previous Week's Price, Mar. 15. | | Price Wednesday, Mar. 20. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'kh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ | 13½ | 12½ | 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,061 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. x.d. | 7 | 8 | 7 | 8 | 2 15 0 | ... | 7½ | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference x.d. | 8 | 9 | 8 | 9 | 3 17 9 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 60,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. x.d. | 9½ | 10½ | 9 | 10 | 4 15 0 | February and August | 9½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5½ | 5¾ | 3 18 3 | " " | 5¼ | ... |
| 84,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary x.d. | 6 | 6½ | 5¾ | 6½ | 4 8 0 | March | 6 | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) x.d. | [illegible] | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,670 | 10 | 8/9 | City of London Electric Lighting Ord. | 7¾ | 8½ | 7¾ | 8½ | 4 11 2 | February and August | 8½ | 8 |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 | 14 | 13 | 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 122 | 127 | 122 | 127 | 3 18 9 | June and December | ... | ... |
| £200,000 | Stock | 9d. | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 7½ | 8½ | 5 | 9 | 6 13 4 | ... | 8½ | 8½ |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ Deb. Stock Certs. (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | 107½ | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10 | 11 | 10 | 11 | 4 16 [illegible] | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. [illegible] | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| £73,009 | Stock | [illegible] | Kensington & Knightsbridge Co. & Notting Hill Co. (Jt. [illegible]) | 103 | 105 | 103 | 105 | 3 16 2 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 2 | 1½ | 1¾ | ... | ... | ... | ... |
| 42,840 | 5 | 2/0 | Do. 6 per Cent. Preference | 4 | 5 | 3 | 4 | 7 10 0 | ... | 3½ | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 94 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 4/5 | Metropolitan Elec. Supply Ord. x.d. | 12½ | 13½ | 12½ | 13½ | 4 2 11 | April and October | 13 | 12½ |
| 13,760 | 10 | 9d. | Do. (£7 10s. paid) x.d. | 7 | 8 | 9½ | 10½ | ... | ... | ... | ... |
| £120,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £180,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 96 | 99 | 97 | 100 | 3 10 0 | " " | 98 | 97½ |
| 6,452 | 10 | 6/9 | Notting Hill Electric Ordinary | 15½ | 16½ | 15½ | 16½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary x.d. | 6½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/8 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 13 0 9 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Trac'n. Ltd., 5% 1st Mor. Deb. | 65 | [illegible] | 65 | 7[illegible] | ... | January and July | 71 | 70 |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 200 | 220 | [illegible] | [illegible] | 3 12 3 | April and October | ... | ... |
| £115,400 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 105 | 103 | 105 | 4 7 5 | " " | ... | ... |
| 40,000 | 5 | 2/0 | St. James's and Pall Mall Electric Ordinary | 14 | 15 | 1[illegible] | 11½ | 5 0 0 | February and August | 14½ | 14 |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £80,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 | 13 | 12 | 13 | 4 0 0 | March and September | 12½ | 12 |
| 30,100 | 5 | 4,1½ | Do. Do. | 13 | 14 | ... | | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 18,000 | 10 | 5/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 6 9 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Tramways Investment Ord. | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. [illegible] Cum. Pref. | [illegible] | 4½ | 4½ | 4½ | ... | ... | 4½ | ... |
| £400,000 | Stock | ... | Do. 4½ Deb. Prov. Certs. | 99 | 101 | 99 | 101 | ... | ... | 100½ | 99½ |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 24 | 24½ | 23½ | 24½ | 3 [illegible] [illegible] | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 11½ | 10½ | 10½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 115 | 118 | 114 | 118 | 3 6 1 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 6% Preference | 9½ | 10½ | [illegible] | 10½ | 4 15 3 | May and November | ... | ... |
| £250,000 | 100 | ... | Do. 4½% 1st Mort. Debs. | 99½ | 101½ | 99½ | 100½ | ... | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 14 | 15 | 15 | 16 | 5 6 8 | ... | 15½ | 14½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | February and August | 12½ | 12 |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 117 | 123 | 120 | 123 | 4 1 4 | ... | 123 | 121½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Prof. | 6 | 6½ | [illegible] | 6½ | 5 15 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5 | ... | ... | 4½ | ... |
| £220,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | 104 | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 8 | ... | 97½ | ... |
| 400,000 | 1 | ... | Cape Electric Trams Shares | 1½ | 2 | 1½ | 1¾ | ... | ... | 1½ | ... |
| 266,297 | 10 | 3/0 | Central London Ordinary | 8½ | 9½ | 8½ | 9½ | 3 17 6 | June and December | ... | ... |
| £655,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 45 | 50 | 47 | 49 | 3 10 0 | February and August | 48½ | ... |
| 37,500 | 10 | 1/3 | Do. Ordinary (Nos. 22,501 to 60,000) | 4 | 5 | 4 | 5 | ... | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1898) | 127 | 137 | 122 | 127 | 3 15 9 | ... | ... | ... |
| £244,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debentures | 116 | 120 | 112 | 117 | 3 9 [illegible] | May and November | ... | ... |
| 80,000 | 10 | 8/0 | Dublin United Trams (1896) Ltd., Ordinary | 12 | 13 | 12½ | 13½ | 5 0 0 | ... | ... | ... |
| 51,981 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £200,000 | 100 | ... | Do. 4½ per Cent. Mort. Debs. (red.) | 102 | 105 | 102 | 105 | ... | ... | ... | ... |
| 3,000 | 5 | ... | Electric Light & Traction of Australia Ltd. (Ord.) [illegible] | 4½ | [illegible] | 4½ | 4½ | ... | ... | ... | ... |
| 20,000 | [illegible] | 7½% | Imperial Tramways Ordinary | 23 | 25 | 23 | 25 | 3 12 4 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 16 | 14½ | 15 | 3 19 5 | " " | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ per Cent. Debenture x.d. | 112 | 114 | 112 | 114 | 3 15 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tract'n 5% Pref. | [illegible] | | ... | | ... | May and November | ... | ... |
| 37,800 | 10 | 2½% | Liverpool Overhead Railway Ordinary x.d. | 7½ | 8 | 7½ | 7½ | 3 1 10 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference x.d. | 13 | 13½ | 13 | 13½ | 3 11 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 112 | 104 | 3 17 2 | January and July | ... | ... |
| $350,000 | $1,000 | 5% | London Street Rly. (Ont.) 1st Mrt. 5% Dbs. (red.) | 100 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £322,744 | Stock | 3½% | Lon. Utd. Trams Ltd. 4½ Deb. Stk. Prv. Crts. (fll. pd.) | 101 | 103 | 101 | 101 | ... | ... | ... | ... |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mort. Debs. (1908) | 102 | 104 | 102 | 104 | 4 15 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½ Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3½ | 3½ | 3½ | 3½ | ... | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | " " | ... | ... |
| 13,334 | [illegible] | ... | Potteries Electric Traction Ordinary | 11½ | 12½ | 11½ | 12½ | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | £7 0 | Do. 4½ per Cent. Debenture Stock | 1[illegible] | 109 | 107 | 109 | [illegible] | ... | ... | ... |
| [illegible] | Stock | 3% | Waterloo and City Ordinary | 5[illegible] | 56 | [illegible] | [illegible] | 3 2 5 | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Prices, Mar. 13. | | Price Wednesday, Mar. 20. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 20. Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £00,000 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 16 5 | January and July | ... | ... |
| 36,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | — | — |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 85 | 91 | 65 | 65 | ... | ... | — | — |
| £827,720 | Stock | 17/6 | Anglo-American | 51 | 54 | 50 | 53 | 6 13 10 | Feb., May, Aug., Nov. | 50 | ... |
| £3,088,640 | Stock | 30/0 | Do. Preferred | 95 | 97 | 94 | 93 | 6 4 0 | " " | 95½ | 91 |
| £3,088,640 | Stock | 5/0 | Do. Deferred | 8½ | 8¾ | 8 | 8½ | 3 19 9 | " " | 8¾ | 8 |
| 13,333,300 | $100 | 6¾ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 13 3 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,030 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 16 11 | " " | 103 | 102½ |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | — |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 6 17 3 | " " | ... | — |
| 18,000 | 5 | 2/0 | Direct Spanish Ordinary | 3½ | 4½ | 3 | 4 | 5 0 0 | April and October | ... | — |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | — |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | — |
| 60,710 | 20 | 3/0 | Direct United States Cable | 9¾ | 10½ | 9¾ | 10½ | 6 16 7 | Jan., Apr., July, Oct. | ... | ... |
| £106,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 103 | 99 | 101 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary [to 1,200] (red.) | 144 | 149 | 145 | 148 | 4 14 10 | Jan., Apr., July, Oct. | 145½ | 143 |
| £1,636,400 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 94 | 97 | 93 | 96 | 3 12 9 | " " | 94 | ... |
| £1,483,300 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 112 | 117 | 113 | 117 | 3 9 0 | May and November | 115 | 113½ |
| 380,000 | 10 | 2/6 | Eastern Extension | 14½ | 14¾ | 14½ | 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14¾ | 14¾ |
| 30,000 | 10 | ... | Do.(Nos. 380,001 to 300,000)£5pd,iss'd at 63pm. all pd | 13¾ | 14½ | 13¾ | 14¾ | ... | ... | 13¾ | — |
| £820,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 116 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 | 102 | 99 | 102 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs.(red.) | 101% | 104% | 101% | 104% | 3 17 8 | May and November | ... | — |
| 180,227 | 10 | 1/0 | Globe Telegraph and Trust | 9¾ | 10½ | 9¾ | 10½ | 5 2 5 | Jan., Apr., July, Oct. | 10⅛ | 9¾ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14¾ | 15½ | 14¾ | 15½ | 3 14 8 | " " | 15 | ... |
| 180,000 | 10 | 5/0 | Great Northern of Copenhagen | 33 | 34 | 33 | 34 | 3 13 6 | January and July | 33½ | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (with Nos | 99 | 102 | 99 | 102 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [1 to 1,200] (red. | 47 | 51 | 47 | 51 | 4 11 0 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | June and December | ... | ... |
| 11,330 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | ... | — |
| 8,381 | £100 Cert. | 6% | Submarine Cables Trust | 131 | 139 | 134 | 139 | 4 14 0 | " " | ... | ... |
| 15,600 | 10/0 | ... | West African Telegraph | 3½ | 3¾ | 3½ | 3¾ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 | 100 | 97 | 100 | 5 0 0 | March and September | ... | ... |
| 30,000 | 3½ | ... | West Coast of America | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ¾ | 1 | ¾ | 1 | ... | May and November | 1½ | 1 |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 3 11 6 | " " | 6½ | 6 |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 3 11 6 | " " | 5 | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 307,900 | 10 | 3/0 | Western Telegraph (late Brazil'n S'bm'rine) | 13¾ | 14½ | 13¾ | 14½ | 4 18 3 | Mar., June, Oct., Dec. | 14½ | 13¾ |
| £475,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | — | — |
| £346,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 103 | 105 | 103 | 105 | 3 16 2 | — | ... | — |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 5 | 5½ | 5 | 5½ | 5 14 4 | August | — | — |
| 334,990 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/3 | 2/9 | 2/3 | 2/9 | 10 18 2 | April and October | — | — |
| 72,680 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 6 0 0 | November | — | ... |
| 86,493 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | — | — | ... |
| 690,000 | 5 | 2 6 | National | 3¼ | 3½ | 3¼ | 3½ | 7 17 2 | February and August | 3½ | 3¼ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 12 | 11 | 12 | 4 12 4 | " " | 11½ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 11 | 12 | 10 | 12 | 5 0 0 | " " | 11½ | 10½ |
| 250,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ | 4¾ | 4½ | 4¾ | 5 5 3 | " " | 4⁹⁄₁₆ | ... |
| £1000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 92 | 95 | 92 | 95 | 3 14 3 | June and December | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 93 | 101 | 97 | 100 | 4 0 4 | ... | 100 | 97 |
| 171,504 | 1 | 6/6 | Oriental | ¾ | 1½ | ¾ | 1½ | 5 3 9 | April and October | — | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 6% Cumulative Pref. | 4¾ | 5½ | 4¾ | 5½ | 4 15 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 14 9 | June and December | ... | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 6% Cum. Pref. | ½ | 1 | ½ | 1 | 5 14 3 | — | ... | — |
| 135,000 | 1 | 1½d. | Aron Electricity Meter 6% Cum. Pref. | 1¼ | 1¾ | 1¼ | 1½ | 7 6 3 | March and September | ... | — |
| 65,000 | 1 | ... | British Electric Works Co. Ordinary | ⅛ | ⅜ | ⅛ | ⅜ | ... | — | ... | ... |
| 60,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | ⅛ | ⅜ | ⅛ | ⅜ | ... | — | ... | ... |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 | 90 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 6 16 4 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 6¾ | 6½ | 6¼ | 6½ | 4 16 0 | January and July | ... | ... |
| 200,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ | 5 | 4¾ | 5 | 6 0 0 | — | ... | ... |
| 90,000 | 3 | 1/3½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 6 8 4 | September | ... | ... |
| 15,721 | 3 | ... | Do. £1 paid | ... | | ... | | ... | — | ... | ... |
| 90,000 | 3 | 1/3½ | Do. 5 per Cent. Pref. Non-Cum. | 2½ | 2¾ | 2½ | 2¾ | 5 9 8 | " | 2¾ | ... |
| 15,721 | 3 | ... | Do. £1 paid | ... | | ... | | ... | " | ... | ... |
| £135,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 106 | 103 | 106 | 4 3 2 | March and September | ... | ... |
| £135,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 105 | 101 | 105 | 4 7 5 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 | 16 | 15 | 16 | 4 13 9 | " " | 15 | 15½ |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | " " | ... | ... |
| £30,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 11 | November and May | ... | ... |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1¼ | ¾ | 1¼ | 7 2 3 | — | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 | 98 | 95 | 98 | 4 12 0 | — | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | — | — | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3¼ | 3¾ | 3¼ | 3¾ | 6 0 0 | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 6 | " " | ... | ... |
| 90,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | — | ... | ... |
| 90,361 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1½ | 2 | 1½ | 2 | 9 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 3½ | 4½ | 3 | 4 | 6 13 3 | " " | ... | ... |
| £344,000 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 88 | 90 | 85 | 90 | 4 8 11 | June and December | 89 | 85 |
| £100,000 | Stock | 22/4½ | Do. 5% 2nd Deb. Standing Prov. Certs. (all pd) | 98 | 100 | 98 | 103 | ... | — | ... | ... |
| 36,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ | 5½ | 4½ | 5½ | 8 1 10 | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 103 | 106 | 4 5 1 | — | 104½ | — |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1¾ | 2¼ | 1¾ | 2¼ | 5 6 8 | January and July | ... | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | — |
| 110,000 | 1 | ... | Giffre Electro Chemical and Power Co. Ord | ‡ | | ‡ | | ... | " | ... | ... |
| 30,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary x d | 16 | 17 | 15 | 16 | 5 6 0 | February and August | 15¾ | 15¾ |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference x d | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | " " | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 10 11 | " " | 21½ | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 103 | 105 | 103 | 105 | 3 17 4 | March and September | ... | ... |
| 37,350 | 12 | 30/0 | Telegraph Construction and Maintnce. | 33 | 42 | 33 | 42 | 5 0 0 | March and July | 33½ | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1900 | 101 | 104 | 101 | 104 | 3 17 0 | January and July | 101 | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 | 12 | 11 | 12 | 6 6 4 | — | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | — | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 11¾ | 12½ | 11¾ | 12½ | 4 16 0 | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6¾ | 7¼ | 6¾ | 7¼ | 4 2 9 | " " | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 | 107 | 103 | 107 | 4 0 0 | May and November | ... | — |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

‡ The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,193. [No. 23. Vol. XLVI.] FRIDAY, MARCH 29, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

## NOTES.

An interesting event during the past week has been the exhibition of the first Diesel engine made in this country. This engine, which was manufactured for the Diesel Engine Co. at the engineering works of Messrs. Scott and Hodgson, Guide Bridge, near Manchester, was shown on Monday last at these works to a large party of engineers and others, many of whom had travelled on purpose from London in a comfortable "special" placarded as the "Diesel Express." The essence of the Diesel internal combustion engine is the Diesel cycle, and the essence of this cycle is—high compression. Everything else about the engine—whether in its Continental four-stroke or in its more recent British two-stroke arrangement—is incidental to the realisation of this high compression in an actual gas or oil engine.

Many years ago Herr Diesel wrote a treatise on "The Rational Heat Motor," embodying a principle on which a higher thermo-dynamic efficiency than formerly could be obtained in internal combustion engines. He also designed and shortly afterwards constructed an engine in which the new Diesel cycle was employed. In this engine the compression before ignition was so great that spontaneous ignition took place, the rapid adiabatic compression of the air heating it to a temperature capable of supporting combustion. Obviously, such conditions would be impossible with the Otto cycle, inasmuch as this high compression of a mixture of fuel and air would result in premature ignition. In the Diesel engine air unmixed by fuel is compressed to about 500lb., the fuel being introduced in a gaseous or vaporous condition only when the compression stroke is quite completed. The fuel, in fact, is injected into the working cylinder by means of air at a pressure of over 600lb. stored in a steel cylinder, which is fed from a separate compression pump on the engine. It is Herr Diesel's aim to introduce the fuel gradually, *i.e.*, at such a rate that combustion shall take place isothermally. Under this ideal condition the cylinder temperature would never exceed that of the air at maximum compression. But though this result is far more closely approached in the Diesel engine than in any engine working on the Otto cycle, we judge from the indicator cards taken on Monday that isothermal expansion is considerably departed from in the early stages of the working stroke. On the whole, however, the set of cards of the cylinder and pumps display highly satisfactory working conditions, whether regarded thermodynamically or from a more practical standpoint.

We refer with some reserve, however, to these indicator diagrams. The exhibition of the engine on Monday was made under conditions that afforded little or no assistance to the expert mind in arriving at a judgment of its merits. Possibly this may have been due to the difficulty in conducting tests amidst a large and pressing crowd, composed mainly of non-technical men. It would have more favourably impressed the representatives of the technical press had arrangements been made for an exhaustive series of tests extending over several hours under strictly defined conditions. As things were, we found the engine running when we arrived—thus being prevented from witnessing a *cold* start. While it continued to run on loads it was indicated profusely; bu tapart from this, and inspection of the exhaust gases, no other running tests were made. After about an hour's run the engine was stopped, and almost directly afterwards it was started again—the re-start taking only five seconds, which, although a marvellously low figure, would have been more convincing had it been a cold instead of a hot start. As to the thermodynamic efficiency, it needed no visit to Guide Bridge to convince us of the superiority of the Diesel cycle in this respect. No one sufficiently conversant with gas-engine theory can fail to discover in the Diesel cycle ample justification for the claim that it attains a heat efficiency of from 85 to 87 per cent. Nor does it surprise us that its realised economy is high; an engine with a thermodynamic efficiency of 85 per cent. should certainly be more economical than any other heat motor yet put on the market. But space prevents

us from discussing further this interesting engine, though we hope to return to the subject at a later date. Suffice it to say that, in principle, the Diesel cycle embodies conditions essential to advancement in the internal combustion engine, and the engine itself probably indicates the broad lines on which that advance will be realized in the near future.

MAJOR CARDEW commenced the last of his three Cantor lectures on "Electric Railways" on Monday with a summarised comparison between the continuous-current and polyphase systems of traction. After giving a list of the arguments for and against the two systems he came to the conclusion that, for the case of railway work on an extensive scale and necessitating transmission of electrical energy to a distance, polyphase generation and distribution were to be preferred. The first point in favour of it was the simplification of the sub-stations, for, as high-pressure transmission would be necessary on account of the distance, sub-stations containing rotatory machinery would be necessary for distribution of continuous current to the trains. This meant economy, as also did the possible employment of much higher pressures (8,000 volts) for the motors on the train, the difficulty of picking up current at these high pressures having now, he considers, been solved. The currents to be carried being less at this high pressure, the sub-stations could be further apart, and the rail-return would be replaced by a copper strip on fairly insulating supports. These and other advantages, including, for instance, the simplification of the motors and the possibility of suspending their rotors entirely on springs, quite counterbalanced the contrary advantages of continuous current, such as the saving of one conductor, the reduction of plant capacity by employing accumulators, the absence of idle currents (amounting to a waste of 15 per cent. in polyphase working, he estimated), and the wider variations in speed which were permissible. There is much to be said in favour of Major CARDEW's views, and it must be remembered that they are intended to apply only to railways and not to tramways. Local circumstances have still to be considered in each case, however, and presumably the Board of Trade has still to be consulted with regard to the high-pressure overhead wire. If the 8,000 volts put forward by Major CARDEW has to be reduced to 500, as in the case of the continuous-current lines in this country, many of the advantages enumerated for polyphase working disappear.

THE latter part of Major CARDEW's lecture worked out the general design of an electric railway line extending 50 miles, with a large local traffic at one end and a small local traffic at the other. He explained an ingenious time table in which slow trains traversing sections of the main line between the times of the half-hourly expresses resulted in an almost ideally quick and frequent service between all points. He showed what considerations should have weight in the choice of the speeds and accelerations, and even fixed the power for the sub-stations and generating stations, and estimated the total cost of erecting the scheme. The picture, drawn thus in broad and bold lines, of an electric railway system putting all parts of London within easy communication of Brighton and its suburbs and the intermediate country, was certainly an alluring one to the electrical engineer, and the vote of thanks proposed by Prof. AYRTON, and willingly accorded to the lecturer by a small but enthusiastic audience, was well merited.

THE weekly discourse at the Royal Institution on Friday evening last was given by Dr. H. T. BROWN, on "Some Recent Work on Diffusion." Although not directly dealing with electrical matters, the lecturer brought forward a number of new facts in regard to diffusion that must have been as attractive and pleasing to the physicists present as to the botanists, for whom the discourse was primarily intended. Indeed, one more illustration was afforded in Dr. BROWN's account of his researches, of the striking way in which every branch of science may gain when attention is paid to "the whispered hints and slender clues" of the world of physical life. Dr. BROWN has listened to hints and clues detected during a study of leaf structure and of the manner in which a leaf breathes. The resulting contribution to the laws of gaseous and liquid diffusion are of no mean order. Thus can a problem in botany afford valuable material for the applied scientist and the engineer.

SUCCINCTLY, the problem in botany was as follows:—It is known that a determinable amount of carbon dioxide passes into any given living leaf in, say, an hour. It is also known that the aggregate area of the orifices of the stomates is an exceedingly small proportion of the leaf surface, being of the order of about one-hundredth of that surface. Comparing that available area with the amount of $CO_2$ to be passed through it, Dr. BROWN found a remarkable disagreement with the laws of free diffusion as understood at the time he began his research. In other words, to quote from his lecture, "it seemed that the leaf knew more about the laws of diffusion than the physicist did." The area of the stomates orifices appeared to be only a very small fraction of the area which theory indicated as being necessary to account for the rapid rate of diffusion from the atmosphere into the leaf. Clearly, the solution of this perplexing problem lay in closely studying the leaf structure from the point of view of facility for diffusion.

THIS was done in an ingenious manner by imitating the leaf conditions in apparatus of larger and more convenient construction. We may explain that the structure of a leaf in the region of the stomates is analagous to a diaphragm perforated by small circular holes at a pitch of about eight or nine diameters, each hole opening into a larger hollow cavity provided on its surfaces with material capable of rapidly absorbing $CO_2$. A glass cylinder with a little caustic potash solution at the bottom, and with a celluloid cover perforated by one or more orifices, is a good representation of these conditions. The amount of $CO_2$ diffusing into the cylinder is indicated by the increased weight of the KHO solution. Comparing the rate of diffusion thus measured with the rate in the case of a similar cylinder quite open at the mouth, it was found that the diffusion through the constricting orifices was always in a larger ratio than

the areas. Exact measurement showed that the diffusion through each orifice varied directly as the first power of the diameter of the orifices, when these were distributed over the diaphragm at a pitch exceeding a certain number of diameters. The best conditions obtain with orifices at a pitch of about eight diameters, which is the distribution found in the stomate orifices on the surface of a leaf. Thus, by a marvellous intensifying action, the stomates serve to accelerate the rate of absorption of $CO_2$ into a leaf, even to a degree that could only be produced chemically by an absorbent many times as active as caustic potash.

In order to investigate this law of diameters, Dr. Brown had recourse to the diffusion of coloured liquids through orifices into an absorbent jelly. By cutting a section of the jelly through a plane perpendicular to the orifice, the curved surface of the advancing diffusion was rendered visible and capable of measurement. A series of curves, representing the diffusion in different parts of the jelly, was obtained by alternately using two liquids of different colour. A measured section through a diameter of the orifice shows, the lecturer stated, that these curves are confocal ellipses having their foci on the edge of the circular orifice. The stream lines of diffusion-flow are consequently confocal rectangular hyperbolæ having the same foci as the ellipses. Dr. Brown appears to think that this affords a pictorial representation of the equipotential surfaces and lines of electric force around two similar and equal charges of electricity placed at a short distance apart. We are unable to follow Dr. Brown in his demonstration of this supposed analogy, for it is clear that the system of electric lines and potential surfaces has not the same geometrical form as the curves obtained with diffusion. However, this slip in no way mars the importance of Dr. Brown's research, which contributes to physics a valuable new law of diffusion, and to engineering and applied science a serviceable method of accelerating free diffusion.

We reported in our last issue the proceedings of the House of Lords Committee in connection with the Sheffield Corporation bill, on Thursday last week, and the decision arrived at. In the portion of the bill relating to tramway extensions, a clause has been inserted by the Committee, at the instance of the gas company and in spite of the opposition of the Corporation, to the effect that the Corporation shall not be relieved by the act from any liability in view of damage to the gas company's mains from fusion or electrolytic action. As such damage is unlikely, it might appear at first sight remarkable that the Corporation should have taken pains to oppose the insertion of the clause; presumably, it is in order to protect themselves from litigation, as there is a danger of every chemical action of the soil on gas pipes being attributed by the gas company to electrolysis, owing to the difficulties of diagnosis in the two cases. Certainly a precedent has now been established, and, as it is therefore likely that other electric tramway bills will contain the same provisions, the expert witness on electrolysed gas and water pipes will probably before long be a new feature in the law courts. It may be pointed out that the hardship is not so great in the Sheffield case, as a Corporation is always situated in a more comfortable position with regard to litigation than a company. But when the positions are reversed, and a company owns electric tramways, in spite of the much-reviled Act of 1870, while a Corporation owns gas or water works, the Corporation's position as to litigation might prove distinctly unfavourable to electrical enterprise.

Bournemouth. The town council have decided to offer the sum of £170,000 for the undertaking of the Bournemouth and Poole Electricity Supply Co.

The Marconi Patent in America.—The New York Circuit Court has decided that Mr. Marconi's wireless telegraph patent is valid, and has dismissed the action for infringement brought by the assignee of the Dolbear wireless telegraph patent.

Another Indiarubber Substitute. The United States Consul at Bergen reports that a Copenhagen chemist has succeeded in producing a cheap substitute for indiarubber. The new material is called "solicium," and is made from asphalt.

Royal Society. Amongst the Papers down for reading yesterday were: "The Growth of Magnetism in Iron under Alternating Magnetic Force," by Prof. E. Wilson, and ("in title only") "On the Electrical Conductivity of Air and Salt Vapours," by Dr. H. A. Wilson.

| Cable Interruptions. | Date of Interruption. |
|---|---|
| Latakia—Cyprus | June 21, 1899 |
| Pará—Maranham | Mar. 2, 1900 |
| Marseilles—Barcelona | Jan. 7, 1901 |
| Sao—Bushire | Mar. 7, 1901 |
| Perim—Obock | Mar. 22, 1901 |

Cable Communications Committee.—At a meeting of this Committee held on Tuesday Lord Balfour presided, and evidence was given by the Hon. W. Mulock, K.C., Postmaster-General of Canada; Mr. F. A. Bevan, chairman, and Mr. Charles Burt, director, of the Anglo-American Telegraph Co; Mr. Underdown, K.C., chairman of the Direct United States Cable Co.; and Mr. A. S. Baxendale, superintendent of Posts and Telegraphs, Selangor (Straits Settlements).

Train Lighting.—Those who manufacture electric lighting plant for trains will be interested to hear that since the serious railway accident at Offenbach last year, the German Government Railway Administration has given much attention to the electric lighting of railway carriages. It has been experimenting with the Stone system, which has already been used to some extent in this country. The South Eastern and Chatham Railway Co. have recently equipped a considerable number of their coaches with the Stone system of electric lighting.

Telegrams for the Troops in China.—The Postmaster-General announces that arrangements have been made with the Eastern Telegraph Co. for facilitating and cheapening telegraphic communication with the British military forces in Northern China. The address to the telegrams may be shortened, and are then only charged as one word, and the charge per word for the message proper is 2s. 9d., or half the usual rate. Telegrams under this arrangement are to be handed in at postal telegraph offices, and not at the offices of the company.

Electric Treatment of Skin Diseases.—Dr. F. W. Smith has found that the efficacy of the Harrogate waters is greatly increased by passing an electric current through the water, the patient being made the positive pole. The discovery was due to one of Dr. Smith's patients undergoing electrical treatment in Harrogate water, the sulphur deposit appearing on his skin soon after his first bath. Prof. Smithells, professor of chemistry at the Yorkshire College, Leeds, and his assistant, Dr. H. M. Dawson, have tested the water, and found that sulphur would be liberated at the positive pole. This treatment may prove useful in the case of certain skin diseases for which applications of sulphur are known to be efficacious.

**Works Management.**—The fourth lecture to the Institution of Junior Engineers on "Works Management" was given by Mr. A. H. Barker, at the Westminster Palace Hotel, on the 19th inst. The lecturer considered in detail the methods of transmitting orders to the works; systems for dealing with correspondence were treated, the filing of letters, &c., being described. The duties of the storekeeper were entered into, to show their bearing on the proper keeping of the costs accounts. The great desirability of a fair trial being given to new material, devices, &c., was pointed out. Accurately conducted experiments were, however, imperative, the results to be recorded and tabulated for future reference. The various methods of remunerating workmen for work done were then fully considered, the difficulties of the piecework system being dwelt upon. The premium method needed the exercise of much organising talent on the part of the management or it would lead to great confusion. The next lecture will take place on April 3.

**Lightning Arresters on High-tension Circuits.**—In the *Electrical World* of New York, for March 9th, an interesting effect in connection with the opening of the 30,000 volt circuits of the Snoqualime plant is recorded. There are two circuits running to Tacoma and two circuits to Seattle. It was found that upon opening the Tacoma circuits the circuit breakers on the primaries of the transformers supplying Seattle would always go out as if on a short circuit. Vice versa, if the Seattle circuits were suddenly opened out would go the circuit breakers on the primaries of the Tacoma transformers. The trouble proved to be caused by a short circuit on the line due to the discharge of the line through the lightning arresters. The instant the Tacoma circuit was broken the Seattle line current would jump across the lighting arresters to ground. Upon disconnecting the ground wires of the arresters, the phenomena disappeared, showing conclusively that the current jumping across the arresters was responsible for the effects produced. The Westinghouse-Wurts arresters are used, and the line voltage per gap is only about 300, which is extremely low, and makes the effect all the more remarkable.

**Proposed Electric Railway from St. Petersburg to Moscow.**—According to the *Engineer* for March 22nd, M. Romanoff constructed at Gatschina, twenty miles from St. Petersburg, during the summer of 1900, a small electric railway on a system which he had invented, and the results were thoroughly satisfactory. He has now drawn up a project for constructing an electric railway from St. Petersburg to Moscow. It has long been well known that the existing Nicolas Railway, connecting the old and new capitals of Russia, and 404 miles in length, is unable to cope with the traffic. The authorities entertain the idea of separating the passenger traffic from the goods traffic, and for this purpose it is said that two other tracks are to be laid down. However, M. Romanoff has now come forward with a proposal to construct an electrical "hanging railway," which shall take the place of increasing the carrying capacity of the present line by the addition of two tracks. The cost of this suggested railway would amount to 98,000,000 roubles, and the yearly cost of its working would represent 12,819,000 roubles, of which sum 80 per cent. is absorbed by the cost of fuel. M. Romanoff computes that the cost of passenger traffic will come to about half a kopeck or ½d. per verst of two-thirds of a mile. The rate of speed to be attained on this "hanging railway" is estimated to be about 120km. an hour, with a limit of 200km.

**The Projected Metropolitan Railway for St. Petersburg.**—The Government Commission appointed to consider the projected electric ring railway for St. Petersburg has concluded its sittings. The Commission has viewed this project most favourably, and expressed its conviction of the immense economic value of such an addition to the existing means of communication in the Russian capital. The various points of issue were settled by means of compromise between the Commission and M. Balinski, who is in charge of the undertaking, but the question of admitting the necessary ironwork free of duty in the empire was left open. The "Duma," or Town Council, demanded from M. Balinski a larger contribution towards the city funds than that of 5 per cent. of the net profits, as orignally proposed. M. Balinski agreed finally to the following demands made by the city authorities: (*a*) To build two iron bridges across the Neva, and also other bridges across various canals; (*b*) to lay down a system of drainage in the streets through which the projected railway passes; (*c*) to install the electric light in the streets traversed by the line; and (*d*) to pave these streets. The city reserves to itself the right of buying the Metropolitan Railway before the concession expires, and imposed the condition that the entire railway shall pass into the possession of the city on the expiration of the concession. However, the Commission reserved these rights for the imperial authorities. According to the *Engineer* there is but little doubt that the points still awaiting settlement will be settled satisfactorily at no distant date.

**Personal.**—On Sunday next, the 31st inst., Mr. C. H. Wordingham, the chief electrical engineer to the Manchester Corporation, will sever his connection with the electricity department of that Corporation. Mr. Wordingham has for many years held the post of chief electrical engineer at Manchester, during which time he has not only performed his official duties with praiseworthy thoroughness and a desire to further the interests of the citizens, but has also placed at the service of the Corporation an amount of technical ability and scientific knowledge of his profession which is unsurpassed by that of any of his confréres. Under his personal direction the Manchester electricity works have expanded from a comparatively small undertaking for supplying private electric lighting, until it has attained to dimensions extending over 45 square miles of densely-populated and busy districts, in which not merely private lighting but also a large amount of street lighting and motor load has been developed. Much of this development has been made on lines due directly to Mr. Wordingham's own inventive skill as an engineer. Besides this, it will be remembered by our readers that the acquisition of the tramways by the Corporation and their projected electrical equipment have necessitated the erection of an entirely new generating station, the designs for which have been made by Mr. Wordingham. Having brought to a close the period of his agreement with the Manchester Corporation, Mr. Wordingham will now practise as a consulting engineer and electrical expert, for which career his ripe experience abundantly fits him. He has our most sincere good wishes for prosperity and success therein. We may add that Mr. Wordingham's professional address is now 19, Brasenose-street, Manchester.——Mr. W. E. Thrift has been elected successor to the late Prof. G. F. FitzGerald in the Erasmus Smith Chair of Natural and Experimental Philosophy at Trinity College, Dublin.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), March 29th.**

North-East Coast Institution of Engineers and Shipbuilders.

*7.15 p.m.* General Meeting at the Marine School, Ocean-road, South Shields.

Electro-Harmonic Society.

*8 p.m.* Smoking Concert at the St. James' Hall Restaurant, Regent-street, W.

Royal Institution.

*9 p.m.* Evening Discourse by the Right Hon. Lord Rayleigh, F.R.S. Subject: "Polish."

**SATURDAY, March 30th.**

Royal Institution.

*3 p.m.* Afternoon Lecture VI. on "Sound and Vibrations," by the Right Hon. Lord Rayleigh, F.R.S.

**MONDAY, April 1st.**

Society of Engineers.

*7.30 p.m.* Ordinary Meeting at the Royal United Service Institution, Whitehall. Paper to be read: "The Production of Metallic Bars and Tubes under Pressure," by Perry F. Nursey.

**WEDNESDAY, April 3rd.**

Institution of Junior Engineers.

*8 p.m.* Meeting at the Westminster Palace Hotel, when Mr. A. H. Barker will deliver his fifth lecture on "Works Management."

## THE OUTHENIN-CHALANDRE ELECTROLYTIC ALKALI PROCESS.

BY JOHN B. C. KERSHAW, F.I.C.

This process for the production of alkalies and chlorine compounds by the electrolysis of solutions of sodium or potassium chloride, is a diaphragm process and is in actual operation at Chèvres, near Geneva, and at Moutiers, in France. Other works are being built to operate the same process in Italy and Spain. The English patents protecting the process are dated 1893 and 1896, and are numbered 15,906 and 15,834 respectively. The first relates to the cell design, the second to a modification in the process for improving the purity of the chlorine evolved from the anode chamber of the cell.

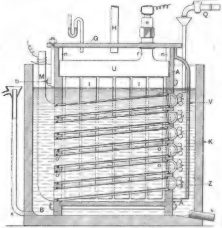


Fig. 1.—Sectional Elevation of the Outhenin-Chalandre Type of Cell.

Fig. 2.—The Chèvres Power Station of the Geneva Municipality.

Fig. 1 is a sectional elevation of the cell. The cell consists of an outer vessel K, and of an inner vessel A, entirely closed and built of materials unacted upon by chlorine gas or its compounds. This inner vessel is filled with rows of porous-diaphragm tubes *o o*, open at each end to the outer chamber, K, of the cell, and inclined at a slight angle, as shown in Fig. I. Each tube is hermetically sealed into the walls of the chamber A by a special device shown at Z, and contains an iron sheet cathode running the whole length of its interior. These sheet cathodes join to a common terminal at M, and each vertical row of diaphragm tubes is thus served with current by the one electrical contact to the mains supply. The anodes, I, are round rods of specially prepared carbon, fixed into the common lead head-piece U, and communicating at *e* with the negative terminal of the dynamo. They hang vertically in rows of seven between the rows of diaphragm tubes, and the chlorine evolved at their surface collects in the upper portion of the anode chamber, and is carried away by the outlet pipe H. The right-hand side of the inner cell is provided with a sheet-iron movable hood, V, and outlet pipe not shown in Fig. 1. This serves to collect and carry away the hydrogen liberated within the diaphragm tubes and facilitates its utilisation for other purposes.

The cell is operated in the following manner:—The inner chamber A is nearly filled with a concentrated solution of sodium chloride, and the outer vessel with a dilute solution of sodium hydrate. The electrical connections are then made. The chlorine gas liberated within the chamber A passes off by the pipe H, and is used for the manufacture of bleaching powder or for some other purpose. The sodium liberated at the surface of the sheet-iron cathodes decomposes the water present, yielding hydrogen gas and a solution of sodium hydrate. The first travels up the tubes, and escapes into the collecting chamber V, whence it passes to a gasholder for storage until required. The solution of sodium hydrate, owing to its higher specific gravity than the surrounding solution, travels down the tubes, and collects on the bottom of the outer chamber of the cell. Since the cell design permits the hydrogen to pass away with a minimum disturbance of the electrolyte in this outer chamber, fairly concentrated solutions of sodium hydrate can be obtained, and when required are run off by the outlet pipe *v*.

The advantages claimed for this type of cell are:—Complete separation of the electrolyte in the anodic and cathodic compartments of the cell, with consequent prevention of hypochlorite and chlorate formation; collection and utilisation

of the hydrogen liberated at the cathodes. The disadvantages would appear to be a high E.M.F. due to the diaphragms, and a very complicated structure, with consequent high cost for maintenance and repairs. That the cell has been operating at Chèvres since 1899 with presumably satisfactory results (for other works to operate the same process have since been planned) is proof that under certain conditions the advantages outweigh the disadvantages named above. The cell, however, cannot be considered a complete success, for oxygen and oxygen compounds are liberated with the chlorine at the anode, and it is in order to suppress these that the process has been modified in accordance with the details given in patent No. 15,884 of 1896. The hydrogen liberated at the cathodes is collected and burned in a special form of burner in an atmosphere of chlorine, and the hydrochloric acid which results from this combustion is fed into the anode chamber of the cell. Should ClO compounds be present these are decomposed with production of $H_2O$ and $Cl_2$. The hydrochloric acid present in excess of that required for the above decomposition shares in the electrolysis with production of Cl at the anode and H at the cathode.

The writer is informed that this modified process is in operation at Chèvres. It is obvious, however, that the chlorine liberated by direct electrolysis of hydrochloric acid is only gained by a double expenditure of electrical energy; for each atom of chlorine obtained in this way has first been separated by electrolysis of sodium chloride. The gain in purity of the chlorine liberated in the anode chamber of the cell is therefore purchased by an increase in the kilowatt hours per ton of chlorine produced, and the advantage is a doubtful one. Until figures have been published showing the yield of the Outhenin-Chalandre cell under actual working conditions, comparison of its efficiency with that of the Castner and Hargreaves-Bird cells is impossible.

The works at Chèvres are operated by power from the Geneva municipal generating station on the Rhone, a view of which is given in Fig. 2. The power is transmitted by air lines a short distance to the electrolytic works, and is used to operate a 1,200 H.P. Thury motor generator and a 500 H.P. Brown-Boveri motor generator, both giving direct current. Fig. 3 is the river-side view of the electrolytic alkali works. A portion of the chlorine produced in this works is used in the manufacture of pure chemicals for laboratory and medical purposes. Liquefied chlorine is also one of the products of the works.

The greater portion is, however, used in the production of bleaching powder. As regards soda products, caustic lyes and solid caustic soda are manufactured to suit the requirements of the firm's customers. At the Paris 1900 Exhibition a block of solid caustic soda was exhibited by this firm testing 75·6 per cent. $Na_2O$, equal to 97·6 per cent. NaOH. This shows that only comparatively small amounts of sodium chloride and other impurities find their way into the cathode compartment of the cell. The works at Chèvres are owned by the "Société Anonyme Suisse de l'Industrie Electro-Chimique Volta," a company which also owns and operates the carbide works at Verniers.

FIG. 3.—THE ELECTROLYTIC ALKALI WORKS AT CHÈVRES, SWITZERLAND.

## A NEW PORTABLE DRILLING MACHINE.

Messrs. Mather and Platt have lately brought out an electrically-driven portable machine (patent No. 1,567, 1901) for drilling holes up to 2½in. diameter when the expense of carrying the tool to the work is less than of carrying the work to the tool. As will be seen from the illustrations, this machine consists of a main column 7ft. high and 12in. in diameter, fitted with a saddle, which carries a radial arm, 8in. in diameter, on one end of which is mounted the drilling head with its spindle and on the other end the driving motor. These parts are constructed to give three independent motions of the drill :—

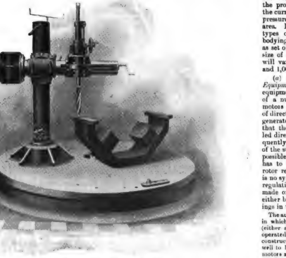
1. The saddle and all parts carried by it can be swivelled in a complete circle round the main column in a horizontal plane.
2. The radial arm can be swivelled in a complete circle in a vertical plane.
3. The radial arm, and with it the drill spindle, can be swivelled about its own axis through a complete circle in a plane perpendicular to the arm.

Besides these motions the head can be traversed along the radial arm and the saddle can be raised or lowered on the main column.

The base of the drill is provided with an electromagnetic arrangement, which holds the drill in position when placed on any flat and smooth surface of iron, and with a good contact an adhesion of 3 tons can be obtained. For specially heavy work it is desirable to supplement the magnetic attachment by dogs.

The drill spindle is 3in. in diameter, it is bored at the end for No. 5 Morse taper socket, and is provided with power feed, by means of a sleeve driven with pinion and two sets of worms and gears, directly off the spindle. By disconnecting the power feed by the clamping nut at the centre of the hand-wheel the spindle may be fed by hand.

The motor attached is of the two-pole enclosed type, capable of developing 2 H.P. at 800 revs. per min., and is wound for 100 or 200 volt circuits.



PORTABLE ELECTRIC DRILLING MACHINE.

The motor shaft is prolonged so as to pass through the helical gear, driving direct on to the drill spindle. This gear has a ratio of 9 to 1, with back gears of 3 to 1.

## SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.*

BY A. C. EBORALL.

Polyphase systems of generation and transmission, combined with direct-current distribution from sub-stations, are very much in evidence at the present time in connection with many large lighting and traction schemes, and there is little doubt but that the use of such combined systems will greatly extend in the future for those cases where power has to be supplied in very large amounts over large areas. The author thought, therefore, that a Paper embodying some notes on the subject might be of interest to many members of the Institution; and, complying with a request of the President, the scope of the Paper has been confined as far as possible to practical questions of everyday working that have come within his own experience. Consequently, many of the points discussed must be quite familiar to those members who have worked in the same direction, who must kindly bear in mind in this connection that the author does not profess to put forward anything new, but merely to bring up for discussion some working notes on the subject.

In the following pages, then, the general ideas underlying the equipment and operation of polyphase sub-stations are first dealt with, and this is followed by some features of working, and a comparison of the different types of machinery that can be employed for the work under consideration, together with some details and examples taken from actual practice. It is always to be understood that the author has in mind the case in which very large amounts of power (transmitted at high pressures) have to be handled—the modern case, in fact. Moreover, on account of their greater commercial importance, three-phase systems are more particularly considered.

### 1. SUB-STATION EQUIPMENTS FOR LIGHTING OR TRACTION.

Considering the general case, applicable to large towns, the polyphase current will be sent over the transmission lines from the distant power station, usually arriving at the various sub-stations in the supply area at a pressure between 5,000 to 10,000 volts between lines, according to the length of the feeders and amount of power to be transmitted; the work to be done comprises the conversion of the whole of the current in question into direct current at 2 × 220 volts for lighting, or 500 to 550 volts for traction, together with the provision of means for regulating the current and feeding it into the low-pressure networks comprised in the area. It can be done by three different types of sub-station, each type embodying a distinct class of equipment, as set out more particularly below; the size of the units in the sub-stations will vary in general between 300kw. and 1,000kw. individual output.

(*a*) *Asynchronous Motor-generator Equipment.*—This type of sub-station equipment consists in the employment of a number of polyphase induction motors driving an equivalent number of direct-current generators; the motor-generator units will be of such a size that the high-pressure current can be led directly into the motors, and consequently the equipment and operation of the sub-station will be of the simplest possible character. No starting gear has to be provided beyond a simple rotor resistance for each motor, there is no synchronising to be done, and the regulation on the direct-current side is made on the fields of the generators, either by hand or by compound windings in the usual way.

The author does not know of a single case in which polyphase motors of large size (either synchronous or asynchronous) are operated with transformed current. The construction of such motors lends itself so well to high insulation of the stator that motors as small as 150 H.P. can be perfectly satisfactorily (and cheaply) built for pressures of 5,000–6,000 volts. With the large units required for sub-station work, it does not pay from either the technical or commercial point of view to employ step-down transformers—at any rate up to 10,000 volts. If the motors are less than about 500 H.P. individual output, and the pressure greater than this figure, it may pay to employ transformers, because the amount of slot insulation required will probably be found to be excessive, necessitating the employment of motors of large dimensions compared with their output. The trouble with high-pressure working without transformers in the sub-stations is, as a rule, in the switch-gear for the motors, but great improvements have been made in this during recent years, and at the present time there is very little to fear in this respect.

With the high-pressure current led directly into the motors, the best arrangement for the sub-station will usually consist in employing starting switch-pillars for the motors, these standing close against them, the direct-current board being away against a wall. The rotor resistance and stator starting switch would be interlocked, and thus, as each switch-pillar is self-contained, the starting up of each set is performed by one movement of a hand-wheel, this taking the place of the engine stop-valve in a steam plant. The employment of a starting switch-pillar adjacent to the motor possesses the great advantage of reducing the length of the heavy rotor cables to a minimum (an important point), while security of working is assisted by interlocking the starting gear.

Of course, if the motors are provided with permanently short-circuited rotors, an auto-transformer device in the stator takes the place of the rotor resistance; this feature of construction and method of working is not advisable, however, being, for work of the character in question, far inferior to that referred to above. It should be borne in mind, in this connection, that it is standard practice nowadays to build all induction motors of large size (having wound-rotors and slip-rings), with an arrangement for short circuiting the rings and lifting up the brushes after once the motor has attained full speed,

---

* Paper read before the Institution of Electrical Engineers, March 14.

thus limiting wear (and loss) on the rings to the period of starting up—30sec. as a usual maximum figure.

If direct current is available at the sub-station, being derived from a motor generator already running, or from another sub station, it is perfectly possible to start up the sets as they are wanted, from the direct-current side. Under certain circumstances, this method of operation will give good results, but in general it is not so convenient as that first described, and consequently rarely used. In any case it is necessary for one or more units in the sub-station to be provided with rotor resistances or equivalent devices, so that they may be started from the alternating-current side whenever this may be necessary.

For feeding three-wire systems, each motor would drive two direct-current machines each of half its output, one at each end of the shaft, the two machines being in series; or the motor would drive a single generator of the same capacity, feeding the outers, auxiliary devices being used in the usual way for balancing the load.

(*b*) *Synchronous Motor-generator Equipment.*—With this equipment, synchronous polyphase motors operated at the line pressure take the place of the induction motors referred to above; conforming with standard practice, the synchronous motors would be of the revolving field type, the exciting current being led into the field system by means of slip-rings and brushes. A sub-station with such an equipment will also be of a very simple character not quite so simple as the foregoing; this is on account of the necessity for synchronising the motors before switching them in, because the starting arrangements are more elaborate, and also because the synchronous motors are not self-exciting. The excitation of the motors would usually be effected from direct-coupled exciters, or from separate (induction) motor driven exciting sets fed by step-down transformers, or from the 'bus bars; frequently the latter method, in conjunction with either of the former methods, will prove to be the most convenient. The performance of synchronous motors depends so much upon the field adjustment (see later remarks), that a well-designed field regulator for each motor is a necessity.

The starting of the motor generator sets may be effected in several ways. By far the best way from every point of view is to start them from the direct-current side, the direct current being derived from the 'bus bars, if other machines (or sub-stations) are running or from a small auxiliary direct-current generator driven by a low-pressure induction motor, if no direct current is available at the switchboard. Of course, as soon as the first machine is running, all the others can be started from it, but it must be remembered that it is always necessary to provide means for starting up any motor generator in the sub-station, from the alternating-current side, either directly or indirectly. One of the best possible adaptations of the above arrangement is to provide an auxiliary (asynchronous) motor generator which can be used for exciting and starting the main units when required; this auxiliary set would be shut down as soon as one or more of the main units is in operation, direct current thus being available at the 'bus bars. If the low-pressure network is arranged to be partly fed, or balanced, by accumulators, the starting and exciting would naturally be effected initially from these, and the whole arrangement becomes one of great simplicity; this is, however, not the general case.

The operation of switching in a synchronous motor generator started in this way is, of course, very simple. The set being brought up to approximately synchronous speed and excited to the right value, the correct speed (as indicated by the synchronising lamps) is attained by regulating the fields of the direct-current machine now running as a shunt-motor with all main resistance out. At the right moment, the main high-pressure switch is closed, and after this the direct-current main resistance perhaps short-circuited. Finally, the fields of both motor and generator are adjusted, the latter in order to take up the load, and the former in order to regulate the idle current of the synchronous motor.

Assuming that no direct current is available, the next best method of starting up the motor generator sets, together with their direct-coupled exciters, is by means of starting motors. On a bracket at that side of the motor generator remote from the exciter, an induction motor is placed, the rotor being mounted directly upon the extended shaft; this motor would be fed from a step-down transformer and would have a capacity of about 10 per cent. of the full load output of the main unit. The number of poles on the starting motor would be fewer than the number of field poles on the synchronous motor, being such that it can bring up the set to a speed somewhat higher than that corresponding to synchronism, in spite of the load on it due to the iron losses and excitation of the main unit, and the friction and ventilation losses of the combination. Moreover, the starting torque of this auxiliary motor must be high, it being preferably attained by the employment of a non-inductive rotor resistance; this latter is also of value when synchronising, although not absolutely necessary.

To start up then, all that has to be done is, firstly, to speed up the combination by switching in the starting motor, and cutting out the rotor resistance until the combination is at maximum speed; secondly, close the field circuit of the synchronous motor, and regulate the exciting current to get the correct pressure; thirdly, reduce the speed by slowly adjusting the rotor resistance, until the synchronising lamps indicate exact synchronism; then switch the synchronous motor on the line, and afterwards cut out the starting motor and adjust both field systems as before.

If the starting motor is constructed with a permanently short-circuited rotor (conforming to American practice), the rotor windings being of comparatively high resistance and the stator fields very strong (in order to get the necessary starting torque), then the third operation above will consist in switching out the starting motor altogether as soon as the correct value of field current has been attained. The speed of the combination will, of course, immediately drop, and the main switches must be closed as the speed passes synchronism, as shown by the pulsations on the lamps. Naturally, the operation of putting the motor on the line cannot be so well done under these circumstances, and hence, as stated above, if a starting motor has to be used at all, it is better to use a rotor resistance in conjunction with it. It may be mentioned, however, in this connection, that if the generating sets in the power-station and the synchronous motors in the sub-station are well designed, and particularly if the latter machines are fitted with damping coils, the synchronous motors will pull themselves into step without doing any harm, if they are switched in at approximately synchronous speed, and consequently careful adjustment may be omitted in cases of necessity. But careful adjustment is always advisable, particularly if the motor is thrown in parallel with a number of machines already running, or if the power-station is lightly loaded, for the efforts made by the incoming machine to pull itself into exact synchronism may start the other motors hunting.

The third method of starting up a synchronous combination is referred to more particularly below, in connection with rotary converters; it consists in starting up from the alternating-current side by opening the field circuit of the synchronous motor, and then connecting the armature directly or indirectly to the line. The necessary torque is produced by the hysteresis drag, helped by eddy currents circulating in the pole-pieces or damping-coils, and is consequently small; the method has nothing to recommend it, although frequently used, and, moreover, a little consideration will show that its employment implies a motor of low efficiency at full load, as otherwise the above-mentioned losses in conjunction with the armature currents would not be great enough to get the necessary torque.

Apart from the question of power-factor, the running performance of synchronous motor generators is very similar to that of asynchronous machines, and, moreover, under proper conditions of supply, they are equally reliable.

(*c*) *Rotary Converter Equipment.*—Sub-stations equipped with rotary converters are of a far more complicated character than either of the types previously discussed, due to the special character of the machines and regulating devices. Although the rotary converter possesses similar characteristics to those of the synchronous motor and also to those of the direct-current machine, yet it possesses in addition a number of special features having a large influence on its performance, the result being that even when such machines are working under the very best conditions, they cannot compare, with regard to simplicity of operation, with either asynchronous or synchronous motor generators.

The first point to be noted in connection with the equipment of a rotary converter sub-station is that the rotaries require to be operated at low pressure. The pressure between any two slip-rings, whatever the nature of the armature winding, is always a definite percentage of that on the direct-current side with a given pole-width, being about 61 per cent. for three-phase and about 71 per cent. for two-phase rotaries,* consequently step-down transformers have always to be inserted between the slip-rings of the converters and the high-pressure feeders. For the large capacity units under consideration separate transformers are always used for each phase of the transmission line; but it may be noted here that for small three-phase or six-phase rotaries (up to about 100kw. capacity) it is always preferable to use three-phase transformers for the purpose, for, owing to their common magnetic circuit, possible pressure variation between the phases of the three-phase transmission becomes reduced in amount, as such transformers form excellent balancers.

In two-phase work there will be two transformers per rotary; in three-phase or six-phase work of the character under consideration there will be three. The manner in which these transformers are connected up in the two latter cases is of importance, and therefore a brief reference may be made to it here. Considering first the three-phase case, it may be stated once that, as a rule, the best arrangement of the three transformers will be to connect them up in a "mesh" on both high and low-pressure sides. This is principally because in the event of one transformer developing a fault and blowing its fuse, the supply need not be interrupted for a moment, for the remaining two will continue to supply a three-phase current

* These are the no load values—when the machine is loaded, they are naturally departed from to a small extent, on account of the armature drop. Moreover, if the impressed pressure-wave is not sinusoidal, the values given will be departed from.

to all three phases of the rotary; the reactions in the latter tend to keep the arrangement symmetrical, and the phases equally balanced. Under these circumstances the rotary can be kept fully loaded over the period of emergency, if not too long—naturally the increase of heating in the two transformers doing all the work must be carefully watched. If the transformers had been "star" connected, single-phase current would be delivered under the same circumstances, and the rotary would have to be immediately cut out on account of the heavy sparking that would occur at the commutator; even supposing sparking to be absent, the machine would not be able to carry anything like its full load over the period of emergency, and, moreover, the system would be thrown greatly out of balance. Another advantage (of secondary importance) with mesh-connected transformers is that the secondaries are cheaper to wind, because the area of the copper in the winding is 58 per cent. of the copper area for the corresponding "star" connected transformer.

One advantage of the "star" connection lies in the fact that the space taken up by the primary winding of each transformer is somewhat less in comparison, because the pressure across each transformer is only 58 per cent. of the full line pressure, and hence winding space is saved, on account of the reduction in the insulation. This is, of course, an advantage, especially when dealing with pressures of the order of 10,000 volts, but, in the author's opinion, it is one not to be compared with the safeguard against total breakdown afforded by the mesh connection.

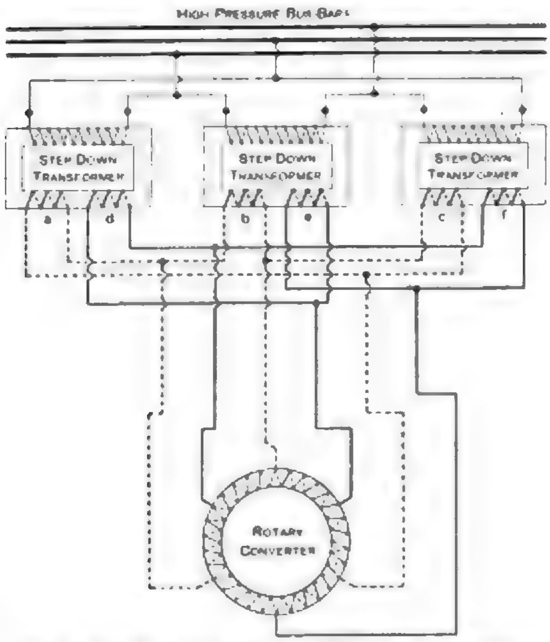


Fig. 1.—Six-Phase Mesh Connection for Rotary Converters.

Exactly the same arguments apply to the six-phase case, in which the secondaries of the transformers are arranged with either a double mesh or a double "star" connection, but preferably the former, as indicated diagrammatically in Fig. 1. It will be seen that this connection makes use of two distinct mesh connections, one superposed upon the other, the two meshes being in electrical connection through the armature windings of the converter. It is obtained from three single-phase transformers, similar in all respects, each being wound with two equal secondary windings.

The three secondary windings, *a*, *b*, *c*, are mesh connected, and led to three slip-rings in connection with the armature winding of the rotary at points 120 (electrical) degrees apart, while the three secondaries *d*, *e* and *f*, are also mesh connected, but in the opposite direction; the three conductors from the points of this mesh are taken to the remaining three slip rings on the shaft of the rotary, which are in connection with points on the armature winding 120 (electrical) degrees apart, and lying midway between the tappings to the three slip rings first mentioned. A little consideration will show that, under these circumstances and because one-half of the secondary of each transformer is cross connected relatively to the other half (the two halves differing therefore 180deg. in phase) the two meshes differ half a cycle (180deg.) from one another, and consequently satisfy the six-phase condition.

While the six-phase connection for rotary converters is more complicated and somewhat more expensive than the three-phase, yet it will undoubtedly pay to use it; as a matter of fact, it is somewhat surprising that the merits of this form of connection do not appear to be generally recognised, for Steinmetz and Kapp long ago pointed out that the output of any given rotary can be increased 40—50 per cent. by its use—that is to say, for the same mean heating of the armature coils, a six-phase rotary has an output to the value of the power factor of the alternating-current side. As the output of any well designed rotary converter is determined solely by the permissible temperature rise (there being no distortion of the field flux under usual working conditions—power-factor approximately unity), this increased output is a great practical advantage. Another advantage of the six-phase connection with rotary converters is that the heating of the armature is much more uniform—as is well known, in two and three-phase rotaries, those portions of the armature winding on each side of the tappings to the slip-rings heat up considerably more than the remaining portions of the winding. With a six-phase winding, the maximum temperature rise on the winding will rarely exceed the minimum by more than 20 per cent. It is not probable that the 12-phase connection will take a place in practice, for the gain in still further increase of output and uniformity of heating would be more than counterbalanced by the increased cost and complication.

On account of the fact that all rotary converters have to be fed from step-down transformers, the switch gear becomes more extensive for, although as a rule not necessary, it is good practice to provide switches in the secondary circuits of the transformers. There is, however, one case where such switches are absolutely necessary, and that is for two-phase rotaries arranged for starting from the direct-current side; in this case, unless the trans-

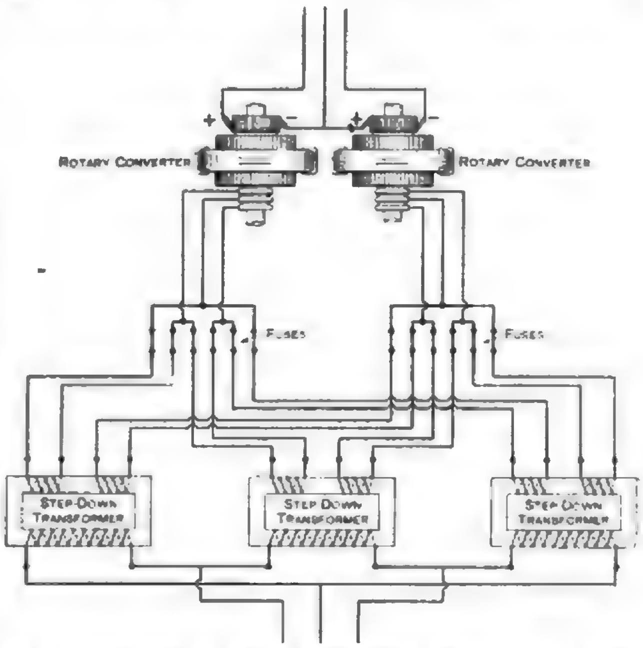


Fig. 2.—Connections for Rotary Converters in Parallel, feeding Three Wire System.

former secondaries are open, they become short-circuited (at the moment of starting) upon the armature winding, causing a great increase in starting current, and violent sparking at the commutator, until the machine is well towards full speed. The heavy current switches in the secondary circuits are best mounted upon, or close to the transformers, which latter should be close up to the rotaries, in order to reduce to a minimum the pressure drop, losses and cost of the heavy conductors.

Before leaving the subject of the transformer connections for three-phase rotary converters, it may be mentioned that a case sometimes arises in practice in which a special transformer arrangement is necessary. When two or more rotaries are not arranged to be fed (for any special reason) from separate groups of transformers on the alternating-current side, and they are connected to a three-wire network on the direct-current side, then it is necessary to wind each unit forming the group of (two or three) transformers feeding the rotaries with a multiple secondary winding, as described above, the arrangement being as shown in Fig. 2, illustrating the connections for two machines. That is to say, it is impossible to operate a number of rotaries feeding a three-wire network from common 'bus bars on the alternating-current side. The reason is readily apparent from the figure—the slip-ring sides of the machines cannot be *directly* paralleled, owing to the connection already existing on the direct-current side—if they were directly joined a disastrous short-circuit would naturally result. It may be noted in passing that the arrangement of the fuses in the secondary circuits of the transformers shown in this figure* (each conductor coming from a slip-ring is fused twice)

* This arrangement of fuses for such a case originated with the General Electric Co. (U.S.A.).

is a good one, for if one transformer gives out, the service will not be interrupted, for the reason already given above.

There is, however, a certain advantage in using *star-connected* transformers for converters feeding three-wire systems, for by the adoption of this form of connection better balancing can be attained; the secondary neutral points of each group of transformers may be profitably connected to the middle wire, which latter may or may not be earthed. Under these circumstances each rotary would be fed from a separate group of transformers.

The next question arising in connection with the equipment of a rotary converter sub-station is that of pressure regulation. It is clear that with motor generator sub-stations (whether asynchronous or synchronous), this question hardly comes in, for, as already indicated, the regulation is performed wholly on direct-current machines of standard design, either automatically or by hand, in the simplest possible manner. The conditions are, however, quite different with rotary converters, because the pressure on either side is practically totally independent of the field strength (although not of the field configuration), and, consequently, the direct-current pressure cannot be varied by regulation on the fields alone.

There are two commercial ways of regulating rotary converters, each depending upon the same principle, namely, that of altering the pressure on the slip-rings in order to get a corresponding alteration on the direct-current side; as already pointed out, the ratio of the two pressures is practically a constant. The first method consists in varying by hand the impressed pressure on the slip-rings, and can be employed in two ways—either the impressed pressure can be altered by altering the ratio of transformation of the step-down transformers, or it can be altered by means of an "induction regulator." In the first case, the step-down transformers are so arranged in conjunction with a multiple contact switch that either the number of secondary turns or the number of primary turns can be altered by hand, thus altering the ratio of transformation; the transformers supplying each rotary have their regulating switches interlocked, so that the turns are cut in or out simultaneously. It is obvious that this method has several disadvantages, the most serious being those of first cost, and difficulty of operation. If the regulation is performed on the primaries, the switches become somewhat difficult and expensive to construct properly, on account of the high pressure of the circuits into which they are connected, while if the regulation is performed on the secondary sides, the expense becomes even greater, on account of the heavy currents to be handled, while the difficulties that arise with the contact surfaces of all regulating switches for heavy currents are well known. But, in addition, there is the difficulty of arranging such switches to regulate gradually, and to avoid short-circuiting the sections of the transformer winding connected to the contacts of the regulator, as these sections are being cut out or in. Consequently, the employment of an induction regulator which does not suffer from any of the above-mentioned defects, and which has but small losses as a rule, will give the best results if hand regulation of the rotaries is asked for or desired.

On account of difficulties connected with insulation, induction regulators should be connected into the secondary circuits of the step-down transformers. As usually constructed, such regulators consist of an iron core arranged in connection with a shunt and series winding in each phase in such a manner that a movement of the core will decrease or increase the mutual induction between the two windings. Thus if the core is moved inwards, the pressure on the converter slip-rings is reduced, on account of the inductive action of the shunt winding on the series winding, while as the core is moved outwards, the effect of the shunt coils on the series coils become less and less, until at the end of the travel of the core the pressure on the slip-rings is practically the full pressure of the transformer secondaries. Such an apparatus is easy and cheap to construct, and very effective in operation, a range of 6 per cent., up or down, being easily attained; moreover, it can be readily arranged to be operated from a distance, and having no contacts or moving conductors, is unlikely to get out of order.

A modification of the induction regulator, first devised, the author believes, by Mr. M. B. Field, is shown in Fig. 3; it possesses the advantage of being somewhat more efficient than the induction regulator described above. The secondary of each step-down transformer has an extension in the form of some extra turns capable of carrying about 25 per cent of the full secondary current; these extra turns are connected to a small regulating switch, and to the windings of smaller section of a small auxiliary transformer (with ratio, say, 1 : 4) as shown. The secondary of the auxiliary transformer is in series with the low-pressure circuit, and adds or subtracts a small E.M.F. to this circuit as desired. It will be seen that both the voltage and current can be very readily handled, without undue expense, and, moreover, the supply is not interrupted should the regulating switch get out of order

The second method of varying the impressed pressure on the slip-rings of the rotary, in order to get the desired direct-current pressure, is of considerable technical interest. Briefly, it consists in compounding the rotaries, and providing a certain amount of self-induction between the terminals of the transformer secondaries and the slip-rings of the machines, if not already existing, by inserting choking coils in the various leads. The rotary converters, being synchronous machines, operate at a power-factor determined wholly by the field excitation; for an alteration of the latter with a given load on the machines increases or decreases the power-factor of the alternating current circuits; for each load on the rotary, there is, of course, a certain excitation that will make the power-factor a maximum, in accordance with the well-known "V" curve. Let now the shunt winding on the fields of a rotary converter, arranged with compound winding, and, if necessary, with small choking coils, be so adjusted that when operating at no load, the machine takes a certain amount of lagging current, say 30-40 per cent. of the full-load current, partly due to the under-excitation, partly due to the reactance in each phase. As the load comes on, the field flux increases, on account of the current in series winding—that is, the lagging current diminishes, and therefore the impressed pressure increases, producing a corresponding rise in the direct-current pressure: this strengthens the fields still more (on account of the shunt winding), until a balance between the two pressures is attained. At full load the field flux is at its working maximum; the input current will be by this time leading, due to the over-excitation having wiped out the lag produced by the reactance, and the direct-current pressure will be raised to the correct value, on account of the increased pressure on the slip-rings. By suitable proportions of the reactance and field windings excellent pressure regulation can be attained in this way in a perfectly automatic manner; it is perfectly easy to arrange for the direct-current pressure to be over-compounded 10 15 per cent., the actual regulation being nearly as good as with an ordinary over-compounded direct-current machine,* provided the

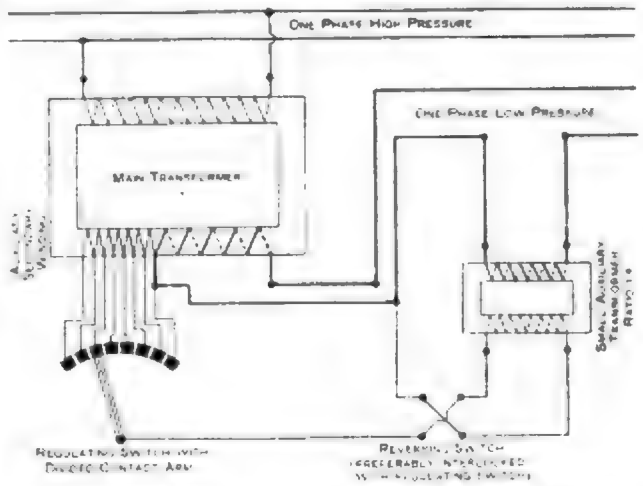


Fig. 3.—Diagram of Connections for one form of Induction Regulator.

pressure at the ends of the feeders in the sub-stations is maintained as nearly as possible constant. The only objection to this method of regulation is the influence it has upon the regulation at the feeding points—that is, at the high-pressure bus bars in the sub-stations, for with a number of the latter in parallel, the variation of the power-factor naturally means that the attainment of constant pressure at the ends of the feeders becomes a difficult matter.

The extent to which over-compounding of rotaries can be carried—by means of the above-described method—depends mostly upon the rating of the machine with regard to the work it has to do. The limit is of course reached when the current running into the rotary is made to lead (by increasing the exciting current) the impressed pressure by 90deg., for then the inductive E.M.F. of the choking coil (which is 90deg. behind the current) is in phase with the impressed pressure, and consequently boosts it by that amount; if the current lags behind the impressed pressure by 90deg., the inductive E.M.F. of the coil is half a cycle behind the impressed pressure, and diminishes the latter to a value given by subtracting the inductive E.M.F. of the choking coil from the impressed pressure. Neither of these limits are found in practice, for if the angle or lag or lead exceeds certain well-defined values (depending upon the shape of the "V" curve—that is, upon the armature reaction of the machine), the rotary will naturally not carry its rated load. The more liberally rated is the converter, the greater is the range of regulation attained; if the amount of over-compounding required is large (say 15-25 per cent.), the rotary must be chosen large for the work it has to do, although not in this proportion.

* With a rotary converter of standard design, the change of field flux necessary in order to get the desired amount of over-compounding is much greater than is required with the equivalent direct-current machine, for the direct-current pressure is not proportional to the field flux, but proportional to the impressed pressure on the slip-rings.

Compound-wound rotary converters are connected and paralleled on the direct-current sides in precisely the same manner as similar direct-current machines, equalising 'bus bars and switches being used, and therefore the same precautions have to be taken with them should accumulators be used in parallel with the low-pressure feeders.

From what has been said above, it will readily be seen that of the two good methods put forward for regulating the pressure on the direct-current sides of the machines, that best adapted for the requirements of lighting work is given by the employment of induction regulators, allowing the pressure to be gradually varied by hand in accordance with the slowly-varying load; for traction work, the employment of compound windings (that is, regulation by lagging and leading currents) is preferable on account of the large range of regulation required, and the rapid variations of the load. In some special cases, however, the combination of the two methods will give very good results.

With regard to the starting of rotary converters, all the remarks already made regarding the starting of synchronous motor generators are applicable, as the only difference in this respect between the two classes of machine is that rotary converers are invariably arranged to be self-exciting from their direct-current sides. Wherever possible then, such machines should be arranged to be started from the direct-current side, either from the 'bus bars, or from an auxiliary asynchronous motor generator. As in the other case, this latter indirect method of starting is far preferable to any other, if no direct current is available at the switchboard.

The next best method to this is that given by induction motors directly coupled to the shafts of the rotaries, while the fourth and last method available (briefly noticed already in connection with the starting of synchronous motors) simply consists in switching the machine directly on the high-pressure lines. As this method has been put forward in connection with several important British schemes, and is in use in more than one of them at the present time, it may not be out of place to devote a few words in its consideration, although in general the method is objectionable.

Any modern synchronous polyphase motor can be started up without difficulty from the high-pressure lines, no matter how constructed; that is, whether the field poles be solid or laminated, whether provided with damping coils or not, &c.—it is only a matter of sufficient starting current and good mechanical design. This method of starting, as used in connection with rotary converter plants, is as follows:—The direct-current main and field-switches are opened, only a voltmeter being left across the direct-current side, and then the line-current is switched on the slip-rings either at full or reduced pressure, this latter being arranged for by an alteration in the number of secondary turns on the step-down transformers. Owing partly to the eddy currents in the pole-pieces, metal cheeks of field-bobbins, damping coils (where these are used), but principally to the hysteresis lag in the pole-pieces, the rotary immediately starts, and is very soon up to synchronous speed. The voltmeter (already referred to) on the direct-current side indicates nothing at the moment of starting beyond very feeble oscillations of the pointer, for the current traversing its coils is, of course, alternating; but as the rotary increases its speed the pointer begins to move backwards and forwards over the scale, its movements corresponding to the rapidly diminishing frequency of the pressure at the direct-current terminals; when synchronous speed has been reached the voltmeter pointer will again be steady, for the current through it is now a direct current. The proper time for putting on the field current is just before synchronism is reached, and is indicated by the voltmeter; when the beats of the pointer are slowest, that is, just below synchronous speed, when the pointer is moving slowly from side to side over the scale, the field current can be put in. But it may be noted here that it makes all the difference at which side of the scale the pointer is when the field circuit is closed; one side is right and the other wrong, depending upon individual circumstances. If the fields have been put on when the pointer is at the wrong side of the scale, then the polarity of the direct-current side of the converter will be reversed; with most machines this means that the rotary must be switched out and synchronised again in order to get synchronism at the right pole. In order to make quite sure that the machine has synchronised at the right pole, it is good practice to provide a pole indicator on each direct-current panel, so that after the excitation has been put on, the polarity of the direct-current side can be checked before the rotary is connected to the direct-current 'bus bars. Needless to say, a lamp can be substituted for the voltmeter mentioned above across the direct-current terminals—it will be bright at the first moments of starting, and also when the neighbourhood of synchronous speed is reached, while between these limits the light will pulsate, and the excitation should be put on when the light is pulsating slowly, the lamp being either bright or dark, according to circumstances.

It will be readily understood that the above remarks regarding the right time to put on the excitation in order to get the right polarity are only applicable to the case of self-exciting machines; if the machines are 'bus excited, which is very seldom, the converter will pull itself round under protest to the correct polarity with a great rush of current, no matter at which pole the machine has synchronised. A point worthy of note is that, even without the exciting current, the rotary will come up to absolute synchronous speed, for there is no induction motor action with the rotary converter or synchronous motor. A rotary converter can operate without field excitation, by reason of the heavy lagging currents that would run through its armature windings under these circumstances; these wattless currents magnetise the fields to the extent necessary to produce the balancing back E.M.F. of the armature. However, such a method of operation cannot be commercial, for the machines would not carry their rated load; the heavy lagging currents would overload the mains and destroy the pressure regulation of both sides of the system, and the rotaries would spark and hunt. Up to the present, the author has not made any tests on the operation of large rotaries without field excitation, for there is generally little time for such experiments when putting down plant, and, moreover, they may turn out to be somewhat costly; it is an interesting question, however, and it would be of value to know from those who have actually made tests on large units under commercial conditions whether the objections given above are as real as they appear to be. Perhaps with machines having high armature reaction (small air-gaps, &c.), the full load could be carried without the machine stopping, but its performance under these circumstances could hardly be otherwise than poor, quite apart from the bad effect produced on the system; moreover, rotaries with considerable armature reaction have a greater tendency to hunt than those with very stiff fields.

When starting a converter in the manner above described, it is necessary to take certain precautions until synchronism is attained; the series field-windings must be open as well as the shunt, and these latter windings must be opened in five or six places. Otherwise they would break down, due to the large E.M.F. (many thousand volts) induced in them by the alternating flux of the armature. Also, as the starting current will never be less than twice the full-load current, even if damping-coils are used, and will frequently be of the order of three or four times the full-load current, it is necessary to make arrangements for short-circuiting the ampere-meters and fuses, otherwise they would be damaged by the overload.

The great objections to the above-described method of starting are, of course, the large starting current required, and the risk of getting the wrong polarity; the former will wholly upset the pressure regulation of the system, partly on account of its magnitude, but principally because of its low power-factor, while the latter might cause an accident, and in any case would cause time to be lost when adding a machine to the circuit. For lighting work the employment of this method is absolutely out of the question.

*(To be continued.)*

## A NEW PLANTÉ PLATE.

The accumulator made by Geoffroy and Delore, at Clichy, near Paris, under the name of the "Omega" is manufactured in Germany by the Berlin Accumulatoren und Elektricitats Gesellschaft who have obtained from the above-named firm the licence to use their French patent. The peculiar and very practical construction of the electrode which makes it specially suitable for stationary batteries for light and power, and especially for tram batteries, is described by Herr Weber in a recent number of the *Centralblatt für Accumulatoren und Elementenkunde.*

The electrode, which can only be used as a positive, is a so-called large surface plate. Practice shows that such Planté plates, especially when they have a straight core, bulge easily, become distorted, bent through, and finally torn, in consequence of the differences between the potentials which are caused by the expansions and contractions of both sides of the surfaces, which take place during charge and discharge. Therefore, in the electrode in question, the centre of gravity is placed on the frame of the core, which ought to prevent curvature.

The patent claim runs thus: Accumulator plates provided on both sides with ribs or projecting flaps, and distinguished by having their core formed in waves or zig-zag.

The construction is shown in Figs. 1 and 2. For practical use the zig-zag shape is preferred for the core, and on it are placed on each side triangular blades side by side a short distance apart which hang together on the point of a prong, whilst on the deepest part of the core, on the other surface opposite this spike a groove is provided whereby each blade can expand freely in all directions. The shape of the core guarantees an extraordinary power of resistance in the plate against impressions and bucklings. The construction has the further advantage that a large active surface is obtained which is about 17 times as large as the projection surface of the plate. The manner of arranging the blades further assures a good circulation of the electrolyte. In the most serviceable form of construction the plate is 22cm. broad, 27cm. high, and 14cm. thick, and the weight of such a plate amounts to about 5kg.

With a discharge current of 30 amperes the capacity of a positive plate between two negatives was determined by the Société Interna-

tionale des Electriciens at the Laboratoire Central d'Electricité at 32·9 ampere-hours with an initial potential of 2 volts, and an end potential of 1·75 volts. Further measurements yielded a capacity of 25 ampere-hours with a discharge of 100 amperes and a fall of potential to 1·7 volt. After continuous charging and discharging with 80 amperes, no injurious effect was found by this extraordinary demand on the plate. With a 3-hour discharge the capacity of the plate increases to 54 ampere-hours.

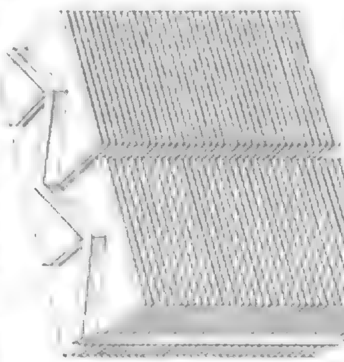


FIG. 1

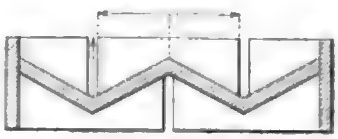


FIG. 2

It was very important for the practical manufacture of the plate that a peculiar method of formation was found, making a complete formation in three days feasible, and at the same time avoiding the employment of chemicals which might have been followed by a destructive action. With this extremely simple and cheap process, Herr Weber claims that it is possible to form plates as rapidly and easily as grid plates filled with paste, so that the difficulties connected with the formation of Planté plates may, he says, be definitely considered as overcome, the more so as the process, modified for each particular case, has shown its applicability to Planté plates of other construction. In conclusion, the article states that a great number of storage batteries have already been set up with these plates for light and power central stations, and the construction has fulfilled in every respect the expectations founded on it.

## ELECTRICITY WORKS ACCOUNTS.

### Westminster Electric Supply Corporation (Ltd.).

The Westminster accounts for 1900 are consistent with the directors' report in indicating how materially the profits were affected by the high prices paid for coal. From our table it will be noticed that the cost per unit was higher by 42 per cent. than it was in the preceding year, and that consequently, instead of a slight diminution, there occurred a material rise in the works and total costs. Yet the whole of the costs column —especially the works costs portion—shows most excellent results. Since the supply of current at 200 volts the revenue has diminished as a result of the allowance of 8 per cent. in the price to customers supplied at that pressure. With the exception of nine all the consumers (5,651) were, at the end of the year, supplied at the higher pressure.

As the result of the experimental street lamps erected near Victoria Station which have been running some time, the company have entered into an agreement with the vestry of St. George's, Hanover-square, for lighting the whole of the parish by electricity. The work of laying mains and erecting lamp-posts to this end is being proceeded with.

During last year the lamp connections were increased by 11·4 per cent., while the output was higher than in 1899 by 15 per cent., with a load factor of 18·8 per cent.

The length of roadway laid with mains now exceeds 54 miles. There are about 219 miles of ways into which over 188 miles of cable and copper strip have been drawn.

We repeat the following table for comparison :—

| Year. | No. of consumers. | Equivalent lamp connections. | Units sold. | Maximum supply demanded. Kw. | Load factor. | Plant capacity. Kw. | Ord. div. % |
|---|---|---|---|---|---|---|---|
| 1891 | 763 | 62,800 | 627,500 | 700 | 10·2 | ... | ... |
| 1892 | 1,255 | 98,646 | 1,217,871 | 1,200 | 11·6 | ... | 3½ |
| 1893 | 1,730 | 131,563 | 1,704,615 | 1,400 | 13·9 | ... | 4 |
| 1894 | 2,259 | 167,700 | 2,173,298 | 1,917 | 12·9 | ... | 5 |
| 1895 | 2,890 | 210,980 | 2,830,396 | 2,130 | 15·2 | 3,765 | 7 |
| 1896 | 3,480 | 249,318 | 3,503,054 | 3,000 | 13·3 | 3,765 | 9 |
| 1897 | 4,000 | 290,561 | 4,355,781 | 3,660 | 13·6 | 4,533 | 12 |
| 1898 | 4,550 | 366,764 | 5,066,195 | 4,400 | 13·1 | 5,658 | 12 |
| 1899 | 5,100 | 421,445 | 6,329,544 | 5,420 | 13·3 | 6,198 | 13 |
| 1900 | 5,651 | 469,589 | 7,281,109 | 6,030 | 13·8 | 7,770 | 10½ |

### Notting Hill Electric Lighting Co. (Ltd.).

Two influences combined to occasion the rise in the cost of supply at Notting Hill last year. First there was the inevitable increase in the coal bill, which placed an additional 0·21d. per unit on the fuel item and raised it to nearly 0·9d. Then under "Repairs and maintenance at station" had to be included £1,209 spent in repairs to accumulators, which involved the entire renewal of one set of batteries and increased the costs under this head from 0·817d. to 0·514d. per unit.

Owing to the fact that the new works in Wood-lane were not ready in time to meet the winter load supply contracts had to be declined, with the result that the additional lamps connected were no more than 9,400, raising the total by 15·8 per cent. It will be noticed from our table that electricity has already been supplied from the generating station at Wood-lane being erected jointly by this company and the Kensington and Knightsbridge Company. The estimated cost of these works was £100,000, and this estimate has not been exceeded. No part of the capital of the Notting Hill Company has been utilised for this purpose.

As explained above, the already high repairs item of 1899 has been greatly increased, the fuel item is naturally beyond fair comparison, but the other two items of generating costs are very reasonable. Another reduction has been effected in both the management and property charges, but the total is still much too high.

The following table shows the growth of the undertaking :—

| Year. | No. of consumers. | Equivalent lamp connections. | Output, units sold. | Total revenue. | Gross or working profit. | Total costs per unit sold. | Ord. div., %. |
|---|---|---|---|---|---|---|---|
| 1891 | 77 | 6,056 | 30,162 | £1,623 | – £555 | 17·34d. | nil |
| 1892 | 124 | 9,438 | 75,667 | 3,513 | + 112 | 10·78d. | nil |
| 1893 | 173 | 12,153 | 107,580 | 4,329 | + 1,481 | 6·36d. | nil |
| 1894 | 234 | 15,669 | 130,266 | 5,123 | + 2,102 | 5·57d. | 1 |
| 1895 | 307 | 20,307 | 182,327 | 6,940 | + 3,223 | 4·89d. | 2 |
| 1896 | 386 | 25,716 | 230,787 | 8,552 | + 4,735 | 3·97d. | 4 |
| 1897 | 571 | 33,000 | 354,969 | 11,626 | + 6,854 | 3·22d. | 6 |
| 1898 | 788 | 46,066 | 455,671 | 13,418 | + 7,252 | 3·25d. | 6 |
| 1899 | 1,012 | 59,154 | 665,129 | 17,674 | + 10,361 | 2·64d. | 7 |
| 1900 | 1,190 | 68,505 | 782,215 | 19,963 | + 9,856 | 3·10d. | 7 |

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 19 0 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.)(Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 16, 1900 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 13, 1900 |
| Cambridge (Company) | April 13, 1900 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| hester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Eastbourne (Company) | May 4, 1900 | Southport (Municipal) | July 7, 1899 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Exeter (Municipal) | Aug 5, 1898 | Stafford (Municipal) | Aug. 17, 1900 |
| Folkestone (Company) | April 27, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | May 18, 1900 |
| Hanley (Municipal) | July 27, 1900 | Westminster (Company) | Mar. 9, 1900 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | Oct. 26, 1900 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Woolwich (Company) | Jan. 12, 1900 |
| Kens'gton & Knightsbr' (Co.) | Mar. 16, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Great Yarmouth (Mun.) | Dec 28, 1900 |

| | WESTMINSTER. | | | | NOTTING HILL. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Westminster Elec. Supply Corporation (Ltd.) | | | | Notting Hill Electric Lighting Co. (Ltd.) | | | |
| *Date of Commencement of Supply* | Nov., 1890. | | | | May, 1891. | | | |
| *System of Supply* | Con.-curr. three-wire, with batteries. | | | | Con.-curr., three-wire, with batteries. | | | |
| *Chief Engineer* | A. B. W. Kennedy. | | | | George Schultz. | | | |
| **YEAR ENDED** | DEC. 31, **1899.** | | DEC. 31, **1900.** | | DEC. 31, **1899.** | | DEC. 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 7,361,745 | | 8,618,640 | | 696,878 | | 827,296 | |
| " SOLD (TOTAL) | 6,329,544 | | 7,281,109 | | 665,129 | | 782,215 | |
| " sold to consumers | 6,329,544 | | 7,281,109 | | 665,129 | | 782,215 | |
| " sold for public lighting, &c. | nil | | — | | — | | — | |
| " used on works | 62,680 | | 80,265 | | 16,251 | | 21,020 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 32·7 | | 30·0 | | 33·2 | | 39·1 | |
| Maximum supply demanded | 5,420 | | 6,030 | | 620 kilowatts | | 640 kilowatts | |
| Number of public lamps | — | | 12 arc | | nil | | nil | |
| Number of consumers | 5,100 | | 5,651 | | 1,012 | | 1,190 | |
| Connections to mains in 8-c.p. lamps | 421,445 | | 469,689 | | 59,154 | | 68,505 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 193,500 | | 243,000 | | 20,000 | | 20,000 | |
| CAPACITY OF PLANT IN KILOWATTS | 6,198 | | 7,770 | | 640 | | 640 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | £649,500 | £105 | £800,000 | £103 | £150,000 | £234 | £250,000 | £391 |
| Share | 399,500 | 64·5 | 550,000 | 70·8 | 100,000 | 156 | 200,000 | 313 |
| Loan (including Debenture charges) | 250,000 | 40·3 | 250,000 | 32·2 | 50,000 | 78·2 | 50,000 | 78·2 |
| RECEIVED (TOTAL) | 649,500 | 105 | 797,600 | 103 | 131,000 | 205 | 172,000 | 269 |
| Share | 399,500 | 64·5 | 547,600 | 70·5 | 100,000 | 156 | 122,000 | 191 |
| Loan (including Debenture charges) | 250,000 | 40·3 | 250,000 | 32·2 | 31,000 | 48·5 | 50,000 | 78·2 |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | nil | — | 2,400 | 0·309 | 19,000 | 29·7 | 78,000 | 122 |
| Share (unissued) | nil | — | 2,400 | 0·309 | nil | — | 78,000 | 122 |
| Share (uncalled) | nil | — | nil | — | nil | — | nil | — |
| Loan (including Debentures) | nil | — | nil | — | 19,000 | 29·7 | nil | — |
| REPAID (TOTAL) | — | — | — | — | — | — | — | — |
| RESERVE OR SINKING FUND | 21,951 | 3·54 | 25,217 | 3·25 | 6,000 | 9·38 | 11,000 | 17·2 |
| DEPRECIATION FUND | 60,330 | 9·73 | 73,712 | 9·49 | | | | |
| EXPENDED (TOTAL) | 683,568 | 110 | 753,007 | 96·9 | 137,351 | 215 | 164,990 | 258 |
| Lands and buildings | 189,916 | 30·6 | 201,422 | 25·9 | 23,559 | 36·8 | 30,071 | 47·0 |
| Plant | 214,506 | 34·6 | 249,114 | 32·1 | 32,734 | 51·1 | 41,632 | 65·1 |
| Mains | 264,970 | 42·8 | 288,317 | 37·1 | 76,196 | 119 | 88,395 | 138 |
| Miscellaneous | 14,176[a] | 2·29 | 14,155[a] | 1·82 | 4,861 | 7·60 | 4,890 | 7·64 |
| BALANCE OF CAPITAL ACCOUNT | −34,068[b] | −5·50 | 44,593 | 5·74 | −6,351[a] | −9·92 | 7,010 | 10·9 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| TOTAL | £132,939 | 5·042d. | £149,751 | 4·935d. | £17,674 | 6·380d. | £19,963 | 6·128d. |
| Revenue from supply | 127,574 | 4·840d. | 143,882 | 4·740d. | 16,423 | 5·930d. | 18,797 | 5·772d. |
| " meters, &c. | 5,144 | 0·195d. | 5,490 | 0·181d. | 654 | 0·236d. | 798 | 0·245d. |
| " public lighting | — | — | 299 | 0·010d. | nil | — | nil | — |
| " sale of lamps, &c. | — | — | — | — | 313 | 0·113d. | 125 | 0·038d. |
| " miscellaneous sources | 221[c] | 0·008d. | 79 | 0·003d. | 284 | 0·103d. | 243 | 0·075d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £54,606 | 2·072d. | £69,916 | 2·303d. | £7,313 | 2·639d. | £10,107 | 3·102d. |
| WORKS COSTS | 34,736 | 1·318d. | 48,032 | 1·582d. | 3,881 | 1·401d. | 6,296 | 1·932d. |
| *Generation of electricity* | *31,531* | *1·196d.* | *44,250* | *1·458d.* | *3,680* | *1·328d.* | *5,780[f]* | *1·774d.* |
| Fuel (including cartage, &c.) | 17,710 | 0·672d. | 28,851 | 0·951d. | 1,902 | 0·687d. | 2,918 | 0·896d. |
| Oil, waste, water, stores | 2,145 | 0·081d. | 2,582 | 0·085d. | 255 | 0·092d. | 385 | 0·118d. |
| Wages at station | 7,974 | 0·302d. | 8,267 | 0·272d. | 646 | 0·233d. | 693 | 0·213d. |
| Repairs and maintenance at station | 3,702 | 0·140d. | 4,550 | 0·150d. | 877 | 0·317d. | 1,674 | 0·514d. |
| *Distribution of electricity* | *3,205* | *0·122d.* | *3,609* | *0·119d.* | *201* | *0·073d.* | *516* | *0·158d.* |
| Wages, &c. | 1,513 | 0·057d. | 2,047 | 0·067d. | 201 | 0·073d. | 516 | 0·158d. |
| Repairs, renewals of mains, &c. | 1,692 | 0·064d. | 1,562 | 0·052d. | | | | |
| *Public lighting* | — | — | *173* | *0·006d.* | nil | — | nil | — |
| Attendance | — | — | 173 | 0·006d. | — | — | — | — |
| Renewals | — | — | | | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 19,870 | 0·754d. | 21,884 | 0·722d. | 3,432 | 1·240d. | 3,811 | 1·170d. |
| *Royalties* | nil | — | nil | — | nil | — | nil | — |
| *Rent, rates, taxes* | *6,646* | *0·252d.* | *7,591* | *0·250d.* | *650* | *0·235d.* | *678* | *0·208d.* |
| *Management* | *13,224* | *0·501d.* | *14,293* | *0·471d.* | *2,782* | *1·004d.* | *3,133* | *0·961d.* |
| Salaries | 10,916[d] | 0·414d. | 11,288[d] | 0·372d. | 2,336 | 0·843d. | 2,614 | 0·803d. |
| Stationery, &c. | 487 | 0·018d. | 485 | 0·016d. | 223 | 0·081d. | 316 | 0·097d. |
| Establishment charges | 670 | 0·025d. | 763 | 0·025d. | | | | |
| Law charges, &c. | 1,151[e] | 0·044d. | 1,757[i] | 0·058d. | 223[b] | 0·081d. | 203[g] | 0·062d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £78,328 | 11·96% | £79,835 | 11·12% | £10,361 | 7·80% | £9,856 | 6·52% |
| Sum carried to Depreciation Fund | 17,014 | 2·596 | 18,654 | 2·60% | 1,550 | 1·17% | 792 | 0·524% |
| Sum carried to Reserve or Sinking Fund | 4,117 | 0·628 | 6,945[j] | 0·967% | | | | |
| Net interest on loans (incl. Debenture charges) | 6,461 | 0·986% | 8,511 | 1·19% | 1,183 | 0·89% | 1,619 | 1·07% |
| BALANCE FROM LAST ACCOUNT | 1,001 | 0·153% | 2,191 | 0·305% | nil | — | nil | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | 53,977 | 8·240% | 49,679[k] | 6·92% | 7,627 | 5·75% | 7,445 | 4·92% |
| *Deficit* | — | — | — | — | — | — | — | — |
| ORDINARY DIVIDEND PAID | 13% | — | 10½% | — | 7% | — | 7% | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 41·1% | | 46·7% | | 41·4% | | 50·7% | |
| Expenditure per kilowatt capacity | £8. 16s. 4d. | | £9. 0s. 0d. | | £11. 8s. 5d. | | £15. 16s. 0d. | |
| REVENUE PER KILOWATT CAPACITY | £21. 9s. 2d. | | £19. 5s. 7d. | | £27. 12s. 0d. | | £31. 3s. 10d. | |
| Expenditure per 8-c.p. lamp capacity | 5s. 7¼d. | | 5s. 9¼d. | | 7s. 3¾d. | | 10s. 1¼d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 13s. 9d. | | 12s. 4d. | | 17s. 8d. | | £1. 0s. 0d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 6s. 3¾d. | | 6s. 4½d. | | 5s. 11¾d. | | 5s. 10d. | |
| Price charged for lighting, per unit | 6d.[f] | | 6d. to 4d.[g] | | 6d. | | 6d.[d] | |
| Price charged for power, per unit | 3d.[f] | | 3d.[h] | | 6d.[c] | | 4d.[e] | |
| Price charged for public lighting | — | | — | | — | | — | |

WESTMINSTER.—REMARKS.—*a* Includes £10,134 to purchase of City of Westminster Electrical Syndicate. *b* Over expended. *c* Includes £[illegible] profit from supply of steam. *d* Includes directors fees, £3,[illegible]. *e* Insurance £649, law and parliamentary charges £[illegible], auditing £[illegible], and experiments and costs re smoke abatement £92. *f* With rebates. *g* 6d. for first 4,000 units per annum, 4d. for remainder less 5 per cent. for supply at 200 volts. *h* Less 5 per cent. for supply at 200 volts. *i* Law £785, insurance £64[illegible], auditing £[illegible], loss on supply of steam £154, and smoke abatement experiments and cost £89. *j* Inclusive of £4,445 written off debenture redemption and new share issue account. *k* After adding £1,702 rents.

NOTTING HILL.—REMARKS.—*a* Over expended. *b* Includes £[illegible] to auditing and £[illegible] to insurances. *c* Less 20 per cent. *d* At 200 volts or 5d. at 100 volts. *e* At 200 volts. *f* Inclusive of £111 paid for electricity supplied from Woodlane Works. *g* Inclusive of £[illegible] to auditing and £107 to insurance.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny.
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## THE WORKING OF THE PATENTS ACTS.

The report of the Committee appointed by the Board of Trade to consider several points in the working of the Patents Acts has now been published and forms a very interesting document. The scope of the inquiry was a very limited one, the most important point submitted to the Committee being to determine "whether any, and if so, what additional powers should be given to the Patent Office to (*a*) control, (*b*) impose conditions on, or (*c*) otherwise limit the issue of Letters Patent in respect of inventions which are obviously old, or which the information recorded in the office shows to have been previously protected by Letters Patent in this country." In considering the suggestions of the Committee on this point, it is absolutely essential to keep in mind the fact that the Government expressly stated—and rightly in our opinion—in the reference to the Committee, that it did not propose to establish any general system of examination as to novelty of inventions in respect of which applications are made for Letters Patent. This requires to be emphasised all the more, in that failure to realise the true position of the Committee seems already to have led to considerable misapprehension of its report. The Committee finds that a large percentage of specifications accepted have been anticipated in whole or in part in earlier specifications; and it therefore recommends that the Patent Office should examine whether any invention, forming the subject of an application, has been claimed or described in any specification of patents *granted in the United Kingdom* dated less than 50 years previous to the date of the application, but that this inquiry should not extend to provisional specifications which have not been followed by a complete specification. The words we have italicised show that this search would be quite inadequate and useless if it had been desired to make the grant of a patent *prima facie* evidence of

its validity: all that the Committee aims at is to prevent the issue, so far as is possible, of invalid "blocking" patents, which may tend to the restraint of trade and to the embarrassment of honest traders and inventors. If a search results in the discovery of anticipating patents, the application is not to be granted without specific references to such patents, unless the applicant can amend his specification so as to satisfy the Comptroller, and an opportunity of doing so will be given him. It is evident that, if this proposal is carried out, it will put more power in the hands of the Comptroller and Law Officer than at present, and it may even be asked whether it is not preferable that the questions of subject-matter and novelty should not be decided by the Patent Office, except, as heretofore, on the most general lines. The tribunal *par excellence* for the determination of these most difficult questions, as they often undoubtedly are, is the High Court. It should be noticed also that two members of the Committee—the Solicitor-General and Col. Harding—seem to take this view, for they maintain that after the result of the official search is put before the applicant, he should be left to amend his specification or not, as he thinks fit. This suggestion, especially if coupled with a further proposal made by Col. Harding—viz., that at the end of every specification notice should be given to the public that the list of specifications cited against it may be obtained on payment of 2s. 6d., seems much more reasonable and much more in keeping with the spirit of our patent laws, which aims at giving assistance to inventors rather than putting restraint upon them.

The procedure suggested by the Committee would undoubtedly lead to a large increase in the number of cases before the Comptroller, and indeed provision is made in the proposals of the Committee for the addition of several qualified assistants to assist that officer in this work. With the example of the American Patent Office before us as a warning, we need not fear that the same delay in the granting of a patent as in that country would be induced by the proposed change of procedure; but it would be regretable if, to compensate a possible delay, the period between the filing of a provisional and complete specification by the inventor should be reduced from nine to six months. The method proposed by the Committee to meet the increased expenditure of the Patent Office, involved in making the search for 50 years back in the case of every application for which a complete specification is lodged, does not meet with our approval, nor do we think the reason given for it by the Committee a forcible one. It is proposed to charge an additional fee of £1 over and above the present fees when the seal is granted to a patent, and this, says the Committee, "as it will only be payable if the patent be completed, will operate as an inducement to applicants not to proceed with patents which are really invalid." In most cases where serious anticipations are put before the inventor, which cannot be got over by judicious amendment of his specification, that fact will be a sufficient inducement to him not to proceed further; but if it is insufficient the extra charge of £1 is not likely to prove more effective, especially when it is remembered that this is only one-hundredth part of the sum which will have to be paid to keep the patent alive for the full term of 14 years. Moreover, if this proposal is carried out, those applicants who find that their ideas have been patented already, and resolve thereupon to proceed no further with their application, get the benefit of the official search for nothing, and the whole cost of that search falls upon the really meritorious inventor whose invention has not been anticipated. Mr. Carpmael differs from the opinion of the other members of the Committee on the ground simply of objection to an increase of fees; and the proposal which he makes aims at a greater inducement to applicants to abandon applications relating to inventions shown by the search to have been already patented; but it may also be employed to explain our point of view. He thinks the fees should be £1 on application, £1 on lodging the complete specification, and £2 on sealing the patent. Under this scheme, by the payment of £1 with the complete specification every applicant would pay for the search made in his own case. If he goes no further, the Patent Office can scarcely with justice demand from him full patent fees, for no patent is granted; but if he does pursue his application he has naturally to make a further payment of £2 as part of the consideration for the four years' protection granted to him.

A somewhat novel proposal is put forward by the Committee in consequence of the limitation of the search to a period of 50 years. The publication of an invention in the form of a patent specification dated 50 or more years previous to the date of the application shall not of itself, the Committee suggests, be deemed an anticipation of the invention. Probably this would not make much difference in patent actions, as it is seldom that a specification 50 years old is seriously relied on as an anticipation; but this curious result will follow, that while the specification itself may not be relied upon, any other publication of the invention—as, for instance, a description of it in a journal—will still be available for the purpose of upsetting a patent which it seems to anticipate. It would be wrong to say that occasions never arise where reliance can be put upon such old discoveries, for scarcely a month ago an American patent for an apparatus using the magnetic blow-out principle was upset chiefly because of the publication by Davy, nearly a century ago, of his discovery of that principle. We can readily imagine a case in which an intricate legal discussion might arise whether a description of an old invention in some journal is merely a repetition of the original patent specification, and is therefore debarred from the consideration of the Court. It will be remembered that prior to 1885 abandoned provisional specifications were published. As the recommendation also says that these should no longer constitute anticipations, no matter what their date, it might also lead to new "inventors" being allowed to make much wider claims than they are really entitled to make. For if anyone could detect in a provisional specification the "missing link" which alone might be necessary to make the invention a success, he would not be tied down, as at present, to a claim merely for the invention of that link, but might claim the whole invention.

The other points dealt with by the Committee are of minor importance. One is the proposed transference of jurisdiction from the Board of Trade to the High Court in the granting of compulsory licences, thus making provision for the award of costs. In this matter, however, Sir Edward Fry preferred a scheme similar to that in force in some foreign countries, for defeazance of Letters Patent if the patentee does not use his privilege reasonably. Much is to be said in favour of both views, but since the case so seldom arises in which it is deemed advantageous to apply for a compulsory licence, it seems unnecessary to us to impose on the foreign inventor the burden of constructing his invention in this country within a specified time under the penalty of declaring his British patent void. If all the recommendations of the Committee are carried out, it would be well for the Government to consider another suggestion made independently by Sir Edward Fry in an appendix to the report, to extend the scope of the Patent Office inquiry to whether the invention is "obviously old."

At present one feels no sympathy with the resuscitator of an old idea who has not taken the trouble to examine the archives of the Patent Office to see if his would-be invention has been anticipated. But should the remarkable 50 year oblivion rule suggested by the Committee be put into effect, there might be a danger of unscrupulous patentees taking advantage of it by serving up "obviously old" ideas in new patents which it might be troublesome to upset. Altogether there is much food for comment and thought in the Committee's recommendations, and we trust that the Government will act with proper deliberation before basing upon them too radical a modification of our patent laws.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. Fournier D'Albe.]

*Distribution of Current over a Cathode.*—In exhausting cylindrical vacuum tubes containing circular cathodes nearly filling up the cross section, it is often noticed that the cathode and canal rays, which at high pressures fill up the whole tube, are gradually driven away from the walls until nothing remains but a thin pencil of rays along the axis of the tube. This observation suggested to A. Wehnelt that a considerable diversity should exist in the current intensity traversing different parts of the same cathode, and to find whether this was the case he constructed composite cathodes consisting of a central plate and a guard-ring round it. He found that in such cathodes the current only flows through the parts covered with visible rays. In the case of oscillating currents, it even happens that the guard-ring acts as an anode, while the central plate acts as a cathode. The cathode rays only proceed from those parts of a cathode from which luminous rays proceed also. When concave electrodes are used, the current density is the same on the inner and the outer surface. If two cathodes of equal area are contained in the same tube, the current flows mainly through the cathode showing the least drop of potential. Impurities have a great disturbing effect, but unevenness of the cathode only at high pressures.

[A. Wehnelt, *Phys. Zeitschr.*, March 2, 1901.]

*Telephonic Transmission.*—If human speech is to be transmitted with complete clearness, every constituent vibration must be reduced in intensity in the same proportion, if at all. That the telephone does not do this is due to the fact that the effective resistance increases with the frequency, while the magnetic induction decreases. This has a serious effect upon distinctness, especially as the frequency of the constituent sounds of human speech vary between such wide limits as 16 and 10,000 vibrations per second. Another complication is introduced by the natural period of the telephone disc. According to Max Wien, a Bell telephone reinforces the notes of 1,100, 2,800, and 6,500 vibrations per second, and several higher pitches as well. A Siemens telephone has two successive maxima at 5,000 and 5,400. The most characteristic notes of the human voice lie between 500 and 8,000, and for these notes the telephones of Bell, Apel and Siemens are equally sensitive. For higher notes, the sensitiveness often shows remarkable differences. Thus a modern Siemens and Halske telephone will transmit the note 4,000 nearly 100 times as loudly as a Bell telephone. The author used an alternate-current siren for these investigations.

[M. Wien, *Ann. der Physik*, No. 3, 1901.]

*Metallic Reflection of Electric Waves.*—Righi's experiments on the reflection of electric waves by metallic surfaces, in the course of which he claimed to have discovered an elliptic polarisation of the waves by reflection, are of profound theoretical interest, especially since both Poincaré, from the point of view of Maxwell's theory, and Drude, from the point of view of the electron theory, have pronounced such elliptic polarisation to be highly improbable. K. F. Lindman has therefore repeated Righi's experiments with improved apparatus, using as a wave-detector not the gapped silver deposit of Righi's, but a modification of Klemencic's thermocouple. The results, whose accuracy excludes errors over 2 per cent., show that, in accordance with theory, plane-polarised electric waves of the order of magnitude of 10cm. are reflected as plane-polarised waves at all angles of incidence, without losing perceptibly in intensity. The azimuth of the vibration also remains the same, and each of the two chief components of the wave suffers a change of phase equal to $\pi$. If any ellipticity exists, the minor axis is in any case so small that its existence cannot be detected with the indicators used. As regards Righi's positive results, the author is inclined to attribute them to disturbing reflections.

[K. F. Lindman, *Ann. der Physik*, No. 3, 1901.]

*Aluminium as an Electrode.*—The fact that an aluminium electrode in a voltameter allows a much stronger current to pass when it acts as a cathode than when it acts as an anode, has never yet been satisfactorily explained. It is not yet certain even whether the layer which produces the higher resistance consists of silica or of aluminium oxide. The recent researches of A. Bartorelli do not decide this question, but they give valuable information concerning the polarisation and the internal resistance of the voltameter in terms of the current traversing it. The maximum polarisation acquired by the voltameter when the aluminium is the cathode is a good deal smaller than when it is the anode, the figures being 25 volts and about 8·1 volts respectively. As regards resistance, it is found that for equal values of the difference of potential between the terminals of the voltameters, its resistance is always less with the aluminium as a cathode than in the opposite case. The ratio of the two resistances varies from a very small value at small E.M.F.s to nearly unity at 25 volts. After both the polarisation and the resistance have become constant, the current varies in a linear manner with the E.M.F., and a small increase in the latter brings about a large increase in the current strength.

[A. Bartorelli, *N. Cimento*, February, 1901.]

*Refraction of Electric Waves.*—By means of his modified radio-micrometer, G. Pierce has measured the refractive indices of paraffin, ebonite, and various specimens of wood. It will be remembered that in this apparatus the movable coil is traversed by thermo-electric currents produced by electric waves impinging upon a knot of fine platinum and platinum-nickel wire and heating up the junction. The measurements of refractive indices were made by observing the distance by which the interposition of a known thickness of the dielectric displaces the nodes of a stationary wave in air. The arrangement of apparatus for obtaining the stationary wave is essentially that of Lloyd's mirror for perpendicular incidence, the succession being radio-micrometer, oscillator, dielectric, and metallic mirror. The refractive indices of paraffin and ebonite for waves 4·4cm. long were found to be 1·56 and 1·75 respectively. All the woods examined showed double refraction, black walnut, with indices 1·70 and 1·49 respectively, showing the largest divergence. The author shows from theoretical considerations that it is a case of true double refraction, and not an appearance due to differences of absorption.

[G. Pierce, *Phil. Mag.*, February, 1901.]

*Self-Induction in Wehnelt's Interrupter.*—T. Mizuno has investigated the effect of self induction in a Wehnelt circuit, and has confirmed Ruhmer's theory as to the part played by self-induction in re-establishing the broken circuit. What plays the most important part after the break of the circuit in consequence of vaporisation is the E.M.F. $L\frac{di}{dt}$ of the current at break. When this E.M.F. is sufficiently large to call forth the spark across the vapour, the current is re-established, because the vapour on the active electrode is thereby cleared off. Since the whole vapour is simultaneously condensed, the value of the current grows again according to Simon's equation, and the process of vaporisation repeats itself. On the other hand, when the E.M.F. of self-induction is not sufficient, the spark cannot take place, and the current is greatly reduced by the presence of vapour which adheres to the surface or the active electrode. In the hammer inter-

rupter, the spark due to the break must be absorbed by a capacity, whereas in Wehnelt's interrupter the insertion of a capacity in parallel stops its action. The author does not say how the spark at break "clears away" the vapour at the active electrode.

[T. Mizuno, *Phil. Mag.*, February, 1901.]

---

## ELECTROMAGNETIC THEORY.—CXXII.*

BY OLIVER HEAVISIDE.

(*Continued from page 458.*)

§ 435. The simply periodic train of waves utilised in the last paragraph possesses some properties which deserve notice, especially as regards the activity of the forces and the waste of energy. There is no waste at all when the speed of the wave train is less than $v$, but there is waste when it is greater. Say that the impressed current at the axis is

$$C = C_0 \cos m(ut - z), \qquad (36)$$

existent permanently. Then

$$V = \frac{C_0}{4cu}\left\{G_0(\lambda rm)\cos + J_0(\lambda rm)\sin\right\} m(ut - z) \qquad (37)$$

is the potential when $u > v$, and $\lambda$ is real; whilst when $u < v$ it is

$$V = \frac{C_0}{4cu} K_0(\kappa rm)\cos m(ut - z), \qquad (38)$$

and $\kappa$ is real.

Start with $u = 0$, and go right through to show the effect of the motion. With stationary electrification, density $\sigma \cos mz$, so that $C_0 = \sigma u$,

$$V = \frac{\sigma \cos mz}{4c} K_0(mr). \qquad (39)$$

It is only the wavy distribution of the electrification that prevents V from being infinite everywhere—namely, when $m = 0$, a well-known electrostatic result, though the electric force is finite save at the axis. At a distance from it, or more generally, when $mr$ is large,

$$V = \frac{\sigma \cos mz}{4c} \epsilon^{-mr}\left(\frac{2}{\pi mr}\right)^{\frac{1}{2}}\left\{1 - \frac{1}{8mr} + \dots\right\}; \qquad (40)$$

and close to the axis, or when $mr$ is small,

$$V = \frac{\sigma \cos mz}{2\pi c}\left\{-I_0(mr)\left(\log\frac{mr}{2} + 0{\cdot}5772\right) + \left(\frac{mr}{2}\right)^2 + \dots\right\}, \qquad (41)$$

which is nearly the same as

$$V = -\frac{\sigma \cos mz}{2\pi c}\log mr. \qquad (42)$$

This makes

$$E = -\frac{dV}{dz} = -\frac{\sigma \sin mz}{2\pi c} m \log mr, \qquad F = -\frac{dV}{dr} = \frac{\sigma \cos mz}{2\pi cr}. \qquad (43)$$

When $m = 0$ the axial component vanishes, leaving the simple state $F = \sigma/2\pi rc$.

Now the effect of increasing $u$ from zero turns $K_0(mr)$ to $K_0(\kappa mr)$, where $\kappa = (1 - u^2/v^2)^{\frac{1}{2}}$. The result is, as may be seen by (40), to decrease the rapid rate at which V falls off as the axis is receded from. But there is still no change of sign of V between the axis and $r = \infty$, for any particular value of $z$, because $K_0(\kappa mr)$ is always positive. This action continues until $\kappa = 0$, or $u = v$. The potential solution is then useless, but it is the case of plane progressive waves travelling at the natural speed $v$. E is zero again, and

$$F = \frac{\sigma \cos m(ut - z)}{2\pi rc}, \qquad (44)$$

without any function of $r$ as a factor, save the usual $r^{-1}$.

Increasing $u$ above $v$ brings in a different state of things, as in (37), where $\lambda = (u^2/v^2 - 1)^{\frac{1}{2}}$. It makes V oscillatory along r, for any special value of $z$; and the larger $\lambda$ is made, the shorter the wave length. By sufficient increase of $u/v$ we may pack the regions of positive and negative V as closely as we please. These results will be understood on remembering the conical nature of the wave fronts corresponding to the different elements of electrification, and that its arrangement upon the axis is alternating.

As regards the electric and magnetic forces, we have

$$F = -\frac{dV}{dr} = -\frac{\sigma}{4c}\left\{G'_0(\lambda mr)\cos + J'_0(\lambda mr)\sin\right\} m(ut - z), \qquad (45)$$

$$E = \lambda^2\frac{dV}{dz} = \frac{\sigma\lambda^2 m}{4c}\left\{G_0(\lambda mr)\sin - J_0(\lambda mr)\cos\right\} m(ut - z), \qquad (46)$$

and $H = cuF$, as before. The big accent means $d/dr$.

Now H is perpendicular both to E and to F. So

$$FH = cuF^2 = cu\left(\frac{\sigma}{4c}\right)^2\left\{G'^2_0\cos^2 + J'^2_0\sin^2 + 2G_0 J'_0\cos\sin\right\} \qquad (47)$$

Averaging, we obtain

$$FH = \tfrac{1}{2}cu\left(\frac{\sigma}{4c}\right)^2(G'^2_0 + J'^2_0). \qquad (48)$$

This is the mean flux of energy per unit area along z or with the wave. It does not involve any waste.

As regards the flux outward along r it is

$$-EH = -cuEF = -cu\lambda^2 m\left(\frac{\sigma}{4c}\right)^2\left\{J_0G'_0\cos^2 - G_0J'_0\sin^2 + (J_0J'_0 - G_0G'_0)\sin\cos\right\} \qquad (49)$$

Averaging, we obtain

$$-cuEF = -\tfrac{1}{2}cu\lambda^2 m\left(\frac{\sigma}{4c}\right)^2(J_0G'_0 - G_0J'_0),$$

where

$$J_0G'_0 - J'_0G_0 = -2/\pi r. \qquad (50)$$

(Vol. II., p. 257.) So the averaged outward flux per unit area is

$$\tfrac{1}{2}cu\lambda^2 m\left(\frac{\sigma}{4c}\right)^2\frac{2}{\pi r}. \qquad (51)$$

This must be multiplied by $2\pi r$ to obtain the waste per unit length of axis. It is

$$2cu\lambda^2 m(\sigma/4c)^2, \qquad (52)$$

independent of the distance. This is real waste of energy. We conclude that the averaged applied force (Newtonian) needed at the axis to keep the electrification moving in the way specified is (52) divided by $u$, or

$$\lambda^2\sigma^2 m/8c. \qquad (53)$$

This increases infinitely with $u$ or $\lambda$. It is zero when $u = v$, or $\lambda = 0$. It remains zero when $u < v$.

To confirm this result, consider the mechanical reaction of the electromagnetic field upon the electrification. It is

$$E\sigma\cos m(z - ut) \qquad (54)$$

at any point on the axis. Or, by (46),

$$\frac{\sigma^2\lambda^2 m}{4c}\{G_0\sin\cos - J_0\cos^2\} \qquad (55)$$

The average of the first part is zero. Of the second it is the negative of (53). So (53) represents the average regarded as impressed, and (52) the average activity.

There are several cautions to be expressed regarding the above. First the investigation has no reference to ordinary waves along wires. They do not behave in the above way, even if all resistance were done away with. The above waves are forced waves, whether $u$ be less or greater than $v$, although only in the latter case is there permanent activity on the average. If we want to represent waves of this type along a wire, we require a continuous distribution of impressed electric force along the wire, or something equivalent. That is, the wire is to be a source of energy, instead of a sink, as is usually the case with waves along them, for the loss of energy by radiation of the heat is a separate matter, which does not come in question. Prof. G. F. FitzGerald was the first to calculate loss by radiation from a wire, but I do not know the precise circumstances he contemplated.* Whether there is any loss depends materially upon the circumstances.

* George Francis FitzGerald is dead. The premature loss of a man of such striking original genius and such wide sympathies will be considered by those who knew him and his work to be a national misfortune. Of course the "nation" knows nothing about it, or why it should be so.

There is waste when the impressed current is everywhere in the same phase, say $C = C_0 \cos nt$, with $C_0$ constant. This is a reduced case of the above—viz.,

$$u = \infty, \quad m = 0, \quad mu = n, \quad \sigma u = C_0. \tag{56}$$

These reduce the expression (52) for the waste to

$$\frac{mu\sigma^2}{8c}\left(\frac{u^2}{v^2} - 1\right) = \frac{nC^2_0}{8cv^2} = \frac{\mu n C^2_0}{8}. \tag{57}$$

This is per second. But $2\pi/n$ is the period, so the waste per period is $\frac{1}{4}\pi\mu C^2_0$, at any frequency, provided the amplitude of the axial current is kept the same. This independence is also true in the former case, down to $u = v$. But we should not apply it to the extreme of zero frequency, or infinitely long period, because then we cannot have reversal of current to make a period.

Also notice that in the calculation of the waste by averaging at the axis, the neglected part, which goes out on averaging, is infinitely large compared with the retained part; which may seem absurd. But the infiniteness is of no consequence at all, when its reason is considered. It is to simplify results that the impressed current is condensed in a line instead of being distributed in a rod. The condensation causes the infinite values at the axis. But the effective results away from the axis are not materially affected by finitising all results by spreading the axial current throughout a small rod. So there is nothing to be alarmed about. It is nothing like so curious as the result in § 465 and § 477, where we found a finite moving force (and electric force) acting quite perpendicularly to the lines of electric force.

§ 486. Having employed in § 484 the simply periodic wave formulæ to build up the two kinds of solution for an electron in steady rectilinear motion, the converse problem presents

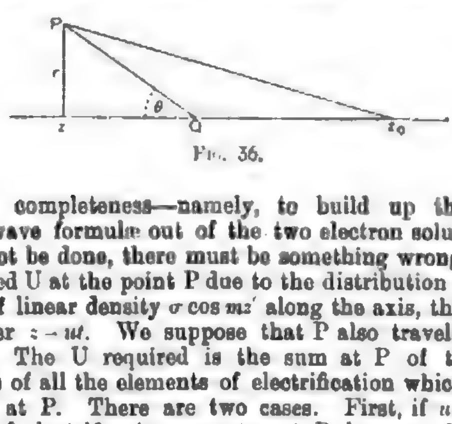


Fig. 36.

itself for completeness—namely, to build up the simply periodic wave formulæ out of the two electron solutions. If this cannot be done, there must be something wrong.

Required U at the point P due to the distribution of electrification of linear density $\sigma \cos mz'$ along the axis, this $z'$ being the former $z - ut$. We suppose that P also travels along at speed $u$. The U required is the sum at P of the steady potentials of all the elements of electrification which produce potential at P. There are two cases. First, if $u < v$, every element of electrification operates at P, because the electric force of an element extends over all space. So, by equating the integral of the electron solution to the simply periodic solution we obtain

$$\frac{\sigma}{4\pi c}\int_{-\infty}^{\infty} \frac{\cos mz_0 \, dz_0}{\{(z_0 - z')^2 + \kappa^2 r^2\}^{\frac{1}{2}}} = \frac{\sigma}{4c} K_0(m\kappa r) \cos mz', \tag{58}$$

where $\kappa$ is real. Put $z_0 - z' = y$, and there results

$$\frac{2}{\pi}\int_0^{\infty} \frac{\cos my}{(y^2 + \kappa^2 r^2)^{\frac{1}{2}}} dy = K_0(m\kappa r), \tag{59}$$

which is a known definite integral.

But in the other case, with $u > v$, the total U at P is derived only from the electrification to the right of Q, if the angle $PQz'$ be the $\theta$ before used making $u \sin\theta = v$, and the electrification is moving from left to right; because the electrification on the left side of Q does not act at P. So the lower limit must be $h = z' + r\lambda$, where $r\lambda$ is the distance $z'Q$ in the figure, instead of $-\infty$. Therefore, by equating the new integral to the new simply periodic solution, we have, with $\lambda$ real,

$$\frac{\sigma}{2\pi c}\int_h^{\infty} \frac{\cos mz_0 \, dz_0}{\{(z_0 - z')^2 - \lambda^2 r^2\}^{\frac{1}{2}}} = \frac{\sigma}{4c}\{G_0(\lambda mr) \cos - J_0(\lambda mr) \sin\} mz'. \tag{60}$$

Putting $z_0 - z' = y$, reduces the left side to

$$U = \frac{\sigma}{2\pi c}\int_{r\lambda}^{\infty} \frac{\cos m(y + z')}{(y^2 - r^2\lambda^2)^{\frac{1}{2}}} dy, \tag{61}$$

which, by comparison with the right side of (60), requires

$$\frac{2}{\pi}\int_{r\lambda}^{\infty} \frac{\cos my \, dy}{(y^2 - r^2\lambda^2)^{\frac{1}{2}}} = G_0(\lambda mr), \qquad \frac{2}{\pi}\int_{r\lambda}^{\infty} \frac{\sin my \, dy}{(y^2 - \lambda^2 r^2)^{\frac{1}{2}}} = J_0(\lambda mr), \tag{62}$$

which are also known Bessel integrals if I correctly understand the formula given by Gray and Mathews, p.230, ascribed to Weber, viz.,

$$\int_1^{\infty} \frac{\epsilon^{iz\lambda}}{(\lambda^2 - 1)^{\frac{1}{2}}} d\lambda = -\{Y_0(z) + (\gamma - \log 2)J_0(z)\} + \frac{i\pi}{2} J_0(z).$$

Finally, it may be remarked that the application of Fourier's theorem to the first of (62) leads to the formula (35) above. (See also Vol. II., p. 106.) We have, therefore, a good harmonisation of results all round by all methods. This is particularly desirable, because no intelligible and valid mechanical analogue has yet been invented which will enable us to see clearly what the behaviour of electrons in motion ought to be, without resort to troublesome mathematics. From another point of view, having established the two steady and the two periodic solutions independently of the various integrals, we may consider the solutions to establish the values of the integrals.

To my mind, proofs of this character are more convincing than those involving the theory of functions.

§ 487. Some light is cast upon the effects due to moving electrification by the connected theory of moving electrisation. It is not necessary that the impressed current in the above investigations should be moving electrification, or $C = \sigma u$, say. We may exhibit the axial source in terms of impressed electric force. I have before pointed out that the effects due to convection current $\rho u$, $\rho$ being the volume density, are the same as those due to impressed e, such that $\rho u = pce$ (*El. Pa.*, Vol. II., p. 509). Here $ce$ may be regarded as intrinsic electrisation, the electric analogue of intrinsic magnetisation, and its time rate of increase is equivalent to impressed electric current. Applying this to a rod reduced ultimately to a mere line, as $\rho$ is turned to $\sigma$, the linear density, e must be multiplied by the cross-section of the rod to preserve equivalence. Thus, put

$$C = cpe_0, \tag{63}$$

instead of convection current, in the equations (12). They become

$$E = -\tfrac{1}{4} q^2 K_0(qr) e_0, \qquad F = -\frac{1}{cp}\frac{dH}{dz}, \tag{64}$$

$$H = -\tfrac{1}{4}\frac{d}{dr} K_0(qr) cpe_0. \tag{65}$$

There are the equations expressing the electric and magnetic forces generated by a straight filament of $e_0$ along the $z$-axis, where $e_0$ may be regarded as the product of section and impressed voltivity; or, equivalently, $ce_0$ may be regarded as the total strength of intrinsic electrisation. These equations may be obtained independently, as before done. (See *El. Pa.*, Vol. II., p. 457, where various results due to a filament of $e_0$ are given. The G function there employed is the negative of the present one. A consideration of the measure of an axial source and the transition from $K_0$ to $G_0 - iJ_0$ will show that the present positive reckoning is proper.)

We may therefore translate results due to varying impressed force to those due to moving electrification. To show explicitly by an example, let PQ be an electrised rod. If at rest, it is known by statical considerations that the electric

$$Q \bullet \qquad \xrightarrow{\;e_0\;} \qquad P$$

displacement outside the rod is the same as that due to a positive charge at P and a negative charge at Q, both of size $ce_0$. That is, the convergence of the intrinsic electrisation is the measure of the fictive electrification. There is no real electrification, because the displacement is made circuital by the flux of displacement $ce_0$ along the rod. There may be electrons, but that is a different matter, involving a finer kind of space division to find them. If we put a negative charge at P and a positive one at Q, both of size $ce_0$, the external

displacement disappears. There is left only the displacement $ce_0$ along the rod from the positive charge to the negative. The rod is then a charged condenser which will not discharge itself even though its poles are conductively connected. To discharge the charges, $e_0$ must be relaxed. (See *El. Pa.*, Vol. I. pp. 466 to 515 for details about real and fictive electrification, and intrinsic displacement. For the benefit of the uninitiated, I should explain that *El. Pa.* means my "Electrical Papers." They can be picked up cheap, because the remainder was sold off in quires for a few pence per volume, on account of the deficiency in storage room. So look in the fourpenny boxes. Though somewhat vexed at first by this disposal of my laboured lucubrations, it has, later, given me and others occasion for much laughter.)*

Now if the rod PQ, electrised but uncharged, be moved at speed $u$ from left to right, the external effects, electric and magnetic, are the same as those due to a pair of equivalent charges, positive at P, negative at Q, both moving the same way at speed $u$. The effects due to a single moving charge are therefore the same as those due to an infinitely long electrised rod, ending at P, and pushing forward. The speed $u$ may be anything from 0 to $\infty$. It is not necessary for the rod to move. The region occupied by the electrisation has to grow at the P end. We may imagine little demons putting on fresh electrisation at any rate we like, and whether P effectively travels at a speed greater or less than that of propagation in the medium makes no difference to the demons individually.

If $u = \infty$, this is the same as putting on $e_0$ all over at the same moment. The result is a cylindrical wave. (*El. Pa.*, Vol. II., p. 460.) D is of two sorts. There is an outer shell in which D is oppositely directed to $e_0$; and inside the shell D is directed the same way as $e_0$. The same reversal occurs with H. At the wave front it is so directed as to make $E = \mu v H$ with outward expansion, as usual. Inside the shell it is reversed.

Now, suppose $u$ is not infinite, but still very great compared with $v$. The cylinder becomes a cone of very small angle, nearly the same cylinder in fact, if we consider only a part of it at a time. It has the same characteristics as before. The cylindrical outer sheet becomes a conical sheet, in which D is directed away from the apex, from right to left. Inside it, D goes the other way, in the direction of $e_0$ at the axis. H is similarly reversed.

These will be seen to be the properties found for a moving electron, when its speed is greater than $v$. For the equivalent electrification is situated at the end of the $e_0$ region where it is growing.

In *El. Pa.*, Vol. II., p. 461, is worked out in some detail the case of finite section and $u = \infty$, and I meant to adapt that investigation here to illustrate the electron theory. But in looking through the troublesome calculations I find some numerical errors, so the matter must be postponed. But a general idea of the cause of the reversal in the theory of e may be shortly given. An electrised rod of finite size corresponds to a disc of electrification at its end. Now the waves are initiated at the surface of the rod, the seat of the curl of e, the impressed voltivity. Induction is generated there at the rate $c$ per second, in a cylindrical sheet. It spreads both ways, outward and inward. Along with it the outer displacement is against e, and the inner with e, just as in the case of plane waves, § 453 above. The inner wave of D condenses to infinite intensity at the axis, but does not change sign in expanding again, being longitudinal or axial. But the corresponding H does reverse effectively. Not in reality, because an element of a circle of H in condensing and crossing the axis preserves its direction. But when the circle expands that element is on the opposite side to its old place. So there is effective reversal of H, as well as of D, compared with those at the outer wave front, save at the beginning. This property continues true when the rod is condensed to a line, and also when $u$ is reduced, so that the wave front turns from a cylinder to a cone.

*(To be continued.)*

* I do not delete this remark under the sad circumstances of the last footnote, for FitzGerald was the first man to see the humour of the proceedings of those unhumorous publishers.

## INSULATION ON CABLES.*

BY MERVYN O'GORMAN.

(*Continued from page 831.*)

Fixing, then, as we unfortunately must, on the dielectric stress which has so far been found in good practice to be the maximum allowable, and which is the same for fibrous cables as Mr. Swinburne found for condensers, namely, about 20,000 volts per centimetre,† we must consider the effect produced upon the "radial" depth of insulation by varying the diameter of the conductor. We are accustomed with low tensions to increase the "radial" with increasing thickness of copper according to some such rules as those of the Institution.‡ This custom is the outcome of experience, and is

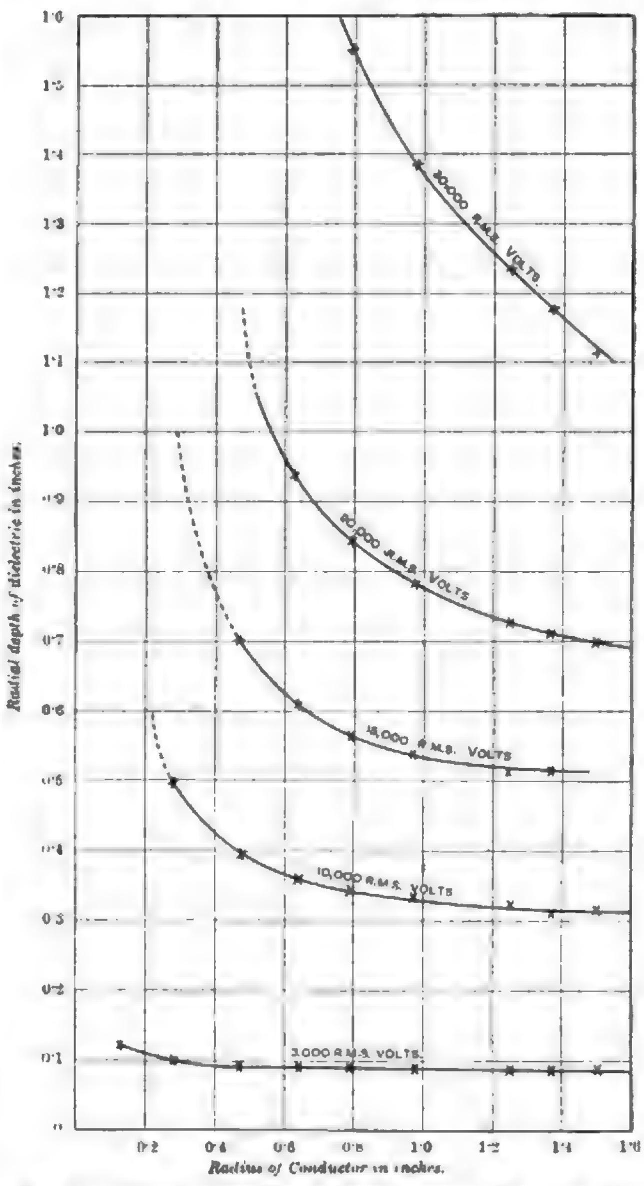


FIG. 10.—Relation between the Radius of Copper and the Radial Depth of Dielectric with Various Voltages. Greatest slope of voltage allowable 20,000 per cm. in the dielectric. Assumed to be homogeneous.

chiefly based on obtaining the mechanical rigidity necessary with the increasing weight and stiffness of copper as well as keeping above the somewhat arbitrary 300 megohm standard (on 19/16 cables).

* Abstract of a Paper read before the Institution of Electrical Engineers, March 7.

† This is less than the dielectric strength of air if we consider the working maximum pressure to be the greatest to which the cable is subjected, and disregard pressure oscillations of unknown origin. As a consequence, the danger of air bubbles has not in the past had the consideration it will have with improved cable manufacture and high voltage. Layers of air, unlike bubbles, may not be a disadvantage if the layers be thin, for a very different reason.

‡ Add 30 mils. to $\frac{1}{4}$th the diameter of the cable.

F

With high tensions, disruptive strengths must eventually be the dominant factor, and the thickness of the insulattion be determined* by assuming that manufacture is so improving that the dielectric is applied in a more and more homogeneous state, clean, free from spangles, dirt, moisture and bubbles, and that for high potentials it will be chiefly necessary to consider the maximum pressure and not mechanical restrictions. We will, therefore, determine the radial depth of insulation by the maximum potential gradient which the materials will stand, and give prices to the cables so determined for both normal and abnormally large pressures and conductors. formula follows Maxwell in assuming that dielectric strength may be measured by the electric intensity when the dielectric ruptures.

There is some possibility that the dielectric strength within the materials is also constant even for small thicknesses, but that owing to the skin resistance between metal and dielectric, and possibly between the various layers of insulation, the measurements of P.D. have come out disproportionately high. The suggestion of a skin resistance I owe to Prof. Perry.

The remaining constants are as follows :—

*Copper* is taken at £100 a ton (or 11d. per pound), a price which

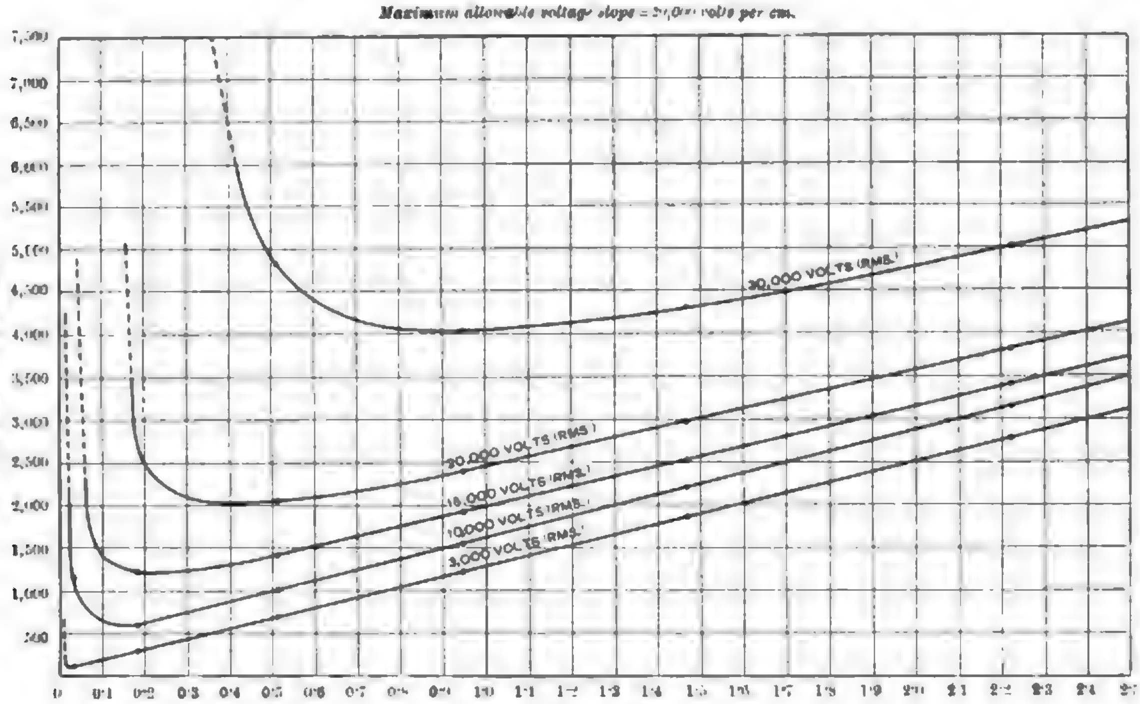


Fig. 11.

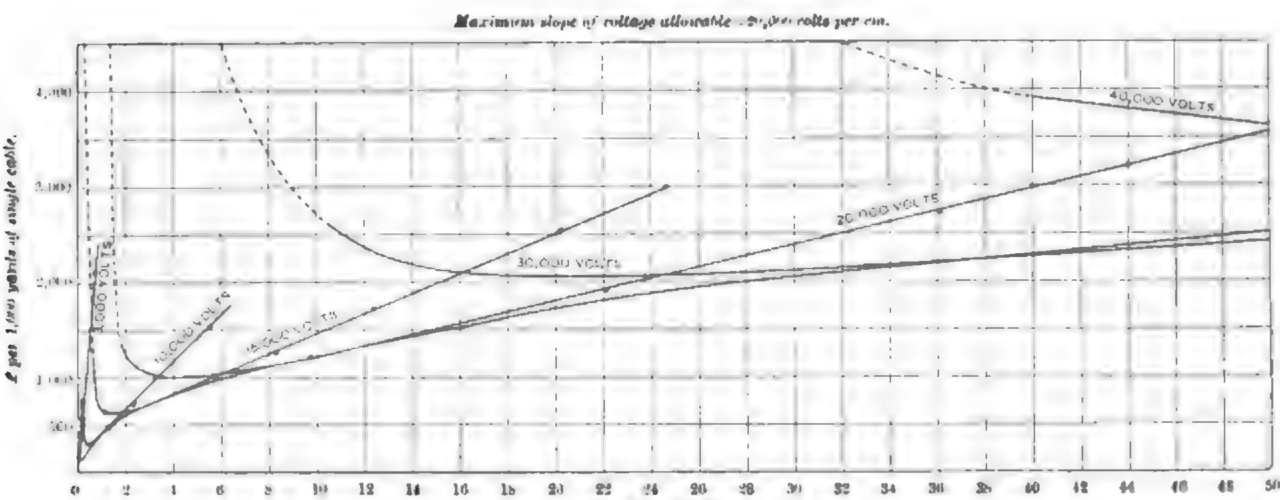


Fig. 12.

The formula which gives the radius R of insulation for a given voltage E is given by Mr. Swinburne†

$$\frac{dE}{d\rho} = \frac{r}{\rho} S. \qquad \therefore \log R = \frac{E}{rS} + \log r$$

$\therefore E = Sr \log_\epsilon \frac{R}{r}$, where S is the maximum allowable stress per centimetre, and $r$ the radius of the conductor in centimetres. This is rather too high. This is to cover market fluctuations. I justify its use because the deductions and curves which follow are only comparative, and the effect on the total price of the various insulation thicknesses outweighs the price of copper on both small and large sizes; for example, between 15,000kw. and 30,000kw. the price of cable is nearly constant, although the copper varies from 0·53 sq. in. to 1·5 sq. in. Another reason for taking a high price for copper is that the labour of handling and jointing will depend on the weight of the cable even though the radial thickness of insulation may go down. Lastly, the decimal figure £100 is easy to correct if a more accurate estimate is available. The £100 is made up as follows — G.M.B. copper in the market £78, cost of wire-drawing £8, stranding £5, shop charges and administration £10.

*Insulation* £50.—This price is too low for rubber cables, but as it is well known that the cost of fibre together with its lead is of the

* This subject has been concisely dealt with by Mr. Swinburne (Engineering Conference, June 7, 1899, in a Paper that was not adequately recognised at the time, owing to the author's being unable to read it himself. I will take the liberty to use it wholesale, both now and later on. I am very greatly indebted to him for help in the course of this Paper and for the general idea of the slope of potentials in cylindrical insulators.

† J. Swinburne's Paper (before Eng. Society, 1897) on "Electrical Transformation."

same *order* as rubber, it will follow that the general trend of the curves holds for rubber also, only the maxima and minima will be more marked for any class of insulation dearer than I have selected unless the disruptive strength is correspondingly greater. Paper £35 a ton, impregnating oil £7, labour £10, administration, &c., £19.

*Lead.*—£25 a ton was taken to allow or the labour of lead-covering, which is high. A thickness of 0·125in. was taken. This thickness is rather small for large cables, which sometimes takes 0·15in. or 0·18in. If this increase of lead had been allowed for, the rate at which the cost of cables increases with increase of output would have been still further diminished, within practical limits of copper section, but the character of the curves would not be altered, only accentuated. (Best Spanish lead £15 a ton, labour £3, administration £6 a ton.)

*The Current Densities* necessary to get the same loss (10 per cent.) of power in the 47-mile transmission at the various voltages are :—

| 40,000 | 30,000 | 25,000 | 20,000 | 15,000 | 10,000 | |
|---|---|---|---|---|---|---|
| 1,000 | 750 | 625 | 500 | 375 | 250 | amps. per sq. in. |

*The Labour* of applying insulation or lead is not a price per pound, but rises according to a different curve not a straight line. It is easy, though laborious, to apply a correction, and it will be found not to affect the general tendency of the curves.

The curves on Figs. 11, 12, 13, and 15, show that increasing the diameter of the conductor may produce such a diminution of dielectric thickness as to lessen the total price, and it follows that when this happens it is cheaper to use hollow than solid conductors for certain sizes of wire—namely, for all those sizes where I have dotted the curve of price.*

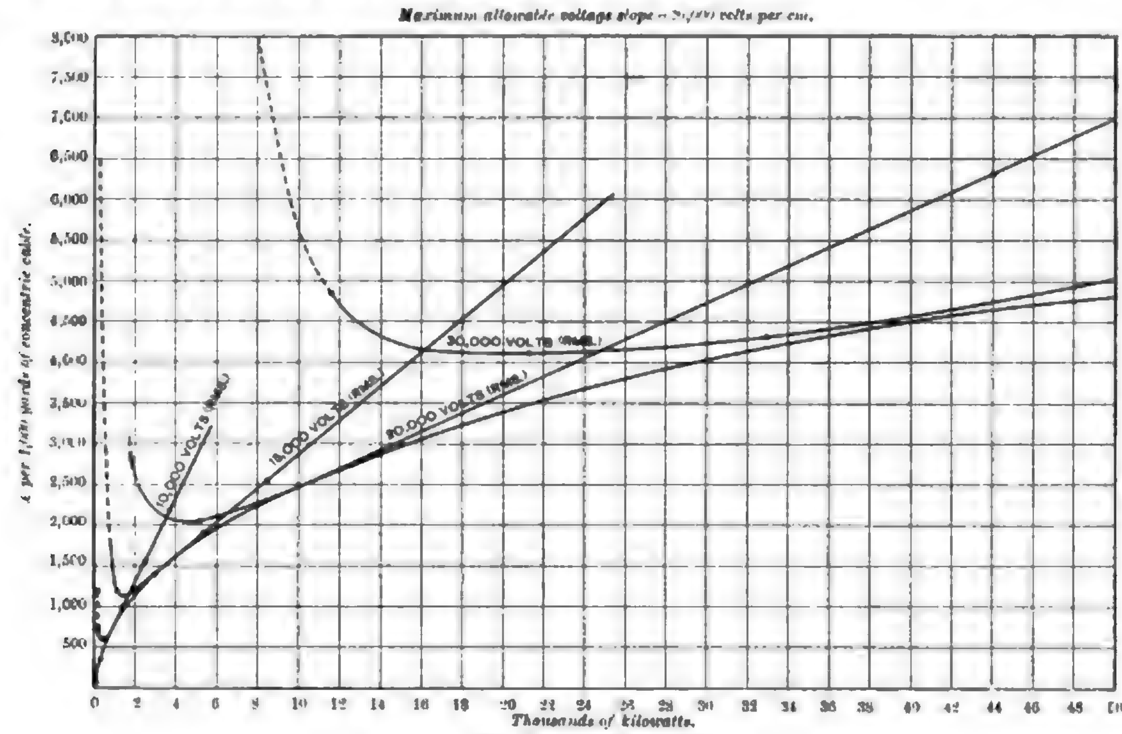


Fig. 13.—Concentric Cables.

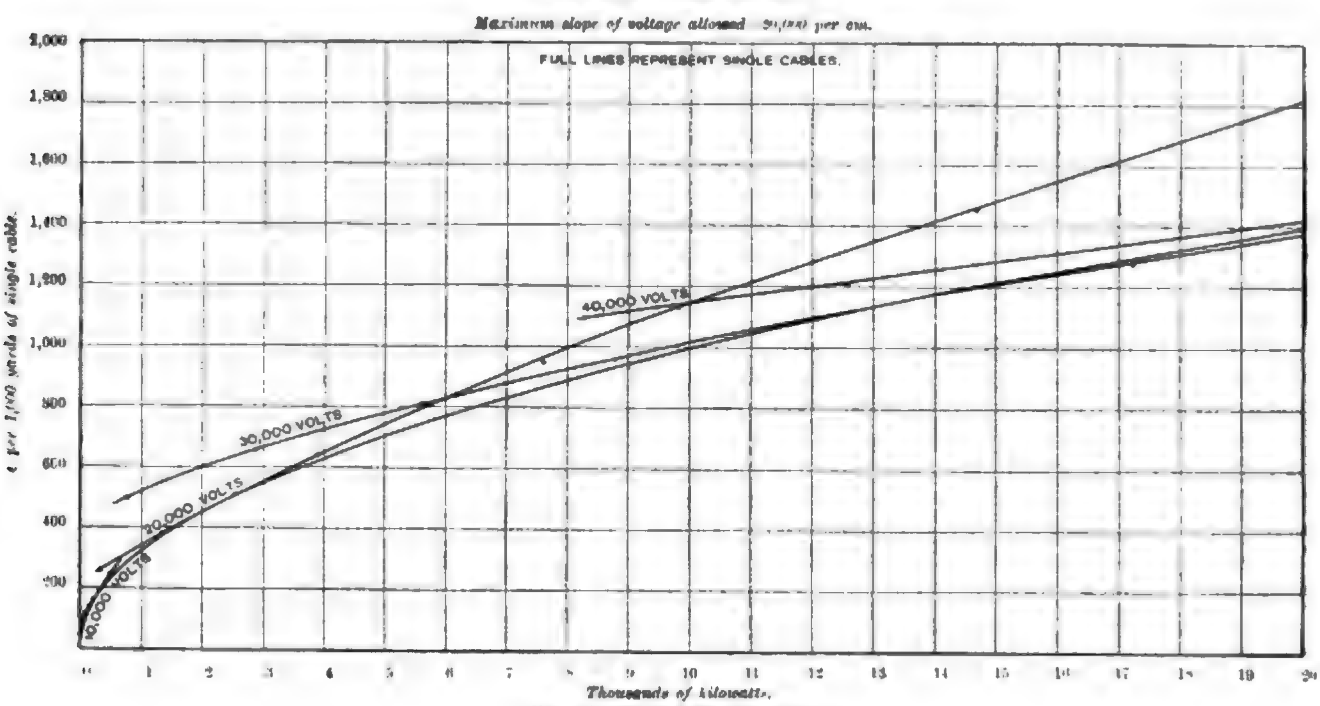


Fig. 14.—"Graded" Dielectrics.

* From this it follows that (leaving out of account high frequencies where there are special advantages for a hollow conductor over a solid one) in high-tension work a considerable gain may be made by using aluminium instead of copper because the aluminium has a greater diameter by 28 per cent., and this gain is the greater for certain sizes and pressures the more expensive the insulating material. I owe this suggestion to Mr. Swinburne. It is further enhanced by the ease of handling, 50 per cent. less weight for equal conductivity, and in cables the difficulties of soldering joints, and the irregular tensile strength complained of by Mr. Gavey (Jan. 10, 1901) are more easily surmounted than in overhead wires.

The *Frequency* has been supposed chosen very low, so that the increased impedance of the conductors may be disregarded for all the practical sizes.

*Skin Effect.*—In the absence of any but meagre evidence to the contrary, the voltage in the insulation next to the conductor is taken as being equal to the voltage of the conductor itself, although it probably is somewhat lower.

*Shape of Conductors.*—These are supposed cylindrical, and free from points or projections of small curvature.

On the above assumptions, the relation between the radius of the copper conductor and the radial depth of insulation is shown in Fig. 10, from which it is seen that the thickness of insulation falls at first rapidly and then steadily as the conductors get larger and larger. Doubling the radial depth by no means allows of doubling the pressure.

*Three-Phase or Single-Phase.*—Mr. Swinburne worked out the thickness, of insulation for the four methods of transmission—*i.e.*, direct current, and with currents of one, two, and three phases, but with a fixed weight of copper and fixed current density to be used in all cases, and I think his results should be considered here. I have therefore worked out two tables of 16 and 17 estimates for his cables on the basis of the constants assumed above.* They show that three-phase currents allow of more power being transmitted for equal weights of bare copper in every case (except one which is scarcely practicable), but in this set of examples they transmit less kilowatts per pound sterling when insulated and lead-covered.

This consideration appears to be in favour of single-phase work for powers of from 1,500kw. to 5,000kw. at and about 10,000 maximum volts, but it does not follow that single-phase is best. On the contrary, with insulated cables considerations of price lead to the opposite conclusion to Mr. Swinburne's, who found that "his figures broadly showed that the direct and single-phase systems are preferable as far as cost and convenience of insulation go." I think he would not have come to this conclusion if he could have got estimates for sizes of copper and voltages other than those he proposed. The broad conclusion is not allowable. The single-phase is best with small copper, cheap insulation, and large voltages; otherwise, not.

This opposite conclusion is derived from the appendix, where the sizes of conductors and voltages are different. It would appear from this investigation of costs that the best method of transmission and the best voltage may, in the near future, be fixed on the basis of such estimates as the present, and that for some powers and voltages single-phase may be cheapest, and for others three-phase—where covered cables must be used. £50 expended on such estimates might easily save £5,000 in cables. It is to be noted that only round wires, lead-covered, and concentric cables have been worked out, as it is arduous work to get the radial thickness with irregular-shaped or bunched wires.

*The Board of Trade Rule* requires that the insulation thickness shall not be less than $\frac{1}{10}$in. for every 2,000 volts. This on large conductors would be too great a thickness according to the log law, because it implies a factor of safety of nearly 40, whereas 20 has been found to do. On conductors of small radius of curvature, however, it would probably not be thickness enough were it not that with small depths of insulation most dielectrics are stronger than for great thicknesses, consequently at the comparatively low pressures hitherto used no inconvenience has been found.

It is to be noted in favour of the Board of Trade rule that air is very much stronger than the Board of Trade limit of thickness; consequently it becomes possible to introduce an air spark gap for lightning arrester of less thickness than the insulation, this being an imperative condition to obtain protection. It is also in accordance with the log law that the *points* or saw teeth of the lightning guards are specially effective in puncturing at the selected place. Were the Board of Trade thickness lowered, the lightning guards would have to be placed in oil.

*A 47-mile Transmission.*—On reference to Figs. 11 and 12 it will be seen that the prices of cables have been worked out for all sizes. The size of cable is represented in square inches first, and then expressed in terms of the kilowatts it will carry, and when voltages vary from 3,000 to 40,000. The most expensive cable shown works out at £2,500 per 1,000 yards, and this is, perhaps, not a ridiculous figure to look forward to in 50 years when we see that the Blue Lakes Power Company have a transmission 36 miles long in existence at the present moment, where the conductor alone, without poles or erection, cost £1,300 a mile.* Nevertheless the interest chiefly lies with smaller sizes than this.

In working out this transmission I had begun to take into account Prof. Ayrton's modification of Kelvin's law for economy in conductors, but this portion of the Paper on "radials" has grown immoderately long. So I will assume that, from approximate estimates, it has been decided to waste 10 per cent. of the power in the line. Suppose, now, that 10,000 volts has been chosen as a suitable voltage for the transmission, we see, from Fig. 11, that the cheapest size of cable to use is 37/14, conveying 500kw.; that is 50 amperes at 10,000 volts, and this gives a copper diameter of 0·28in. In a similar way it will be seen that for any voltage there is one particular diameter over the copper, or under the insulation, which is cheapest, and if I want to transmit less power than corresponds to the solid copper, I must use a tube of copper, or in certain cases very easy to determine† of aluminium, or in a conceivable condition of the metal market a zinc wire. This is more than even the aluminium companies have hoped for.

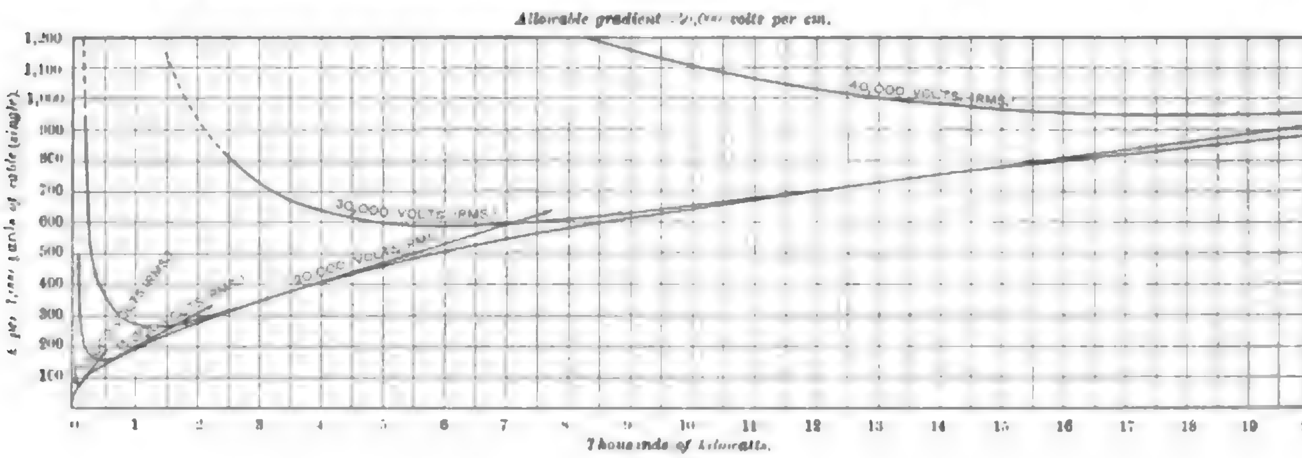


Fig. 15.

If, however, we want to transmit more power than is allowed for by the cheapest conductor at 10,000 volts, had we not better increase the voltage as well as the copper, and if so, how much shall each be increased? The answer to this question is given by the bottom curve (Fig. 12) which is tangential to all voltages, and we see that it is much better not to fix upon the voltage irrespective of the relative prices of copper and insulation upon which that curve is based—a consideration which is, I believe, somewhat novel. Suppose, for instance, the power to be transmitted is not 500, but, say, 2,000kw.: Fig. 12 shows that the best voltage is 15,000, the best copper section by an easy calculation is 0·334 sq. in., and the price per 1,000 yards of single cable is approximately £600.

There is one interesting coincidence shown by these curves. It is that at 10,000, the cheapest conductor is 37/14, namely, the size of the B.I.W. Co.'s Deptford cable; the radial depth of insulation is $\frac{1}{2}$in.—viz., the Board of Trade thickness for that voltage. From the 14,140 volts maximum I was glad to get corroborative evidence in favour of adopting a gradient of 20,000 volts per centimetre for fibre cables in these estimates.

If now we turn to that part of the curve which is (because of the cost) entirely beyond practical consideration, say 50,000kw. to be transmitted 47 miles, this may be effected either:

| | | | |
|---|---|---|---|
| At 40,000 volts | the cost per 1,000 yards is | | £3,650 |
| " 20,000 | " | " | " 3,500 |
| " 25,000 | " | " | " 2,600 |
| " 30,000 | " | " | " 2,500 |

This last price is at the rate of 11d. per kilowatt per 1,000 yards with a 10 per cent. loss in the line on a 47-mile transmission. If we com-

* [The actual tables are given in Mr. O'Gorman's Paper, but are omitted here.—Ed. *E.*]

* J. Kershaw, "Aluminium as a Conductor," I.E.E., Jan. 10, 1901.

† When diameter determined by economy of insulation is only 1·28 times the diameter of copper necessary to carry the current.

pare this with what will be admitted to be a more practical case, say of a 37/14 cable at 10,000 volts with a 10 per cent. loss in the line on a 12-mile transmission for about 1,840kw., we find that the price is £310—viz., more than 3½ times as great as the above per kilowatt per 1,000 yards of cable, namely, 39d.* In fact, the larger cable is the more economical if not the more practical of the two. Its diameter is large, of course, being 3·9in., which is just about the largest size a modern lead press can deal with; nevertheless, 50 years may see some such cables made, for already 25,000kw. are generated in more than one existing power-house.

*The dotted portion of Curves Figs.* 11 *and* 12.—It is seen that given any number of kilowatts to transmit the cheapest voltage at which to work is given by the lower curve, which is concave downwards. But if the pressure is thus fixed, the subsidiary small cables which work at the same pressure are apparently exceedingly expensive, as shown by the dotted early part of the curve for each voltage. This is not the case, however, and that is why those portions are dotted. If we do not choose to pay for so thick a radial depth of insulation as will keep the maximum stress below 20,000 volts per centimetre, we can work at a less factor of safety and take the consequences. These are exemplified by enlarging on one of Mr. Swinburne's remarks on Mr. Mordey's Paper on capacities.

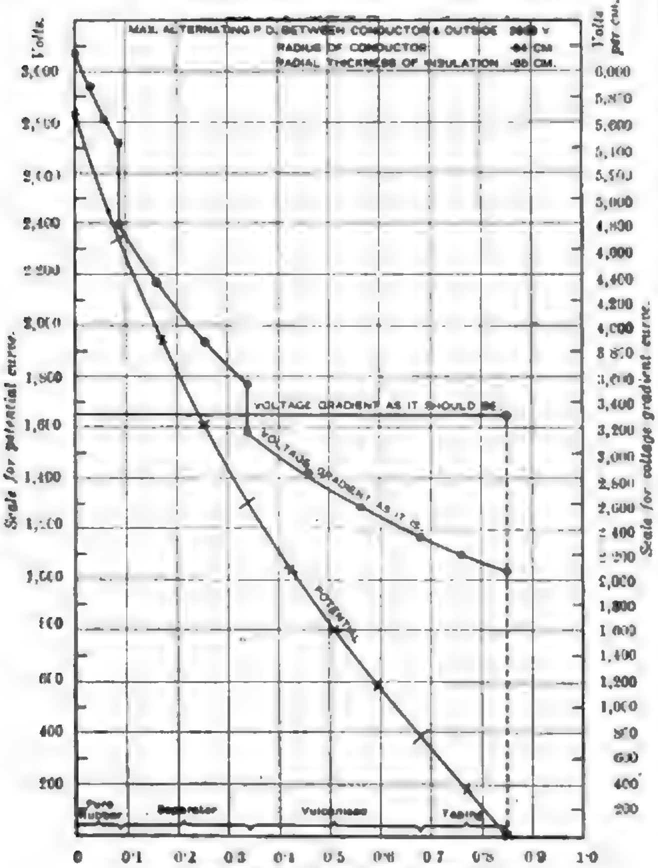


FIG. 16.—Curves showing the Potential and Rate of Fall of Potential through the Insulation of a 37/14 Cable made up as follows:

| | |
|---|---|
| Next to core .. .. .. | 0·065cm. of pure rubber |
| Then .. .. .. .. | 0·255cm. of separator |
| Then .. .. .. .. | 0·34cm. vulcanised rubber |
| And outside .. .. .. | 0·17cm. of Taping |

If a small wire at 30,000 volts is hung in air in a dark room, a glow is visible all round it up to a certain radial distance. This is the distance up to which the air has electrically yielded, as if its "elastic limit" had been passed. It has not quite broken down like a steel bar that is "short," but like one that has passed the elastic limit and absorbs energy in stretching. The analogy is very superficial, but the brush discharge absorbs energy, as is well known. I would suggest, then, that when the insulation on a cable is so thin with respect to the radius of its conductor that it allows of a fall of potential at a rate greater than, say, 100 kilovolts per centimetre,* it does not necessarily disrupt and char, but while keeping its other physical characters yields to the electric pressure up to a point within the insulation, and absorbs energy as a brush discharge does. Unfortunately, air is the only insulation which has been investigated under these conditions.

If this is so, the consequence of using cables having a smaller dielectric thickness than corresponds to the curves is that energy is lost and capital economy made at the expense of the factor of safety against disruption. The way to reduce the energy loss to a minimum, and to nearly halve the cost of many high-tension cables, is to reduce the voltage gradient where it is too steep by "grading" capacity conductivity and dielectric strength.

Fig. 14 shows the economy effected by using a "graded" cable, although the price of insulation has been taken at *double* the price for the insulation of curve 17.

Fig. 15 shows the economy of doubling the strength of the insulation.

Fig. 16 shows the unequal stresses to which an ordinary 37/14 high-tension cable may be put if no attention is paid to "grading." The horizontal line shows what the stress would be if the insulation were "graded" and the same voltage applied.

*(To be concluded.)*

* In the Deptford transmission the B.I. cable cost is, I suppose, about 52d. per 1,000 yards and per kilowatt; the loss of volts in the line is not 10 per cent. in this case, but if it were 10 per cent, instead of about 5 per cent. the cost would still be 26d., or twice and a-half as great as in the above transmission of 50,000kw.

* The disruptive strength of vulcanised rubber found by T. Gray is 470. 100 is the disruptive strength of most oils.

## BOARD OF TRADE ELECTRIC LIGHTING REGULATIONS.

(*Concluded from page 835.*)

*Friday, March 22nd.*

This day's sitting concluded the enquiry.

Mr. MOON, K.C., speaking first of all on behalf of the Chelsea Company, referred to the terms of the proposed arbitration and the suggestion by the opposition that the consumer was entitled to some compensation in connection with the lamps. But there was no dispute whatever as to the efficiency of the 200 volt lamp. The whole of Glasgow and St. Pancras and three parts of the Chelsea consumers were using them, and in these instances it was the 100 volt lamp which was only used by the exceptional customers. So far as being in the same position, as regards an efficient article, as in 1896, when there was no lamp on the market which could be used for 200 volts, he said it was now becoming generally adopted in all new installations. He agreed with Mr. Lyttelton that it was even now a matter of controversy—not acute, however—not as to efficiency, but as to relative efficiency. In other words, whether for the money paid the same result was obtained with 200 volts. Prof. Kennedy's evidence as to his tests had not been assailed, and added to this there was the evidence of Col. Crompton and Mr. Percy Still. Even Mr. Drake had not suggested there were any complaints from the consumers in the Chelsea district. Further, one of Mr. Gunyon's tests had shown there was a 200 volt lamp which was capable of producing the same efficiency and consumption of current as a 100 volt lamp, and there was nothing like the difference suggested by Lord Londonderry's agent, whom he would advise to have his meter tested.

Mr. CROIS remarked that this had been done.

Mr. MOON replied that then there must be a mistake somewhere, because if a certain manufacturer could make good 200 volt lamps then why could not others do the same. Of course they could do so. Coming to the evidence against him, he thought it somewhat remarkable that a manufacturer should send to Prof. Ayrton a number of lamps to test unless he had some object in the result of the tests, because a manufacturer had the means of testing them himself. It looked as if in thus going out of his way to send these lamps to be tested he might possibly have desired to show that the 200 volt lamp was not as effective. He merely suggested this and passed it by. The other series of tests mentioned by Prof. Ayrton was upon some lamps which had already been used by a consumer and which were obviously of bad manufacture. This sort of evidence could not stand against that of Prof. Kennedy and Col. Crompton, who had actually made long life tests, and therefore the contention of the London County Council that they should receive compensation on account of the inferiority of the lamps was not fair. He was perfectly willing that this should be one of the things the arbitrator should investigate and that he should give such compensation as he thought fit in each particular case, but he objected to any directions being given to the arbitrator on the matter. He wanted open arbitration and no such limits ought to be put upon the arbitrator's discretion. The case of a consumer's premises badly wired in the first place was an instance. If he were paid the whole cost of efficiently re-wiring it for 200 volts the company would be giving him something in the shape of a good installation for an unsatisfactory one. He corrected Mr. Lyttelton's statement that the companies were practically asking for a dispensation of the ordinary law of trespass, and maintained he was only asking for the powers given under the Electric Lighting Act of 1882. For the Metropolitan Company he did not propose to call any witnesses, or make a speech on this company's behalf. This was a special case in an *a fortiori* direction, because it was a question of changing from 50 volts to 100 volts, and not to 200 volts. This change ought to be permitted because there was nothing to be said against 100 volt lamps.

Mr. R. C. GLEN, summing up on behalf of the Paddington Borough Council, in whose district the Metropolitan Company supply, failed to see any difference in this case. He did not suggest that the company was in any way unreasonable, but by supporting the change to 200 volts, although they did not immediately anticipate the use of this pressure themselves

they were asking to be put on a level with those companies that did, and so at some future time they could change without any trouble to 200 volts. To his mind it was immaterial what the present change on the part of the Metropolitan Company might be, the principle was the same. Coming to the present application for changing to 200 volts, he said that so recently as 1895 the Board of Trade had determined, after full consideration, that the consent of the consumer should be obtained. Therefore, it was necessary to consider what had happened since then, and in doing so he opposed the arguments of the other side. It was perfectly obvious that the company, finding that supply at the higher pressure would be in every way to their own interest—and there being some 200 volt lamps on the market which did not exist in 1895—determined to force the change in their district. A careful review of the evidence made it clear that where the change had been made it had been done by a system of terrorism, and not taking the consumer into their confidence; and disguising the fact that the consumer could withhold his consent. But when the consumers had got to know this, and had stood out, the company put obstructions in the way, and now wished to prevent people from exercising their rights. If the companies had made this application before changing any consumer, no doubt the Board of Trade would have insisted, in view of the large number, on compensation to the consumers, but the rights of the few were exactly the same as if there were a large number. Even if the lamps were practically identical, and thus the consumer lost nothing here, the companies admitted that unquestionably they themselves did benefit by the change, and therefore why should the consumer not share that benefit? Mr. Moon had referred to Prof. Kennedy's tests, but it was admitted by that witness that these lamps were sent to him at his request, and therefore it was a likely thing that the very best picked lamps would be sent. The evidence had also gone to show that below 8 c.p. the lamps would not stand the increased voltage and retain their proper candle-power, and as these small candle-power lamps were largely used, it was quite clear that in the event of any change in pressure, special provisions must be made with regard to this matter. He quoted the evidence of Lord Londonderry's agent as proof that more current was used, to the disadvantage of the consumer and as, on Prof. Kennedy's showing, there was more danger of fire, the insurance companies were entitled to more ample protection, but at the company's expense. Although the present regulation was a little hard on the supplier, he submitted that the London County Council proposal should be accepted as it stood as being a very fair suggestion. He thought, in view of Col. Crompton's statement that the companies in days gone by had been lax in their inspection of installations, a consumer ought to have his installation brought thoroughly up to date, and in this way make the company suffer for its past sins.

Mr. DANCKWERTS, K.C., for the City of London Corporation, referred to Mr. Still's evidence as so much stillborn nonsense, especially regarding the reduction of loss in consumers' leads. Prof. Kennedy's tests were not made under what he called service conditions, and this witness had further stated that the consumer was in no better and no worse position by the change. But the evidence had gone to prove that unless the overhauling of the premises was of the most complete, severe, and minute character there was a greater risk of fire. Mr. Balfour-Browne had argued that the consumer should pay for this. But why? The company was getting a benefit out of the change, and if this thing were taken before a Parliamentary Committee they would not stand the smallest chance, and yet Sir Courtenay Boyle was asked to do it. As a matter of fact no case in favour of the change had been made out at all. Transformers would be less expensive and inconveniencing to the consumer and less injurious to the public. Further still, there was a person who had been left out of the arguments altogether, viz., the very small consumer, and to suggest arbitration at the consumers' expense to such a man was all nonsense, because he could not afford to do it. If there was to be any change—and there was a big "if"—it ought to be made in such a fashion that there was a minimum of occasion for arbitration; in other words, the conditions likely to be prevalent in every case must be prescribed hard and fast. Prof. Kennedy had admitted that the expense should be borne by the company, and the common thing in such cases was to allow full compensation for all damage and something else for using violence to the rights of the consumer, which, in this case, he suggested should be a supply at 10 per cent. less cost than to anybody else. A *sine quâ non* was that all damage should be made good, and this ought to be done by somebody selected by the consumer, but paid by the company. In addition to this the company ought to undertake to satisfy the insurance company, in premises where the change had been effected that the insurance should continue, if necessary, at the company's expense. The costs of the arbitration should only be borne by the consumer if it were proved that he had been unreasonable, and a point he had been instructed to strongly press upon the Board of Trade was that in every case where the company insisted on going to arbitration they should pay the costs without exception. It was here that the small consumer came in again, and, as a matter of fact, with very few exceptions, they would all be small cases. If the change in the regulations were made, he submitted that these were the only reasonable terms upon which it could be done. At the same time, he thought it a wholly unreasonable proceeding, and that matters would be in a better condition by leaving the law as it stood at present.

Mr. ROSKILL, K.C., speaking on behalf of the City of London Electric Lighting Co., argued that there was no such thing as a vested right to any consumer. He was entitled to no such consideration, and it would be monstrous for a man to be able to blackmail a company about a thing of which he was not in undisputed possession. Thus Mr. Danckwerts' suggestion of the 10 per cent. reduction went to the wall. Mr. Danckwerts was also quite wrong in saying that no benefit came to the consumer. The lamp controversy could be settled by the Board of Trade, and in the meantime a consumer was absolutely indemnified by the words "of and incidental to." In the face of Mr. Chamen's evidence as to the troublesome nature of motor transformers, it was bad form to urge the use of such machines as had been done. With regard to the interests of the small consumer, for whom Mr. Danckwerts seemed to have a very affectionate regard, he was amply protected by the clause put in by Sir Courtenay Boyle, but the suggestion that the arbitration should be carried out under the Lands' Clauses Act was a direct invitation to every small and large consumer to levy conditions upon the company. With the exception of the London County Council, Paddington, and the City Corporation, no local authority was appearing against the change, and these three particular bodies did not represent the consumers. They simply represented themselves, and not a single argument had met the contention that this change was right, that it was inevitable, and that the clause suggested by Sir Courtenay Boyle met in every possible way any reasonable objection to be urged against it.

At the conclusion of Mr. Roskill's speech several protests were made on behalf of some London boroughs, that although they were not actually opposing the proposal, they were content to comply with whatever the Board of Trade ruled

Mr. ROSKILL replied that he was not referring to London, and further, that the bodies protesting were not at present supplying electrical energy.

This closed the enquiry.

## CORRESPONDENCE.

### ALTERNATING-CURRENT WATTMETERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest the article by Mr. C. V. Drysdale on the "Theory and Use of the Alternating-Current Wattmeter," in your issue of last week. Mr. Drysdale appears to put the whole problem in a more practical way than I have seen before. I have not had time to go through all his arguments in detail, but they look to me to be on the right lines.

With regard to Mr. Drysdale's reference to my own work on alternating-current measurements, which has chiefly been by the use of electrostatic instruments, I founded my work all along on the reasons which Mr. Drysdale gives, viz., that, "The electrometer method theoretically should be the method par excellence, as it is free from inductive error, and can be used with special convenience on high-voltage circuits." I would, however, add to this the important points that electrostatic instruments can be calibrated, and their readings can be reproduced with permanent known voltages more readily and with simpler means than instruments of the dynamometer type, and also that they can be made direct-reading. As Mr. Drysdale says, there are difficulties in using electrostatic instruments, and till both methods were thrashed out further, I have always felt great hesitation in strongly advocating one system as against the other. What I have done is this, believing, as Mr. Drysdale says, that the electrostatic system was theoretically the best, and also that the possession of electrostatic instruments such as are required for this work would be useful in other electrical departments, I have for a number of years, and more especially during the last four or five, been steadily plodding along investigating the actions involved in electrostatic instruments and trying to improve them in detail and get over various objectionable points. I have also tried, and I think with some success, to work out a comprehensive system of alternating testing founded on the use of such instruments. This I think I may fairly say I have done now, and I believe for most work it is better and handier than a dynamometer system. If Mr. Drysdale would like to call on me I should be happy to go into the matter with him and show him exactly what I have achieved.

The Paper which I read in Paris I am now having reprinted in full in English, and if anybody who is interested in these matters would care for a copy I should be happy to send him one. This will explain many points. As regards the rest of the fundamental questions which arise in the use of electrostatic instruments, I have, I believe, now worked these out one by one, and as I have done so I have written the best account and explanation of them which I could; these disjointed memoranda have been laid aside one by one, but press of business has so far prevented my bringing them forward publicly, the more especially as to get them properly understood I think it is necessary that someone should write a small book on the subject.—Yours, &c.,

London, March 19. G. L. ADDENBROOKE

## WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

*(Translation.)*

SIR: Before removing the air-wires of the three stations at Antwerp, Malines, and Brussels, I made a final experiment on the 20th inst. on the employment of alternating currents. A very violent tempest which raged at Antwerp tore down the stays supporting the air-wire on the tower of Notre Dame, so that the air-wire presented a succession of bends and kinks, and had become hooked round several of the projections of the tower. The conditions were thus very unfavourable. But it is an ill wind that blows nobody any good, for I had a certain proof that the employment of alternating currents is preferable to the employment of Hertzian currents. In fact, of all the signals transmitted from Antwerp, using the oscillator, no single one was received at Malines; whilst all the signals transmitted from the same station, but utilising alternating currents, reached the relay station at Malines and were all sent on to Brussels.

To sum up, I merely verified the phenomena discovered by others,—phenomena which had passed by almost unnoticed. In 1885 my fellow-countryman Calzecchi-Onesti discovered the effect of alternating currents on metallic filings. In 1891 Edison patented a system of wireless telegraphy in which transmitters produced nothing but alternating currents. In my experiments of the 20th inst. I therefore applied to the receiver the discovery of Calzecchi-Onesti and to the transmitter the idea of Edison.—Yours, &c., E. GUARINI.

Brussels, March 24.

[We have also received a letter from Lieut. Poncelet objecting to the criticisms on M. Guarini's experiments in our last issue. He considers that the object of the experiments was actually attained, as signals transmitted from Brussels were successfully received at the repeater station and re-transmitted by the apparatus to Antwerp. So far as we can gather from Lieut. Poncelet's letter, during the last days of the experiments the only failures occurred in the receiving part of the repeater. —ED. *E.*]

## THE ALLEGED DECLINE OF BRITISH COMMERCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The bogey of "Made in Germany," and the reiterated cry that British commerce is being worsted in every market of the world lead me to ask for a little space in your columns to place before your readers one or two reasons why they need not give way to feelings of despair or even despondency over the situation. By the articles which are published from day to day in newspapers and magazines, our foreign trade is made to appear decadent, while that of Germany and America is shown to be as rapidly growing. "Give a dog a bad name and hang him"; tell the whole world day by day that the Briton is a degenerate, and that his German and American rivals are cutting him out, and the prophets will bring about the fulfilment of their own forebodings; merchants and manufacturers will become discouraged, and capitalists will look abroad for more promising fields in which to invest, and then we may write "Ichabod" over the gateways of our custom houses. A great number of writers take it for granted that Germans and Americans have made relatively far greater progress than Britons during the past 20 years; indeed, the opinion of some of the authorities in the symposium on this subject, held in a monthly review this month, clearly is, that Britain has lost its supremacy in the field of foreign commerce, and that it has fallen into a second or third place, behind Germany or America. I have seen enough of German and American factories and institutions to fill me with respect for them, yet I have felt no uneasiness concerning our own prospects. It may be all very well to attempt to spur on the British manufacturer to greater endeavour by warning him of what his rivals are doing, but exaggeration, and in many cases, false statements, are not justifiable.

With your permission, Sir, I would like to lay the following broad statement of facts before your readers, so that they may draw their own conclusions, from official data. The annual gross exports of merchandise from the United Kingdom, Germany and the United States, as given in the statistical abstract of the Board of Trade, divided among the inhabitants of the respective countries, during the period from 1879 to 1899, split up into three equal terms of seven years, is as follows:—

| Periods. | United Kingdom. Total exports per capita. | Germany. Total exports per capita. | U.S.A. Total exports per capita. | Germany and U.S.A. comb'd. Total exports per capita. |
|---|---|---|---|---|
| 1879 to 1886 | £8 4 1 | £4 17 5 | £3 2 2 | £7 19 7 |
| 1886 to 1892 | 8 0 11 | 4 8 4 | 2 14 1 | 7 2 5 |
| 1893 to 1899 | 7 9 0 | 3 12 2 | 2 18 9 | 6 19 11 |

The above decreases are due to the fall in value of late years, the actual volume of trade has, of course, greatly increased. Besides showing that the Briton is doing more, man for man, than his two great rivals combined, the above statement proves that he is increasing his lead. In the foregoing the export business only has been taken into account, and, moreover, no credit has been claimed for the great preponderance of the British shipping and financial interests, in which this kingdom is *facile princeps*.

Thanking you in anticipation for the space granted me in your influential columns.—Yours, &c.,

Royal Statistical Society's Rooms, GEO. J. S. BROOMHALL.
London, W.C., March 25.

# PARLIAMENTARY INTELLIGENCE.

## BOURNEMOUTH CORPORATION BILL.

On Monday the bill promoted by the Corporation of Bournemouth came before the Select Committee of the House of Lords presided over by Lord Stanmore.

Mr. PEMBROKE STEPHENS, K.C., for the promoters, said he would deal first with the tramway proposals under the bill. By the act of last year the Corporation had power to construct a number of tramways, and No. 1 tramway in the present bill was an additional line as an alternative route on a portion of the main line route through the borough. No. 2 was a short line of tramway to connect two already authorised lines, and No. 3 was an extension of an already authorised line into the district of Winton. The local authority of Winton was in favour of Bournemouth making the line. No. 4 tramway was for the purpose of giving access to the generating station, for which powers were asked in the bill. The Corporation were already empowered to supply electricity for public purposes, and under the Tramway Order of 1900 were authorised to construct and work by electricity their tramways. There was a small generating station at present in existence, but it was entirely insufficient to meet the present needs. The petition of the Poole and District Traction Co. against the bill, submitted that it was inexpedient that the Corporation should be authorised to construct the Winton branch as the petitioners were willing and anxious to extend their system to that place. The petitioners also complained that the effect of the Winton extension would be to increase the number of cars which the Corporation would be entitled to run over the company's lines under the provisions of the Act of 1900; and that if the Corporation were granted the powers now asked for, the company should be allowed running powers over the Winton line. Last year when the Traction Company tried to get into Bournemouth the Corporation came forward with a bill of their own, and the matter was thoroughly threshed out. Parliament granted the Corporation powers for all the tramways asked for, but as the Traction Company had laid great stress upon the inconvenience which would result if the Corporation did not carry their scheme into effect, Parliament sanctioned the company's line into Bournemouth up to a certain point on condition that power should drop if the Corporation constructed their lines within two years. Parliament also acceded to the demand of the company for through communication over the Corporation lines from the Christchurch to the Poole side, giving as an equivalent to the Corporation running powers over the outside pieces of lines belonging to the company.

Mr. MOON (for the Traction Company) said the company offered that arrangement, it was not imposed.

Mr. PEMBROKE STEPHENS said it had been found necessary to widen certain streets, and to construct loop lines to relieve the traffic, and it was for this reason that it was now proposed to nearly double the cost of last year's undertaking. The question was how did these proposals injure the outside tramway company. He submitted they had no *locus*, and should not be heard. Their's were merely local tramways with permission to pass through the borough. The contention of the company amounted to this: that they, having got these running powers, the Corporation were never to put in any junctions. If the company ceased their opposition the Corporation would be willing that they should have running powers over No. 1 tramway.

Mr. MOON said his clients were owners of the Poole tramway and the Christchurch branch. The Bournemouth Corporation had always resisted tramways in the borough until 1900 and had refused to permit any tram

way to enter the borough. In 1889 the Light Railway Commissioners passed a line from Poole to the Hotel Metropole, Bournemouth, but the Corporation refused their sanction, and the light railway was stopped at the boundaries of the borough. Last year the company promoted a tramway from Christchurch to the Hotel Metropole. In that case, as the standing order provided that the dissent of the local authority should only apply when two-thirds of the proposed line was within its area, the bill came before Parliament, and it was admitted that it was undesirable there should be a break at the boundaries of Bournemouth. If the additional line now asked for to Winton were sanctioned the Corporation would have increased running powers over the company's lines because there would be a fresh stream of traffic brought on to them from Winton. The Corporation would be taking advantage of the power they got last year to carry over the company's lines a traffic which was not then contemplated by either party or by Parliament. If these powers were granted the company ought to have something in return, and what they asked for was through running powers to Winton over the proposed new lines, but not running powers over the whole system of the Bournemouth tramways.

Mr. PEMBROKE STEPHENS said before the company could get to Winton they must pass over the Bournemouth Corporation's authorised line, and that they had no power to do. The Poole line was made, the Christchurch line was not made, and the Corporation's lines were being proceeded with as fast as possible.

The Committee decided that the Traction Company had a *locus standi*.

Mr. LACEY, C.E., said he was consulting engineer to the Bournemouth Corporation. The effect of the running powers given to the company by last year's act was such as to necessitate the duplication of the tramway line through Bournemouth. Therefore the proposals now made were the effect of the powers the Traction Company obtained last year. The doubling of the lines over which the company had been given running powers would cost the Corporation line £25,000 or £30,000. It would be a serious matter if the company were to be permitted to ask for more every time an extension was made by the Corporation.

Mr. MOON contended that if the Winton line had been before Parliament last year running powers would have been granted to the company on reciprocal terms.

The Committee found the preamble proved so far as the tramways proposed were concerned, and ordered that the Traction Company should have running powers over the Winton lines as well as the loop line proposed.

In dealing with the petition of the Bournemouth and Poole Electric Supply Co.,

Mr. PEMBROKE STEPHENS said the petitioners took exception to clause 12 of the bill dealing with lands for the new generating station; clause 31, by which local authorities adjacent to the borough or along the route of any tramway worked by the Corporation might be supplied with energy subject to the approval of the Board of Trade; and to clause 32, authorising the supply of energy to any tramway company authorised to construct lines under the Light Railway Act. With regard to clause 12, the present generating station was not large enough to meet the needs of the borough for tramway and electric lighting, and therefore a larger one must be erected. The petitioners were only afraid that the station would be so convenient and so large that their business would be damaged. In regard to clause 31, its powers could only be exercised with the sanction of the Board of Trade. What was sought was that the Corporation having its own system for its own cars should have power to supply anybody who might require electric power.

Mr. LACEY, C.E., having spoken in support,

Mr. BALFOUR BROWNE, K.C. (for the Bournemouth and Poole Electric Supply Co.), said Bournemouth had at present no power to supply any private individual with electricity, but the Corporation were now seeking powers to enable them to compete with his company.

Mr. PEMBROKE STEPHENS said they did not seek to supply private lighting at all.

Mr. BALFOUR BROWNE said if anyone offered and had power to supply for electric lighting, then Bournemouth would be able to supply them with power in bulk, which would be competition with his company. He asked the Committee to reject this portion of the bill as interfering with his company. Outside London competition in electricity was not allowed, and in London the competition was between companies and not between companies and local authorities.

The Committee ultimately decided that clauses 31 and 32 should not stand part of the bill.

On Wednesday the Committee dealt with the clauses of the bill, when a new clause was brought up on behalf of the Corporation to give effect to the decision of the Committee in regard to the granting of running powers to the Poole and District Electric Traction Co. over the direct Winton line. On behalf of the Traction Company running powers were also asked over a divergent line towards Christchurch, but this the Committee refused to grant.

On Tuesday the Committee, after considering the remaining portions of the bill, passed the preamble.

### UNDERGROUND RAILWAYS IN LONDON.

In the House of Lords, on Friday last, it was resolved that a Committee, consisting of the Earl of Lauderdale, the Earl of Rosse, Viscount Knutsford, Lord Windsor and Lord Herries be appointed to join with a Committee of the House of Commons to consider and report:

1. Whether the lines of route for underground railways in and near London, proposed by bills which have been or may be introduced during the present session, are best calculated to afford facilities for present and probable future traffic; and, if not, what modifications of those lines of route are desirable.

2. What special provision, if any, should be made for the protection of owners, lessees and occupiers of properties adjacent to underground railways from possible damage and annoyance.

3. What special terms and conditions, if any, as to construction and working, should be imposed upon the promoters of these lines.

4. Whether any, and which, of the schemes proposed by the said bills should not be proceeded with during the present session of Parliament.

### KING'S NORTON AND NORTHFIELD TRAMWAYS BILL.

Discussion on this bill was resumed by the Select Committee of the House of Commons presided over by Lord Stanmore. The District Council seeks powers to construct electric tramways on the overhead trolley system to connect the district with the Birmingham tramways.

The Committee decided that the preamble of the bill was proved except for the part known as the Middleton Hall-road line. The promoters of the bill reserve the right to carry their tramway by an alternative route. The Committee decided to limit the borrowing powers of the Council under this scheme to a sum to be specified in the bill, and subject to the approval of the Local Government Board.

### WIRELESS TELEGRAPHY IN THE NAVY.

In the House of Commons, on Tuesday, in reply to Sir J. Leng, Mr. ARNOLD FORSTER said the "Ophir," the vessel carrying the Duke and Duchess of York on their Colonial tour, was not fitted with wireless telegraph apparatus. Wireless telegraphy had been in use in the navy for some time, and it was not expected that any special information would be derived from the operations conducted by the cruisers accompanying the "Ophir," or that any report upon the subject would be of value. Thirty-six ships in the navy were fitted with wireless telegraph apparatus, and arrangements were in progress for similarly equipping other ships of the fleet.

## LEGAL INTELLIGENCE.

### London County Council v. Metropolitan Electric Supply Co. (Ltd.).

This case was before Mr. Justice Farwell on the 22nd inst. on a motion by defendants that under sec. 4 of the Arbitration Act, 1889, all proceedings might be stayed.

Mr. BALFOUR BROWNE, K.C., for the motion, said that the matter in dispute arose out of the London County Council Improvements Act, 1899, under which the Council got leave to make a thoroughfare from Holborn to the Strand. The Metropolitan Electric Supply Co. had one of their great generating stations in Sardinia-street and opposed the bill under which the Council obtained their powers. The company said that if the Council stopped them in working for a single day all their customers would have to get their electricity elsewhere, and they would lose them. Accordingly a clause was inserted in the Council's special act securing the company's continuity of supply. The company said they did not so much want compensation for the taking away of their property as that they should be secured in giving a continuous supply of current. Under the section of the Council's Act of 1899, referred to, it was provided that the Council should pay or secure to the satisfaction of the company a sum equal to the cost of erecting a new generating station upon another site with new plant, capable of generating and supplying electrical energy to an output of not less than 4,000kw., the Council to pay the company all costs, expenses and damages incurred on a failure by the company to carry out its contracts. It was provided that all disputes should be settled by arbitration, and that the Council should not enter upon and take any part of the existing site of the company's station until the expiration of two years after they had provided, at their own expense and vested in the company, a site clear of buildings and available for the erection of a new generating station. The Council gave the company a site, and had to give the company time to erect a generating station upon it. There had been negotiations with regard to the clause as to the capacity of the new plant, and it appeared from the writ the Council had issued that they had misunderstood the company's contention as to this capacity, as the company had never asked to have a plant provided capable of an output of more than 4,000kw., but one capable of producing not less than 4,000kw. It was a matter for arbitration to determine what machinery would secure to the company that output. He contended that arbitration was the proper proceeding to decide the point in dispute. The company had appointed Sir F. Bramwell as their arbitrator. He did not know who had been appointed by the Council, but his submission was that the two arbitrators were capable of deciding the matter. Of course the onus was upon the Council to show that the matter was one for the Court of Chancery to hear and determine. The arbitration was pending. It seemed to counsel that if his lordship had to decide this question the expense would be added to considerably as he would have to hear expert evidence of what a plant capable of supplying 4,000kw. was.

His LORDSHIP said it seemed to him that all that was referred to the arbitration was the amount of compensation.

Mr. BALFOUR BROWNE said he asked that the action should be stayed until the arbitration had been disposed of.

His LORDSHIP said it might be the more expensive to do as counsel now suggested.

Mr. BALFOUR BROWNE asked if his Lordship would have the case heard at once?

His LORDSHIP said he could not decide the case without expert evidence, and thought that two great bodies like plaintiffs and defendants should be able to determine on the best course to pursue. If both sides could get their evidence together he would be willing to take the case before Easter.

Mr. BUTCHER, K.C., for the Council, said it was in the interests of his clients to proceed with the case at once, as they wanted to make the street. The company had two years from the time they got the site. It certainly was a case in which the question ought to be decided at once. His clients could be ready the week after Easter.

Mr. BALFOUR BROWNE said the question of 1,000kw. might mean £50,000 or £60,000. It might, of course, mean that his clients would have to go to the House of Lords. He thought the better plan would be for his Lordship to stay the action until the arbitration was heard. He had power to do it under the Arbitration Act.

In the result it was arranged that his lordship should take the case on April 24 with oral evidence.

His LORDSHIP (to Mr. Balfour Browne): The expert evidence is as to what plant is necessary for you for your supply.

Mr. BALFOUR BROWNE: Yes.

His LORDSHIP: You must have arbitration, but you may not think it worth while to proceed with it.

Mr. BALFOUR BROWNE said that might be so.

## Brentford District Council v. the London United Tramways.

This case came before Mr. Justice Farwell yesterday, and was an action claiming that in accordance with the true construction of the United Tramways Acts, 1898 and 1899, the defendants were not entitled to commence the construction of tramway No. 7 of their system on lands within the plaintiffs' district until they had complied with the requirements imposed upon them by the provisions of the Tramway Act of 1870, and for an injunction to restrain defendants from excavating the soil or interfering with the surface of a certain highway, and from using that road or any part for the purposes of a tramway.

Mr. BUTCHER, K.C., for the plaintiffs, said that the first point to be decided was whether or no defendants, before they broke up the road and put in the mains they proposed to lay down, were bound to widen it. It was admitted that the defendants had not yet taken any steps to do that. The second point was whether—assuming plaintiffs were wrong on the first point—defendants had given a regular notice before they commenced or endeavoured to break up the street? Defendants alleged that they were not bound to give any notice. The question of notice was not a mere technical matter at all, because he should call evidence that along this road the defendants proposed to break up and lay their mains at a certain depth there were a very considerable number of drains communicating with main sewer. If the defendants were allowed to go and break up the streets and lay mains to any depth they liked, it might be a serious matter to plaintiffs. The notice that the defendants had given the plaintiffs did not give them any information as to what depth it was proposed to lay the mains, nor how they proposed to avoid touching drains and sewers. It appeared that in 1898 plaintiffs gave defendants notice of their intention to oppose defendants' bill authorising the construction of the tramways, as they considered it would interfere with their rights. On March 1, 1898, an agreement was come to between plaintiffs and defendants, the effect of which was that plaintiffs abandoned their opposition to the bill in consideration of defendants granting them certain concessions. In substance the provisions of the agreement were inserted in defendants' special act. The whole question in dispute turned upon the construction of this agreement and the special act of the defendant company.

The case for the defendants was that what they were doing was merely laying down an electric cable for the purpose of feeding the lines already constructed, and that this did not form part of the construction of tramway No. 7 at all, and that such notice as had been served by them upon plaintiffs was a sufficient compliance with the Act of 1870. The defendants further said that their mains were made of such flexible material that they could easily avoid touching the sewers and drains.

At the conclusion of the arguments his Lordship, in giving judgment, came to the conclusion that what the defendants were doing was for the purpose of bona fide supplying electric power for the purposes of their several authorised tramways running north and south, and although it might be possible to use that electric energy for the purposes of tramway No. 7 when completed, the mains were not laid for that purpose. He decided that defendants were quite within their rights in doing what they had done, and that they had, on the point as to notice, satisfied the requirements of sec. 31 of the 1870 Act. The action therefore failed, and must be dismissed with costs.

## Barlow Bros. v Robert Jay.

Mr. Justice Lawrance and a jury, on Tuesday and Wednesday, heard an action to recover the price of certain electric lighting work done on the defendant's premises and for damages for breach of contract. The defence was that the defendant was induced to enter into the contract by misrepresentation on the part of the plaintiffs. The plaintiffs were Barlow Bros. & Co., electrical contractors, Shaftesbury-avenue, London, and the defendant a jeweller in Essex-road, Islington, London.

Mr. FOOTE, K.C., for plaintiffs, said defendant employed plaintiffs to do the work, but the defence raised was that the plaintiffs induced him by fraud to enter into a contract by representing to him that the current necessary for the complete lighting of his premises could be obtained from the Islington Vestry, that the plaintiffs at the time were informed by the engineer to the Vestry that the Vestry was not able to supply the necessary current, and that the plaintiffs fraudently concealed the said facts from the defendant. According to his instructions, a more impudent charge of fraud was never made. Mr. Jay was negotiating with the Vestry for the electric lighting of his premises long before plaintiffs were employed. He obtained full information from them, and at the time knew exactly what power they had to provide current. There was no foundation for the allegation that plaintiffs had ever concealed or misrepresented anything. The work began as far back as Sept., 1899, when, at defendant's request, plaintiffs gave an estimate of £123, and finally agreed to do the work for £117. 10s. The installation was to be for 200 16 c.p. lamps. Before the work was completed defendant was informed that the Vestry would be unable to supply all the current required, and he refused to allow the contract to proceed, though plaintiffs told him he could use 8 c.p. instead of 16 c.p. lamps until the Vestry was able to supply more current, when the lamps could be changed.

Mr. WALLACE, K.C., M.P., for defendant, said plaintiffs were installing the electric light for other people in defendants' neighbourhood, and he asked whether it would be possible to get a supply of electricity from the Vestry. Mr. Barlow told him that he could, and upon that assurance he entered into the contract. It was a fact that other tradesmen were unable to get more than half the supply they required, and plaintiffs were aware of the fact: they were in communication with the Vestry on this very subject. Plaintiffs, in full possession of this knowledge, went on fitting up. Counsel further contended that if the plaintiffs were entitled to payment at all, the work done and materials used were not worth more than £25.

The jury found for plaintiffs for the whole of the account charged—£90. 11s. 9d.—and judgment was given accordingly.

## London Electrical Cab Co. (Ltd.).

The petition for the compulsory winding-up of the London Electrical Cab Co. (Ltd.) was before Mr. Justice Wright on Wednesday.

Mr. COUNSEL, in support of the petition, said the case was before his lordship in October last, and he now had the report of the receiver, which stated that efforts had been made to procure a purchaser of the licences which formed the assets of the company, but up to the present an offer of £25 was all that had been suggested. The nominal capital of the company was £150,000 in £1 shares, and 101,331 shares had been issued. There were also £15,000 debentures. The company was promoted by the Traffic Syndicate (Ltd.).

His LORDSHIP: The official receiver's report shows that there are no assets.

Mr. COUNSEL said unless assets could come from the winding-up there would be none.

His LORDSHIP: Then it is of no use applying for a compulsory order.

Mr. COUNSEL then said he asked that the petition should stand over, with liberty to apply.

His LORDSHIP said he had decided on the merits, and there were no misfeasance assets to come in, and the receiver had satisfied him that there were no tangible assets. The petition would therefore be dismissed with costs, but if Mr. Counsel made a fresh application founded on material he would hear it. There had been charges of fraud insisted on, and therefore he should allow the costs.

## Manchester and Liverpool Electric Railway Syndicate (Ltd.) v. Cavendish.

This case was in the list for hearing before Mr. Justice Channell on Tuesday, but upon being called it was stated that it had been settled, and that there would be judgment for the plaintiffs. Judgment accordingly.

## Watson v. Hartlepool Electric Tramway Co.

At Durham recently an action was tried before Mr. Justice Kennedy and a special jury, in which the plaintiff, Mr. T. C. Watson, sued the defendant company for damages for personal injuries sustained whilst travelling on one of the company's electric tramcars. Plaintiff's case was that in June, 1899, he was a passenger on one of defendants' cars, and was passing under Throston Bridge, close to which place the double track lines of the tramway route converged, and as the two overhead trolleys wires from which electric current was obtained for the service were both on the same side of the road, any attempt on the part of the driver of one car to pass another caused the spring frame of the trolley pole to protrude over the top guard of the inner car. The car upon which plaintiff was travelling stopped near the converging loop of line, when another car came along and ran past at a good speed. Plaintiff, who was standing on the top of the first-mentioned car, was engaged in conversation when he was struck on the back of the head by the projecting spring frame, and knocked over the end of the car, falling into the road on his head. He was picked up unconscious. He was confined to his bed for 16 weeks, and the injury to his brain rendered his removal to an asylum necessary. Counsel for the plaintiff was unable to call his client, as, owing to the injury, his mind was a blank in regard to the whole occurrence.

The defence was that plaintiff had contributed to the accident by sitting on the rail at the top of the car or by leaning back over the rail. Defendants further denied negligence.

After hearing the evidence the jury found for the plaintiff for £1,162 and costs, and judgment was given for this amount.

## Obstructing Electric Tramways.

The magistrates at Bolton were engaged recently in hearing an action of an unusual character, in which a brewer's drayman named Turner was charged with obstructing the electric tramways. The summonses, four in number, were issued at the instance of the Bolton Corporation, who were represented by Mr. Langdon, who said the action was brought under sec. 50 of the Tramways Act, 1870, which provides that an offence is made out if any person, without lawful excuse, wilfully cause an obstruction to any carriage using a tramway. He submitted that the term "lawful excuse"

meant if the defendant had a right to do it. Evidence was called to show that defendant was in charge of a dray belonging to his employers, Messrs. J. Sharman & Co. (Ltd.), brewers. The dray was drawn up outside the "Bridge Inn," Bolton, when the 8:35 Tonge Moor electric car was about to pass. The car was unable to pass because of the dray and also by reason of certain empty barrels which were standing on the tram lines. Five cars became obstructed, and the dray was not removed for 32 minutes. When expostulated with Turner said he had received orders not to move, and that if he did move he would lose his situation.

Mr. SUTTON, for the defence, contended that it was the Corporation who were obstructing, and not his client. He questioned the jurisdiction of the magistrates to try what he contended was a question of right which should be tried in the Chancery Court, but the magistrates decided that the question of right was not such as to oust their jurisdiction. Counsel then urged that the Corporation had laid the tramway 1½ft. nearer the "Bridge Inn" than they had any right to do. There had been no suggestion of obstruction before the electric cars were run, and Bridge-street was the only way by which the brewery company could unload barrels from their lurries.

Mr. WINDER (the magistrates' clerk) asked the magistrates to deal with the question whether the lurry was kept in the street for a longer time than was necessary, but the magistrates failed to agree, and the case was adjourned for a fresh bench of magistrates.

Ultimately three of the summonses were dismissed, but without costs, and in the case of the fourth the magistrates found defendant guilty, and imposed a fine of £5 and costs.

### Maxwell v. British Thomson-Houston Co.

At the West Riding (Yorks.) Assizes, on Wednesday, before Mr. Justice Kennedy and a special jury, Miss Agnes Maxwell sought to recover damages for personal injuries from the British Thomson-Houston Co. (Ltd.). Mr. E. Tindal Atkinson, K.C., and Mr. A. P. Longstaffe were for plaintiff; Mr. S. C. Macaskie, K.C., and Mr. H. Marshall for defendants; and Mr. Scott Fox, K.C., and Mr. A. W. Bairstow, for Messrs. R. W. Blackwell & Co. (third parties), sub-contractors under defendants. On June 10, 1899, plaintiff was a passenger on the top of a horse car in Cookridge-street, Leeds, and workmen were engaged in erecting the apparatus in connection with the electric tramways. The iron bars on a derrick extended over the tramway, and the danger was not observed until the car was driven underneath the bars. These came in contact with a number of passengers on the car, including plaintiff, who was struck in the throat and rendered unconscious.

Counsel said the parties had agreed as to the amount of damages (£650), and the only question for the jury was that of liability, including the question as to the liability of the third party, the contract having been sublet. This latter question was, however, to be tried in London.

Defendants attributed the accident to negligence on the part of the driver of the tramcar.

His LORDSHIP said the jury had to say whether there was any want of reasonable care in the use of the derrick which caused the accident or materially contributed to it.

The jury answered in the affirmative, and on that finding counsel for plaintiff asked for judgment.

Mr. MACASKIE urged that defendants were not responsible in point of law for those in charge of the derrick, as they were the servants of a sub-contractor, and therefore the action was wrongly brought.

Mr. TINDAL ATKINSON held that defendants, having established a duty, could not get rid of their responsibility by delegating it to another person.

His LORDSHIP found that defendants had been properly sued, and gave judgment for plaintiff.

Stay of execution for seven days was granted.

### Heath v. Gascoigne.

On Wednesday Mr. Justice Ridley and a jury heard an action for slander brought by Mr. Ernest C. Heath, electrician, against Mr. H. T. Gascoigne, manager of the Avondale Hotel, London. Plaintiff was employed in doing electrical work at the hotel and charged defendant with having accused him of stealing a switch, whereas plaintiff stated that he had merely removed a switch from one part of the hotel to fix it in another part, and had put up a new switch in the place of the one removed. Defendant denied having charged plaintiff with theft, and as an alternative pleaded privilege.

The jury awarded plaintiff £40 damages, and judgment was given accordingly.

**Electric Tramways in Canada.**—The statistician of Canada has compiled some interesting figures regarding the 84 electric railways of the Dominion. During the year ended December 31, 1899, 630 miles of track were used, and the total number of miles run by cars was 29,646,847. Passengers carried numbered 104,083,659, which was equal to carrying every man, woman, and child in the Dominion 20 times. Compared with the previous year, the number of passengers increased nearly 9,500,000, and the number of miles run over 1,000,000. The amount of paid-up capital invested in electric railways is $21,700,000.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The British Electric Traction Co. require a manager to superintend the erection of 7 miles of overhead construction for electric tramways in Scotland. See advertisement.

Belfast Gas and Electric committee requires an engineer-in-charge. Applications to the city electrical engineer (Mr. Victor A. H. McCowen). See advertisement.

The electrical engineer to the Wimbledon District Council (Mr. F. Barnes Spencer) has a vacancy for an articled pupil. See advertisement.

A mechanical and electrical draughtsman is required at the Lancaster Corporation electricity works. Applications by April 1.

Mr. H. Mozley has been appointed manager of the Burnley Corporation tramways at £350, rising to £400 per annum.

Mr. Charles O. Dawson has been appointed electrical engineer by the Bridlington Council to take charge of the electrical plant at the Royal Prince's-parade, Bridlington.

The London County Council received 112 applications for the post of resident foreman at the electricity generating station for the lighting of the Victoria Embankment and Westminster Bridge. The Highways committee recommended that Mr. R. Simpson be appointed, and the Council approved.

Mr. W. E. Halton has been appointed chief superintendent of telegraphs at Manchester. Mr. Halton joined the service of the Electric and International Telegraph Co. in 1860, and, after the transfer of the telegraphs to the State, was appointed a technical officer. For several years he has been in charge of the special Press arrangements of the Manchester district.

Mr. Louis J. Hunt, A.M.I.C.E., of Messrs. Siemens Bros. & Co., Woolwich, has been appointed chief electrical engineer to the Sandycroft Foundry Co.

Mr. Alfred H. Clarke, A.I.E.E., mains engineer to the National Electric Supply Co., of Preston, has been appointed electrical engineer to the Nederlandsch Indische Industrie en Handel Maatschappij, of Amsterdam and London, to take charge of their plant in Dutch Borneo. Mr. Clarke sails on April 4 on the P.O. liner "China."

**Aldershot.**—Progress is being made with the work of wiring the various buildings and establishments of Aldershot Camp. The scheme drawn up by the Commanding Royal Engineer (Col. W. Pitt) has been divided into 26 sub-divisions, and contracts for wiring and fitting up Albuhera, Barossa, Corunna and Maida Barracks have been given to Messrs. Drake and Gorham, Messrs. Edmundson, Messrs. Foote and Milne and the National Electric Wiring Co. The generating station will be situate north of Thorne Hill, and will be capable of supplying current for 24,000 8 c.p. lights. Col. Pitt has the assistance of Mr. Mayne as consulting electrician.

**Arbroath.**—A plebiscite of the ratepayers is to be taken to decide whether the Council are to establish electricity works or a company is to be allowed to obtain powers.

**Association of Municipal Corporations.**—At the annual meeting on Friday last it was resolved that the subject of the proposed alteration in the Parliamentary standing orders under the Tramways Act, 1870, by which the existing veto of a local authority as regarded the construction of tramways within its districts would be removed, should be referred to the council, and that they should consider the whole subject and take such action on behalf of the association as they might deem necessary.

**Belfast.**—An inquiry was held here on Wednesday into the application of the Corporation to borrow £95,000 for electric lighting extensions. The town clerk (Sir Samuel Black) gave particulars of the rating value, &c., of the city; and the chairman of the Electric committee (Councillor Andrews) said the output of the works had increased from 82,000 units in 1895 to 824,000 in 1900, while the increase in money value was about five times. The present machinery could meet the existing demand, but if this demand continued as during the last few years, it would be absolutely necessary to extend the plant and mains. When they started they charged 7d. per unit for lighting and 4d. for power, while now the rates were 6d. for the first hour and 2d. for subsequent hours of lighting; and for power 3d. for the first hour, and 1½d. after. The working of the undertaking had so far shown a small surplus after paying interest on sinking fund. Technical evidence was given by the city electrical engineer, Mr. Victor A. H. McCowen.

**Benwell.**—The Newcastle and District Electric Lighting Co. will apply next session for a provisional order for this district

**Bermondsey (London).**—The charge for electric current has been fixed at 6d. per unit for the first hour's maximum daily demand for private lighting and 3d. after, 3d. for places of worship, and 2½d. for power.

**Bilston.**—The Council have decided to enter into an agreement with the Midland Electric Corporation for Power Distribution for the supply of electric current for public lighting.

**Birkenshaw (Bradford).**—The Council have instructed Mr. Stephen Sellon to make a valuation of the Dewsbury, Batley and Birstall Tramway Co.'s undertaking within the district, with a view to its purchase by the Council.

**Blackpool and Lytham Tramway.**—This tramway has been purchased by a syndicate, which proposes to double the line and to continue it from Lytham to Freckleton, and from thence to Preston as a light railway. Electric traction will at the same time be adopted.

**Brighton.**—The annual statement of accounts was presented to the Council last week, and the Lighting committee recommended that the balance of net revenue (£107. 15s. 2d.) be carried to reserve. In moving its adoption the chairman (Councillor Holloway) reminded the Council that when they decided on reducing the price of electricity to 1d. he opposed it, thinking that something might occur to seriously reduce their reserve. The increased cost of coal, change of voltage, overhauling cables, &c., had reduced the reserve to £1,792. 4s. 5d., and he expected that by the end of the year practically the whole would be absorbed. If they had kept to the 1½d. per unit to the end of the year they would have had £4,000 to the good to add to reserve, and he thought a mistake had been made in lowering the price. Ald. Sendall said he had calculated the increased cost of coal at £1,630, so that could not be the cause of the unsatisfactory balance-sheet. There was a balance of £1,640 to be accounted for. It was because their trading did not pay. They ought to have a good sound reserve fund or provision for depreciation. He asked the chairman whether all the assets named in the balance sheet were worth the amounts set against them? Councillor Holloway: Yes. Ald. Sendall further stated that they ought to properly provide for the depreciation of such an exceptionally scientific matter as their electricity works, and he asked them to consider the wisdom of either increasing their charge or preparing a proper depreciation account, so that in years to come they would not be hampered by a large capital account. Councillor Buckwell said the undertaking represented an asset of £400,000, and considered that altogether they had a handsome reserve if they considered the value of all their assets. Councillor Carden said the electric lighting undertaking was going to be far more profitable than the Council had any conception of. He pointed out that the revenue of the lighting undertaking was £51,000 last year, and they then paid £10,000 in redemption of capital in respect of the lighting on a total capital of £339,000. The average price charged to consumers in Brighton was 3½d. per unit, and they sold nearly 2,000,000 units to private consumers last year at 1d. per unit. At that price electricity was equal to gas at 7d. per thousand. In addition, they sold over 600,000 units at 1d. for street lighting. Their output last year was 3¾ million units. He was quite satisfied that the electricity undertaking was one of the most magnificent and profitable that a corporation could possibly have. Ald. Sir John Blaker thought the accounts should be audited by an outside accountant, and suggested there were many items put down as representing capital that did not actually do so. Councillor Neale said Councillor Carden boasted of the number of units the Council had sold, but he affirmed it cost more than 1d. per unit to produce the current, and that accounted for the loss. Councillor Holloway said in 1898 the gross profits were £19,200, and after a reduction to 1d. in 1899 they fell to £16,700. Last year they pulled up, and the gross profits were £19,600. They had reduced the 1½d. unit rather too early. The minutes were then agreed to.

**Cleckheaton.**—An inquiry will shortly be held into the application of the Council to borrow £25,000 for electricity works.

**Compensation Claim.**—A special jury has awarded Messrs. Halsey and Davison, cardboard manufacturers, of Marshall-street, Soho, London, £6,500 compensation for trade disturbance, owing to the St. James' and Pall Mall Electric Light Co. having acquired their premises for the extension of works and generating station.

**Dublin.**—At the Corporation meeting on Monday a discussion took place on the report of the Lighting committee as to the building contract for the Pigeon House generating station. First a report was read from Mr. Ruddle, electrical engineer to the Corporation, from which it appeared that Mr. Ruddle was unable to agree with some of Mr. Hammond's figures as to the cost of production and delivery to consumers of electric current, Mr. Hammond comparing Leeds with Dublin, which Mr. Ruddle could not accept as a reasonable comparison, owing to the difference in the cost of fuel. Mr. Ruddle suggested that the comparison should be made with Portsmouth. Mr. Ruddle said he had no knowledge of the sub-strata of the Pigeon House Fort in connection with the foundations. He saw no provision in Mr. Hammond's estimate for tunnels or for reorganising the system of mains and sub-stations. He considered a fair estimate of the possible capital outlay on the scheme would be £290,000, without including anything for lighting the recently-united townships, if it was ultimately decided to do so. The total income in Mr. Hammond's estimate was £38,300 and the estimated cost (at 1·5d. per unit) was £16,500, leaving a net balance of £21,800 per annum to meet all capital charges. This was on an assumed private consumption of 16 units per lamp. But if the private consumption was taken on its present basis of 14½ units per lamp, the income would be only £35,828, and if the cost of generation was taken at his (Mr. Ruddle's) figures of 2d. per unit, the available balance would be reduced from £21,800 to £14,974. The Lord Mayor pointed out that Mr. Ruddle had prepared this report at his (the Lord Mayor's) request, and that Mr. Hammond had not yet seen Mr. Ruddle's figures. The discussion on the Electric Lighting committee's report was then taken. Mr. Irwin (chairman of the Lighting committee) moved its adoption, and said he considered it was now manifest to everyone that Mr. Hammond's proposals were practicable. With regard to Mr. Ruddle's criticisms, he (Mr. Irwin) said that gentleman, in taking up the attitude of a consulting engineer against Mr. Hammond's figures, was undertaking a grave responsibility. He (the speaker) was not there as apologist for Mr. Hammond, and he would ask the Council to dismiss from their minds for the time being the statements and criticisms which had been made, and simply to consider the facts and figures placed before them in the committee's report. The expenditure figures in this report showed an excess of £5,000 over those prepared by Mr. Hammond in a total expenditure of £260,000, and against this excess Mr. Hammond claimed to take a credit for over £5,000. With the acceptance of the tender for buildings the Council would have disposed of all the really important and serious items of the scheme, as they had only some £60,000 worth of tenders now to come in. With regard to Mr. Ruddle's figures that gentleman was not experienced in laying down electric installations, whereas Mr. Hammond was one of the greatest authorities on the cost of generation and distribution of electricity, both as a contractor and as an advising expert. The committee now proposed that the tender of Messrs. J. and W. Stewart should be accepted. Ald. Ireland thought that in face of the difference of opinion of the experts the Corporation should engage another electrical expert to guide them in their decision. He was, personally, of opinion that it was not even now too late for the Dublin Tramway Co.'s proposal to be considered. He thought they should adjourn the discussion in order to obtain further expert opinion on this vital matter. The Lord Mayor desired to repeat that for Mr. Ruddle's report he was entirely responsible, and he believed Mr. Ruddle's figures and opinion were given in a perfectly conscientious way. An amendment was proposed that the consideration of the report should be adjourned for a month. Ultimately a vote was taken, when the committee's report was carried by 39 votes to 15.

**Durham.**—The Sunderland District Council has approved the scheme of the B. E. T. Co. for the construction of electric tramways from Fulwell-road, Sunderland, to Whitburn and South Shields.

**Ealing.**—After April 1 the price of electric current will be reduced to 6d. per unit.

**Eastbourne.**—An inquiry was held on Thursday last into the application of the Council to borrow £50,882 for electric lighting extensions. The town clerk (Mr. H. W. Fovargue) explained that on the recommendation of their consulting engineer (Mr. W. C. C. Hawtayne) the Council some time ago resolved, for the sake of the economical working of their electricity undertaking, to replace some of the antiquated machinery and to remove the generating station to Roselands, a property of the Corporation. The borough accountant stated that the first year's working, after the purchase of the undertaking by the Council, after allowing for interest and other charges, showed a balance of £834. 11s. 2d.

**Electric Power Installations.** — The Edinburgh Colliery Company have resolved to adopt electric power for haulage and pumping at their Wallyford collieries. A 200 H.P. dynamo is being put down, and electric current will be transmitted to the machinery underground; a new pump working 1,500yds. from the pit's bottom will replace five steam pumps, and will throw 350 gallons per minute to a height of 700ft.

The South Durham Iron and Steel Co. are also putting down plant for operating some of the machinery at their malleable works, Stockton.

**Electro-Culture.**—For some time past there have been rumours and statements in the Irish papers regarding a process of potato rearing known as "electro culture," which is variously stated to have resulted in crops being produced of an increased weight varying from twice to eight times that usually obtained from a given area. In the House of Commons last week the Chief Secretary for Ireland's attention was called to the matter, but the right hon. gentleman was able to give but cold comfort to Mr. O'Shaughnessy. It appears that the new Irish Department of Agriculture is not satisfied that the experiment is a success, but propose to have a test made this season under its own supervision when the value, or otherwise, of the process will be demonstrated.

**Gateshead-on-Tyne.**—A trial trip over the Felling electric tramway route took place on Wednesday.

**Greenock.** — The accounts of the electricity department show that the amount authorised to be borrowed was £100,000, and that

£50,000 had been borrowed at 3 per cent. The total expenditure is £40,769. 4s. 10d.—£8,700 on lands, £6,341. 16s. 3d. on buildings, £12,151. 3s. 7d. on machinery and £13,288. 13s. on mains and services. The net profit (£764. 3s. 3½d.) has been carried to net revenue account. It was decided to send the financial statement back to the committee to have same amended and adjusted in terms of the auditor's report.

**Ham (Surrey)**.—The London United Tramways' offer to supply electric current for lighting and power at a price not exceeding 4d. per unit. The scheme of the Richmond (Surrey) Electric Light and Power Co. for lighting this district has fallen through owing to the Board of Trade having struck out of the company's provisional order two of the districts proposed to be supplied.

**Ingleton**.—A retiring member of the Council (Mr. Walker) recently offered to present the ratepayers with the plant now rented from the local electric light company, and the Council have accepted the offer.

**Leeds**.—The Beeston-hill–Woodhouse-street electric tramway route was opened for traffic last week.

**Lambeth (London)**.—The South London Electric Supply Corporation has set down for argument before the Court of King's Bench the case which the Lambeth magistrate has now stated in connection with the recent conviction of the company for alleged smoke nuisance at their Bengeworth-road works, when ten fines of £10 each were imposed. At the time the magistrate was asked to state a case, on the ground that there was no positive evidence of nuisance given, and that it was not sufficient under the act merely to show that black smoke issued from the chimney for any length of time, unless it was also proved that such smoke was a nuisance to the neighbourhood.

**Light Railways**.—The Bromsgrove light railway order has been issued, and authorises the construction of light railways between Bromsgrove railway station, Bromsgrove town, and Lickey End, the work to be completed within three years. The amount of the company's capital is fixed at £33,000.

The Light Railway Commissioners recommend the granting of the application of the Lyndhurst Electric Light and Traction Co. for power to construct a light (electric) railway from Lyndhurst-road station to Lyndhurst town, a distance of over two miles.

The permanent way of the light electric railway from the Stourbridge tramway at Coulbournbrook to Kinver was inspected on Friday.

**Liverpool**.—The Corporation have now 269 electric cars in operation, and the remaining 17 horse-drawn vehicles will shortly disappear.

**London County Council**.—At Tuesday's meeting it was decided to loan Hackney £30,000, Hammersmith £13,500, and Stepney £5,163 for electric lighting extensions.

The Council has decided to appeal to the House of Lords against the recent decision of the High Court on the question of the legal power of the Council to run omnibuses in connection with their tramway services.

The Council decided that the Highways committee should consider the various schemes for tube railways, and a general scheme for tramway extensions in London. The Highways committee was also instructed to take steps to bring the views of the Council before a joint Committee appointed to consider deep level electric railways.

**Macclesfield**.—The Board of Trade have refused the application of the Electrical Power Distribution Co. for a provisional order as the Corporation are themselves applying for an order.

**Maidstone**.—The Callender Company have made a start with the work of laying electric lighting mains. The Council have fixed the charges for electric current for private lighting at 7d. per unit for the first hour's maximum demand and 2d. after. Current will be supplied to places of worship at 4d.

**Manchester**.—In a recent report the city surveyor (Mr. T. de Courcy Meade) states that at present there are, in the northern district of the city 624 wires, 5,815 in the central district and 1,359 in the southern—a total of 7,798 wires over existing lines of tramway. Over the projected new tramway lines there will be 584 wires in the northern, 1,785 in the central and 1,412 in the southern districts—a total of 3,781 wires making in all 11,579 telephone and telegraph wires. The report also states that there are about 60 miles of cast-iron underground telephone pipes in the public streets, 3in. in diameter. Each pipe contains a lead-covered cable containing 306 wires. The best method of dealing with the overhead telephone wires would be to subdivide the distributing areas by laying short lengths of underground service pipes from the nearest existing underground cable routes to smaller distributing areas off the main thoroughfares. By this arrangement it is urged the wires crossing tramway routes would be no longer required, as the telephone instruments would be served by short distributing wires in self-contained areas and crossing minor streets only. The overhead cables are, of course, insulated, and contain about 104 wires each. The danger from telegraph wires crossing over tramway routes could (the report concludes) be reduced by enclosing them in insulated cables. The town clerk is to prepare a report on the legal position of the Corporation as regards overhead wires, the Telegraph Act of 1899, and the agreement with the National Telephone Co.

The consulting engineer (Prof. Kennedy) attended a special meeting of the Electricity committee last week to consider the best method of providing a temporary generating station for the electric tramway until the completion of the Stuart-street station. Prof. Kennedy thought that plant of about 5,000 H.P. should be erected for provisional purposes, and was authorised by the committee to prepare a plan and specifications for the construction of the temporary station upon the land purchased for the Stuart-street works.

**Marylebone (London)**.—The Board of Trade have again decided to grant a provisional order to the Borough Council. It will be remembered the Council were similarly successful last year, but the confirmatory bill was rejected on motion for second reading in the House of Commons.

**Motor Vehicle Trials**.—The Liverpool Self-Propelled Traffic Association notify that the entry forms for this competition are now ready for issue to intending competitors and a fourth class, in which there are no restrictions upon the tare or platform area, has been added.

**Municipal Telephony**.—Huddersfield Corporation have obtained 400 promises from tradesmen and others to become subscribers to the proposed municipal telephone exchange, and a canvass is now being made in the suburban and neighbouring districts.

**Newbury**.—The Board of Trade have intimated that, owing to the failure of the Council to give effect to their provisional order of 1892 they propose to dispense with their consent to the application of the Urban Electric Supply Co. for an order. The Board are being asked by the Council to reconsider this decision.

**Newport (Mon.)**.—An inquiry was held here on Tuesday into the Council's application for sanction to borrow £28,000 for electric lighting. The town clerk (Mr. A. Newman) said the £28,000 was roughly divided into £8,000 for improvements in the existing installation, £4,740 for compensation for alleged damage from vibration, £10,000 for new mains, sub-stations and transformers, and £5,121 the expected cost of the contemplated change of pressure from 100 to 200 volts. In reply to Mr. Newman the inspector said the Local Government Board would not sanction a loan to be used in wiring private houses on the deferred payment system, but the Corporation could do such work out of revenue. Mr. Newman said that did not put them on an equal footing with the gas company, who were their competitors in lighting.

**Presentation**.—On Saturday last Mr. G. S. Ram was presented by the staff of the Coventry Corporation electricity works with a spirit and cigar cabinet on the occasion of his leaving the works for his new London appointment.

**Richmond (Surrey)**.—A conference took place at the Board of Trade last week between representatives of the Council and of the local electric light company in connection with the application of the latter for a provisional order for Ham, Hampton, Hampton Wick, and Teddington. Considerable opposition having been lodged by the Hampton and Teddington authorities, the Board of Trade decided that these districts be struck out of the scheme. The company's representative thereupon withdrew the application altogether.

**Shanklin (Isle of Wight)**.—The District Council recently received offers from the Isle of Wight Electric Light and Power Co. and the Shanklin Gas Co. for the public lighting, and at a recent ratepayers' meeting the principle of electric lighting was approved.

**Shoreditch (London)**.—The Lighting committee recommend the Council to sanction an expenditure of £15,700 for extensions of electric mains, especially in connection with the new station at Haggerston.

**Spanish Imports**.—The value of electric cables imported into Spain in 1899 was £80,000. The value of machinery imported in the same year was £300,000, £40,000 of which is listed as "motor machinery."

**Stamford**.—The Urban Electric Supply Co., which obtained a provisional order in 1900, is about to establish electricity works in this town.

**Walsall**.—The accounts of the electricity department show that the profit on last year's working, after payment of interest and sinking fund, amounted to £119. 8s. 5d., against £61. 13s. 5d. in the previous year.

**West Ham (London)**.—At the last meeting of the Council Councillor Pert moved that no further contracts should be entered into with Messrs. S. Z. de Ferranti (Ltd.) until the Council had considered a report from their electrical engineer as to the defects in the plant supplied under the firm's first contract, and a statement made by the town clerk as to the legal position of the Council with Messrs. Ferranti. He said that since his motion had been put on the paper the Council had made a further contract with Messrs. Ferranti, but

it would serve his purpose if they had the report from their engineer. This might prevent the Council having any further dealings with that firm. The mayor said he could not accept the motion until their previous resolution had been rescinded. Councillor Godbold urged that a full investigation should be made. Ald. F. Smith referred to a serious failure in the supply on the previous Saturday night, and said consumers were becoming very dissatisfied. Councillor Crow considered the discussion very unfair to Messrs. Ferranti. They were now face to face with a serious breakdown, and he thought they should delay for a time proceding with current contracts. Further objection was taken to the motion, which was lost on a division by 16 to 22.

**Workhouse Lighting.**—Bradford workhouse is now lighted electrically, current being supplied for the first time on Wednesday.

**Electro-Harmonic Society.**—A smoking concert (the last concert of the season) will be held at the St. James' Hall Restaurant this (Friday) evening, at 8 p.m.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Colwyn Bay* District Council invite tenders for a water-tube boiler, feed pump, injector, steam exhaust and feed pipes, &c. Specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Clirehugh, and Sillar), 2, Queen Anne's-gate, Westminster, S.W., and 78, King-street, Manchester, but can only be obtained from the latter office. Tenders must be delivered to the clerk (Mr. J. H. Roberts) by April 13. An advertisement contains additional particulars.

*Leeds* Lighting committee invite tenders for steam, feed water, exhaust, overflow, blow-off, and other pipes, valves, hot-wells, feed-water pumps, economiser, &c., in connection with engines of 4,000 I.H.P. Specifications, &c., from the manager (Mr. Harold Dickinson), 1, Whitehall-road, and tenders to town clerk (Mr. W. J. Jeeves) by Monday, April 15. An advertisement contains additional particulars.

*Burnley* Electricity committee invite tenders for the supply and erection of two boilers and economisers and accumulators. Specifications, &c., may be obtained on application to the borough electrical engineer (Mr. Robert Birkett), Aqueduct-street, Burnley, and tenders (addressed to the chairman) must be delivered to the town clerk (Mr. A. Steele Sheldon), Town Hall, Burnley, by April 9. See advertisement.

*Dublin* Lighting committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane and workshop equipment. Specifications may be obtained from the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, London, S.W., and tenders to the clerk (Mr. Henry Campbell), City Hall, Dublin, by 4 p.m. April 22. An advertisement contains other particulars.

*Kircaldy* Corporation invite tenders for the supply, delivery, and erection of engines and dynamos, storage battery and overhead travelling crane. Specification may be seen at but not obtained from the offices of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders to town clerk (Mr. Wm. L. Macindoe) by 10 a.m. April 15. An advertisement gives further details.

*Edinburgh* Corporation invite tenders for the supply of arc lamp carbons and cast-iron pipes, pavement and road box frames and covers for the electricity department for one year from May 15. An advertisement contains further particulars and tenders must be lodged with the town clerk (Mr. Thomas Hunter, W.S.) by April 20.

*Portsmouth* Corporation invite tenders for the supply and erection of additional boilers, feed pumps, mechanical stokers, economiser, steam, feed, and other pipes, chequer plating, and sundry ironwork. Specification, &c., can be had of the superintendent of the electric lighting station, Gunwharf-road. Tenders to the Town Hall, Portsmouth, by 4 p.m., April 16. An advertisement contains further particulars.

*Battersea* (London) Borough Council invite tenders for electric pumps, pipe work, &c., for condensing water, and pipes and pits for condensing water supply. An advertisement contains further particulars, and specification, &c., may be obtained from the town clerk (Mr. W. Marcus Wilkins), Municipal Buildings, Lavender-hill, S.W., to whom tenders must be sent by noon, April 30.

*Middlesbrough* Electric Lighting committee invite tenders for boiler and engine-house plant and condensing apparatus, further particulars of which are set out in an advertisement. Specifications, &c., may be obtained at the offices of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., and tenders must be addressed to the town clerk (Mr. George Bainbridge), Town Hall, Middlesbrough, by April 30.

*Motherwell* Electric Light committee invite tenders for steam dynamo and switches, &c., steam, feed, and exhaust pipes, &c. Specifications from the town clerk (Mr. James Burns), and tenders must be in by April 29. See advertisement.

The directors of the *Lancashire and Yorkshire Railway* require tenders for the supply of stores during 12 months ending April 30, 1902, including signal, telegraph and electric light wires, signal and telegraph fittings, wire, screws, steel sheets, tubes and tubing, reflectors, oil, castings, &c. Particulars and forms of tender from stores department, Osborne-street, Manchester, and tenders to secretary (Mr. R. C. Irwin), Hunt's Bank, Manchester, by 10 a.m. April 8.

*Hornsey* District Council invite tenders for boiler-house and engine-house plant, condensing and water cooling apparatus, pipework, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains, and arc lamps, &c., for public lighting, meters and workshop equipment. Tenders to clerk by 4 p.m. April 11.

*Manchester* Rivers committee invite tenders for electrical and hydraulic appliances for one bacteria bed. Tenders by April 13.

*Manchester* Tramways committee require life guards for tramcars. Tenders by 30th inst.

*Metropolitan Asylums Board* invite tenders for the supply and erection, at Tooting Bec hospital, of electric generating and heating plant. Tenders to the Board, Embankment, London, E.C., by 10 a.m. April 24.

*Bradford* Corporation require a combined motor balancer and boosters, with switch gear for same, for their Bolton-road electricity works. Tenders to town clerk by April 3.

*Salford* Corporation invite tenders for wiring for motors, dynamo leads, engine room and switchboard connections, &c., at Strawberry-road generating station. Tenders to town clerk by noon April 9.

*Sunderland* Corporation invite tenders for 104 arc lamp pillars and 104 arc lamps and accessories. Tenders to chairman of Lighting committee by noon April 3.

*Aylesbury* District Council invite tenders for the construction and maintenance, for a term of years, of electricity supply works. Tenders to clerk by 4 p.m. April 22.

*Partick* Corporation require tenders for steam, &c., pipes, feed pump, water storage tank, feed water heater, and sundry ironwork. Tenders to town clerk, 97, W. Regent-street, Glasgow, by April 9.

*Glasgow* Parish Council and Lunacy District Board require tenders for 12 months' supply of electric lamps and fittings. Tenders to 38, Cochrane-street, Glasgow, by 30th inst.

*Rochdale* Corporation invite tenders for steel tramrails and fish-plates, tie bars, bolts and nuts, anchor joint and sole plates, points and crossings, and drain rails. Tenders by April 1.

*Halifax* Corporation invite tenders (until April 4) for trolley wire, and for steam piping (until April 11).

### TENDERS RECEIVED AND ACCEPTED.

Eastbourne Corporation have received the following tenders for extensions of plant, &c.:—

*Underground Mains.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| W. T. Glover & Co. (*accepted*) | £7,663 | 13 | 9 | W. F. Dennis & Co. | £11,762 | 0 | 0 |
| G. A. Nussbaum | 12,796 | 0 | 0 | St. Helens Cable Co. | 10,052 | 15 | 5 |
| Telegraph Manfg. Co. | 12,070 | 0 | 0 | W. T. Henley's Co. | 10,032 | 17 | 4 |
| Johnson & Phillips | 11,673 | 0 | 0 | Callender's Co. | 9,580 | 5 | 4 |
| Elec. & Gen. Contracting Co. | 11,666 | 0 | 0 | Ditto | 8,770 | 12 | 0 |
| | | | | Western Electric Co. | 8,915 | 10 | 0 |
| | | | | Siemens Bros. & Co. | 8,369 | 0 | 0 |

*Arc Lamp and Posts.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Brockie-Pell Arc Lamp | £2,305 | 0 | 0 | Veritys Limited | £1,731 | 14 | 8 |
| Brush Co. | 2,275 | 0 | 0 | Reason Mfg. Co. | 1,704 | 0 | 0 |
| General Electric Co. | 2,099 | 0 | 0 | Callender's Co. | 1,653 | 15 | 0 |
| Walsall Electrical Co. | 2,004 | 10 | 0 | Oliver & Co. | 1,631 | 18 | 0 |
| Johnson & Phillips | 1,907 | 7 | 0 | Crompton & Co. | 1,600 | 0 | 0 |
| W. Lucy & Co. | 1,825 | 15 | 0 | Gilbert Arc Lamp Co. | 1,588 | 0 | 0 |

The tender of the Callender Co. was subject to receiving the order for the mains section. No tender for arc lamps and posts has yet been awarded.

*Transformers and Chambers.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| British Elec. Trans. Mfg. Co. (*accepted*) | £3,937 | 0 | 0 | Johnson & Phillips | £4,183 | 0 | 0 |
| * S.Z. De Ferranti (Ltd.) | 5,068 | 0 | 0 | † Callender's Co. | 3,624 | 0 | 0 |
| Brush Co. | 4,768 | 13 | 6 | ‡ Gilbert Arc Lamp Co. | 1,599 | 0 | 0 |

* Exclusive of large chambers and fixing small. † Subject to receiving order for mains section. ‡ Transformers only.

The Dublin Corporation decided on Monday to accept the tender of Messrs. J. and W. Stewart for the erection of an electricity generating station at the Pigeon House at £29,051. 9s. 3d.

Brighton Town Council have accepted the tender of Messrs. Babcock and Wilcox for two additional water-tube boilers for the tramway power station at £2,150; and for steam, feed and other piping at £643.

Woolwich Borough Council have accepted the tender of Messrs. Oliver & Co. for arc lamps and posts at £2,400.

Shoreditch Borough Council is recommended by the Lighting committee to accept the tender of Messrs. Pierson & Co. for the supply and erection of the constructional steel and ironwork at the new generating station in Whiston-street for £6,279. There were 11 tenders, that recommended being the lowest.

Messrs. Dick, Kerr & Co. have secured the contract for the supply of the motors and controllers for the electric cars of the Manchester tramways.

## BUSINESS NOTICES.

The Scottish agency of the St. Helens Cable Co. is now at 19, Waterloo-street, Glasgow.

Owing to the increase of business in the Midlands and the North the Hart Accumulator Co. have opened offices at 33, Temple-chambers, Brazennose-street, Manchester.

The Lahmeyer Electrical Co. (Ltd.) (particulars of whose registration are given on another page), have opened offices at 11, New Oxford-street, London, W. Mr. Charles Leven has been appointed manager.

Mercier's Patents (Ltd.) are removing to new works at 252, Chapel-street, Salford, after April 4.

After April 1 the registered offices of the Electric Lighting and Traction Co. of Australia (Ltd.) will be St. Mary Abchurch House, 123, Cannon-street, London, E.C.

Messrs. S. Williams and T. Harrison (trading as Williams and Harrison), electrical engineers, Southport, have dissolved partnership. Debts by Mr. Williams, who continues.

## BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of Lewis and Ernest Emanuel Benjamin took place at the London Bankruptcy Court, on Wednesday, when some remarkable disclosures were made—interesting especially to the creditors. The statement of affairs showed liabilities £8,116 3s. 11d. unsecured creditors £7,480. 7s. 8d., assets valued at £5,912. The assets consist of 5,000 £1 fully-paid deferred ordinary shares in Johnstone, Benjamin & Co. (Ltd.), valued at £5,000; 752 £1 fully-paid ordinary shares in the same company, £752; bad and doubtful book debts, £100; and estimated surplus from securities held by creditors treated as fully secured, £60. Mr. E. E. Benjamin stated that he commenced business 10 or 12 years ago as a dealer in metals, at Mildmay-park, under the style of Johnstone & Benjamin. He took that name because it sounded well and made the business appear more important. About 1892 he removed to Bow, and added wire covering to his business. From that time he described himself as an electric wire manufacturer and metal merchant. Shortly afterwards Lewis Benjamin joined him and the style of Johnstone, Benjamin & Co. was adopted. Lewis Benjamin introduced about £300. In December, 1900, the business was assigned to a company called Johnstone, Benjamin & Co. (Ltd.), of which he and his cousin were managing directors at salaries of £250 a year. The company were to pay £9,200 for the business. A valuation of the assets was made up of book debts, £1,785; stock-in-trade, £2,902; machinery and plant, £2,542; cash at bankers, £395; lease, £1,000; and goodwill, £576. The promoter (a Mr. Phillips) received £500 in cash, but, with this exception, the whole of the purchase price was paid in paper. The balance was paid as to £5,000 in deferred ordinary shares, £1,500 in ordinary shares, and £2,200 in debentures. Of these debentures £900 were handed to Mr. Adams as trustee under his (witness's) marriage settlement, £200 were given to Mr. Adams as security for repaymet of a loan of £150, and the balance of £1,100 went to the trustees of his partner's (Lewis Benjamin's) marriage settlement. As regarded the 1,500 ordinary shares, Phillips received 500, the trustee of witness's marriage settlement about 250, and the remainder were taken possession of by the official receiver in bankruptcy. The official receiver also received the 5,000 deferred shares. The dividend on these shares was deferred until 10 per cent. had been paid on the ordinary shares. The object of selling the business to the company was to extend it by the introduction of further capital, but that object had not been attained. The nominal capital of the company was £15,000, only a small portion of which was subscribed. Phillips, who was another cousin, showed him letters containing promises that the whole of the £15,000 capital would be taken up. The goodwill of the business and witness's share of the capital were subject to the trusts of his marriage settlement. There was a similar provision in Lewis Benjamin's marriage settlement. The present unsecured debts were owing to creditors who had supplied goods. He did not consult creditors before selling the business to the company. He could not say whether nearly all the trade debts were incurred in the latter half of 1900, but the statement of affairs would show. Although a large amount of stock was sold to the company not one of the creditors who had supplied it was consulted as to the transfer of the business. He did not consider £2,900 worth of stock to be a large amount. The rights of creditors were now confined to the realisation of the paper which he had handed to the official receiver and to the bad and doubtful book debts. He admitted that in December and January he made various payments to relatives. Asked as to whether there was a single relative who did not receive payment of his debt either in cash, shares, or debentures in December or January, he said he had relatives abroad to whom he owed money. Since the date of the receiving order he and his cousin had been managers of the business instead of managing directors, their salary still being £250 each. A meeting of creditors was held on Jan. 21 last, when the liabilities were returned at £8,472. These liabilities were incurred before passing over the business to the company. His marriage settlement was executed in August, 1893, before his marriage. In December, 1900, he paid other creditors besides his relatives. If the whole of the company's capital had been subscribed they would have been able to pay their creditors in full. Mr. Lewis Benjamin was also examined, and the examination was then concluded. The report of the first meeting of creditors in this matter appeared in our issue of March 1, and the list of principal creditors on Feb. 1.

A. J. Greenberg (trading as the Midland Electrical Co.), 30, Arthur-street, Erdington, and 20, Caroline-street, St. Paul's, Birmingham, has been adjudicated bankrupt. The first meeting of creditors will take place on April 3, at 174, Corporation-street, Birmingham, and the public examination on April 29 at Birmingham County Court.

J. E. Bunce, electrical fittings manager, 16, Elmfield-terrace, Halifax, has been adjudicated bankrupt. The first meeting of creditors will take place on April 3 at the O.R.'s, Town Hall-chambers, Halifax, and the public examination on April 29 at Halifax County Court.

---

**Fire.**—A somewhat serious fire occurred at the Summers Town works of the Conduit and Insulation Co. (Ltd.) on Thursday night last week. The works cover considerable space, and consist of a central block of old one-storey buildings, to which new brick buildings to meet the special needs of the company's business have been added from time to time. The fire started from an unascertained cause at the back of the boiler-house, located in the centre of the old buildings, and was discovered by some workmen who were on overtime. The works fire apparatus was immediately put into operation, but a high wind prevailed at the time, and rendered it impossible to save the main workshop. The new brick buildings, containing a large stock of raw and finished material, were, however, preserved. We understand the company is in a position to furnish stock supplies of material, and to keep going without serious inconvenience large contracts in hand, but ask indulgence from the trade in respect to any delays which may occur in furnishing special material. It is hoped that within a few weeks the business will again be running as usual. The main loss is covered by insurance.

**Concrete Conduits.**—A new system of impregnated concrete conduits for electric cables, &c., is being introduced by the Armoured Concrete Construction Co., 109, Victoria-street, Westminster, London. This system is claimed to be entirely impervious to moisture, and the bitumen with which they are coated is said to be in no way affected by the drawing-in of the electric cables. The conduit is manufactured by patented machinery, and, it is stated, requires no concrete case or bed. We are also informed that the system has been adopted by the German Imperial Telegraph Department.

**Correction.**—By a slip of the pen, "Electrical Undertakings" was given as the title of a new journal in our last issue. This should have been *Electrical Investments*.

**B.T.H. Plant.** — Pamphlet No. 90, issued by the British Thomson-Houston Co., illustrates and describes the O.K. type of ampere hour meter for continuous-current circuits only.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 20 to March 26, with the ports of destination:—

*Africa*—Alexandria, £248; Cape Town, £2,503 (including £1,383 telegraph material); Durban, £223; East London, £25; Port Elizabeth, £1,467. *Argentina*—Buenos Ayres, £1,230 (including £631 telegraph material). *Australasia*—Adelaide, £1,398 (including £743 telegraph wire); Auckland, £91; Brisbane, £425; Fremantle, £1,463 (including £231 telegraph material); Hobart, £185; Melbourne, £286; Perth, £94; Sydney, £6,359; Wellington, £3,598. *Belgium*—Ostend, £204. *Brazil*—Rio Janeiro, £17. *Ceylon*—Colombo, £58. *Chili*—Santiago, £23. *China*—Shanghai, £51. *Germany*—Hamburg, £147. *Holland*—Amsterdam, £60; Rotterdam, £93 (telegraph material). *India*—Bombay, £88; Calcutta, £848 (including £281 telegraph material); Madras, £8. *Italy*—Leghorn, £17. *Mexico*—Coatzacoalcos, £135 (telegraph apparatus). *North Atlantic*—£2,600 (telegraph cable). *Norway*—Christiania, £51 (telegraph wire). *St. Helena*, £35. *Spain*—Grenada, £41 (telegraph apparatus). *Straits Settlements*—Singapore, £32. *United States*—Boston, £145. *West Indies*—Trinidad, 110 (including £105 telegraph material). *Zanzibar*, £36. Total, £26,011, against £12,935 in the corresponding week last year (March 21 to 27).

# COMPANIES' MEETINGS AND REPORTS.

## South London Electric Supply Corporation, Ltd.

The ordinary general meeting of this Corporation was held on Wednesday, Mr. GEORGE ELLIS, J.P., presiding.

The SECRETARY (Mr. Herbert H. Boyer) read the notice calling the meeting, and also the report of the auditors.

The CHAIRMAN said: Gentlemen, although the accounts which are now in your hands do not show a large profit for 1900, this would undoubtedly have been much greater but for the abnormal price of coal during the whole of this year. The increase, in fact, has been 35 per cent., and the number of lamps connected has been 70 per cent. From the report you will see the actual number of lamps added to the circuit has been 17,697 8 c.p., and to-day the total number stands at 45,863, besides which we hold applications for a further 3,552 8 c.p. Had this increase been spread over the whole year the effect of it on the revenue would have been much greater, and as the demand for additional lamps still keeps up, the prospects of the Company for the future appear likely to satisfy us all. In March last year the price for current used for lighting purposes was reduced from 6d. per Board of Trade unit to 5½d., and that for power and heating from 4d. to 2d. per unit, the meter rentals being also slightly revised. The Board have also introduced a scheme for installing six lights on consumers' premises absolutely free of all cost to them, and when I tell you that at the present moment there are as many as 205 consumers wired under this scheme, and, in addition to the six lights thus installed, these consumers have added many lights at their own expense, I feel sure you will agree with me that it has already proved itself a success. A glance at the map will show how evenly divided our consumers are over the whole area in which we have powers, and this, notwithstanding that a large portion consists of small shops and residences which are necessarily but small consumers of current, leads us to hope that the normal increase will be as steady and wide-spread as the work has been up to now. No effort has been spared in obtaining business by circularising and personally canvassing the inhabitants and advertising. Owing to the preponderance of small property in our district the increase in the use of electric light is sure to be gradual, and not rapid, and it would, therefore, in ordinary course, be some time before we could see the demand come up to the capabilities of our station. The Directors have, however, before them certain proposals to which at present I am not at liberty more fully to refer, which, if carried through, will produce an immediate and very large increase in the consumption. If, as I hope, these negotiations are completed, we shall be able and glad to congratulate you and ourselves on a very valuable addition to our business. No doubt you have noticed the remarks regarding the shutting down of the dust destructor in the report. It has been impossible to arrive at any reliable result as to the precise value of the destructor as a steam-raising factor and fuel economiser owing to this regrettable incident occurring just at the time when the refuse was becoming of a combustible nature, and at a period when it would have demonstrated its utility more effectually. The Lambeth Vestry first insisted on the erection of the destructor, necessarily in the midst of a crowded district, as the whole of Lambeth is. It was built and worked on the most approved modern principles and with the utmost care, and then the Vestry, as soon as it had got to work, obtained an order to close it on the ground that residents in the district complained of it. Adequate provision for the utmost economy in the generation costs has been made, and with this object the Board gave instructions for the erection of economiser and condensing plants: the former is now complete and in operation, and already effecting a very important saving in the coal consumption; the condensing plant is in the hands of the contractors, and is being pushed forward with all possible speed. With regard to the thermal storage plant, there has been, I am sorry to say, considerable delay owing to the non-delivery of the vessels; but these are now in position, so that the plant will be completed forthwith. The Company has in the last three years been passing through the unproductive period which has characterised the progress of every electric lighting undertaking. There have been a succession of difficulties to be dealt with, but the Directors think they can now confidently count on having surmounted these. The business has reached the profit-earning stage quite as quickly as the majority of the metropolitan lighting undertakings, and the Directors hope that even on the current year's working a dividend for the shareholders may be shown. I need hardly say that the Directors, among whom a large proportion of the shares are held, will be quite as pleased as you will be to effect that result. I now have much pleasure in moving the adoption of the report and accounts.

Mr. J. ATHERTON seconded, and said he had every confidence in the Company, and although he was, he thought, the largest shareholder, he was sorry he had not more shares.

Mr. A. BOLTON asked for some explanation of the item in the revenue account, "Contribution chargeable to and paid by contractors, £3,000."

Mr. W. LEE inquired if it were not possible to obtain some compensation from the local authority for first ordering the Company to erect the destructor and then immediately making them close it.

Mr. BUSH said to pay a dividend of 5 per cent. required £16,250, and he thought that the business must increase to an extraordinary extent if they were to get anything like such a dividend next year. As to public lighting, could the Chairman say when the Company were likely to obtain a contract for lighting the streets? When the Company was promoted it was expected that such a contract would be obtained. In conclusion, he inquired whether there was likely to be a further call of capital necessary in the course of the next 12 or 18 months.

Mr. BOLTON said the expenditure on fuel was very extravagant, and he did not understand it. Nothing had been written off for depreciation, even in respect of the storage battery, which stood in the balance-sheet at £1,800.

Mr. SIMMELKJÆR asked if the Chairman's attention had been drawn to the fact that the Company's working expenses were so considerably in excess of those of other companies?

Mr. KEDDELL, referring to the item of sundry debtors £7,664, asked whether they might consider it as good. It was a large sum to be owing.

The CHAIRMAN in reply said they considered the item of sundry debtors was a perfectly good asset. With regard to the destructor it was difficult for him to reply at the present time, as they were in negotiation with the Lambeth Vestry. He would say however that at first the Vestry acted in anything but a friendly way to them.

Mr. ATHERTON said that he thought the Chairman might state that the Vestry were showing a more friendly spirit now. They had gone so far as to invite the Board to a conference. Four or five representatives of the Board had met the mayor and a committee, and had a very pleasant meeting. The Vestry, or rather the new municipal council, had discussed the lighting of the district with 350 arc lamps, and he did not at all doubt that a pleasant arrangement would be arrived at with a little diplomacy and give and take on both sides.

The CHAIRMAN: A question was asked about the £3,000 paid back by the contractors. It is perfectly true that our coal bill has been far too high. This has been due to the fact that the engines supplied by the contractors were not economical. It was pointed out to the contractors that our coal bill was enormously high, and so they have given us back £3,000 as a settlement for that; but beyond that the engines have been altered—at least three out of the five are completed—and they are as economical as any engines we have had experience of. A gentleman has said that nothing has been written off for depreciation. Well, as the plant is still in the hands of the contractors and is not entirely paid for, and as any repairs at the present have to be made good by them, I do not think that the question of depreciation arises.

Mr. BOLTON: Your storage battery is not in the hands of the contractors.

The CHAIRMAN: I believe only 80 per cent. of that is paid, but it is a very small thing. Mr. Bush asked as to the kilowatt estimate. I may say that in our case it does work out at about £88 per kilowatt. He also said that the profit of this year and last year was made up of interest on money on deposit, but allow me to tell you that there has been a weekly profit for some time past quite independent of all interest, so that I think Mr. Bush has taken rather a gloomy view of the case. From the middle of last October we have made a profit on working. Then Mr. Bush said that we must earn £15,000 or £16,000 to pay 5 per cent., but our plant is large enough as it now exists to earn that money.

The motion was then carried, as were also resolutions re-electing the retiring directors, Mr. George Ellis, J.P., and Mr. Jacob Atherton, and the auditors, Messrs. Price, Waterhouse & Co.

A vote of thanks to the Chairman terminated the proceedings.

## Direct Spanish Telegraph Co. (Ltd.).

The forty-ninth ordinary general meeting of this Company was held on Tuesday, the MARQUIS OF TWEEDDALE, K.T., presiding.

The MANAGER (Mr. Ch. Gerhardi) having read the notice calling the meeting,

The CHAIRMAN said: You will have gathered from the directors' report that the result of our operations during the past year is a profit of £10,817, which, after placing £5,000 to the reserve fund, enables the directors to recommend the usual dividend of 10 per cent. on the preference shares and 4 per cent. on the ordinary shares. I may point out that the dividend will this year be paid out of the revenue without recourse to the contingencies account, as was the case last year, and the balance of £369, which it is proposed to transfer to the contingencies account, will bring that item up to £566. The reserve fund, after deducting the cost of the repairs to the Bilbao cable, and the renewal of the underground cables at Bilbao, amounting to £8,515, together with a small loss incurred on the realisation of one of our investments, will stand at £55,243 or £1,627 less than on Jan. 1 last year. The traffic receipts show an increase of £1,029. This increase will, I think, be considered satisfactory when it is borne in mind that the Bilbao cable was interrupted for 36 days during the year; and although we have a very excellent agreement with the Eastern Telegraph Co., yet the benefit of that agreement does not entirely compensate us for the loss which arises through the interruption of the Bilbao cable. It is also worthy of note that these receipts are made up of smaller rates per word than was formerly the case, owing to the fact that since the Spanish-American War the extra European traffic, which yielded a larger rate per word, has considerably decreased. On the other side, European business, namely, bona fide commercial traffic between England and Spain, has increased. The ordinary expenses show a decrease of £210. An outlay of £138 was incurred in improvements at Barcelona, and £252 in providing automatic apparatus, greatly increasing the carrying power of our cables. It will have been observed that two serious interruptions took place during the year under review in the Falmouth-Bilbao cable, the removal of which involved the heavy expenditure of £6,975. It is very satisfactory to learn from the reports of the officers in command of the repairing expeditions that the cables were found to be in excellent order, always excepting the spot where the faults

occurred and the immediate vicinity; and there is every reason to believe that, owing to the changes in the position of the cables, together with the introduction of a considerable amount of new cable, there would not be, at least in the immediate future, any demand for renewal. The expenditure of £1,539 on re-laying and deviating the underground wires at Bilbao was incurred for the important purpose of maintaining in first-rate condition the communication between the shore ends of the cable and the telegraph offices. The work was carried out by our able Bilbao superintendent, Mr. Tonkin, thereby effecting a considerable saving of money. Since the beginning of the year, I regret to say that the Barcelona cable has been interrupted, and owing to the extremely bad weather which has prevailed in the south of Europe, the interruption has not been removed to this date. The weather at last shows signs of improving, and we have every reason to hope that the fault will be repaired in the course of a very few days. The cost of the repairs of the Bilbao cable in January amounted to about £4,200. It is impossible at the moment to say what the cost of the Barcelona cable repairs will be, but it will be considerable, and we must expect that the two repairs will make serious inroads into our reserve fund, depleting it to the extent of at least £10,000 by April next. I will now move the adoption of the report and accounts.

Mr. J. DENISON-PENDER seconded the resolution, which was carried unanimously.

Resolutions approving the dividends recommended in the report, re-electing the retiring director (Mr. F. Alexander Johnston), and the retiring auditors (Messrs. Deloitte, Dever, Griffiths & Co.) were then carried unanimously, and a vote of thanks to the Chairman terminated the proceedings.

## Oldham, Ashton, and Hyde Electric Tramway (Ltd.).

The fourth annual general meeting of this company was held on 21st inst. under the presidency of Mr. Emile Garcke.

The SECRETARY (Mr. H. A. Stagg) having read the notice convening the meeting,

The CHAIRMAN said: Notwithstanding two or three adverse circumstances, the result of the year's working was satisfactory. The net credit balance enabled us to pay all the charges in respect of the debentures and the cumulative preferential dividend, to place £1,000 to depreciation, to pay a dividend on the ordinary shares of 6 per cent., and to carry forward £177. 11s. 8d. With regard to depreciation, we might, as the whole of the maintenance and upkeep of the plant, rolling stock, and permanent way has been paid for out of revenue, have placed a smaller amount to depreciation; but it is exceedingly desirable that we should not only keep the whole of the undertaking in a high state of efficiency, but that we should also provide for the expiring tenure of the company's undertaking and for the possible replacement of permanent way or rolling stock at some distant date. The traffic receipts, although proportionately less than in the previous half-year owing to the strike, are fully up to the average. The expenses are on the level of the previous half-year. The only item which shows an increase is that of administration and general expenses, which stand at £1,518. That is due to items of expenditure which have occurred for the first time during the past year—debenture trustees' fees, office expenses, &c., to say nothing of the strike expenses. There has been further expenditure on capital account of £6,219 owing to the conversion of several of the trailer cars into motor cars and provision for additional cars. We are now running 38 cars instead of 29. We have also enlarged our depôt and provided electric lighting and improvements to the permanent way and plant generally. The other items in the balance-sheet I think explain themselves. The unfortunate strike of our motormen and conductors was mainly owing to the action taken by the trade union of the district. Our superintendent had taken sundry measures of a perfectly justifiable kind to prevent interference with our men by the union officials. The union took the view that we were making an attack upon them, and they, without any real grievance on the part of the men, ordered a strike. Another circumstance which was a primary cause of the strike, was alleged to have been the reduction of the number of men as the result of the reduction of traffic which always follows after the summer months' working. We had decided to reduce the number by eight. The union took umbrage at that, and the strike took place, and continued some five or six weeks, but during that time we maintained the services in a thoroughly efficient manner. We ran a car every few minutes. The unions of the district instituted an effectual boycott, and fined any member of any trade union who travelled on our cars 5s. for each journey. They also adopted the forcible method of stone and mud throwing, so that respectable people were deterred from travelling; the company suffered serious loss, the men suffered loss of wages, and the only result of the strike was that the union was able to assert its authority and to bring itself into evidence. The men came back after five or six weeks, and their number was reduced as was originally decided, so that the principle for which the directors found it necessary to fight is accomplished. I must refer to the litigation with the Hyde Corporation, which was another question of principle. We were advised by our expert engineers and by the best legal advice that we were in the right. It was a point which had never been raised before by any local authority, and as we had no experience to guide us we were bound to act upon the advice we were able to obtain. But the decision of the Court of Appeal was given against us. This action involved some expense, but there is a question pending between the company and the contractors as to the liability in respect of that expense. One other matter is the question of the promotion of the light railway order for the extension of the line. We have always thought it better policy to develop our business slowly rather than make a very large undertaking of it straight away; and we felt satisfied that if we did good work and rendered the public service which had not been rendered before that we should receive the support of the local authorities, but the very success of the business roused not only the admiration but the envy of the authorities, who decided to oppose our extensions, not because they were not desirable or were not required, but because they thought the tramways should be in the hands of the local authorities. The local authorities have, in fact, since the rejection of our order, promoted a bill to authorise very much the same line that we proposed to promote. Their application is now before Parliament, and the directors propose to use whatever powers they possess in opposing the order promoted by the local authorities. With regard to the proposal to increase the capital of the company. This at present consists of 4,000 preference and 4,000 ordinary shares of £10 each. We propose this should be increased by £20,000, £10,000 ordinary and £10,000 preference shares, £10,000 ordinary shares, or half ordinary and half preference shares to be issued to the shareholders in proportion to their holdings. I now move the adoption of the report and accounts.

Mr. L. A. ATHERLEY-JONES, K.C., M.P., seconded the motion.

Col. WHALE asked for details regarding the item of £1,482 for strike expenses.

Mr. E. J. EVANS considered the undertaking was going on in an eminently satisfactory way so far as its earning powers were concerned. The cost of administration had, however, he thought been most excessive.

The CHAIRMAN: As to the item in connection with strike expenses, we had to import motormen and conductors, and were under the necessity of housing those men, and to some extent to provide them with provisions. These matters involved considerable expense, and represent the item, which includes the expenses attributable to the working of the system during the period of the strike. The cars ran empty during that period. The revenue was very small indeed, but the expense was not only the same as before but, as a matter of fact, it was much larger than under normal conditions. We have lost not merely the £1,482, but we have also lost traffic and the profit which we would have had on that traffic. With regard to the cost of working the undertaking which Mr. Evans described as excessive, I think he is under a misapprehension. The table at the end of the report last year shows the cost per passenger as 0·87d. This year the cost is 0·88d., or only 0·01 per cent. increase upon last year. It is true that the proportion of expenses to receipts has gone up from 59·3 to 65·8 per cent. but that is not due to any increase of expenses, but is entirely due to a reduction of the receipts per passenger, resulting from the reduction of fares which we have had to make in order to conciliate the local authorities, the trade unions, and the public generally.

A resolution increasing the capital of the company as outlined in the chairman's opening remarks was approved.

The retiring directors, Mr. Alderman R. Whittaker, J.P., and Mr. L. A. Atherley-Jones K.C., M.P., were re-elected, and the retiring auditors re-appointed, after which a vote of thanks to the chairman was carried.

Amendments in the Articles of Association in accordance with the powers of the Companies Act, 1900, were then approved, and the proceedings terminated.

## Bournemouth and Poole Electricity Supply Co. (Ltd.).

The fourth ordinary general meeting was held on Tuesday, under the presidency of Mr. A. H. Sanderson.

The SECRETARY (Mr. H. B. Renwick) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, before submitting a formal resolution to approve the directors' report and accounts I would refer you to the balance-sheet. You will there see that the capital appropriated to the Bournemouth provisional order, 1890, was, at the end of 1899, £143,230. 0s. 7d., and at Dec. 31, 1900, £169,572. 2s. 7d. Our investment in the Richmond (Surrey) Co., which at the end of 1899 was £79,700, now stands at £84,636. 0s. 2d. The Poole and Branksome, 1897, order and the Christchurch and District, 1899, order stand in the balance-sheet at £1,049. 7s. 11d. These, I consider, are valuable assets, and will doubtless be a source of considerable profit to us in the future. Our sundry debtors, embracing customers, interest and dividends, &c., stand at £11,793. 6s. 7d. These are all good debts, and have most of them been collected since. On the other side, the whole of our capital of £150,000 has been fully subscribed. The issue we made in March last of £70,000 4½ per cent. debenture stock at £3 premium was over-subscribed, and the balance from premiums on this issue has been put to reserve. The balance-sheet also shows the items put to the usual reserve and depreciation accounts. You will observe from the credit side of the revenue account that we have had a satisfactory increase from the sale of current during the past year—£16,438. 12s. 11d., against £13,299. 8s. 1d. for 1899. Our total revenue from all sources (£17,504. 13s. 8d.) shows an increase of £3,038. 1s. 7d. over the previous year. Our expenditure on coal shows an increase of £1,257. 15s. 3d. owing to increased cost and the additional consumption required for the increased output of current. The total revenue charges show an increase of £1,964. 2s. 11d., duly accounted for by the increased cost of fuel. After payment of all the standing charges, directors' fees, &c., there is a net balance of £8,052. 10s. 5d. available for distribution. The full year's preference dividend has already been paid, and the directors now propose that a dividend at the rate of 6 per cent. per annum be paid on the ordinary shares. I should like to make a few further comments on the subject of capital expenditure. In addition to putting down machinery somewhat in advance of our requirements, in order that we may not run short of plant while our business is increasing, we have adopted a forward policy in the matter of laying mains through Bournemouth, and have found this policy highly satisfactory in every instance. To accommodate our additional machinery we have had to extend our works, and have spent a considerable sum on buildings, as you will see. I believe all these amounts have been well spent. When I addressed you in March last year I informed you that the Corporation of Bournemouth were applying for a provisional order to supply electric energy in competition with this company. The issue was then uncertain, but the Board of Trade has, I am

now happy to inform you, refused to grant the order in respect of private lighting, but have given the Corporation an order to enable them to supply current for public lighting. As we have not supplied current for this purpose we are not prejudicially affected by the Corporation obtaining this order. A table, which has been handed me by our indefatigable secretary, Mr. Renwick, gives data which will interest you. I find that on December 31, 1891, we had an equivalent of 5,550 8 c.p. lamps connected: in 1892 there were an additional 3,438 lamps applied for; in 1893, 5,564 lamps; 1894, 4,628; 1895, 1,798; 1896, 2,255; 1897, 3,546; 1898, 8,752; 1899, 9,276; 1900, 10,499 lamps. The number of units sold in the year to December 31, 1893, was 159,016, and in 1900, 671,762. I was able to inform you at our last meeting that a contract had been entered into with the Poole and District Electric Traction Co. to supply current to work their tramways, and this contract will give us a very desirable day load, and we are already in receipt of revenue from this contract. Our interest in the Richmond Company is a satisfactory one, the company having made good progress. We have, as you are aware, a provisional order for the lighting of Poole and Branksome, but have for certain reasons delayed carrying out this large work. We are now considering this matter very seriously, and it will be necessary for us to come to you or to apply to the public for additional capital. In all these transactions we have had great assistance from all our officers, who have worked thoroughly and indefatigably for the benefit of the company. From our secretary, Mr. Renwick, our assistant secretary, Mr. Brightman, and Mr. Ingram, our engineer at Bournemouth, we have received the greatest assistance. I now move the adoption of the report and accounts.

Mr. HOSKER seconded the motion.

A SHAREHOLDER asked if there was any probability of the Bournemouth Corporation entering into a contract with the company for the public lighting.

The CHAIRMAN: We could, in my opinion, supply current to the public lamps cheaper than the Bournemouth Corporation could do so, and I believe that if we had supplied the Corporation with current for the lighting of the public gardens and pier up to the present time we should have effected for them a very considerable saving, but they prefer to do it themselves—as corporations have a way of preferring. Sometimes these bodies make a profit and sometimes a loss, but from the way their accounts are made up you do not always find out whether there is a profit or a loss.

The motion was then carried unanimously.

Resolutions approving the payment of the proposed dividends, the re-election of the two retiring local directors—Mr. A. H. Sanderson and Mr. Hosker—and fixing the remuneration of the directors at £500; and for the re-appointment of the retiring auditor, were then approved.

A cordial vote of thanks to the directors and staff was then carried.

At the extraordinary meeting, which followed, the resolutions amending the articles of association in accordance with the Companies Act, 1900, were approved.

## Willans and Robinson (Ltd.).

The fourteenth report of the directors of this company for the half-year ended Dec. 31 shows that, after writing off as depreciation from plant, patents, &c., £5,855. 15s. 8d., and paying debenture interest, the balance to credit of profit and loss (including £6,757. 2s. 11d. brought forward) is £39,360. 10s. 10d. The directors propose the payment of the preference dividend and a dividend at the rate of 10 per cent. per annum on the ordinary shares, also a bonus of 2 per cent. on the ordinary shares for the year 1900, these payments absorbing £20,761. 16s. 11d. The amount payable to the original directors is £5,686. 16s. 5d., and the balance available is £12,912. 6s. 6d. The directors propose to carry £2,000 to debenture redemption, and £3,500 to reserve, leaving £7,412. 6s. 6d. to be carried forward.

The auditors having questioned the propriety of investing the debenture redemption fund (the creation of which is a voluntary act on the part of the company) in the names of trustees, and thus placing it beyond the control of the company, the directors have taken counsel's opinion, and are advised that future investments should be in the company's name.

The opinion of counsel and of the auditors has also been taken as to the appropriation of share premiums, and copies of these opinions, &c., have been circulated among the shareholders.

The growth of the business in the past two years has largely diverted to more pressing uses the additional capital intended for new buildings and plant. Between December, 1898, and December, 1900, while the value of buildings and plant increased by about £78,000, the floating capital of the business, including sums locked up in stock of all kinds, in work in progress, and in balances owing by debtors, increased by no less than £115,000. The directors regard this growth as the natural consequence of the increased volume of the company's trade, and as justified by the increased profits of the same period. But it results that if the extensions of premises and plant, which are more than ever necessary, and to which the company is, in fact, committed, are to be properly carried out, and especially if the new boiler works near Chester are to start upon the scale plainly desirable, the capital of the company must be increased, and the shareholders will be asked at the forthcoming meeting to authorise the creation of new shares (in equal proportions of preference and ordinary) to raise the share capital from £500,000 to £750,000, to be issued as may be required.

The first portion of the extension works at Rugby is nearly completed, and the boiler works at Queensferry make good progress.

The Admiralty has ordered Niclausse boilers to be fitted in the new armoured cruiser "Suffolk" of 22,000 H.P., and in a sloop of 1,400 H.P. The directors consider that the interim report of the Admiralty boiler committee, recently published, is likely to have favourable results upon the future of the Niclausse boiler.

## Dover Electricity Supply Co. (Ltd.).

The directors' report for the year to Dec. 31 states that applications were received for the equivalent of over 3,002 8 c.p. lamps. The output to private consumers shows an increase of 30 per cent. over that of 1899. There is also to record a growing use of electric energy for motive power. Considerable extensions of the mains, and the provision of a large direct-current set for power purposes have been carried out during the year. A contract has been entered into with the Admiralty harbour contractors, under which a large amount of energy will be required for some years. The steady growth of the company's business will probably necessitate the issue of the balance of the preference shares. The directors have been approached by the Dover Corporation as to the transfer of the undertaking to the Corporation, but the directors do not advise a sale to be made. The gross profits of the year amounted to £2,986. 10s. 6d., and the net profit a balance of £1,759. 11s. 4d., out of which a dividend of 3½ per cent. on the ordinary shares is recommended.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—At a meeting held on Monday, Mr. A. E. Mitchell-Innes said this was a very prosperous and progressive enterprise, and he thought, in view of the great strides which their business had made, and the large number of new electric light customers they had, the shareholders would understand why more money was required. The amount actually required to pay for the new electric generating machinery and rolling stock which they had already secured or contracted for and the further purchases which they contemplated during the current year, amount to less than £40,000. Business in British Columbia has never been better, and there are a number of factors contributing to this improved outlook, including the building of railways into Vancouver and Victoria, the establishment of additional steamship communication with Australia, the landing of the Pacific cable and the general prosperity of the country. Evidence of the brightened outlook is shown in an offer they had received to underwrite the whole of their proposed issue of £64,000 in preference shares at a reasonable brokerage from one of the most important of the great Canadian banks.

W. T. GLOVER & CO. (LTD.)—The directors' annual report states that the sales of the company's manufactures show a considerable increase over those of the preceding year, while prices have been fairly maintained. The works of the Trafford Park Electric Power and Light Supply Co. which the company have erected were now giving a supply of current to the company's works and to the majority of works in operation in the park. The demand for power was rapidly increasing, so that the company was likely to benefit considerably by the continued expansion of the enterprise. The directors consider that the time has come to dispose of a part of their interest in the Trafford Park Company by a public issue of shares, or otherwise. In view of large contracts in hand, requiring further working capital, the directors intend to offer for subscription the balance of 25,000 ordinary shares, and the rest of the debentures already authorised. The Trafford Park works are now in operation, and the company has benefited, and will no doubt benefit still more, by the increased facilities for manufacture. The disturbance caused by removal of plant and erection of new plant, however, prevented the full effects of the improved accommodation from being felt during the past year. At the meeting on Wednesday the chairman (Mr. Henry Edmunds) announced that the company had secured orders which would probably require them to double their premises. The motion for the adoption of the report was agreed to, and dividends of 5 per cent. on the preference and 10 per cent. on the ordinary shares were approved.

HOVE ELECTRIC LIGHTING CO. (LTD.)—At the meeting of this company, held on Monday, the directors' report, set out in our last issue, was adopted. Col. Filgate, who presided, said they had ordered another boiler for erection this summer, and hoped, with this, to be able successfully to meet the demand for electric current during the ensuing winter. They had secured a suitable site for a new station, which was much needed. The proposed extensions would involve considerable outlay, but not more than the progressive nature of their business demanded. They would shortly have to consider what reductions they could make in their charges for current. They had arranged to supply consumers at 220 volts at 7d. per unit for the first hour instead of 8d., and this had led to a number of their customers changing over from 110 volts. The alteration had been warmly opposed by the Hove Corporation, and this opposition had had its result. In fact, recently, that body had refused to allow the change, although more than four years ago they authorised the company to connect future consumers at 220 volts. Such action by the Corporation must tend to prevent the company reducing their charges sooner than would otherwise be the case. Fresh capital would be required this year in some form. The gross revenue had been £13,841, an increase of £1,771 over 1899, and the expenditure had been £6,125, an increase of £1,152. The final dividend at the rate of 9 per cent. per annum, making 8 per cent. for the year (comparing with 7½ per cent. for the previous year) was approved.

IMPERIAL TRAMWAYS CO. (LTD.)—At the annual meeting on Saturday the chairman (Mr. George White) said the directors proposed to extend the Darlington tramways and adopt electric traction. They were unable to enter into an agreement with Darlington Corporation for taking current from the Corporation mains, and, after negotiations, the Corporation determined to purchase the company's undertaking. These negotiations were proceeding, and he believed a sale of the lines would shortly be made upon mutually agreeable terms. The Board of Trade had appointed Sir Frederick Bramwell as arbitrator in the sale of the company's Reading lines to the Corporation, but the latter had asked the company to suggest some reasonable price for agreement to obviate the necessity for arbitration. In regard to the Middlesbrough, Stockton and Thornaby electric

tramways, there was a quiet but steady growth of traffic, and the receipts were exceedingly satisfactory. The extension of the Middlesbrough line to Clarence Ferry would be opened in May. The London United Company, in which the Imperial Company was so largely interested, had also made great strides during the past year.

**MERSEY RAILWAY CO.**—At the half-yearly meeting on Monday Mr. James Falconer said the proposed change from steam power to electric traction was by far the most important question the directors and shareholders had to consider. It was the end and object of their whole policy, but it was a subject surrounded by many difficulties. The form of electric traction best suited for a full-sized railway tunnel like theirs had not yet been determined by experience in this country. By their Act of 1900 the company would be enabled to place the stock required for paying for the electric reconstructional and equipment works in front of the existing perpetual debentures, but the extreme of the conversion to electric traction must not lead them to lose sight of the great importance of securing the best system. The Wirral Railway Co. had also obtained power to convert their system of working from steam to electric traction, and the board were in communication with that company with the object of arranging mutually satisfactory terms for a joint system of electrical working.

**NATIONAL ELECTRIC WIRING CO. (LTD.)**—The report of the directors of this company for the year to Dec. 31 last states that the gross profit is £9,636. 0s. 2d., from which has to be deducted expenses of administration, allowances on contracts, &c., £5,642. 4s. 8d., leaving £3,993. 15s. 6d., which, with £281. 1s. 5d. brought forward, makes £4,274. 16s. 11d. The directors recommend a dividend at the rate of 4 per cent. for the year, taking £2,499. 11s. 8d., depreciation, &c., £1,390. 19s. 6d., carrying forward £384. 5s. 9d. The increase in the business during the year has been very satisfactory, and the orders taken from Jan. 1, 1901, to date show this increase more than maintained. Several large contracts have been secured, involving the complete equipment of plant for power and lighting. During the year 2,240 installations (of an aggregate of 57,519 8 c.p. lamps) have been completed, of which 777 (19,973 8 c.p. lamps) were "free" wiring, and 1,463 (37,546 8 c.p. lamps) were contract, while 590 installations 33,084 8 c.p. lamps) were in hand. Free wiring contracts have been entered into with the Corporation of Swansea, the Borough of Poplar, and the Scottish House-to-House Electricity Co.

**WOOLWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)**—The annual meeting of this company was held on Monday, when the directors' report for 1900 was submitted. The increase in lamp connections have risen from 9,610 to 19,425, and the sale of current from £3,372 in 1899 to £6,109 in 1900. The result of the trading for the year (with £63. 10s. 3d. from last account), after payment of debentures and loan interest, leaves a profit of £2,026. 8s. 9d., and the directors recommend a dividend at the rate of 5 per cent. absorbing £1,022, and that £600 be placed to renewal fund. During the year the works were largely extended. A new 250kw. dynamo set was added, additions were made to the boiler power, and the mains were considerably extended. It is proposed to increase the capital to £50,000 by the issue of 25,000 £1 shares, to be offered pro rata to the shareholders. The following is an abstract of the proceedings at the meeting supplied to us on behalf of the company:—Mr. J. A. Findlay said the expenditure had only gone up by a little over £700, and but for the increased price of coal these expenses would have been £500 less. The capital account showed a large increase, due to the great extensions of the company's business. The company had passed through a number of lean years, now they had entered on something more in the way of fat years, and there was every prospect of the improvement continuing. Mr. F. E. Gripper said the number of lamps connected was doubled in 1899, was doubled again last year, and there should be a very considerable increase this year. The report was adopted. Mr. Findlay said they had been approached by the Woolwich Borough Council with reference to the sale of their undertaking, and if they were made a reasonable and suitable offer they would call the shareholders together to consider it.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**DERBYSHIRE AND NOTTINGHAMSHIRE ELECTRIC POWER SYNDICATE (LTD.)**—Registered March 19, with a capital of £10,030 in 100 ordinary shares of £100 each and 600 deferred shares of 1s. each, to carry on in the counties of Nottingham and parts of Derby south of the River Trent and elsewhere the business of an electric power supply company in all its branches. The subscribers are A. Lupton (civil engineer), M. H. Mills, M.I.C.E., J. W. Thackeray, A. Grove, C. Allan, D. Fox, W. W. Horsfield (boiler maker), S. J. Chadwick, J. Hirst, C. B. Crawshaw, C. Fox, M. Deacon, M.I.C.E., R. Holliday, F. Hunteman, British Westinghouse Electric and Manufacturing Co., E. H. Fraser, J. T. McCraith, T. B. Springett, and P. Castle-Smith. The first directors are M. H. Mills, D. Fox, J. Hirst, E. H. Fraser, J. T. McCraith, J. W. Thackeray, C. B. Crawshaw and A. Grove.

**ELECTRITES CO. (LTD.)**—Registered March 14, with a capital of £500 in 1s. shares, to acquire inventions relating to the production, treatment, storage, application, distribution and use of electricity, and in particular to acquire certain inventions and a registered design from Mr. F. B. Lacy and to carry on the business of makers of electrical apparatus, &c.

**LAHMEYER ELECTRICAL CO. (LTD.)**—Registered March 21, with a capital of £100,000 in £10 shares, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in all kinds of plant, machinery, equipment, apparatus and appliances for the generation, distribution, accumulation, and employment of electricity and other motive and lighting power, contractors for the erection of electrical and other works and plant, &c. No initial public issue.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27 1/16d. per oz. (March 28). Consols (2¾ per cent.) 95 7/16—95 11/16 for money, 95⅝—95⅞ for account; 2½ per cent. 95—96 (March 28). Consols Pay Day April 3. Stocks and Shares Continuation Days, April 10 and 24. Ticket Days, April 11 and 25; Pay Day, April 12; Mining Share Carry-over Days, April 9 and 23.

**BURY, ROCHDALE AND OLDHAM TRAMWAY CO.**—During the half-year to Dec. 31 last an arrangement was come to between the Corporations of Heywood and Rochdale and also between Heywood and Bury, whereby the Rochdale Corporation ran their electric cars to the centre of Heywood, and the Bury Corporation theirs from Bury to the same centre. The authorities both east and west of Heywood have associated with a view to act jointly in the matter of purchase.

**DIRECT UNITED STATES CABLE CO. (LTD.)**—An interim dividend of 3s. per share (tax free), being at the rate of 3 per cent. per annum for the quarter ending 31st inst., is payable on and after the 26th prox.

**EASTERN TELEGRAPH CO. (LTD)**—This company announce the payment on April 15 of dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending March 31, and an interim dividend of 1¼ per cent. on the ordinary stock (tax free) in respect of profits for the quarter ended Dec. 31, 1900. The transfer books will be closed from April 6 to April 15 inclusive.

The Eastern Telegraph Company also announce the payment on May 1 of interest for the half year ending April 30 on their 4 per cent. mortgage debenture stock. The transfer books will be closed from April 24 to May 1, inclusive.

**EASTERN AND SOUTH AFRICAN TELEGRAPH CO. (LTD.)**—This company announce the payment on May 1 of interest on their 4 per cent. Mauritius Subsidy Debentures. The transfer books will be closed from April 24 to May 1, inclusive.

**EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH CO. (LTD.)**—Subject to confirmation by the shareholders, the directors have declared a dividend, for the quarter ended Dec. 31, of 2s. 6d. per share, together with a bonus of 4s. per share (or 2 per cent.), making a total distribution of 7 per cent. for the year 1900, payable April 25th. The share register will be closed from April 17 to 24 inclusive.

**EVERED & CO. LTD.**—The report for 1900 states that, after providing debenture interest, &c., a net profit remains of £18,252, making, with £6,986 brought forward, £25,238. An interim dividend at the rate of 7½ per cent. per annum has been paid, and the directors now propose a further dividend at the same rate and a bonus of 2½ per cent. for the year, to write £2,000 off plant and buildings, and to carry forward £6,164.

**GLOBE TELEGRAPH AND TRUST CO. (LTD.)**—The directors have declared an interim dividend of 2s. 6d. per share on the ordinary shares.

**NORWICH ELECTRICITY CO. (LTD.)**—At the annual meeting, held last week, Sir Charles Gilman congratulated the shareholders on the continued increase in the company's business, which was for 1900 about £3,000 over the previous year. Owing to the advance in the price of coal they had only an increased balance in hand of £930, but this sufficed to show the progressive state of the business. The number of their customers was steadily increasing, and this required the issue of further capital to provide the necessary mains and machinery. A dividend at the rate of 6 per cent. was declared.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks. | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Mar. 23 | 550 | + 32 | 42 | 28,116 | + 3,550 |
| *Birmingham Tramways. | " 23 | 4,020 | + 59 | 11 | 44,421 | + 663 |
| *Blackburn Corporation.. | " 22 | 407 | + 37 | 12 | 4,662 | + 439 |
| Blackpool Corporation... | " 21 | 213 | + 51 | 51 | 30,376 | + 7,997 |
| Blackpool and Fleetwood | " 23 | 162 | − 26 | 12 | 1,736 | − 135 |
| Bolton Corporation ...... | " 24 | 1,238 | ... | 51 | 69,378 | ... |
| Bradford Corporation... | " 21 | 800 | − 449 | 51 | 31,827 | + 12,396 |
| Brisbane Trams ........ | Feb. 6 | 1,835 | + 49 | 5 | 10,674 | + 1,742 |
| *Bristol Trams & Carriage | Mar. 22 | 3,576 | + 1,175 | 12 | 43,283 | + 12,258 |
| *Buenos Ayres & Belgrano | Feb. 21 | 2,593 | + 604 | 8 | 22,025 | + 3,163 |
| Carlisle Trams. Co. ... | Mar. 23 | 117 | ... | 12 | 1,337 | ... |
| Central London Railway | " 23 | 6,188 | ... | 12 | 73,007 | ... |
| City & South London Ry. | " 24 | 2,082 | + 723 | 12 | 24,236 | + 9,657 |
| Cork Elec. Trams ........ | " 21 | 346 | + 34 | 11 | 3,902 | + 411 |
| Dover Corporation ...... | " 23 | 154 | + 17 | 51 | 10,627 | + 704 |
| Dublin & Lucan Rly. ... | " 23 | 71 | + 11 | 12 | 846 | + 155 |
| Dublin United ........... | " 22 | 3,076 | + 251 | 12 | 27,369 | + 3,561 |
| Dublin Southern Dist.... | " 22 | 645 | + 80 | 12 | 8,433 | |
| *Dundee Corporation ... | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation ... | " 23 | 8,339 | + 268 | 12 | 100,293 | + 2,805 |
| Halifax Corporation...... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpo. ... | " 23 | 680 | + 104 | 51 | 35,142 | + 3,082 |
| Hull Corporation ......... | " 23 | 1,482 | + 789 | 38 | 54,917 | + 29,723 |
| *Liverpool Corporation... | " 16 | 8,048 | + 1,034 | 11 | 85,905 | + 12,389 |
| Liverpool Overhead Rly. | " 24 | 1,475 | + 256 | 12 | 17,744 | + 884 |
| Portsmouth Corporation | " 23 | 472 | − 34 | | ... | ... |
| *Sheffield Tramways ...... | " 24 | 2,913 | + 1,097 | 12 | 33,565 | + 11,851 |
| Southampton Corporat'n | " 21 | 550 | + 288 | ... | ... | ... |

* Partly electrical

**ROCKHAMPTON (QUEENSLAND) GAS AND COKE CO. (LTD.)**—In the report for the half-year ended Dec. 31 a deficit of £217. 2s. 11d. on the electricity department is announced. Dividends at the rate of 7 per cent. per annum upon the ordinary and 9 per cent. upon the preference shares have been declared.

**STOCK EXCHANGE NOTICE.**—Application has been made to the committee to appoint a special settling day in, and to grant a quotation to the further issue of 40,000 £1 shares of the *Cape Electric Tramways (Ltd.)* and to allow the further issue of £26,991 4 per cent. debenture stock of the *Kensington and Knightsbridge Electric Lighting Co. (Ltd.)* and the *Notting Hill Electric Lighting Co. (Ltd.)* and £120,000 5 per cent. second debenture stock (in lieu of provisional certificates now quoted) and 100,000 ordinary £5 shares of the *Buenos Ayres and Belgrano Electric Tramways (Ltd.)* to be quoted in the official list. The latter is a special application. The Stock Exchange committee has also been asked to quote the further issue of £10 ordinary shares of the *British Electric Traction Co. (Ltd.)* in the Official List.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Mar. 20. | Price Wednesday, Mar. 27. | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 27 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ⅞ 1 | ⅞ 1 | ... | ... | ... | ... |
| £100,000 | Stock | ... | Do. 4½ 1st Deb. Stock Prov. Certs. (red. and con.) | 70 75 | 70 75 | ... | ... | 72½ | ... |
| 6,000 | 10 | 10/0 | Bournemouth and Poole Elec. Supply Ord. | 12½ 13½ | 13½ 13½ | 3 14 1 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 11 | 10 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 104 | 101 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord. | 7 8 | 7½ 8½ | 3 17 9 | ... | 8 | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8 9 | 8½ 8½ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ 7½ | 6½ 7½ | ... | ... | ... | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 10 | 9 10 | 4 10 0 | February and August | 9½ | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ 5¾ | 5½ 5¾ | 3 18 3 | " " | ... | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5½ 6½ | 5½ 6½ | 4 8 0 | March | 6½ | ... |
| £150,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 112 | 109 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 110 | 100 110 | 4 10 11 | April and October | ... | ... |
| 70,879 | 10 | 8/0 | City of London Electric Lighting Ord. | 7½ 8½ | 7 8 | 5 0 0 | February and August | 8½ | 7½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 13 14 | 13 14 | 4 5 9 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 123 127 | 121 126 | 4 0 4 | June and December | 123 | ... |
| £200,000 | Stock | ... | Do. 4½ 2nd Deb. Stock Certs. (all pd.) | 101 103 | 101 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 8 9 | 8 9 | 3 13 4 | ... | 8½ | ... |
| 30,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ 12½ | 11½ 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ Deb. Stock (all pd.) (red.) | 106 109 | 106 109 | 4 2 7 | | 107 | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ 6 | 5½ 5½ | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ 8½ | 7½ 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 10 11 | 10½ 11½ | 4 11 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. Deb. Stk. (red.) | 6½ 7 | 6½ 7 | 4 2 7 | January and July | ... | ... |
| £73,000 | Stock | 25/0 | Kensin. & Knigtbg. Co. & Notting Hill Co. (Jnt. Stk.) 4% | 103 105 | 103 105 | 3 16 2 | | ... | ... |
| 110,000 | 3 | ... | London Electric Supply Ordinary | 1½ 1¾ | 1½ 1¾ | ... | ... | ... | ... |
| 49,340 | 5 | 3/0 | Do. 6 per Cent. Preference | 3 4 | 3 4 | 7 10 0 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 101 | 91 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,080 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 12½ 13½ | 12 13 | 4 13 4 | April and October | 12½ | 12½ |
| 13,780 | 10 | 9d. | Do. (£7 10s. paid) | 9½ 10½ | 9 10 | ... | ... | ... | ... |
| £720,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 113 | 110 113 | 3 19 8 | June and December | ... | ... |
| £280,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 100 | 97 100 | 3 10 5 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 15½ 16½ | 15½ 16½ | 4 4 10 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ 6½ | 6½ 6½ | 3 16 11 | " | ... | ... |
| 300,000 | 1 | 1/6 | Rand Electric | ½ ⅝ | ⅝ ⅞ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 75 | 65 75 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 210 220 | 200 210 | 3 12 9 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 103 105 | 103 105 | 4 7 5 | " " | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 13½ 14½ | 13½ 14½ | 5 0 0 | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ 9½ | 8½ 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 101 | 91 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 2½ | 2 2½ | ... | ... | ... | ... |
| £60,000 | Stock | 4% | Do. 4% Debentures | 80 90 | 80 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ 3½ | 2½ 3½ | ... | ... | ... | ... |
| 79,900 | 5 | 5/0 | Westminster Electric Supply Ordinary | 12 13 | 11½ 12½ | 4 4 0 | March and September | 12½ | ... |
| 30,100 | 5 | 4/1½ | Do. Do. | ... | ... | ... | ... | ... | ... |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | |
| 200,027 | 5 | 2/0 | Anglo-Argentine Shares (1 to 200,027) | . . | 3½ 4½ | 4 17 0 | April and October | 4 | 3½ |
| £230,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | . . | 121 135 | 4 14 10 | ... | 125 | ... |
| 46,446 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 15 | 14 15 | 4 6 4 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 3½ 3½ | 3 3½ | ... | ... | 3½ | 3½ |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ 4½ | 4½ 5 | ... | ... | 4½ | ... |
| £100,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 101 | 99 101 | ... | ... | 99½ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ 24½ | 23½ 24½ | 3 4 0 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ 10¾ | 10½ 10¾ | 3 13 4 | ... | ... | ... |
| £110,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 116 | 114 117 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ 7½ | 6½ 7½ | ... | ... | ... | ... |
| 13,600 | 10 | 5/0 | Do. 5% Preference | 10 10½ | 10 10½ | 4 15 3 | May and November | 10½ | 10½ |
| £220,000 | 100 | ... | Do. 4½% 1st Mort. Debs. | 99% 100% | 100% 101% | ... | ... | 100½ | 100 |
| 80,000 | 10 | 6/0 | British Elec. Trac. Ord. | 15 16 | 15 16 | 5 6 8 | ... | 15½ | 15½ |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11½ 12½ | 11½ 12½ | 4 16 0 | February and August | 12½ | 12½ |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 120 123 | 120 123 | 4 1 4 | ... | 122½ | 121 |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 5 5½ | 5 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ 5 | 4½ 5 | ... | ... | ... | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 107 | 104 107 | 4 13 6 | ... | 105½ | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 96 99 | 96 99 | 5 1 8 | ... | ... | ... |
| 34,440 | 10 | 2/0 | Calcutta Trams. (Nos. 1 to 40,000) | . | 10½ 11½ | . | . | ... | ... |
| £150,000 | 100 | | Do. 4½ 1st Deb. Stock (Red.) | . | 103 105 | . | . | ... | ... |
| 110,000 | 1 | | Cape Electric Trams. Shares | 1½ 1¾ | 1½ 1¾ | ... | ... | ... | ... |
| 206,295 | 10 | 2/6 | Central London Ordinary | 9½ 9½ | 9½ 9½ | 2 19 6 | June and December | 9½ | 9 |
| 10,000 | 5 | 1/3 | City of Birmingham Trams. Co. 5% Cum. Pref. | .. | 5½ 6½ | 4 6 11 | ... | ... | ... |
| £200,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | . | 103 10 | 3 17 8 | ... | ... | ... |
| £655,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 41 40 | 43 40 | 2 10 0 | February and August | 41 | .. |
| 37,500 | 10 | 1/5% | Do. Ordinary (Nos. 32,501 to 50,000) | 4 5 | 4 5 | ... | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 137 | 132 137 | 3 13 0 | " " | ... | ... |
| £500,000 | Stock | 5% | Do. (1896) | 122 127 | 122 127 | 3 18 9 | ... | ... | ... |
| £344,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 112 117 | 112 117 | 3 9 5 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams (1896) Ltd., Ordinary | 13½ 13½ | 13 14 | 4 5 9 | ... | 13½ | ... |
| 53,981 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 16 | 15 16 | 3 15 0 | ... | ... | ... |
| £300,000 | 100 | 3½ | Do. 3½ per Cent. Mort. Debs. (red.) | 103 105 | 98 102 | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ 5½ | 4½ 4½ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary x d | 23 24 | 21½ 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference x d | 14½ 15 | 14½ 16 | 3 16 8 | " " | ... | ... |
| £200,000 | Stock | 4½% | Do. 4½ per Cent. Debenture | 112 114 | 113 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | ... | 10½ | ... | May and November | ... | ... |
| 37,500 | 10 | 3½% | Liverpool Overhead Railway Ordinary x d | 7½ 7½ | 7½ 7½ | 4 1 10 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference x d | 13 13½ | 13 13½ | 3 15 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 104 | 102 104 | 3 17 2 | January and July | ... | ... |
| $360,000 | $1,000 | 5% | London Street Rly. (Ont.) 1st Mrt. 5% Dbs. (red.) | 100 102 | 100 102 | 4 18 0 | ... | ... | ... |
| £325,744 | Stock | 3½ | Lond. Utd. Trams 4½ 1st Mt. Db. Stk. Prv. Crts. (fly pd) | 102 104 | 102 104 | ... | ... | 103½ | 103½ |
| £60,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mor. Debs. (1908) | 102 104 | 102 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 104 | 102 104 | 4 6 7 | ... | ... | ... |
| 21,000 | 5 | ... | New General Traction Ordinary | 3½ 3½ | 3 3½ | 3 8 8 | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ 5½ | 4½ 5½ | 6 0 0 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | ... | ... | " " | ... | ... |
| 18,334 | 10 | ... | Potteries Electric Traction Ordinary | 11½ 12½ | 11½ 12½ | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference | 10 11 | 10 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 87 0 | Do. 4½ per Cent. Debenture Stock | 107 109 | 107 109 | 4 2 9 | ... | ... | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 93 93 | 94 97 | 3 2 2 | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Mar. 20. | | Price Wednesday, Mar. 27. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Mar. 27. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | Highest | Lowest |
| £96,800 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | — | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 55 | 65 | 55 | 65 | ... | ... | ... | ... |
| £837,720 | Stock | 17/6 | Anglo-American | 50 | 53 | 50 | 53 | 5 13 10 | Feb., May, Aug., Nov. | 50 | ... |
| £3,058,640 | Stock | 20/0 | Do. Preferred | 94 | 95 | 94 | 96 | 6 4 0 | „ „ | 95½ | 94 |
| £3,058,640 | Stock | 5/0 | Do. Deferred | 5 | 5½ | 5 | 5½ | 2 18 9 | „ „ | 5 | ... |
| 13,333,300 | $100 | 7½ | Commercial Cable Capital Stock | 165 | 175 | 165 | 175 | 4 12 3 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,039 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 102 | 104 | 3 16 11 | „ „ | 102½ | ... |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 5 | „ „ | 16½ | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | „ „ | ... | ... |
| £20,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 8/0 | Direct United States Cable | 9¾ | 10¼ | 9¾ | 10¼ | 6 16 [illegible] | Jan., Apr., July, Oct. | 10 | 9¾ |
| £109,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 [illegible] | June and December | ... | ... |
| £4,000,000 | Stock | [illegible] | Eastern Ordinary [1 to 1,000] (red.) | 143 | 148 | 143 | 148 | 4 14 10 | Jan., Apr., July, Oct. | 145½ | 145 |
| £1,836,486 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 98 | 93 | 96 | 3 12 9 | „ „ | 94 | ... |
| £1,432,360 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 117 | 113 | 117 | 3 9 0 | May and November | 115 | 114½ |
| 250,000 | 10 | 2/6 | Eastern Extension | 14¼ | 14¾ | 14¼ | 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14½ | 14¼ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) 25p.L's'd at 63pm, all pd | 13¾ | 14¼ | 13¾ | 14¼ | ... | ... | 13¾ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 115 | 111 | 115 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 | 103 | 99 | 103 | 3 18 3 | February and August | 100½ | ... |
| £200,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 17 6 | May and November | 101½ | 101 |
| 190,227 | 10 | 1/9 | Globe Telegraph and Trust | 9¾ | 10¼ | 9¾ | 10¼ | 5 2 5 | Jan., Apr., July, Oct. | 10¼ | 9¾ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14¾ | 15¼ | 14¾ | 15¼ | 3 18 8 | „ „ | 15¼ | 14¾ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 32 | 34 | 32 | 34 | 3 13 6 | January and July | 32½ | ... |
| £83,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (with Nos | 99 | 103 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [1 to 1,000] (red. | 47 | 51 | 47 | 51 | 4 14 0 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 108 | 103 | 108 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 18 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 124 | 129 | 4 13 0 | ... | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 2½ | 3½ | 2½ | 3½ | 4 9 3 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 | 100 | 97 | 100 | 5 0 0 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 19 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ | ¾ | ½ | ¾ | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | „ „ | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | „ „ | 6½ | [illegible] |
| £90,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 207,960 | 10 | 3/0 | Western Telegraph (late Brazil'n Subm'rine) | 13¾ | 14¼ | 13¾ | 14¼ | 4 19 3 | Mar., June, Oct., Dec. | 13¾ | ... |
| £75,000 | [illegible] | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £945,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 324,850 | 10 | 3% | Consolidated Telephone Con. and Maintg. | 2/3 | 2/9 | 2/3 | 2/9 | [illegible] | April and October | ... | ... |
| 72,600 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 5 0 0 | November | ... | ... |
| 86,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | ... | ... | ... |
| 690,000 | 5 | 2/6 | National | 3¼ | 3¾ | 3¼ | 3¾ | 7 17 2 | February and August | 3⅜ | 3¼ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 13 | 11 | 13 | 4 12 4 | „ „ | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 | 12 | 10 | 12 | 5 0 0 | „ „ | 10½ | ... |
| 950,000 | 5 | 2/6 | Do. 5 per Cent. Non Cumulative 3rd Pref. | 4¼ | 4¾ | 4¼ | 4¾ | 5 0 7 | „ „ | 4½ | ... |
| £1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 92 | 94 | 92 | 94 | 3 15 11 | June and December | 94½ | 94 |
| [illegible] | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 | 101 | 97 | 101 | 4 0 4 | ... | 97 | ... |
| 171,504 | 1 | 0/6 | Oriental | 1 | 1¼ | 1 | 1¼ | 5 3 9 | April and October | ... | ... |
| 66,000 | 5 | 2/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 16 3 | June and December | ... | ... |
| £119,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 105 | 108 | 105 | 108 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | [illegible] | [illegible] | [illegible] | [illegible] | 5 14 3 | ... | ... | ... |
| 135,000 | 1 | 6½d. | Aron Electricity Meter 6% Cum. Pref. | [illegible] | [illegible] | [illegible] | [illegible] | 5 17 2 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 50,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £50,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 | 90 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 1/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 6 13 1 | July and February | 10⅝ | 10½ |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5¼ | 5¾ | 5¼ | 5¾ | 4 18 [illegible] | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | [illegible] | ... | ... | ... |
| 90,060 | 2 | 1/2½ | Brush Electrical Engineering | 1¾ | 1⅞ | 1¾ | 1⅞ | 6 8 [illegible] | September | 1¾ | ... |
| 16,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2¼ | 2½ | 2¼ | 2½ | 5 9 8 | „ | [illegible] | ... |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | 105½ | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 6 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 | 16 | 15 | 16 | 4 13 9 | ... | ... | ... |
| 40,000 | 5 | 3/6 | Do. 6 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | „ „ | ... | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | [illegible] | November and May | [illegible] | 5½ |
| 450,000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | 1 | 1¼ | 1 | 1¼ | [illegible] | ... | ... | ... |
| £150,000 | Stock | 4½% | Do. 4½ First Mort. Deb. (red.) | 95 | 99 | 95 | 99 | 4 12 [illegible] | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 13 9 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | 1 | 1¼ | 1 | 1¼ | 6 6 8 | ... | ... | ... |
| 64,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 64,000) | 3¼ | 3¾ | 3¼ | 3¾ | [illegible] | January and July | [illegible] | [illegible] |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 6 | „ „ | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 5 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1/6 | Edison & Swan United ("A" Shares, £3 paid) | 1½ | 2 | 1½ | 2 | [illegible] | February and August | ... | ... |
| 17,139 | 5 | [illegible] | Do. (£5 paid) | 3 | 4 | 3 | 4 | 6 13 [illegible] | ... | ... | ... |
| £344,783 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 85 | 90 | 87 | 90 | 4 9 [illegible] | June and December | [illegible] | [illegible] |
| £100,000 | Stock | [illegible] | Do. [illegible] Deb. Stock [illegible] | [illegible] | 101 | 96 | 101 | [illegible] | ... | ... | ... |
| 86,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4¼ | 5¼ | 4¼ | 4¾ | 8 1 [illegible] | Half-yearly | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | 104½ | ... |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1¾ | 2¼ | 1¾ | 2¼ | 5 8 8 | January and July | [illegible] | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £143,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| 110,000 | 1 | | Gülcher Electric Light and Power Co., Ltd. | ¼ | | ¼ | | ... | ... | ... | ... |
| 30,000 | 5 | 15/0 | Henley's Telegraph Works Ordinary | 15 | 16 | 15 | 16 | 6 5 0 | February and August | 15½ | ... |
| 30,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | „ „ | ... | ... |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | „ „ | ... | ... |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 19 11 | „ „ | [illegible] | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 102 | 105 | 102 | 105 | 3 17 9 | March and September | ... | ... |
| 37,350 | [illegible] | [illegible] | Telegraph Construction and Maintenance | 37 | 41 | 37 | 41 | 5 3 5 | March and July | [illegible] | ... |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1903 | 101 | 104 | 101 | 104 | 3 17 [illegible] | January and July | ... | ... |
| 35,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 | 12 | 11 | 12 | [illegible] | ... | 11½ | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 30,000 | 5 | 6/0 | Willans and Robinson Ordinary | 12¾ | 13¼ | 12¾ | 13¼ | [illegible] | April and October | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6¾ | 7¼ | 6¾ | 7¼ | 4 2 9 | „ „ | [illegible] | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security allowance has been made for accrued interest [illegible] redemption.
† The London Stock Exchange Committee [illegible] to quote these.

# JANDUS
# ALTERNATING CURRENT
# ENCLOSED ARC LAMP.

**HIGH POWER-FACTOR. LONG LIFE.**

**INTERCHANGEABLE FOR SERIES WORKING.**

| | |
|---|---|
| **NOISELESS** | On any periodicity from **40** upwards. |
| **LONG LIFE** | Burns from **85** to **100** hours. |
| **ECONOMY** | Burns direct on 200 volts with **3½** amperes **without Choker.** |
| **WHITE LIGHT** | Very steady. Total absence of jumping and flickering. |
| **DIFFUSION** | Perfect. No shadows. |

**Guaranteed for Twelve Months.**

SOLE AGENTS for the

**JANDUS ARC LAMP & ELECTRIC CO., Ltd.,**
**DRAKE & GORHAM,**
***66, Victoria Street, Westminster.***
Telegrams: "ACCUMULATOR LONDON." Telephone: 393 and 71 Westminster.

**Also 100, King Street, MANCHESTER;**
**Baltic Chambers, 50, Wellington Street, GLASGOW; and**
**Westminster Chambers, East Parade, LEEDS.**

*SUB-AGENTS FOR THE NORTH:*
ROBERT BOWRAN & CO.,
3, St. Nicholas Buildings,
NEWCASTLE-ON-TYNE.
Telegrams:
"BOWRAN NEWCASTLE."

*SUB-AGENTS FOR THE MIDLANDS:*
THE ELECTRICAL TRADES' SUPPLY, Ltd.,
Cornwall Buildings, Cornwall Street,
BIRMINGHAM.
Telegrams:
"MOTORS BIRMINGHAM."

**CALL AND SEE IT WORKING.**

**Please write for the**
**1901**
**JANDUS CATALOGUE.**

c

# BELLISS & MORCOM LTD.

(SUCCESSORS TO G. E. BELLISS & CO., LTD.),

LONDON OFFICE: 9, Victoria Street, S.W. ENGINEERS, BIRMINGHAM.

## SPECIALITY: PATENT SELF-LUBRICATING QUICK-REVOLUTION ENGINES FOR ELECTRIC LIGHT, POWER OR TRACTION.

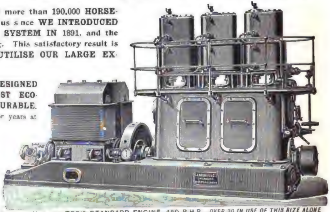
Over 1,400 **SETS**, equal to more than 190,000 **HORSE-POWER**, have been built by us since **WE INTRODUCED THIS SELF-LUBRICATING SYSTEM IN 1891**, and the demand is rapidly increasing. This satisfactory result is due to the care taken to **UTILISE OUR LARGE EXPERIENCE**.

Our Engines are **SIMPLY DESIGNED** and **STRONGLY BUILT, MOST ECONOMICAL, EFFICIENT** and **DURABLE**. They run **WITHOUT WEAR** for years at full load.

QUICKER DELIVERY CAN BE GIVEN OF STANDARD SIZES.

**Established 1852.**

Telegraphic Address:
"BELLISS, BIRMINGHAM."



Representing our TEC/5 STANDARD ENGINE, 450 B.H.P.—*OVER 30 IN USE OF THIS SIZE ALONE*

---

THE

# CONSOLIDATED TELEPHONE CONSTRUCTION & MANUFACTURING CO., LTD.

## INTERCOMMUNICATION TELEPHONES.

**The Best in the Market.**

***Write for Prices.***

***Liberal Terms to the Trade.***

**Head Office: 38, Victoria Street, Westminster, LONDON, S.W.**

---

# EVERETT, EDGCUMBE & Co.

A NEW SWITCHBOARD INSTRUMENT.

## WRITE FOR PRICES

OF THESE AND OF OUR

## Continuous Record

## Recording Instruments.

**HEAD OFFICE AND WORKS:**
22, CHARTERHOUSE SQUARE, E.C.
Telephone 1052 HOLBORN.

**SHOW ROOMS:—**
11, VICTORIA STREET, WESTMINSTER, S.W.

TELEPHONE No. 5077 BANK. TELEGRAMS: "INDICES LONDON."

# WHEATLEY KIRK, PRICE & CO.

(ESTABLISHED 1860).

## Electrical Auctioneers, Valuers, AND ARBITRATORS.

Average Annual Valuations exceed £2,000,000 Sterling.

**46, Watling Street, London, E.C.**

AND

**Albert Chambers, Albert Square, MANCHESTER.**

Telegraphic Address: "INDICATOR MANCHESTER. Telephone No. 3212.

---

SUBMARINE CABLES TRUST.—NOTICE is Hereby Given that on and after MONDAY, the 15th April instant, the COUPON due on that date will be paid by Messrs. GLYN, MILLS & Co., of 67, Lombard-street, E.C., between the hours of 10 a.m. and 2 p.m. The Coupons should be left with the Bankers FOUR clear days before payment.

By Order of the Trustees, SIDNEY COLLETT, Secretary.

Winchester House, 50, Old Broad-street,
London, E.C., 4th April, 1901.

---

## KING'S COLLEGE, LONDON.

ELECTRICAL ENGINEERING.—The SPECIAL EVENING COURSE of LECTURES and LABORATORY WORK on ALTERNATING CURRENTS commences APRIL 29th. For Prospectus apply to the SECRETARY.

---

## J. W. BARNARD,

Offices: 4, GREAT WINCHESTER ST., E.C.
Warehouse: 6, Great Winchester St., E.C.
(For Recharging and Repairs)

SOLE AGENT FOR E.P.S. SMALL STORAGE BATTERIES FOR Sale or Hire,

MANUFACTURED BY THE ELECTRICAL POWER STORAGE CO., Ld.,
Battery Makers by appointment to H.M.

---

**Field Rheostats, Speed Regulators, Theatre Dimmers.**

## Wirt Electric Co.

PHILADELPHIA, U.S.A.

---

# DOULTON & CO. Limited.

MANUFACTURERS OF

# INSULATORS

BATTERY JARS,
POROUS CELLS,
AND ALL KINDS OF
**Pottery for Electrical Purposes.**

LAMBETH, LONDON, S.E.

---

## STANLEY

2 Gold Medals.

Manufacturer of

**DRAWING and SURVEYING INSTRUMENTS**

Of Every Description, of the Highest Quality and Finish, at the most Moderate Price.

— PRICE LIST POST FREE. —

Address: W. F. STANLEY & CO., Ltd., Great Turnstile, Holborn, LONDON, W.C. Telegrams, "Turnstile London." Telephone, 186 Holborn.

---

## TENDERS INVITED.

## BOROUGH OF SOUTHWARK.

PARISH OF ST. MARY NEWINGTON.

CONTRACT No. 14.

The Works and Depot Committee of the Council are desirous of receiving TENDERS for the SUPPLY, DELIVERY and ERECTION of **INCANDESCENT LAMP BRACKETS, SWITCHES** and **FITTINGS** to the Gas Lamp poles. Specifications and Forms of Tender can be obtained on and after 9th instant at the Offices of the Engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, S.W., on payment of a fee of Five Guineas, which sum will be returned on receipt of a bona-fide Tender.

The Corporation do not bind themselves to accept the lowest or any Tender, and the Contractor whose Tender is accepted shall enter into a formal agreement, under seal with sufficient sureties, for the due fulfilment of his Contract.,

The Contractors will be required to sign the following Declaration:—

"We hereby declare that we pay the workmen employed by us not less than the recognised Trade Union rate of wages in each Branch of the Trade."

Sealed Tenders, endorsed "Tender for Electric Lamp Brackets and Fittings, Contract No. 14," to be sent on or before noon the 18th day of APRIL, 1901, to the undersigned.

By Order,
J. A. JOHNSON, Town Clerk.

Town Hall, Walworth-road, S.E., 2nd April, 1901.

---

## POPLAR UNION.

ENGINEERING WORKS.

**PIPING.**

The Guardians of the Union of Poplar, London, E., invite TENDERS from responsible Companies or Firms for the provision and carrying out of the necessary STEAM, EXHAUST, HOT and COLD WATER PIPING, VALVES, WATER METERS, &c., at their new Works adjoining the Union Buildings in High-street, Poplar.

A copy of the Conditions of Contract, Specifications, Drawings, and Form of Tender, may be obtained between the hours of 12 and 3 on and after April 12th, at the offices of the Consulting Engineer, Mr. F. J. Warden-Stevens, A.M.I.M.E., A.M.I.E.E., 34, Victoria-street, Westminster, on deposit of the sum of £2 2s., which will be refunded if a bona-fide Tender is submitted and the Specification, Drawings, &c., are returned complete.

It must be clearly understood that no Tender will be considered from any Company or Firm who have not carried out high pressure steam pipe work.

Tenders must be submitted to the undersigned at or before 6 p.m. on WEDNESDAY, the 1st day of May.

The Guardians do not bind themselves to accept the lowest or any Tender.

(Signed) G. H. LOUGH, Clerk to the Guardians.

Offices: Upper North-street,
Poplar, London, E., April 2nd, 1901.

---

## CITY OF WAKEFIELD.

The Electric Lighting Committee of the City of Wakefield are prepared to receive TENDERS for the SUPPLY and ERECTION of:—

Section E.—**ARC LAMPS, TRANSFORMERS, SWITCHES, &c.**

Specifications and Conditions of Tender may be obtained from the undersigned on payment of One Guinea, which will be returned on receipt of a bona-fide Tender.

Tenders must be sent to the undersigned not later than TUESDAY, the 16th April, 1901, sealed and endorsed "Arc Lamps."

The Corporation do not bind themselves to accept the lowest or any Tender.

ROBT. BLACKMORE, City Electrical Engineer.

Electricity Works, Calder Vale-road, Wakefield.

---

## WANTED and FOR SALE.

STEAM BOILER.—Wanted to hire, with standing room, about 100lb. pressure and 30 N.H.P., to test new Engine of 800 to 1,200 revs. per minute, adaptable to Dynamo. Address, LEGENDRE, 114, Kennington-road, S.E.

WANTED, LAMP TOPS, with Platinum, Scrap Platinum, &c.—EDEY & Co., 29, Ludgate-hill, London, E.C.

THE WATER POWER AGENCY.—Applications are invited at once from those requiring power of various amounts, up to 6,000 H.P. Apply SECRETARY, 212, West George-street, Glasgow.

ACCUMULATOR CHARGING.—C. H. CATHCART and CO., having plant specially adapted for this purpose, Charge Cells of all sizes promptly, thoroughly and cheaply. Terms on application. Accumulators on Hire for temporary lighting, experimental uses, &c.—3, Dorset-buildings, Salisbury-square, Fleet-street, E.C. (Telephone No. 280.)

---

# LANGDON-DAVIES ELECTRIC MOTOR CO., LTD.

101, Southwark Street, LONDON, S.E.

Telegraphic Address: DAMOPHON LONDON. Telephone 277 HOP.

**ALTERNATE CURRENT MOTORS.**

---

**Contracts Open, Appointments Vacant, and other Official Notices, &c., can be received up to 7 p.m. on Thursdays for insertion in the current week's issue.**

### *CHEAP PREPAID ADVERTISEMENTS*

*relating to* **SITUATIONS VACANT AND WANTED, MISCELLANEOUS PLANT WANTED, FOR SALE, AND FOR EXCHANGE,** *are inserted in* "THE ELECTRICIAN" *at the following special low rates:*

| | |
|---|---|
| *Three Lines and under* ... ... ... | 1s. 6d. |
| *Per Line after* ... ... ... ... | 6d. |

Nine Words to the Line.

*Cash must accompany all orders for advertisements inserted at these rates; if inserted "to account," they will be charged full scale rate.*

### PARTNERSHIP.

WANTED, PARTNERSHIP in established Electrical Manufacturing or Contracting Firm.—3,071, *Electrician* Office, Salisbury-court, Fleet-street, London.

### SITUATIONS VACANT AND WANTED, &c.

WANTED, ELECTRICIAN to take charge of Power and Lighting Plant in Paper Mill, country district, Devonshire. Must put in spare time in mechanics' shop. Married man preferred.—Write, giving particulars of experience and wages required, to COUNTRY PLANT, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED.—The British Electric Traction Company, Limited, have a VACANCY for an ASSISTANT ENGINEER with good experience in supervision and management of Cable Laying on Solid and Draw-in Systems, Road Work, &c.—Apply, for Application Form, to THE ENGINEERING MANAGER, The British Electric Traction Company, Ltd., Donington House, Norfolk-street, Strand, W.C.

ELECTRIC TRACTION.—The British Electric Traction Company are prepared to admit a limited number of qualified electrical students as PUPILS to pass through the various departments of the business. Particulars as to premium and otherwise on application to the SECRETARY Donington House, Norfolk Street, Strand.

SWITCHBOARD ATTENDANT WANTED, must have had practical experience in continuous-current station, three-wire system, with batteries. Commencing salary 30s. for 56-hour week, 8-hour shifts.—Applications, stating age and experience, with copies of three recent testimonials, to be sent to R. A. CHATTOCK, Esq., M.I.E.E., City Electrical Engineer, Town Hall, Bradford.

WANTED, DRAUGHTSMAN used to Electrical Fittings, &c. Write, stating experience and salary required, to DOREN, care of Fielding & Co., 43, Old Queen-street, Westminster, S.W.

ELECTRICAL ENGINEER, six years engineer to large firm of manufacturers, open to APPOINTMENT either in industrial work or with consultants. Thoroughly conversant with power and lighting work on land and ships. Experienced designer of plant, including polyphase and continuous-current dynamos and motors, high speed engines, gearing and hoisting machinery, projectors, motor regulators, fittings, &c. Experienced in management, organisation and estimating.—3,004, *Electrician* Office, Salisbury-court, Fleet-street, London.

## ELECTRICAL ENGINEERING TAUGHT BY MAIL

Thousands are successful and gaining better positions and salaries studying at home by our mail system. We teach Electrical Engineering, Mechanical Engineering, Mechanical Drawing, Electric Lighting, Electric Railways. Short Popular Electrical Course, Elementary Mathematics, &c., by mail. Study in spare time only. Institute endorsed by Thomas A. Edison and other prominent men of U. S. and England. Catalogue free.

Electrical Engineer Institute of Correspondence Instruction, Dept. 8, 240 to 242, West 23rd-st., New York, U.S.A.

***Ready Shortly.***

The NEW EDITION of

## A POCKET BOOK OF ELECTRICAL ENGINEERING FORMULÆ.

By W. GEIPEL and H. M. KILGOUR.

**Over 800 pages. Price 7s. 6d. net.**

Prospectuses of the New Edition will be ready in a few days, and will be sent post free on application to the Publisher.

"THE ELECTRICIAN" PRINTING & PUBLISHING CO., Limited,
1, 2 & 3, Salisbury Court, Fleet Street, London.

**NOW READY.**

With Numerous Illustrations. Demy 8vo. Paper Covers. Price **2/6** net, post free

## THE THEORY OF COMMUTATION.

By C. C. HAWKINS, M.A., M.I.E.E.

"THE THEORY OF COMMUTATION" deals with commutation in the continuous-current dynamo, and has special reference to Prof. Arnold and Dr. Mie's method of taking into account the contact resistance of the copper or carbon brushes in the mathematical equation of the short-circuit current.

LONDON—"THE ELECTRICIAN" PRINTING & PUBLISHING CO., LTD.
1, 2 & 3, Salisbury-court, Fleet-street.

## C. PASS & SON, LTD..

Bedminster Smelting Works, BRISTOL.

SELLERS OF

***ANTIMONIAL LEAD OF ALL GRADES.***

BUYERS OF

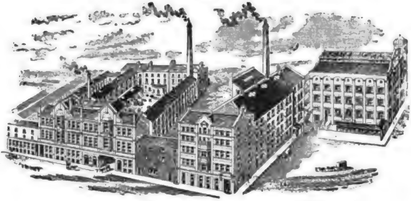
**LEAD ASHES & LEAD RESIDUES FROM ACCUMULATORS.**

Telegrams: "PASS, BRISTOL." Telephone, 478.

**VULCANISED INDIARUBBER**

# *Electric Light Cables.*

Supplied to Corporations, Electric Lighting Companies, Engineers, and Contractors.



GREENGATE RUBBER AND CABLE WORKS, SALFORD.

# I. FRANKENBURG. LTD., MANCHESTER.

***LONDON OFFICE:***
***128a, Queen Victoria St., E.C.***

***GLASGOW: Messrs. J. & A. ANDERSON,***
***62, Robertson St.,*** } Agents for Scotland.

**Large Stock. Prompt Delivery.**

## COMBINED VULCANIZED BITUMEN & IMPREGNABLE PAPER

# CABLES

FOR STREET MAINS.

## THE ST. HELENS CABLE CO., LTD.

Scottish Agency: 19, Waterloo Street, GLASGOW.

OUR PRODUCTION IN LARGE AND SMALL CABLES AVERAGES IN EVERY 24 HOURS 70,405 YARDS.
DELIVERY, SPECIALLY OF LARGE CABLES, FROM STOCK.

**WARRINGTON.**

---

CHICAGO: HIGHEST AND ONLY AWARD FOR TROLLEYS. DIPLOMA AND MEDAL FOR INSULATORS.
BRUSSELS: 1897, "HORS CONCOURS, MEMBRES DU JURY."

# ROBT. W. BLACKWELL & CO., LIMITED,

ENGINEERS AND CONTRACTORS FOR

## ELECTRIC TRAMWAY CONSTRUCTION AND EQUIPMENT.

POLES, TROLLEY-WIRE, FEEDERS, RAILBONDS, INSULATORS, TROLLEYS, MOTOR-TRUCKS, ENGINES, LINE MATERIAL and SUPPLIES OF EVERY DESCRIPTION,

59, CITY ROAD, LONDON, E.C.

Telegrams: "KURKES LONDON." Codes: "A B C," "A 1," "Liebers," &c. Telephones: 1479 & 1480 London Wall.

---

Price 12/6, post free (U.K.) 13/3; British Colonies, 14/-; Europe, 14/6; U.S.A. and other Countries, 15/-.

## "THE ELECTRICIAN"

# Electrical Trades' Directory & Handbook

ESTABLISHED IN THE YEAR 1882.

# THE BIG BLUE BOOK.

**INDISPENSABLE** to all associated with **ELECTRICAL ENGINEERING.**

The Handbook Division consists of 600 pages of Original and other Matter specially prepared for this work relating to

| | |
|---|---|
| ELECTRIC LIGHT & POWER. | ELECTRIC TRACTION. |
| ELECTRIC "BULK" SCHEMES. | TELEGRAPHS & TELEPHONES. |
| ELECTRICAL FINANCE. | MUNICIPAL LIGHTING, POWER AND TRACTION SCHEMES. |

STATE AND MUNICIPAL TELEPHONES.

*SEND FOR A FULL DIGEST POST FREE ON APPLICATION.*

OFFICES: 1, 2 AND 3, SALISBURY COURT, FLEET STREET, LONDON, ENGLAND,
AND ALL LEADING BOOKSELLERS.

Digitized by Google

## SUN ELECTRIC FANS

***BEST QUALITY.***

***MODERATE PRICE.***

**SUN FAN CO., Ld.,** 4a, Thornton Road, BRADFORD.

LONDON.—6a, Billiter Buildings, Leadenhall Street, E.C.
GLASGOW.—65, Waterloo St. MANCHESTER.—82, Deansgate Arcade.

*FULL PARTICULARS ON APPLICATION.*

---

## THE JACKSON-MENSING Arc Lamps

FOR
INDOOR or OUTDOOR LIGHTING.

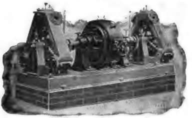
Mechanically and Electrically Perfect.

*Send for New Pocket Price List to the Sole Makers:*

**P. R. JACKSON & CO., Ltd.,**
Salford Rolling Mills, MANCHESTER.

---

## MERRYWEATHERS' PATENT "HATFIELD" PUMP



## FOR Boiler Feeding.

AS SUPPLIED TO THE CENTRAL LIGHTING STATION OF THE BRISTOL CORPORATION.

*SEND FOR **PAMPHLET** SHOWING ITS APPLICATION*
***FOR ALL PUMPING SERVICES.***

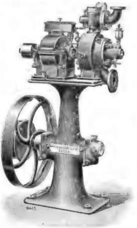
**MERRYWEATHER & SONS, Ld.,**
Water and Electrical Engineers,
63, Long Acre, LONDON, W.C.
Works: GREENWICH ROAD, S.E. *(Telephone: 132 Deptford)*

---

## GREENWOOD & BATLEY, LTD.

***Albion Works, LEEDS,***

Electrical and General Engineers.



MOTORS AND DYNAMOS.

DE LAVAL'S PATENT STEAM TURBINE DYNAMOS, TURBINE MOTORS, PUMPS & FANS.

*SEND FOR CATALOGUES.*

---

## CALLENDER'S

**CABLE & CONSTRUCTION CO., Ltd.**

LAYING CALLENDER MAINS AT

**MOTHERWELL.**

# WILLANS CENTRAL VALVE ENGINES

FOR

## Electric Lighting

AND

## Traction.

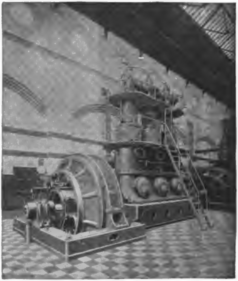
**15**

**1,200 H.P. SETS**

HAVE BEEN SUPPLIED FOR THE

LIVERPOOL
CORPORATION
TRAMWAYS.

***STANDARD SIZES UP TO 3,000 H.P.***



1,200 H.P. Set.

## WILLANS & ROBINSON, LTD., *RUGBY, England.*

---

## DAVEY, PAXMAN & CO., Ltd., Engineers, COLCHESTER.

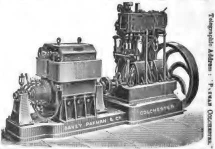
MAKERS of a GREAT VARIETY of STEAM ENGINES and BOILERS.

## SPECIALITY: Steady Running Engines for Electric Lighting.

Paxman's Patent "Economical" Boiler, from 8 h.p. upwards.

This Boiler is one of the Best Steam Generators before the public, not only for Efficiency, but for Economy and Durability. It contains particularly good features and high qualities.

PAXMAN'S PATENT
AUTOMATIC EXPANSION GEAR
and
ADJUSTABLE GOVERNORS
Ensure a Steady and Constant Speed
in any emergency.



"Windsor" Vertical Compound Engine, with Dynamo combined made in all sizes.

Telegraphic Address: "PAXMAN COLCHESTER."

Catalogues and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ltd., Engineers, Colchester.**

LONDON OFFICE—78, QUEEN VICTORIA STREET, E.C.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,194. [No. 24. Vol. XLVI.] FRIDAY, APRIL 5, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

### CONTENTS OF THE CURRENT NUMBER.

## NOTES.

Mr. Gerald Balfour's proposal to continue for five years, with slight amendments, the Light Railways Act, 1896, is one that will have the entire sympathy of electrical engineers. In the ordinary course this tentative and provisional act would lapse at the close of the present year. It was never designed as a permanent measure, and in its existing form it could never satisfactorily operate as such. As a tentative experiment it has thus far not been without considerable success. The situation at the present moment is, indeed, peculiar. The Light Railways Act, 1896, has abundantly demonstrated the absolute necessity for such an enactment; we could not possibly return to the old *régime*, which gave no alternative beyond the Tramways Act, 1870, or special private legislation. It would be disastrous to allow the act to lapse next December without having some measure equally or more effective ready to take its place.

On the other hand, the time is scarcely ripe for the draughting of a permanent measure having the scope of the existing Light Railways Act. Intended originally as a practical tonic to be administered to the declining agricultural trade of this country, it has shown that it can usefully become also a stimulus to rapid inter-urban passenger traffic on lines of cheaper and lighter construction than our standard railways. The Light Railways Act, in fact, relieved the electric traction industry of a heavy incubus imposed on it by the Tramways Act. In this sphere of its operation, no less than in its agricultural influence, the limited term of the Act has not been sufficient to test adequately its full working effect. Neither electric inter-urban traffic nor agricultural light railways have yet been sufficiently developed to warrant final legislation. It is, therefore, a distinctly well-advised course that the Government have decided to adopt in practically carrying on the existing act until December 31, 1906. With regard to the proposed modifications which relate to the lending powers of the Commissioners, particulars will be found in our "Parliamentary Intelligence" this week.

The "Bill to provide for the adjustment, in accordance with changes of Boundary effected under the London Government Act, 1899, of the Areas within which Local Authorities and Companies are authorised to supply Electricity," read a first time in the House of Commons last week, is mainly of local interest. Viewed generally, it might at first sight appear to have been framed in entire ignorance of the principles of electric supply, but on examining it in detail, with the assistance of a map, one finds that the scope of the bill is limited. In the case of the transference of a part of an area in which a company or local authority has powers to supply to an adjoining local authority, the bill proposes that the powers are also to be transferred to the new borough council, dating from January 1, 1902. The number of cases in which this will have effect when the bill becomes law is fortunately small, for otherwise much difficulty and delay on account of diversity of pressures and systems of distribution might have been anticipated. We are glad to note that a certain discretion is given to the Board of Trade with respect to postponement of the transference of powers in certain cases, and also with regard to the naming of an arbitrator in the event of two parties not coming to an agreement as to the purchase price of mains and connections.

There can be no doubt that standardisation in every branch of machinery is most important for the British manufacturer at a time like the present, when he is face to face with the ever-increasing competition of the cheap labour markets of the Continent and the gigantic trusts of the United States. Mr. Sidney Short, in his Paper read before the Manchester Section of the Institution of Electrical Engineers last week, deals with the standardisation of one of the most important

of the electrical manufactures—the dynamo,—and we must congratulate him on having handled his subject in sufficient detail to afford scope for ample discussion. We consider that it is most important to the electrical industry that standard outputs at fixed pressures should be settled once for all, but, as we have repeatedly pointed out in these columns, it is the manufacturers who should agree among themselves what standards are to be adopted. Now that the demand for electrical machinery of a certain class has assumed considerable dimensions, and is of a constant nature, such things as brush-holders, commutators, and similar details, may well, as Mr. SHORT suggests, be standardised, or we think they might even be suitable subjects for specialised and separate manufacture. On the other hand, it is hardly to be expected that makers will consent to sink their individuality sufficiently to agree to standard sizes of yokes, pole-pieces, tooth-space, armature windings, *et hoc genus omne.* Uniformity in these parts is certainly desirable in the machines of each individual maker, but is hardly a matter for a general standardisation; and we fear that the idea of interchangeability of dynamo parts of different manufacture, in the same way as incandescent lamps, for instance, is rather Utopian.

AN unsigned article in the *Electrical World* of New York for February 2nd gives some interesting details of the refinery of the Anaconda Copper Refining Co. We are told that the refinery now contains 1,400 vats, each depositing 210lb. copper per day of 24 hours; that the E.M.F. required per vat is about 0·3 volt; that 200 vats are worked in series with a current of 4,000 amperes; and that each vat when fully charged contains 8,200lb. of anode copper, testing 99·6 per cent. Using these figures for purposes of calculation, we can arrive, with the aid of well-known electro-chemical constants, at the following data:—The theoretical capacity of the Anaconda plant is 48,545 metric tons of raw copper per year. As, however, it is practically impossible to run the whole of the vats constantly, the actual capacity of the refinery may be taken as 34,200 tons per annum; and that is the amount of electrolytic copper the Anaconda Company is probably now putting on the market. The value of the copper kept locked up in the vats in order to obtain this output is £309,000, a figure which shows that copper refining by the electrolytic method demands a very large capital when carried on upon such an extensive scale.

THE number of watt hours required to yield 1lb. of copper at Anaconda was estimated, in 1897, by Mr. J. B. C. KERSHAW, to be 174 (see *The Electrician*, Vol. XXXVIII, p. 386). Using the more recent figures, the calculation yields 148 watt hours per pound of copper, and the energy efficiency of the electrolytic process as carried out at Anaconda has apparently advanced from 31 per cent. to 37 per cent. This improvement is, however, probably only an apparent one, due to the greater purity of the anode copper used in the vats.

THE only new facts of real significance given in the article which we are discussing, are that special heating vats are used at Anaconda to maintain the electrolyte at the required temperature, and that the electrolyte is circulated in an *upward* direction through the depositing vats. For vats containing a large number of electrodes placed close together, and coupled either in parallel or in series, this is the only system of circulation which ensures continuous renewal of the electrolyte between each pair of electrodes, but we believe that it was formerly the custom in all copper refineries to circulate the electrolyte in a lateral or transverse direction through the vats, and that this method is still employed in many of the refineries. The disadvantage of the Anaconda method is that it involves the insertion of the supply pipe to each vat in the centre of the bottom, and the provision of overflow channels on one or both sides of the vat; but the more regular working of the process with this system of circulation compensates for the increased expenditure upon vat construction. The same system of circulation is adopted in the Corbin electrolytic cell for hypochlorite production, the object in this case also being to obtain a rapid and complete renewal of the electrolyte between electrodes placed close together.

**Royal Institution.**—H.M. the King has graciously consented to become the patron of the Royal Institution.

**Erratum.**—On p. 851, line 23, column 1, of our issue last week, *for* "confocal rectangular hyperbolæ" *read* "confocal hyperbolæ."

**King's College (London).**—A special course of lectures and laboratory work on "Alternating Currents" commences on 29th inst.

**Electrical Separation of Nickel.**—The Lake Superior Power Co. is building plants for smelting and refining nickel, and proposes, by a new electrical process, to separate and save all the by-products of the ore.

**A National Electrical Contractors' Association in the United States.**—The *Electrical World* of New York mentions that a meeting has been called in Buffalo to form a national electrical contractors' association for the protection of mutual interests of the members and promoting a more cordial feeling in the contracting trade.

**Cable Interruptions and Repairs:**—

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Marseilles—Barcelona | Jan. 7, 1901 | — |
| Sao—Bushire | Mar. 7, 1901 | — |
| Perim—Obock | Mar. 22, 1901 | — |
| St. Louis—Bathurst | — | Mar. 29, 1901 |
| Sierra Leone—Conakry | April 2, 1901 | — |

**Tube Railways Committee.**—The names of the Joint Committee appointed to consider the schemes before Parliament for constructing underground electric railways in London consists of the Earls of Lauderdale and Rosse, Viscount Knutsford, Lord Windsor, Lord Herries, Sir William Arrol, Mr. Ashton, Mr. Cawley, Sir Michael Foster and Sir J. Dickson-Poynder.

**Pacific Cable.**—It is announced that the expedition sent to the west coast of Vancouver island to decide upon a landing place for the Pacific cable in those regions have selected San Juan and the mouth of Banfield Creek as alternative points. These places are respectively about 100 and 125 miles distant from Victoria. Mr. R. E. Peake (of Messrs. Clark, Forde and Taylor), the engineer sent out by the Pacific Cable Commission, is head of the expedition.

**Starting Induction Motors.**—When an induction motor is started a resistance is inserted in the rotor and gradually switched out as the motor gains speed, the rotor being finally short-circuited at full speed. The idea of performing the short-circuiting automatically has been put into effect by the Allgemeine Elektricitäts Gesellschaft by means of a switch fixed on the motor shaft and actuated by centrifugal force. This device is described in detail in the *Elektrotechnische Rundschau* of March 15th.

Electric Tramways in Jamaica.—*The Electrical World* of New York for March 28rd, in an article on "Canadian Electrical Enterprise in the West Indies," briefly describes the electric tramway system at Kingston, Jamaica, which is worked from a water-power station 25 miles distant from the town. Three turbines have already been installed, and 24 miles of track equipped. The power is transmitted at 16,000 volts along a double line on steel poles, and is transformed to 550 volts to operate the tramway.

High-Speed Electrical Monorails.—Sir Frederick Bramwell, in a letter published in the *Journal* of the Society of Arts for March 22nd, advocates the trial of a system of braking not depending on the insistent weight applied. He mentions that on the São Paulo Railway Sir James Brunlees used the "Clip" brakes, which grip the sides of the rails after the manner of a pair of tongs. A single handle worked two such brakes, one on each rail. He considers that if such brakes were properly brought before the notice of a Parliamentary Committee all fear as to the ability to stop high-speed trains ought to be dispelled.

Electrolysis from Trolley Currents.—In order to prevent damage to underground pipes by electrolysis, a bill has been introduced into the Legislature of Indiana, U.S.A., which provides that every street railway company in the State using the overhead trolley system or any other system employing an uninsulated, a grounded or rail return, or feeding circuit, shall instal a double trolley system, or its equivalent, subject to the approval of the boards of public works, or of common councils in cities having no such boards. The bill will, if carried, also make unlawful the grounding or connection to the earth or any grounded construction wires conveying current for electric light, heat or power.

"Traction and Transmission."—We have received a copy of the first number of a new monthly publication, entitled "Traction and Transmission," the periodical being intended as a monthly supplement to *Engineering*. Issued at the price of 2s. per copy, the new comer into the ranks of technical journalism is got up in good style, with the aid of large type and numerous plates on thick paper. The first number commences with an article on "Standardisation of Electrical Apparatus," by Mr. H. F. Parshall, followed by several signed and unsigned articles. Framed more in the magazine style than as a newspaper journal, the new monthly should find a welcome from the engineering profession.

Meeting of German Men of Science and Medicine.—The seventy-third meeting of the Versammlung Deutscher Naturforscher und Aerzte will take place in Hamburg from September 22nd to 28th. The Council has decided to reduce the number of sections into which the congress was divided. There are to be 11 sections on natural science subjects and 16 on medical subjects, *i.e.*, 27 in all, instead of 88 as formerly. The alteration is with a view to promoting the interest taken in kindred scientific subjects, and to this end there will also be a general meeting of all the sections to hear and discuss Papers on the modern development of the atomic theory, especially in regard to ions, gas ions, and electrons.

Accidents in London Electricity Works.—On Tuesday two accidents—one of a serious character—occurred in connection with electricity supply undertakings in the metropolis. At the South-street (Manchester-square) station of the Metropolitan Electric Supply Co. a 6in. copper connecting piece between the stop valve of one of the boilers and the main steam pipe burst, and a man was killed and another scalded. The interruption to supply, however, was not serious, and the statement in the *Times* and other papers that "the boiler-house was wrecked by the bursting of the boiler" is incorrect. The City of London Electric Lighting Co. was the victim of the other accident. One of this company's sub-stations, situated underneath the disused churchyard of St. Nicholas Acons, in Nicholas-lane, caught fire, and some time elapsed before it could be extinguished and all the consumers re-connected to the company's mains. The street-lighting service was not interfered with.

The Lead-Covering of Cables.—In a Paper on "The Production of Metallic Bars and Tubes under Pressure," read before the Society of Engineers on Monday, Mr. Perry F. Nursey dealt with the subject historically, referring first to some water-pipes made by the Romans and excavated at Bath. They measured about 18in. wide by 4in. deep, and were made from a dished strip of lead which constituted the top, whilst a flat strip, having its edges turned up over the edges of the upper strip, formed the bottom. The lead of which these pipes were made was stated to have been obtained from mines in the Mendip Hills, where lead pigs have been discovered bearing the stamps of the Roman Emperors Claudius, Vespasian and Hadrian respectively. Coming down to the present day, Mr. Nursey described the improved lead pipe press of Mr. Alexander Wylie. In the later examples of this press, instead of the container being kept hot by a fire or a ring of gas jets it is jacketed and steam-heated, and, in the presses employed for covering cables, the cable passes horizontally through a core.

Electric Traction in France.—*L'Industrie Electrique* for March 25th gives statistics of the electric tramlines and railways in France. The general tendency is to have large power stations generating three-phase high-tension current at a frequency of 25 ∼, and to distribute at 550 volts direct current, in most cases accumulators being placed in sub-stations for starting the converters. The following table shows the progress made:—

| — | 1895. | 1900. | 1901. |
|---|---|---|---|
| Total length of lines in kilometres | 37·4 | 752·5 | 1,486·3 |
| Total power in kilowatts | 1,525 | 28,308 | 64,383 |
| Number of cars | 20 | 1,295 | 2,425 |
| Number of lines (aerial) | 2 | 56 | 76 |
| " " (underground system) | .. | 3 | 5 |
| " " (third-rail) | 1 | 1 | 4 |
| " " (accumulators) | 2 | 6 | 8 |
| " " (mixed accumulators and trolley) | .. | 4 | 6 |
| " " (mixed trolley and underground) | .. | 2 | 2 |
| " " (mixed trolley and surface contact) | .. | .. | 7 |

Cooper's Hill College.—The following letter has been sent by the Secretary of State for India to the president of the Royal Indian Engineering College at Cooper's Hill:—

At the request of the Secretary of State the Board of Visitors of the Royal Indian Engineering College have taken evidence from the members of the teaching staff of that college upon the proposed changes in the curriculum suggested by the president, and they have embodied their conclusions with regard to those proposals in a report, which has been under the consideration of the Secretary of State in council, and to which he has given his approval.

2. The report confirms their previous expression of opinion as to the necessity for changes in the course of instruction which in recent years has been carried on at the college. These changes will require the retirement of Messrs. McLeod, Hearson, Heath, Shields, Reilly, and Hurst.

3. The pensions and gratuities sanctioned for these gentlemen in Sir Horace Walpole's letter of January 15, 1901, will be issued to them with effect from April 4th.

4. In view of the further recommendation submitted by the Board of Visitors that the instruction in physics, which has hitherto been restricted to the first and second year students, should be extended to the students of the third year, it has been decided that Mr. W. N. Stocker shall, for the present and until further experience has been gained, be retained as Professor of Physics. The contemplated developments in the teaching of electric engineering render it possible that the new lecturer in electro-technology may not be able to devote a sufficient portion of his time to the teaching of physics.

5. It must, however, be understood that Prof. Stocker can no longer be responsible for or connected with that department of the college which includes electro-technology. He will take up such a position in relation to the lecturer in this branch as you may assign to him.

6. You will communicate the purport of this letter to each of the gentlemen concerned.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**FRIDAY**, April 12th.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel. Paper to be read: "Iron Lined Tunnelling Construction," by A. Woodroffe Manton.

**SATURDAY**, April 13th.

INSTITUTION OF JUNIOR ENGINEERS.

*3:30 p.m.* Visit to the Great Northern and City Railways Works to inspect the plant described in Mr. Manton's Paper.

## DIELECTRIC LOSSES IN CONDENSERS AND CABLES AND THEIR BEARING ON ELECTRICAL SUPPLY.

BY CHARLES V. DRYSDALE, B.SC.

Although the subject of dielectric losses in cables has attracted great attention since Mr. Mordey's Paper, it is curious that no one has pointed out the great importance of the matter as bearing upon the methods of generation and distribution of electrical energy. In most towns in this country we are confronted with the problem, not of transmitting power over long distances, but of producing current for both lighting and power purposes, and transmitting it over moderate distances with the least possible risk of breakdown, difficulty in regulation, and of complexity in distribution, consistent with economy. Too great stress, of course, cannot be laid on the power side of the question, as it is only by the increase of motor loads that the cost of supply can ever be greatly reduced.

The problems of lighting and power supply are, however, essentially different. As far as glow lamps are concerned the nature of the current is of no importance, provided the pressure is constant; while for power purposes small variations in pressure are unimportant in comparison with the different effects of direct currents, single and polyphase alternate currents. For glow lamp lighting single-phase alternate current is the most suitable in the cases considered, for arc lamps continuous-current, and for motors continuous-current or polyphase supply.

One solution of the problem seems to be that of supplying single-phase lighting current and 400 to 500 volt continuous current for power. The complexity and cost introduced by the duplication of plant and mains, however, must cause this to be regarded as an unsatisfactory solution of the problem, especially as small 500 volt motors are by no means ideal in working. Two and three-phase working have of late made their appearance, though more apparently for transmission purposes, since the two or three-phase current does not appear to be directly used for motor driving, except in the case of isolated plants.

A number of English engineers, however, notably Mr. Ferranti, appear to doubt the advisability of employing polyphase currents under the conditions which prevail in this country. The most salient advantages and disadvantages of polyphase as compared with single-phase systems may be briefly summarised as follows:—

*Advantages:* Lighter and cheaper generators for given output; greater economy in conductors for given voltage; more satisfactory starting and running of motors.

*Disadvantages:* Greater complexity in switch gear and distributing network; greater difficulty in regulation.

The economy in the conductors is not much affected by single or polyphase distribution. The economy in copper of three-phase star connection with earthed centre, for instance, is only 4 or 5 per cent. above three-wire single-phase with the same extreme pressure, an amount too small to affect the question. If single-phase current could be made equally satisfactory as regards the starting and running of motors as polyphase current all requirements would be met, while the superior simplicity of the system with the absence of regulation difficulties may well make up for the difference in the cost of the generators. For glow-lamp lighting it is perfectly satisfactory, and for street arc lighting, in combination with rectifiers, it appears to work well.

The question of motors almost entirely turns on the introduction of suitable condensers. It is safe to say that single-phase motors can never be so satisfactory both as regards cost, starting torque, overload capacity and efficiency as two or three phase-motors, owing to the idle coils and the reverse rotating field. If, however, condensers can be made at reasonable cost, which will stand working pressure continuously without deterioration, and which do not themselves absorb an appreciable amount of power, it is quite easy to obtain a quadrature current from the ordinary single-phase mains that will serve either for increasing the starting torque of single-phase motors, or even possibly for running ordinary two-phase motors.

Condensers in the form of plates in liquid have been used considerably for starting single-phase motors, but such condensers are obviously unsuitable for continuous running. Condensers with insulating dielectrics are prohibitive for use with motors directly, owing to the large capacity required. The best solution of the difficulty would possibly lie in placing condensers in the ordinary transformer sub-stations, and to transform down the quadrature current thus obtained for use where power is required. As the condenser is then used on the high-pressure mains, a considerable current can be obtained on transformation. Fig. 1 shows such an arrangement, by which the ordinary single-phase high-pressure supply is transformed into a two-phase low-pressure current with common return. For lighting purposes the ordinary mains are used, while where power is required the third wire is simply brought in. If single-phase motors are used a small condenser will serve, as only a small proportion of the motors would be started at the same instant; while if the condensers could be made at moderate cost, it might even be possible to run ordinary two-phase motors. The condensers, if satisfactory, would require no attention, while an immense impetus to the use of power would be given if users were relieved in the case of small motors of the necessity of buying special starting switches or condensers. No source of power is so convenient as the simple two or three-phase motor.

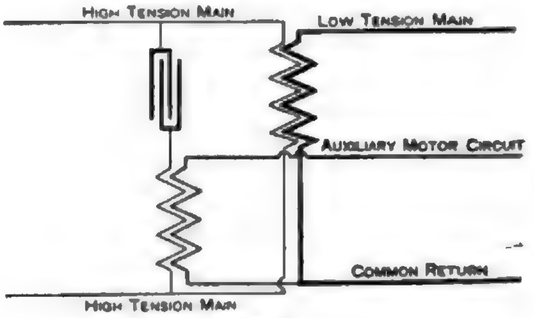


Fig. 1.

To give some idea of the capacity required, a condenser of 20 microfarads on a 2,000 volt 50 ~ supply would take a current of 18·56 amperes. If we transform this down to 100 volts we should have a current of 250 amperes available, nearly in quadrature with the lighting mains. This would probably be quite sufficient for starting all the motors supplied from an ordinary sub-station, while the size and cost of the condenser would probably be much less than that of a 20kw. transformer. The arrangement is equivalent to the monocyclic system of Steinmetz without the necessity for a third high-tension conductor.

Another and probably better way of connecting would be to use a two-phase transformer, with the condenser in one of the primary circuits. Of course, any such system would require very careful working out in order to get approximate regulation and freedom from resonance effects, but the writer has tried it experimentally on the small scale, and found it to work well.

The question, however, of the power lost in the condensers is a very important one. As with transformers they have to be kept fully running day and night, with the result that a small expenditure of energy in them represents a serious amount when extended over so long a time. As far as cables are concerned, it is sometimes practicable to disconnect them when the load is not high, but the condenser current should be available at all hours. It is for this reason, therefore, that a knowledge of the dielectric losses in various insulating materials is of very great value, and it is to be hoped that a considerable amount of information on this matter will be forthcoming from various investigators, as owing to the large sizes of the cables and condensers necessary to obtain reliable results, it is not easy for one observer to obtain results on many different materials. Tests of the dielectric loss after

running some time under working conditions would also be of great value, as there is some reason to believe that the losses are materially influenced by the conditions and treatment of the insulating material.

The writer has recently been making some tests on both cables and condensers in the laboratories of the Northampton Institute with a special form of wattmeter, particulars of which appeared in *The Electrician*, March 15, p. 777. By careful design of this instrument, and calculating the possible errors in it, he has shown that the inductive or capacity errors in the instrument cannot cause an error of more than 0·001 in the power-factor, and when used on high voltage circuits with a high liquid resistance in series, these errors become absolutely negligible. Particulars and drawings of this wattmeter were given in the article above referred to. Fig. 2 is a diagram of the connections employed, which were so arranged that the current taken by the shunt circuit of the wattmeter did not pass through its main coils, since the shunt current at 2,000 volts, with a resistance of half a megohm, represented an expenditure of energy of about 80 watts. The loss due to the $C^2r$ in the main coils of the wattmeter was carefully allowed for. The tests were made on (*a*) Two paraffin paper condensers of 5mfd. and 10mfd. capacity respectively, previously used at the General Post Office. (*b*) Two Swinburne condensers of about 1mfd. and 4mfd. capacity respectively, obtained about three years ago from Messrs. Nalder and Hilton, of Bow Common-lane. (*c*) A length of about 165yd. of 800 megohms rubber insulated 7/16 cable, new from the

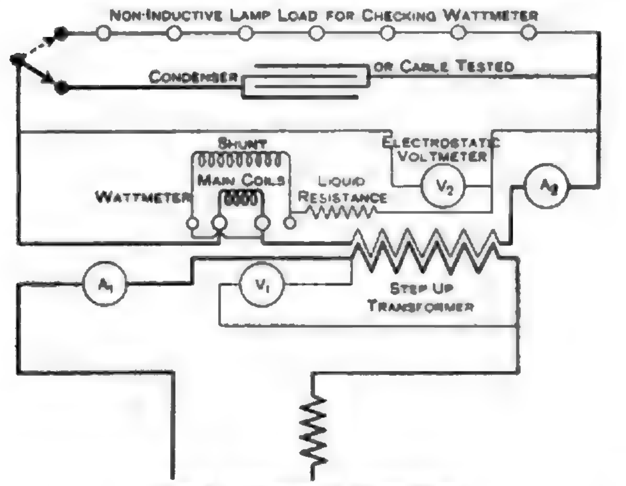


Fig. 2.—Diagram of Connections.

Telegraph Manufacturing Co., Helsby, and (*d*) 440yd. of 19/16 H.T.C. paper insulated B.I.W. cable. The condensers and cables were all tested with 100 ~ current, having approximately a sinusoidal wave form, and the pressures at which they were tested are given in the tables appended. These pressures were taken either on a Kelvin multicellular or an Ayrton-Mather electrostatic voltmeter depending on the voltage, while the current was read either by a hot wire or electro-magnetic ammeter, carefully standardised against a Siemens dynamometer. The subjoined table is a summary of the results obtained :—

*Losses in Dielectrics.*

| Cable or condenser tested. | P.D. Volts. | App. power. Watts. | True power. Watts. | Power-factor. | Capacity in mfds. |
|---|---|---|---|---|---|
| P.O. paraffin paper condensers : | | | | | |
| 5mfd. | 240 | 188 | 4·07 | 0·0217 | 5·20 |
| 10mfd. | 240 | 371 | 8·28 | 0·0220 | 10·30 |
| Swinburne condensers : | | | | | |
| Paraffin oil insulation { Small | 2,000 | 3,090 | 255 | 0·0827 | 1·16 |
| Paraffin oil insulation { Large | 1,800 | 8,300 | 429 | 0·0517 | 4·15 |
| Rubber-insulated cable : | | | | | |
| 7/16 300 Ω 165yd | 2,000 | 260 | 10·4 | 0·040 | 0·0624 |
| Paper-insulated H. T. C. lead-covered cable, B.I.W. Co., 440yd : | | | | | |
| Tested between { (1) Inner and outer | 2,000 | 225 | 4·3 | 0·019 | 0·071 |
| Tested between { (2) Outer and sheath. | 2,000 | 800 | 17·0 | 0·021 | 0·25 |

In the above table the power-factor given is the mean of several experiments, while the apparent and true powers are given for one particular case in order to show the amounts dealt with. There is, therefore, in some cases a slight apparent discrepancy between the figures. The most noticeable features of the results are the extremely high power-factors given by the Swinburne condensers. The smaller of these broke down soon after the test was made, but the insulation resistance was satisfactory in both before the test,

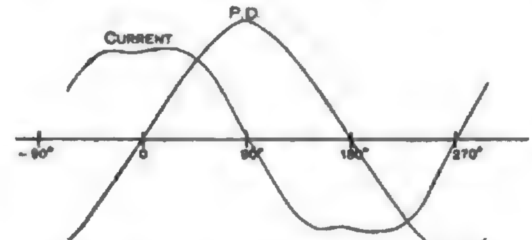


Fig. 3.—Wave Forms on Inner and Outer of B.I.W. Cable.

and there was no reason to suppose that the power was to any extent due to leakage. It is possible that these condensers were defective in the first place, as they were obtained after the discontinuance of their manufacture. On the other hand, they were certainly satisfactory, both as far as insulation and dielectric strength were concerned, three years ago, when the writer tested them. The high power-factor may, therefore, be due to deterioration in the meantime.

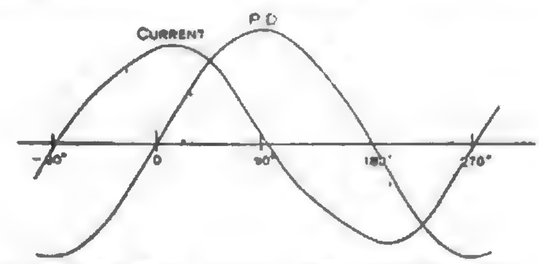


Fig. 4.—Wave Forms on Outer and Sheath of B.I.W. Cable.

In the case of the rubber cable the test was made after the cable had been immersed in water for a fortnight. Tests of its insulation appeared satisfactory, but a rough test of its power-factor when first immersed indicated a much smaller amount of power than that given. This cable also broke down with 2,200 volts about a quarter of an hour after the tests were finished although the readings were quite steady when taken. This also points to some variation of the absorption of power.

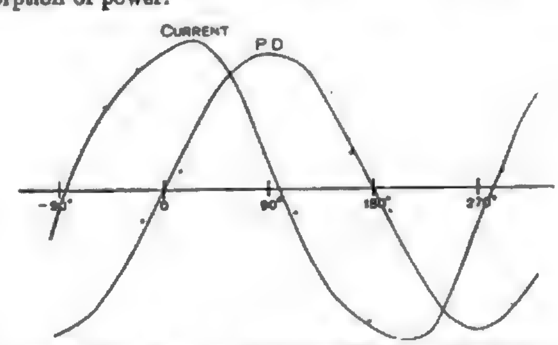


Fig. 5.—Wave Forms on 1 microfarad Swinburne Condenser.

*Capacity Measurements.*—A number of measurements of the capacity of the cables and condensers were made at different potentials during the tests by observing the current and P.D. Despite Prof Ayrton's strictures on this method, it is a very valuable one for capacity measurements if the wave form is very closely sinusoidal, and it is easy to ascertain from the wave form the approximate effect of small departures from the sine wave. Mr. Mordey has stated that the capacity, as

taken in this way, was constant at all potentials, but in the writer's experiments this was not so, the capacity in most cases increasing at high pressures. The results given by Mr. Mordey, though irregular, seem really to confirm this conclusion, while from analogy with mechanical strain it would appear likely that at high stresses the displacement would increase more rapidly than the pressure. An example is given in the capacity of the B.I.W. cable above mentioned.

| P.D. volts. | Current amperes. | Capacity microfarads. |
|---|---|---|
| 1,130 | 0·050 | 0·705 |
| 1,650 | 0·073 | 0·705 |
| 1,735 | 0·077 | 0·707 |
| 1,975 | 0·088 | 0·710 |
| 2,150 | 0·097 | 0·718 |

These small variations may, of course, have been caused by changes in the wave form, but they have been found consistently on different condensers and at different times.

*Wave Forms.*—In order to approximately verify the conclusions both as to power and capacity, observations were carefully taken of the forms of the P.D. and current waves by a contact maker. The curves are shown in Figs. 3, 4, 5, and 6, the latter two being from the results of three of the electrical engineering students at the Northampton Institute, Messrs. Coates, Nottley, and Pitt. Time has not permitted the working out of the power from these curves, but the lead of the current in each case appears to correspond with the power results as given by the wattmeter. The curves also indicate

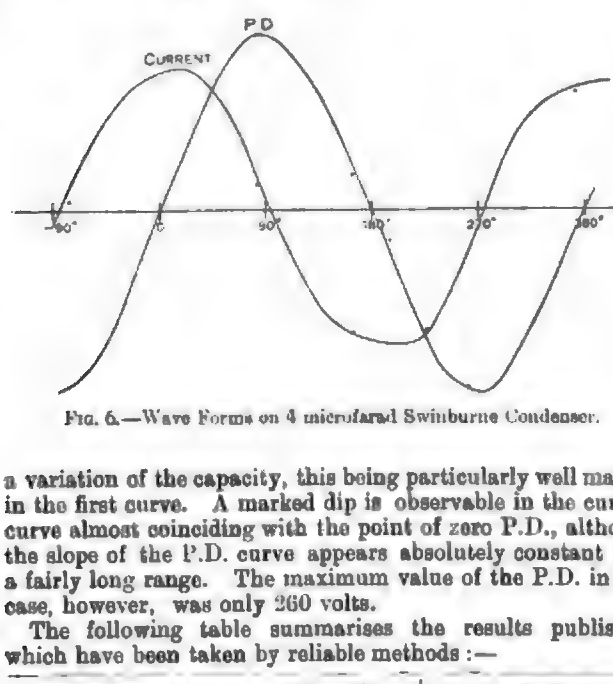


FIG. 6.—Wave Forms on 4 microfarad Swinburne Condenser.

a variation of the capacity, this being particularly well marked in the first curve. A marked dip is observable in the current curve almost coinciding with the point of zero P.D., although the slope of the P.D. curve appears absolutely constant over a fairly long range. The maximum value of the P.D. in this case, however, was only 260 volts.

The following table summarises the results published, which have been taken by reliable methods :—

| —— | Power-factor. | Authority. |
|---|---|---|
| Swinburne condensers | 0·01 | Prof. Ayrton. |
| Ditto ditto | 0·01 | Dr. Hoor. |
| Ditto ditto | 0·052 - 0·083* | Writer. |
| Condensers at Vienna and Rome central stations | 0·015 | Dr. Hoor. |
| Paraffin paper condensers— | | |
| Muirhead | about 0·1† | Mr. Addenbrooke. |
| P.O. | 0·022 | Writer. |
| Rubber-insulated cables— | | |
| Silvertown | 0·028 - 0·029 | Prof. Ayrton & Mr. Mather. |
| Helsby | 0·040‡ | Writer. |
| Paper-insulated cables— | | |
| B.I.W. | 0·024 | Prof. Ayrton & Mr. Mather. |
| B.I.W. | 0·019 - 0·021 | Writer. |
| Jute-insulated cable | 0·027 | Prof. Ayrton & Mr. Mather. |
| High-tension conc., Budapest— | | |
| Ω dielectric at 2,070 volts | 0·0206 | Dr. Hoor. |
| 3,000 volts | 0·0187 | Ditto. |

* Condensers probably defective. Latter broke down after test.
† Specially constructed for low absorption.
‡ Cable immersed in water for a fortnight before test and broke down after test.

The above figures appear to show that the power-factor for most dielectrics, *when new*, lies between 0·02 and 0·03. From the results found by the writer, however, on Swinburne condensers and the rubber cable it would seem that this may be largely increased with age or treatment. In view of the important part which cables and condensers play in alternate-current working this matter seems worthy of especial investigation.

The writer wishes to acknowledge the great assistance he has received in these tests from Mr. A. C. Jolley and Mr. L. W. Phillips, two of his assistants at the Northampton Institute.

## ON ELECTRIC INERTIA AND THE INERTIA OF ELECTRIC CONVECTION.*

BY PROF. ARTHUR SCHUSTER, F.R.S.

§ 1. Our calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes, where electricity is conveyed by a number of irregularly-distributed ions. In the immediate neighbourhood of such an ion the magnetic field will be many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is under-estimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of moving positive and negative electrons. It is the object of this Paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may affect experimental results.

§ 2. I begin by calculating the total energy of a number of electrically charged, equidistant particles, placed in a straight row, and all moving with the same speed ($u$). If the charge ($q$) of each particle is taken to be spread uniformly over a spherical surface of radius $a$, the magnetic energy is $q^2u^2/3a$,† so that the particle behaves as if it had a mass $2q^2/3a$. Without making any assumption, as to whether the magnetic forces are to be taken as vanishing within the electron or not, we may use the above expression, taking $a$ to be a linear quantity, not necessarily the radius of the electron but of the same order of magnitude. If there are $n$ particles per unit length at a distance $d$ apart so that $nd = 1$, the energy per unit length will be $q^2u^2/3a$, as far as the magnetic field established by each particle is concerned. The mutual energy of different particles has to be added in order to obtain the total magnetic energy. A pair of particles at a distance $r$ from each other will have a mutual energy of $q^2u^2/r$, and each particle with its nearest neighbour on either side will, therefore, contribute a term $2q^2u^2/d$. Taking the remaining particles in pairs we get for the mutual energy of a central particle and $p$ pairs on either side

$$\frac{2q^2u^2}{d}\left(1+\tfrac{1}{2}+\tfrac{1}{3}+\ .\ .\ .\ \frac{1}{p}\right)=\frac{2q^2u^2S}{d}.$$

The series S may be added up and the result expressed in the form

$$S = B + \log p,$$

where B is a number approximately equal to 0·577.

If $p$ is very large the total magnetic energy per unit length of the central portions of the row will be

$$n^2q^2u^2\left(2S+\frac{1}{3an}\right)=C^2\left(2B2+\log p+\frac{1}{3an}\right), \quad . \quad . \quad (1)$$

where C stands for the current.

3. I now compare this expression with that calculated on the usual supposition, which is, that the electrification is not confined to electrons, but fills continuously a rectangular space having a square cross-section with sides equal to $d$, and having a length equal to $(2p+1)d$, for which we write 2D. The total magnetic energy in this case will be the same as that of two linear conductors of the same length, and at a distance apart which is equal to the geometric mean of the square section $r_0$ where

$$r_0 = 0{\cdot}447d.$$

For unit current in each of the conductors, the linear elements of which are $ds_1$, $ds_2$, the magnetic energy between the conductor $s_2$ and the element $ds_1$ is

$$ds_1\int ds_2\left(\frac{1}{r}+\frac{1}{2}\frac{d^2r}{ds_1^2}\right).$$

The well-known ambiguity, as to the expression under the integral sign, disappears in our case, because we are only comparing the magnetic energy on two suppositions, and must, therefore, consistently

* Communicated by the Physical Society to the *Phil. Mag.*
† Heaviside, *Phil. Mag.*, April, 1889, p. 324.

use in both cases the same expression for the mutual energy of two current elements. As D is large, the value of $\frac{dr}{ds_1}$ for small values of $s_1$ will be sensibly equal to $\mp 1$ according as $s_2$ is large on the positive or negative side, and consequently we find the above expression to be equal to

$$ds_1\left(-1+\int_0^D \frac{2ds_2}{\sqrt{r_0^2+s_2^2}}\right)$$

or
$$2ds_1(\log(D+\sqrt{r_0^2+D^2})-\log r_0-\tfrac{1}{2}). \quad . \quad . \quad . \quad (2)$$

We may substitute $pd$ for D, and the above expression then becomes, neglecting $r_0$ compared with D,

$$ds_1\left(2\log\frac{2pd}{r_0}-1\right)$$

The bracket being independent of $s_1$ we conclude that the central portions of the column have a magnetic energy which for a current C and unit length is

$$C^2\left(2\log p2+\log\frac{2d}{r_0}-1\right)=C^2(2\log p+1{\cdot}996).$$

The excess of (1) over this will be the required difference in the magnetic energy. Introducing the numerical value for B this difference becomes

$$C^2\left(\frac{1}{3a}-0{\cdot}842\right). \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This expression being proved for any portion of the circuit which can be considered straight for a length which is large compared with the distance between the electrons, may be taken to hold for the complete circuit, as, excluding sharp angles, every circuit may be divided into portions satisfying this condition.

4. Some additional explanation is necessary for ordinary conductors whose cross-section is many times larger than the distance $d$ between the electrons. The cross-section of such conductors may be divided into square elements, each square having sides equal to $d$. If we imagine the electrons to be placed at the centre of each square we may calculate the mutual energy of any two parallel columns and thus obtain further correcting terms. It is easily seen that these terms will be positive and tend to diminish the negative term in (3). They will also be small and of the same order of magnitude as other quantities we neglect. It serves no useful purpose, therefore, to calculate them out in detail. If A is the area of the cross-section, the number of electrons spread over it will be $An^2$, so that the total correction to the magnetic energy becomes

$$An^2q^2u^2\left(\frac{1}{3a}-\frac{0{\cdot}842}{d}\right).$$

If $d$ is large compared with $a$ the second term may be neglected. In that case, writing $i$ for the current-density $n^2uq$, and N for $n^3$ which represents the number of electrons in unit volume, we obtain for the correcting term per unit volume of the conductor

$$\tfrac{1}{2}\mu i^2,$$

where $\mu$ stands for $2/3a$N. The flow of electricity will behave, therefore, as if it had inertia, the apparent mass for unit current-density and unit volume being $\mu$. The dimension of $\mu$, as pointed out by Hertz, is the same as that of a surface. We may conveniently use the expression "electric inertia" for the quantity $\mu$; the energy due to electric inertia is the energy of the magnetic field due to the moving electrons over and above that which is calculated in the usual way.

5. The investigation has been restricted to the case of a number of electrons moving in one direction, with the same speed and keeping the same equal distances from each other, but the result holds more generally. The magnetic field established by a positive electron moving in one direction is the same as that of a negative electron moving with the same speed in the opposite direction. Superposing on our system of one kind, a second one carrying opposite electricity in the opposite direction, N being the number of electrons of each kind and $Ai_1$, $Ai_2$ the currents conveyed in the two directions, the energy per unit volume becomes

$$(i_1^2+i_2^2)/3Na$$

or
$$\mu=\frac{i_1^2+i_2^2}{(i_1+i_2)^2}\cdot\frac{2}{3Na}.$$

The assumption that two sets of electrons move so as to keep equal relative distances is not, of course, satisfied. The change in the relative distance will increase the mutual energy between the electrons, but the increase will be of the order of magnitude which we have neglected, and the term we have retained is not affected by the relative distance of the electrons. For the purpose of this Paper it is not, therefore, necessary to go beyond the above expression.

The correction to self-induction for a conductor of length $l$ and uniform cross-section A will be $\frac{1}{2}\frac{\mu l}{A}$ or

$$l\{1+2\kappa(\kappa-1)\}/3NAa,$$

where $\kappa$ is that fraction of the total current which is conveyed by the positive electricity. If both kinds of electrons take equal parts in conveying the current, the correction becomes

$$l/6NAa.$$

The correcting term increases in importance with diminishing cross-section, and might be made large, if the cross-section could be reduced so as to be comparable with molecular dimensions.

6. We must now enter into a discussion of the numerical quantities involved. In the case of metallic conductors we may, in the absence of contrary evidence, reasonably take N to be of the order of magnitude of the number of molecules per unit volume. Taking the molecular distance to be $10^{-8}$ this gives $N=10^{24}$. As regards the linear quantity $a$, observations made on cathode rays determine it, in my opinion, and in any case fix a lower limit. The deflection of these rays by the magnet shows that the moving electron has itself a mass or is carried by a small mass. J. J. Thomson adopts the latter view, but it seems to me to be more natural to take the inertia of the cathode particle to be the magnetic inertia of the electron. If $m$ is the mass, real or apparent, of the particle carrying the negative charge, we may determine the ratio $q/m$. Measurements of this quantity were first made by myself in 1889,* and since then more accurate determinations by my original method or by other and better methods have been carried out by J. J. Thomson, Kaufmann, Lenard, and Wiechert. Taking the latter's estimate as being deduced from the most direct method, I shall use $1{\cdot}3\times10^7$ in electromagnetic measure for the value of $q/m$. If $q$, as was assumed by me and afterwards proved by J. J. Thomson, is the same quantity as that carried by the ion in a liquid, we know that in the case of, *e.g.*, hydrogen $q/m'=10^4$, if $m'$ denote the mass of an atom of hydrogen. Now, from the density $\rho$ of the gas and the number N′ of hydrogen molecules per unit volume, we may calculate $2m'=\rho/N'$. Taking $\rho=9\times10^{-5}$, $N'=21\times10^{18}$, we find $m'=2\times10^{-24}$, and hence $q=2\times10^{-20}$ †.

Also $$a=\frac{2q}{3}\cdot\frac{q}{m}=\frac{2}{3}\times2\times10^{-20}\times1{\cdot}3\times10^7=1{\cdot}8\times10^{-13}.$$

The linear dimension of the electron would therefore have to be about 30,000 times smaller than the molecular distance in solids, but I can see nothing more astonishing or improbable in this than in the alternative assumption of particles having masses 1,300 times smaller than the masses of hydrogen atoms.

The electric energy per unit volume and unit current density was found to be $1/3a$N, which in the case of solid conductors would therefore become $2\times10^{-12}$ C.G.S. units. We possess, fortunately, a series of experiments by Hertz in which he investigated the possibility of electric inertia, and found that if it exists it must be smaller than $18\times10^{-7}$ for unit current density and unit volume. The effect we have calculated is much smaller than the number given by Hertz, and as this represents the limit beyond which he could not push his experiments, we must for the present give up the hope of testing the results of our theory. There seems only one chance—and not at all an impossible one—that in some cases the effects may be considerably larger than those calculated above. Perhaps in some bad conductors like carbon, the distance between the moving electrons is greater than the distance between the molecules. If it is 50 times as great, we should get within the limits to which Hertz worked.

7. In the case of electrolytes the electric inertia of moving ions is small compared to their mass inertia. The latter must, to some extent, affect the motion of electricity in electrolytes, and it becomes a matter of interest to obtain, if possible, some experimental evidence to establish the effects of this mass inertia.

If N molecules of a dissociated salt are dissolved in unit volume of water, and if $u_1$, $u_2$ represent the velocities of the ions having masses $m_1$, $m_2$, the energy per unit volume is

$$\tfrac{1}{2}N(m_1u_1^2+m_2u_2^2).$$

If the masses of the ions contained in each molecule referred to hydrogen are $a_1$, $a_2$, and $\alpha$ represents the ratio between the mass and charge for a hydrogen atom, which is numerically equal to $10{\cdot}4\times10^{-5}$,

$$m_1=a_1\alpha q, \quad m_2=a_2\alpha q.$$

Introducing the current density

$$i=Nq(u_1+u_2),$$

and the weight $p$ of dissociated molecules per unit volume, which is related to the other quantities used by the equation

$$p=N(m_1+m_2)=N\alpha q(a_1+a_2),$$

we obtain for the energy of ionic motion

$$\tfrac{1}{2}\mu i^2=\frac{1}{2}\cdot\frac{a_1+a_2}{p}\alpha^2\left[\frac{a_1u_1^2+a_2u_2^2}{(u_1+u_2)^2}\right]i^2.$$

If $u_1$ refers to the kation, the ratio $u_2/u_1+u_2$ is Hittorf's constant deduced from the migration of ions. Denoting this by $n$ we have finally

$$\mu=\frac{a_1+a_2}{p}\alpha^2(a_1(1-n)^2+a_2n^2).$$

* Bakerian Lecture, *Proc. Roy. Soc.*, Vol. XLVII., page 526, 1890.

† Owing to some arithmetical blunder, this quantity was put down as $3\times10^{-23}$ in my Bakerian Lecture.

Taking for instance nitrate of silver, for which $n = 0{\cdot}53$, $a_1 = 108$, $a_2 = 62$, the energy of ionic motion per unit volume and unit current becomes equal to $3{\cdot}8 \times 10^{-5}/p$, where $p$ is the number of grammes of nitrate of silver per cubic centimetre of water. Hertz gives in the Paper quoted for the same salt the number $7{\cdot}8 \times 10^{-5}$, which is nearly double the value I find. As Hertz does not indicate his method of calculation, it is not now possible to trace the discrepancy, unless there is some slip in the above reasoning. In order to discuss the possibility of an experimental verification of the increase in self-induction due to electric inertia, we may consider two narrow tubes placed side by side. If the tubes have an internal diameter of 1mm., their axes might be placed 2mm. apart and the coefficient of self-induction would in that case be equal to 6·6 per centimetre of the double conductor. The ionic inertia would increase the value by $7{\cdot}6 \times 10^{-5}/pA$, which is nearly equal to 1 if $p = 0{\cdot}01$. The increase in self-induction amounts therefore to about 15 per cent., but the whole quantity is so small that it could not be measured very accurately. When the dilution of the electrolyte becomes great, the ionic inertia may become considerable. Thus, in the case of the purest water obtained by Kohlrausch, he estimates that there was 0·08 milligramme of dissociated hydrogen per cubic metre. This gives $p = 7{\cdot}2 \times 10^{-10}$. In order to avoid making any assumption as to the quantity $n$, we may substitute that value for it which gives the smallest value to $\mu$. This is found to be $n = a_1/(a_1 + a_2)$, so that if

$$a_1 = 2, \quad a_2 = 16, \quad a^2 = 108 + 10^{-10}, \quad p = 7{\cdot}2 \times 10^{-10},$$

$$\mu = \frac{a_1 a_2}{p} \cdot a^2 = 480.$$

The energy of straight parallel currents close together as in the above example would therefore in this case be almost entirely due to the ionic motion, but it will appear in § 9 that the chances of experimental verification are not very great, as long as an increase in the value of $\mu$ is accompanied by a corresponding increase in the resistance.

8. The case of gases presents several features of special interest. The effect of inertia on the deflection of the cathode ray has already been alluded to, and the fact that in the positive portion of the discharge, the current is conveyed by a comparatively slow diffusion of molecules has been proved by me in 1885.* In the positive part of the discharge the number of ions is proportional to the current, as follows from Hittorf's experiments. To make an estimate of the inertia involved in the diffusion, I take as an example one of my experiments for which I have calculated approximately the ratio of the number of ions to the total number of molecules as $1{\cdot}2 \times 10^{-6}$ at a pressure of $\frac{1}{4}$mm., at which the density of nitrogen is $5 \times 10^{-7}$. The quantity called $p$ above is in this case $10^{-12}$, and taking $a_1 = a_2 = 7$,

$$\mu = 49 \times 10^{12} a^2 = 5{\cdot}4 \times 10^6.$$

This value holds for a current-density of $1{\cdot}5 \times 10^{-4}$, and will be inversely proportional to the current-density. The electric energy of convection in gases may therefore be very large and exceed many times the magnetic inertia calculated on the usual hypothesis. As an example I take a circular tube of radius $r$ bent into the form of a circle of radius R, and as a first approximation we may take the expression

$$L = 4\pi R \left(\log \frac{8R}{r} - 1{\cdot}75\right);$$

the electric energy of convection per unit current is $\mu R/r^2$, so that the total energy per unit current becomes

$$\frac{R}{r^2}\left[\mu + 4\pi r^2 \left(\log \frac{8R}{r} - 1{\cdot}75\right)\right].$$

With $r = 1$, $R = 10$ the numerical value of the second term is 34, and this term is, therefore, quite insignificant compared with the first. A coil might be made of a good many windings still leaving the inertia of convection great compared to the magnetic inertia. In any problem in which the self-induction of gases has to be calculated, the ordinary methods would give erroneous results.

9. The general equations of electric motion will be altered by the introduction of the inertia, whether it be the inertia of the electron or, as in the case of liquids or gases, the inertia of the ion. If E represents the component of electric force in any one direction, and $u$ the flow in the same direction, the ordinary equations of electric motion are

$$\rho u = E,$$

with two other equations giving the components in two other directions, $\rho$ being the resistivity of the medium. If, however, the electric flow possess inertia, the electric forces will be doing work in increasing the energy of convection, the rate of doing work per unit volume being $\mu \dot{u} u$. Hence the complete equation will be

$$\rho u + \mu \dot{u} = E.$$

In the case of conductors, we may put

$$E_1 = -\left(\frac{d\psi}{dx} + \frac{dF}{dt}\right),$$

* Bakerian Lecture, pp. 548, 550.

$\psi$ being the electrostatic potential and F the X component of the vector potential, and introducing the conductivity $\kappa$ for $1/\rho$, the equation becomes

$$u + \kappa\left(\frac{dF}{dt} + \frac{d\psi}{dx}\right) + \kappa\mu\frac{du}{dt} = 0,$$

or, as $\nabla^2 F = -4\pi u$,

$$4\pi\kappa\left(\frac{dF}{dt} + \frac{d\psi}{dx}\right) = \nabla^2 F + \kappa\mu\frac{d}{dt}\nabla^2 F,$$

with the corresponding equations for the other components of the vector potential. The electrostatic potential disappears in the usual way by introducing the components of magnetic induction ($a$, $b$, $c$) for those of vector potential, the typical equation in that case being

$$4\pi\kappa\frac{da}{dt} = \left(1 + \kappa\mu\frac{d}{dt}\right)\nabla^2 a.$$

If the flow is periodic so that $a$, $b$, $c$ are proportional to $e^{ipt}$, where $i$ stands for $\sqrt{-1}$, we obtain by dividing out the time factor

$$\nabla^2 a = \frac{4\pi\kappa i p}{1 + \kappa\mu i p} a.$$

This equation shows that the inertia will affect the magnetic induction, and consequently the lines of flow only, when $\kappa\mu p$ becomes an appreciable fraction. But $\mu$ itself we have found small in liquids and solids, while $\kappa$ is never greater than $10^{-3}$. Hence $\kappa\mu p$ cannot produce appreciable effects until $p$ becomes of the order of magnitude which holds for luminous radiations. But that case will require separate treatment, as our equations are not correct for rapid variations of the currents. In the numerical example given in § 8, $\mu$ was found to be equal to $5{\cdot}4 \times 10^6$ for a current density of $1{\cdot}5 \times 10^{-4}$. The product $\kappa\mu$ in the case considered will be independent of the density. The fall of potential in the experiment was 5 volts per centimetre, so that the conductance was $0{\cdot}3 \times 10^{-12}$, and the cross-section being 2 the product $\kappa\mu$ becomes $0{\cdot}8 \times 10^{-6}$. This product would be considerably larger at lower pressures, and when the frequency is of the order of magnitude of leyden jar discharges it is very likely that the term depending on the inertia of convection is very appreciable. Some of the facts brought to light in J. J. Thomson's work on luminous discharges produced by induction in tubes without electrodes seem to point in that direction. When $\kappa\mu p$ becomes large compared to unity, the equation reduces to

$$\nabla^2 a = \frac{4\pi a}{\mu},$$

so that, for instance,

$$a = e^{-\sqrt{\frac{4\pi}{\mu}}x} \cos pt$$

would represent a possible disturbance.

10. The effects of inertia may become very appreciable in the case of luminous vibrations, to which our equations do not apply, as the term depending on the specific inductive capacity has been left out of account. In forming the more complete equations a difficulty presents itself which is due to the fact that the displacement currents may also to some extent have inertia or what is equivalent to inertia. The apparent masses will not be in general the same as those involved in the conduction currents, though in the case of displacements of electrons in the molecules, the order of magnitude may be the same.

If $\frac{1}{2}\mu' i^2$ represent the energy per unit volume due to electric inertia where $i$ is the displacement current, the complete equations for the magnetic induction become, for a medium of specific inductive capacity K and conductivity $\kappa$,

$$\left(1 + \mu\kappa\frac{d}{dt} + \frac{\mu' K}{4\pi}\frac{d^2}{dt^2}\right)\nabla^2 a = K\frac{d^2 a}{dt^2} + 4\pi\kappa\frac{da}{dt}$$

with the two corresponding equations for $b$ and $c$.

If $a$ varies proportionally to $e^{-ipt}$ this reduces to

$$\left(1 - i\mu p\kappa - \frac{\mu' K p^2}{4\pi}\right)\nabla^2 a = -(Kp^2 + 4\pi\kappa i)a.$$

In non-conductors the terms involving $\kappa$ disappear, and $a = e^{iqx}$ is a solution provided that

$$q^2\left(1 - \frac{\mu' K p^2}{4\pi}\right) = Kp^2,$$

which gives for the velocity of propagation $p/q$ the equation

$$\frac{p^2}{q^2} = \frac{1}{K} - \frac{\mu'}{4\pi}p^2;$$

dividing by $V^2$, where V is the velocity of light in vacuo, we obtain for the refractive index of the medium ($n$)

$$\frac{1}{n^2} = \frac{1}{KV^2} - \frac{\mu\pi}{\lambda^2}.$$

If the second term is small we find to the first approximation, writing $n$ for $V\sqrt{K}$,

$$n = n_0 + \frac{\mu' \pi n_0^3}{\lambda^2} + \ldots$$

J. Willard Gibbs * nearly 20 years ago deduced from the mere assumption that the medium possesses a fine-grained structure an equation for the relation between velocity of wave-propagation and wave-length which is identical with the above, and it was pointed out by him that his equations include the case in which the medium is endowed with electric inertia.

It seems of interest to determine the order of magnitude of the quantity $\mu'$. The coefficient of $1/\lambda^2$ may be calculated from the optical dispersion and for ordinary flint-glass is found to be about $10^{-10}$, the corresponding value of $n_0$ being about 1·6. Hence $\mu' = 10^{-11}$ approximately. This value does not differ very materially from $2 \times 10^{-12}$, which is the estimate of $\mu$ which has been made for solid conductors in § 6. As the latter estimate depends on the cube of molecular distance which was assumed to be $10^{-24}$, the difference between the two numbers falls within the possible errors of estimation. I do not, however, attach much importance to the apparent equality of the numbers and mention it only as a remarkable coincidence, which probably is accidental. For the quantity called $\mu$ diminishes with increasing distance between the molecules, and for gases at atmospheric pressure would be 50,000 times smaller than for liquids. There would, therefore, be a very wide discrepancy between $\mu$ and $\mu'$ in the case of gases. Should the coincidence between $\mu$ and $\mu'$ in solids prove to be more than accidental it would prove that the greater part of the kinetic energy in a luminous vibration traversing a transparent solid is accounted for by the kinetic energy of the electrons attached to the molecules and set in motion by the vibration. This proposition is obviously not true in the case of gases, but may hold for solids. It would be of some interest to discuss the effects of metallic reflection in connection with the equations which are given at the beginning of this paragraph. H. A. Lorentz† has already introduced a term depending on inertia in the equations of motion of light, and pointed out that without such inertia the electromagnetic theory of light could not explain the known experimental facts. But even the inertia term introduced by Lorentz, was not sufficient to account for all the discrepancies between theory and experiment. My equations differ from those of Lorentz by the introduction of two constants $\mu$ and $\mu'$ which need not be identical, for there is no *a priori* reason why the inertia of the conduction current should be the same as that of the displacement current. The numerical results of Lorentz's investigation are not easily interpreted, as he used the Helmholtz form of the equations, which involves a large and unknown coefficient. Attention may be drawn in conclusion to several Papers by P. Drude ‡ "On the Electron-theory of Metals."

* "American Journal of Science," Vol. XXIII., p. 262 (1882).
† *Zeitschrift fur Math. u. Physik.*, Vol. XXIII., p. 197 (1878).
‡ *Annalen der Physik*, Vol. I., p. 556, Vol. III., p. 369, and *Physik. Zeitschrift*, Vol. I., p. 161.

## INSULATION ON CABLES.*

BY MERVYN O'GORMAN.

(*Concluded from page 871.*)

### Appendix.

In the appended tables the various systems are compared on the common basis that the voltage between no two conductors exceeds 14,140 maximum. The strain, therefore, on the insulation of the generators or transformers is the same in all cases.

The systems are as follows:—

A. Direct-current with one concentric cable, the outer being earthed. Working pressure between condrctors, 14,140 volts. (It *might* be cheaper to use two single cables and earth a middle *point* as in Mr. Swinburne's case 1; but this has not been worked out, and is not very usual in practice, except on the three-wire system, which is not considered.

B. Single-phase alternating current. Working pressure, 10,000 volts, otherwise same as A.

C. Biphase with two concentric cables; *neither outer is earthed*, but a middle point in the machine, as shown at J in S. P. Thompson's book on "Polyphase Electric Currents," at Figs. 50 and 51, is earthed. Working pressure 10,000 volts on each phase.

D. Biphase with two concentric cables, the outer of both being earthed, these outers being the common return. Working pressure, 7,070 volts on each phase.

E. Triphase with three single conductors, none of them earthed, but the common junction of the star winding is supposed to be earthed. Working pressure, 10,000 volts on each phase.

F. Triphase with two concentrics, the outers being earthed, the two outers together forming the third conductor, which is equally divided between the two concentrics. Working pressure, 10,000 volts on each phase.

### DISCUSSION.

The PRESIDENT (Prof. Perry) read a letter from Mr. Jacob, of Messrs. Siemens Bros. & Co., in which he pointed out that the method proposed by Prof. Perry in the Paper was to all intents and purposes the same as the one described by him (Mr. Jacob) in the *Electrical Review* in 1896, and which had been used by him for many years at Messrs. Siemens works for various purposes.

Mr. JAMES SWINBURNE said that Mr. O'Gorman had very generously acknowledged a Paper of his read before an Institution conference, and had pointed out that it got very little attention. This Paper really dealt with the question of "grading," but it had been absolutely unintelligible when it was read. He had afterwards thought of enlarging it, but Mr. O'Gorman had now done this in a way quite unthought of by him. As far as he understood it, in the case of a direct-current cable, the difficulty was that the fall of potential was greatest near a small surface. Mr. O'Gorman's way of getting over the difficulty was to arrange the fall of potential, or

* Abstract of a Paper read before the Institution of Electrical Engineers, March 7.

**I.—Max. allowable slope of volts = S = 20,000 volts per centimetre. 5,000kw. put into cable; loss of 10 per cent. in 20 miles.**

N.B.—In all cases when two or more cables are required, the cost of all the cables required is included in the above prices.

| System. | Amperes per wire. | Max. volts for R. | Eff. volts. $= e$. | Eff. amps. $= i$. | Power formula. | Kw. delivered. | Cost per 1,000 yards. | Kw. per £1. | Comparative costs. |
|---|---|---|---|---|---|---|---|---|---|
| A. Direct-current ............ | 354 | 14,140 | 14,140 | 354 | $ei$ | 4,500 | £675 | 6·67 | 1 |
| B. Single-phase ............... | 500 | 14,140 | 10,000 | 500 | $ei$ | 4,500 | 1,201 | 3·75 | 1·77 |
| C. Biphase ....................... | 250 | 14,140 | 10,000 | 250 | $2\,ei$ | 4,500 | 1,444 | 3·12 | 2·14 |
| D. Biphase ....................... | 354, 354, 500 | 10,000 | 7,070 | 354 | $2\,ei$ | 4,500 | 1,687 | 2·67 | 2·5 |
| E. Triphase ...................... | 288 | 8,180 | 10,000 | 166 | $3\,ei$ | 4,500 | 970 | 4·64 | 1·43 |
| F. Triphase ...................... | 288 | 14,140 | 10,000 | 166 | $3\,ei$ | 4,500 | 1,111 | 4·05 | 1·64 |

**II.—S = 20,000 volts per centimetre. 5,000kw. put into cable; loss of 10 per cent. in 47 miles.**

| System. | Amperes per wire. | Max. volts for R. | Eff. volts. $= e$. | Eff. amps. $= i$. | Power formula. | Kw. delivered. | Cost per 1,000 yards. | Kw. per £1. | Comparative costs. |
|---|---|---|---|---|---|---|---|---|---|
| A. Direct-current ............ | 354 | 14,140 | 14,140 | 354 | $ei$ | 4,500 | £1,370 | 3·28 | 1 |
| B. Single-phase ............... | 500 | 14,140 | 10,000 | 500 | $ei$ | 4,500 | 2,520 | 1·77 | 1·84 |
| C. Biphase ....................... | 250 | 14,140 | 10,000 | 250 | $2\,ei$ | 4,500 | 2,940 | 1·53 | 2·15 |
| D. Biphase ....................... | 354, 354, 500 | 10,000 | 7,070 | 354 | $2\,ei$ | 4,500 | 3,630 | 1·24 | 2·65 |
| E. Triphase ...................... | 288 | 8,180 | 10,100 | 166 | $3\,ei$ | 4,500 | 2,010 | 2·24 | 1·46 |
| F. Triphase ...................... | 288 | 14,140 | 10,000 | 166 | $3\,ei$ | 4,500 | 2,131 | 2·11 | 1·55 |

**III.—S = 20,000 volts per centimetre. 2,500kw. put into cable; loss of 10 per cent. in 20 miles.**

| System. | Amperes per wire. | Max. volts for R. | Eff. volts. $= e$. | Eff. amps. $= i$. | Power formula. | Kw. delivered. | Cost per 1,000 yards. | Kw. per £1. | Comparative costs. |
|---|---|---|---|---|---|---|---|---|---|
| A. Direct-current ............ | 177 | 14,140 | 14,140 | 177 | $ei$ | 2,250 | £423 | 5·24 | 1 |
| B. Single-phase ............... | 250 | 14,140 | 10,000 | 250 | $ei$ | 2,250 | 670 | 3·36 | 1·56 |
| C. Biphase ....................... | 125 | 14,140 | 10,000 | 125 | $2\,ei$ | 2,250 | 1,069 | 2·11 | 2·48 |
| D. Biphase ....................... | 177, 177, 250 | 10,000 | 7,070 | 177 | $2\,ei$ | 2,250 | 1,010 | 2·23 | 2·35 |
| E. Triphase ...................... | 144 | 8,180 | 10,000 | 83 | $3\,ei$ | 2,250 | 579 | 3·88 | 1·35 |
| F. Triphase ...................... | 144 | 14,140 | 10,000 | 83 | $3\,ei$ | 2,250 | 741 | 3·04 | 1·72 |

**IV.—S = 20,000 volts per centimetre. 2,500kw. put into cable; loss of 10 per cent. in 47 miles.**

| System. | Amperes per wire. | Max. volts for R. | Eff. volts. $= e$. | Eff. amps. $= i$. | Power formula. | Kw. delivered. | Cost per 1,000 yards. | Kw. per £1. | Comparative costs. |
|---|---|---|---|---|---|---|---|---|---|
| A. Direct-current ............ | 177 | 14,140 | 14,140 | 177 | $ei$ | 2,250 | £764 | 2·95 | 1 |
| B. Single-phase ............... | 250 | 14,140 | 10,000 | 250 | $ei$ | 2,250 | 1,370 | 1·64 | 1·79 |
| C. Biphase ....................... | 125 | 14,140 | 10,000 | 125 | $2\,ei$ | 2,250 | 1,745 | 1·29 | 2·21 |
| D. Biphase ....................... | 177, 177, 250 | 10,000 | 7,070 | 177 | $2\,ei$ | 2,250 | 1,939 | 1·16 | 2·51 |
| E. Triphase ...................... | 144 | 8,180 | 10,000 | 83 | $3\,ei$ | 2,250 | 1,049 | 2·14 | 1·36 |
| F. Triphase ...................... | 144 | 14,140 | 10,000 | 83 | $3\,ei$ | 2,250 | 1,240 | 1·82 | 1·62 |

D

"cook" it by altering the specific resistance so that he got a uniform fall of potential instead of a quick fall here and a slow fall there. But this could not be done with safety, as he was altering the dielectric strength as well. All these simple calculations, when reduced to practice, would be found to be misleading. The really best cable would be a matter of compromise and experiment between layer and layer, and was not a thing which could be calculated out carefully. Exactly the same thing would hold as regards specific inductive capacity, which Mr. O'Gorman proposed to cook in his alternate-current cable. It would be exceedingly difficult to do either of these without altering the properties of the insulation in other ways, and what ought to be done was to get the best insulation possible for the price. The cooking of the material it was pointed out would help a great deal, but a great deal more would have to be done by altering the dimensions of the cable, &c. A cable was very much like the same problem as a gun. If they could only manage to do something corresponding to wire guns in cables it would be very nice. As regards unbleached manilla being about as good as anything, he said there was another material which also was very good, in fact, rather better—viz., "butter-skin." What it was he did not know, but it was usually sold for packing butter in. It was not waterproof but it was oil-proof. As it answered the purpose and was cheap he had not bothered about how it was made. It was a very heavily-sized paper, which was curious, as it was the exact opposite to what Mr. O'Gorman used. He asked Mr. O'Gorman not to judge the value of his Paper by the amount of discussion, because it was a very difficult Paper to discuss. None of them really knew anything about cables except Mr. O'Gorman, and in this statement he included the cable makers. He did not know what the cable makers would say in the discussion, but he thought they would say nothing at all, and probably pretend they had all sorts of secrets and did not like to let them out. Whenever industries had secrets it only amounted to the fact that the people themselves were working in the same way and doing old things and were ashamed to let others know what they were doing. This was really the first scientific Paper written on the subject. When it was remembered that cables occupied about one-half of the capital of an electric undertaking, it would be seen that the Paper was as important as one on boilers, dynamos, engines, transformers, motors, and voltmeters, and everything else which they had been discussing in the Institution since the beginning.

Mr. CHARLES BRIGHT said that he could remember very well indeed when rubber manufacturers used to look askance upon what was being done at Deptford, and thought that it was sure to end in failure. It redounded greatly to the credit of electric light engineers that, although paper was known to telegraph people, it was never persevered in. If paper cables had not been brought to their present successful issue, and the trouble in making joints overcome, we should not have the present enormous mileage of electric light mains all over the country. He thought that, in the early fifties, Sir William Siemens settled that most classes of indiarubber, whether vulcanised or not, did absorb water, at any rate under a certain pressure; but if Mr. O'Gorman was only dealing with land cables he did not think it was necessary to trouble about it. It was only when it came to a question of a 2-mile submarine depth that absorption of water came out unfavourably to indiarubber almost as much as it was favourable to gutta-percha.

Mr. G. L. ADDENBROOKE said that in most parts of the world overhead wires were allowed, except in crowded areas, and if we had these facilities it was extraordinary what could be done in the distances and cheapness of distribution. There was nothing but this question of insulation between us and objects of the greatest economic and industrial importance. The whole subject of cable insulation wanted taking up in just such a way as Mr. O'Gorman had done, and although actual practical results were not given in the Paper, the subject had been opened up in a scientific and proper manner. Whether the conclusions were right or wrong it mattered very little. Cable makers now were very wealthy and could well afford a little money for experiments, and he felt sure that if scientific cable experiments were persisted in for a sufficiently long time, it would be bound to result in very great improvement which would be of enormous industrial benefit.

Mr. J. E. KINGSBURY, while congratulating Mr. O'Gorman on his Paper, objected that he had made remarks about cable makers which were hardly merited. It was not a fact that the purchaser did not care what he bought, neither was it correct that cable makers were regardless of the material they put into a cable. In the introduction of any new article it must either be something that the purchaser knew was durable or something he was content to take on a very specific guarantee from very responsible people. He was inclined to think that the author had generalised too greatly.

Mr. S. Z. DE FERRANTI said that at present cable manufacture, which was apparently a very simple process, was given the very greatest care to, especially in view of the great competition there was. What he thought the most interesting part of the Paper to the electrical public generally, was Mr. O'Gorman's discussion of the most economic voltage, the most economic cable and the particular style of cable for the transmission of various powers to different distances. It was very curious to see how the higher voltage in some cases was less economic than the lower one. Copper was often quite a small factor in the total cost. Insulation might be much more serious, and in a case he had in mind he remembered being exceedingly surprised to find that a 10,000 volt transmission and distribution, although the distances were considerable, was nothing like so economical as a 5,000 volt one. It was not the simple question that Mr. O'Gorman had assumed of merely transmitting power to one specific place, it was when it had to be distributed at the end to various places of various sizes that the trouble came in. It might be decided which voltage was the most economical to start with, but in time it would be found that the starting voltage was no longer the most economical, and so it was very hard to calculate what to do. It was very much in the nature of a speculation to know what was the best voltage and the best lines to go upon. The question of the thickness of dielectric for high pressures was quite a serious matter, and he agreed with the Paper that, for large cables, the thicknesses according to the Board of Trade rules were too great. He felt strongly upon this because it was one of the things which to a certain extent handicapped the industry of distribution of this kind on account of its adding unnecessarily to the proposed total cost. These high tension cables were mostly paper-covered and protected by lead. It was a question of much heavier lead, and with lead at recent prices it was a very serious matter indeed. The Board of Trade rule was apparently a very simple one, and it might, or might not, be curious that it exactly corresponded to the 10,000 volt mains originally laid from Deptford, which had a radial thickness of ½in. for the insulation. The rule came after the mains, and no doubt it was quite a good way of dealing with the matter—in fact, a practical way. Referring to Mr. Swinburne's remark that cable makers were not likely to say anything, Mr. Ferranti did not think there were many secrets in the cable industry. He would like to have some, for he would rapidly convert them into patents, which would probably produce some very pleasing results.

Mr. E. K. SCOTT thought that, although at 2,000 volts the semi-solid system as it had been used at Chatham and Worcester was more expensive than the paper cable lead-covered and laid in bitumen, with 30,000 volts they wanted something strong. It was not a question of expense. Supposing a paper-covered cable was put down for 30,000 volts, according to the Board of Trade rule the cable would be about as thick as a finger, and the insulation one and a-half times as thick. This meant putting the cable through the machines 30 times; it would cost £600 a mile, and require a traction engine to draw it in. The cables which would have to be used for high pressures must be drawn in: the people would not stand this breaking up of the streets every day. Of all cables, paper was the worst to draw in, and it was the most easily damaged. A paper cable dielectric also depended upon the oil. But in the Brooks main it was all oil. This was the very thing which was wanted. There was jute to protect the cable whilst it was being drawn in and to support it from the bottom of the conduit. A porcelain conduit was an insulation in itself, as it were, and they could be made in 3ft. lengths and the joints could be made sufficiently good to protect the main, because the oil immediately it got outside hardened and sealed the thing. There was a good deal to be said for the Brooks main, especially for these power schemes.

Mr. F. C. RAPHAEL said that Mr. O'Gorman had spoken of the degradation of rubber, but, to his credit, had not followed a custom which seemed to have become quite fashionable at the Institution, and spoken of the degradation of the British electrical engineering industry. The reason was that there is no fear of the decadence of the British cable industry. We still stood first, and were likely to do so, although there was the fear of stagnation Mr. O'Gorman had alluded to. Mr. O'Gorman had pointed out the large value of the cables manufactured yearly, but copper was responsible for a larger proportion of this sum than insulation. He did not agree with Mr. O'Gorman that high-pressure cables were more profitable to manufacture than low-pressure cables. Among the practical points touched upon, the author had mentioned an ideal dielectric which would seal up when it had been subjected to a high-pressure discharge. He (the speaker) believed that some recent specifications had contained this provision; at all events, people had an idea that it was a new thing, and that all good cables nowadays had got to seal up if by any chance the insulation sparked through; but he could not feel it was a good thing. Any automatic device which could not be supervised was liable to get out of order. A self-sealing fault was purely an automatic device, and the longer it worked the worse it got. Supposing a cable sparked through, and the fault afterwards sealed up. A little while after, the same effect of capacity or induction which had caused a rise in pressure and produced the fault might occur again, and the cable would undoubtedly spark through again at the same place. He had had some experience with self-sealing dielectrics 10 years ago, long before they were considered a good thing, and he had found them a regular nuisance. He had found sometimes that a cable would spark through, blowing the fuse; and if the fuse was put in again, the cable immediately sparked through again. But on disconnecting it from the switchboard later on and testing it, it would be found that the fault had sealed up, although the moment the cable was connected to the dynamo again it sparked through once more. He thought it would be very much better if the cable broke down right away, as the switchboards were fitted with automatic devices, and there were disconnecting boxes on the network to prevent harm being done. With regard to the question of high insulation, Mr. O'Gorman had admitted that this was good in the feeders, but had expressed a doubt as to whether it was good in distributors. It was, however, a question of being able to test the mains satisfactorily in the factory. A cable of 10 megohms per mile with a slight leak in it, would possibly not decrease appreciably in insulation resistance if put in water for 24 hours, whereas with a cable of higher insulation resistance the leak would be discovered in the factory instead of only after the cable had been laid underground. This matter was often confounded with what one might call abnormally high insulation. A bad fibrous cable, say, testing 200 or 300 megohms per mile could be stripped, put in the tanks, and brought up to 1,000 or more megohms per mile, but at the same time weakening the insulation mechanically. This did not prove that, in general, high insulation was bad. As a general rule a good cable with a high insulation was better than a good cable with low insulation, assuming the same insulating material. It seemed ridiculous to have to say this, and yet people argued, through love of paradox, that high insulation was bad, and that low insulation was good. He believed that the Société Industrielle des Téléphones, at the Paris Exhibition, showed some cables with vulcanised rubber round the copper and with paper outside this, under the lead, and this was, perhaps, something in the direction of Mr. O'Gorman's grading. Mr. O'Gorman had rather scoffed at the very high factor of safety used in cable

insulations. The reason for this high factor of safety was that mixtures of very complex organic compounds were being dealt with, and it was not easy to determine their precise composition. They could not be expressed by chemical formulæ, and, moreover, they were not easily reproducible. The same applied to tape, paper, &c. One could not always be sure of procuring exactly the same sort. Such difficulties were very much increased in connection with a graded cable, and the same applied to the effect of various accidents in manufacture.

Mr. M. O'GORMAN, replying, said that Mr. Raphael was entirely mistaken in his estimate of the relative importance of copper. In a high-tension cable the copper did not cost anything like the amount that the stuff outside did. Alluding to the sealing up of faults, he replied that he did not think such automatic actions got out of order very much. If there was a substantial insulation, as he supposed, it ought to seal up always. With regard to Mr. Scott's remarks on Brookes mains, the cable had to be mechanically strong, and the jute which surrounded the Brookes main, had no particular mechanical strength either radially or crosswise, whereas paper had a definite mechanical strength across one of the directions of stress. Mr. Kingsbury had said that a purchaser bought either because he knew what he was buying or because he relied on the responsibility of a very responsible person. He thought a purchaser could not know what he was doing to rely entirely on the responsibility of the cable manufacturer. In further reply to Mr. Kingsbury, he pointed out that the graded cable involved no new materials. He utilised the old ones entirely. Instead of putting the resin outside he put it near the conductor.

A vote of thanks was accorded to Mr. O'Gorman at the conclusion of the discussion.

## TELEPHONE STATISTICS.

The 1901 edition of "'The Electrician' Electrical Trades' Directory and Handbook" gives the following statistics relating to Post Office telephone exchanges, &c., to Dec. 31, 1900. The list includes all the Post Office exchanges open at that date and the provincial exchanges in course of construction :—

*Post Office System.*

| Exchange. | Opened. | Call offices. | Exchange connect'ns. |
|---|---|---|---|
| Aberdare | October 21, 1891 | 1 | 23 |
| Abergavenny | February 24, 1896 | 1 | 12 |
| Aylesbury | October 24, 1900 | 5 | 40 |
| Barry | January 20, 1890 | 2 | 15 |
| Blaenavon | Constructing | 1 | 12 |
| Blyth | February 7, 1890 | 2 | 6 |
| Bridgend | December 13, 1900 | 1 | 14 |
| Cardiff | August 31, 1881 | 5 | 228 |
| Castle Eden | Constructing | 1 | 8 |
| Chesham | " | 1 | 18 |
| Cork | ... | 1 | 6 |
| Cowbridge | July 13, 1898 | 2 | 12 |
| Durham | ... | 1 | 2 |
| Ebbw Vale | February 24, 1890 | 1 | 16 |
| Ferndale | August 22, 1898 | 1 | 17 |
| Hexham | ... | 1 | 11 |
| Hinckley | ... | 1 | [illegible] |
| Hull | ... | 4 | 25 |
| Jarrow | ... | 2 | 6 |
| Leicester | ... | 7 | [illegible] |
| Limerick | ... | 1 | 2 |
| Llantwit Major | October 11, 1889 | 1 | 9 |
| London | ... | 3 | 120 |
| Loughborough | ... | 1 | 5 |
| Merthyr Tydvil | September 7, 1891 | 3 | 11 |
| Middlesbrough | June 5, 18[illegible]2 | 3 | 37 |
| Morpeth | July 4, 1892 | 1 | 8 |
| Newcastle on Tyne | October 1, 1882 | 31 | 672 |
| Newport (Mon.) | August 31, 1881 | 5 | 100 |
| North Shields | December 31, 1883 | 7 | 33 |
| Nottingham | ... | 1 | 9 |
| Penarth | July 11, 1900 | 1 | 8 |
| Pentre | February 17, 1893 | 1 | 52 |
| Pontypool | June 28, 1887 | 5 | 30 |
| Pontypridd | September 1, 1888 | 9 | [illegible] |
| Porth | August 22, 1898 | 1 | 22 |
| South Shields | August 31, 1883 | 2 | 14 |
| Spennymoor | March 7, 1898 | 1 | 4 |
| Stockton-on-Tees | February 7, 1885 | 3 | 18 |
| Sunderland | December 5, 1881 | 7 | 53 |
| Swansea | October 22, 1883 | 1 | 9 |
| Talywain | May 17, 1883 | 1 | 19 |
| Tonypandy | September 21, 1891 | 1 | 57 |
| Tonyrefail | March 8, 1899 | 1 | 9 |
| Treherbert | August 22, 1898 | 1 | 21 |
| Tring | Constructing | 1 | 18 |
| Tylorstown | " | 1 | 8 |
| Tyne Dock | ... | 1 | 8 |
| Tynemouth | ... | 1 | 5 |
| Wendover | Constructing | 1 | 13 |
| West Hartlepool | November 6, 1882 | 3 | 22 |
| | Total | 141 | 1,925 |

*National Telephone Co.'s System.*

At the same date (Dec. 31, 1900) the number of exchanges owned by the National Telephone Co. was 988, the number of call offices 2,552, and the number of stations 200,208. The progress of the National Company's operations at Dec. 31st in each year (where not otherwise stated) is shown as under :—

| Year. | No. of exchanges. | No. of call offices. | No. of stations. |
|---|---|---|---|
| 1888 (Nov. 30th) | 126 | 246 | 9,938 |
| 1889 (Nov. 27th) | 251 | 475 | 25,713 |
| 1890 | 313 | 692 | 31,862 |
| 1891 | 381 | 917 | 42,590 |
| 1892 (April 30th) | 489 | 1,199 | 54,637 |
| 1893 | [illegible] | 1,263 | 64,041 |
| 1894 | 582 | 1,347 | 73,338 |
| 1895 | 629 | 1,334 | 82,089 |
| 1896 | 698 | 1,279 | 94,407 |
| 1897 | 782 | 1,384 | 106,188 |
| 1898 | 853 | 1,665 | 120,144 |
| 1899 | 930 | 2,214 | 169,927 |
| 1900 | 988 | 2,552 | 200,208 |

The company's exchanges were distributed as under :—

| — | Exchanges. |
|---|---|
| **LONDON** | 47 |
| **PROVINCE OF SCOTLAND :** | |
| Aberdeen | 11 |
| Banff | 9 |
| Dumbarton | 4 |
| Dumfries | 12 |
| Dundee | 12 |
| Edinburgh | 20 |
| Galashiels | 18 |
| Glasgow | 19 |
| Greenock | 12 |
| Hamilton | 9 |
| Inverness | 7 |
| Kilmarnock | 9 |
| Kirkcaldy | 10 |
| Oban | 2 |
| Paisley | 4 |
| Perth | 3 |
| Stirling | 11 |
| Total | 172 |
| **NORTHERN PROVINCE :** | |
| Bradford | 15 |
| Dewsbury | 11 |
| Durham | 8 |
| Grimsby | 1 |
| Halifax | 5 |
| Huddersfield | 11 |
| Hull | 11 |
| Leeds | 17 |
| Middlesbrough | 10 |
| Newcastle on Tyne | 20 |
| Scarborough | 1 |
| Sunderland | 11 |
| West Hartlepool | 4 |
| York | 1 |
| Total | 126 |
| **N. W. PROVINCE:** | |
| Ashton-under-Lyne | 4 |
| Bacup | 4 |
| Barrow | 15 |
| Birkenhead | 10 |
| Blackburn | 10 |
| Bolton | 6 |
| Blackpool | 6 |
| Burnley | 5 |
| Bury | 3 |
| Douglas | 5 |
| Lancaster | [illegible] |
| Liverpool | 17 |
| Manchester | 20 |
| Oldham | 3 |
| Preston | 8 |
| Rochdale | 3 |
| Southport | 4 |
| Stockport | 6 |
| Warrington | 5 |
| Wigan | 4 |
| Total | 143 |

| — | Exchanges. |
|---|---|
| **MIDLAND PROVINCE :** | |
| Birmingham | 12 |
| Chester | 24 |
| Chesterfield | 5 |
| Coventry | 8 |
| Derby | 3 |
| Hanley | 18 |
| Kidderminster | 6 |
| Leicester | 12 |
| Lincoln | 6 |
| Northampton | 6 |
| Nottingham | 11 |
| Sheffield | 13 |
| Wolverhampton | 14 |
| Total | 139 |
| **SOUTHERN PROVINCE :** | |
| Bournemouth | 9 |
| Brighton | 14 |
| Cambridge | 7 |
| Canterbury | 7 |
| Dover | 7 |
| Eastbourne | 1 |
| Guildford | 13 |
| Hastings | 2 |
| Ipswich | 10 |
| Luton | 16 |
| Maidstone | 8 |
| Norwich | 12 |
| Oxford | 4 |
| Portsmouth | 5 |
| Ramsgate | 6 |
| Reading | 19 |
| Ryde | 9 |
| St. Helier | 8 |
| Southampton | 9 |
| Tunbridge Wells | 4 |
| Total | 170 |
| **WESTERN PROVINCE :** | |
| Bristol | 23 |
| Cardiff | 23 |
| Exeter | 11 |
| Gloucester | 21 |
| Newport | 13 |
| Plymouth | 22 |
| Swansea | 15 |
| Torquay | 9 |
| Total | 135 |
| **IRELAND :** | |
| Belfast | 18 |
| Cork | 5 |
| Dublin | 18 |
| Limerick | 6 |
| Londonderry | 3 |
| Waterford | 6 |
| Total | 56 |

Grand Total, 988.

*Municipal Exchange.*

The only "municipal" exchange which can be said to have been in actual operation at Dec. 31, 1900, was that of the States of Guernsey, of which the following particulars are given :—

| Switch Rooms at | Subscribers connected direct. | Extension lines. | Public telephones | Junction lines. |
|---|---|---|---|---|
| St. Peter-Port ............... | 358 | 21 | 9 | 10 |
| St. Sampson's... ... ........ | 77 | 4 | 3 | 6 |
| Castel ....... ......... | 46 | 6 | 4 | 4 |
| St. Martin's .................. | 77 | 1 | 5 | 6 |
| St. Peter-Wood ... ......... | 21 | — | 2 | 2 |
| Forest ..... .................. | 8 | — | 1 | 2 |
| Braye-Road ... ............ | 19 | — | 2 | 2 |
| Totals ... ... ... ..... ..... | 606 | 32 | 26 | 16 |

Total number of lines of all descriptions, 694.

The St. Peter-Port exchange has, in addition, five service lines, six private lines, and three firemen's alarms.

## ELECTRICAL POWER IN BRITISH WORKS.*

BY W. GEIPEL, M.I.E.E.

It is a matter of no small importance to British manufacturers that they should take every possible precaution to adopt the most economical and efficient means of driving their machinery ; indeed, statesmen of the highest ability and greatest foresight, such as Lord Rosebery and Mr. Chamberlain, have recently warned us to be prepared in this century for a commercial and manufacturing struggle with other countries on a scale not hitherto experienced in the century which has just closed. To this end, then, let us first consider what are the defects in the existing methods of driving works, and how electricity can be utilised to obviate them. Older methods of operating important work in vogue in this country may be, broadly speaking, divided into three classes :—1. Works driven by one large engine, from which the power is transmitted by shafting to the various tools. 2. Works driven by separate engines, each receiving its steam through long pipes running from a central bank of boilers. 3. Works driven by boilers and engines scattered over the works.

*Class* 1.—In this case the engine should be already operating under the most favourable conditions—viz., with high-pressure steam and condensing, which, consequently, cannot be improved upon. On the other hand, the power is transmitted by ropes, belts, or gearing from the engine, by means of shafting, to the machinery, with a loss which may be small or great. I propose, then, briefly to discuss this.

*Loss in Shafting.*—In some cases where the works are compact and the machines are well placed the loss may be small ; as little as 20 per cent. and even less has been recorded ; but this is only obtained where the shafting is short, by using great care in the lining of the shaft and adjustment of the bearings, and by giving more than ordinary attention to the lubrication of the bearings ; it is, further, only obtained where the shafting and belts are well-proportioned to their work, and where the load on the machines is constant. In the majority of cases the loss is greater. I found at the Bristol Waggon Works, prior to the introduction of electric driving, it varied from 22 to 57 per cent., and in one case considerably more, while the loss generally was nearer 50 than 25 per cent. At the Hartlepool Engine Works Sir Thomas Richardson found it to vary from 25 to 70 per cent. ; the average was 43 per cent. At Furness, Westgarth & Co.'s engine works, Middlesbrough, in one shop where two long lines of shafting and a comparatively small number of tools were used, the loss was 75 6 per cent. ; in two other shops it was 59 and 42 per cent. In the United States Mr. C. H. Benjamin made somewhat exhaustive tests, from which I have compiled the following table.

It will be seen that the loss varies from 14 to 81 per cent., the average in six cases where the machines were doing heavy work being 62 per cent. and in six cases of light work 55 per cent. ; in the former, however, the load was generally variable, while in the latter there was a constant full load. It will be noted that the power transmitted in these tests was comparatively small, generally considerably under 100 H.P. The average H.P. per square foot of shafting was 0·046. The H.P. per bearing, column 7, is nearly as great for light as for heavy shafting, probably on account of the greater speed of the former. It is obvious, other things being equal, that the larger the works and the greater the average distance of the machines from the driving engine, the greater must be the loss in the shafting. It may be expected, therefore, that there are many works where the

| Nature of work. | Total H.P. | Percentage to drive shafting. | State of load. | H.P. per 100ft. shafting. | H.P. per 100lb. shafting. | H.P. per bearing. | H.P. per belt. |
|---|---|---|---|---|---|---|---|
| Wire drawing and polishing... | 400 | 39 | ½ | [illegible] | 0·58 | 1·37 | 1·76 |
| Steel stamping and polishing... | 74 | 77 | ¾ | [illegible] | 0·35 | 0·84 | 2·4 |
| Boiler and machine work ...... | 38 | 65 | ¾ | 4·77 | 0·21 | 0·55 | 0·48 |
| Bridge machinery ..... ......... | 59 | [illegible] | 1 | 3·28 | 0·13 | 0·34 | 0·52 |
| Heavy machine work............ | 112 | 57 | 1 | 5·7 | 0·23 | 0·58 | 0·45 |
| Heavy machine work............ | 168 | 54 | 1 | 8·55 | 0·31 | 0·8 | 0·47 |
| Light machine work ........... | 40 | 51 | 1 | 2·75 | 0·27 | 0·29 | 0·09 |
| Manufacture of small tools ... | 74 | 54 | 1 | [illegible] | 0·4 | 0·69 | 0·12 |
| Manufacture of small tools ... | 47 | 52 | 1 | 2·5 | 0·23 | 0·24 | 0·11 |
| Sewing machines and bicycles | 190 | 57 | 1 | 4·35 | 0·43 | 0·39 | 0·21 |
| Sewing machines ............... | 107 | 70 | 1 | 5·08 | 0·13 | 0·41 | 0·15 |
| Screw machines and screws ... | 241 | 47 | 1 | 6·13 | 0·38 | 0·63 | 0·23 |
| Steel wood screws .............. | 117 | 14·5 | ½ | 2·53 | 0·11 | 0·18 | 0·13 |

above losses are exceeded ; indeed, it has been stated that in a large cotton mill as little as 1 per cent. of the power of the engine is applied to the cotton itself.

*Class* 2.—In this case the steam may be economically generated by a central bank of boilers, but it is transmitted through long lengths of piping in which condensation and loss of pressure result, while the engines, apart from using wet steam at a low pressure, are in themselves usually of the most uneconomical type. First, then, there is the

*Loss in Steam Pipes.*—This is frequently the most serious loss of all ; it is one which is not readily appreciated, while on the other hand it is, generally speaking a continuous loss, not only throughout the day but also at night. In how many cases is steam shut off the pipe while the engine is not working, where it is the custom for the engine-driver to shut down by the engine, not the boiler, stop valve ? More especially does this question apply to engines used intermittently where the loss in the pipes forms an even greater percentage of the comparatively small power used. Further than that, even when the boiler stop valve is closed, how often is it the case that the steam is effectually shut off from the pipes ? My experience is that, in the vast majority of cases, the stop-valve leaks and allows the steam to pass into the pipes, so that continual condensation takes place. It is true that the pipes should be efficiently lagged, but even then the loss is considerable, while in most works, where long pipes are used, the lagging is either inferior or there is little or none at all. Roughly speaking, this loss in condensation amounts to no less than the equivalent in steam of half a ton of coal per annum per square foot of uncovered pipe surface, if continually under steam, and exposed to the atmosphere, while, with the best lagging, the equivalent is ⅛th of a ton. The importance of this loss is at once apparent if it be remembered that an aggregate pipe surface of several thousand square feet is frequently found in a large works.

*Loss in Engines.*—Where the engines are small and scattered throughout the works at a distance from the boilers, it is almost invariably the case that they are low pressure non-condensing engines. They may consume in steam anything from 50lb. up to 250lb. per I.H.P. per hour. According to Mr. Bryan Donkin, who tested 100 different engines taken at random, the average was 150lb. per I.H.P. per hour. Sir T. Richardson stated in a Paper read before the North-East Coast Institution of Engineers and Shipbuilders that he found the average consumption of 31 different engines in his own works, exclusive of losses in steam-pipes, to be 51lb. per I.H.P. per hour. The following table summarises the results of various tests which I made upon five engines which were at the time used to drive the Bristol Waggon Works. The engines varied in size from 100 H.P. to 8 H.P. The results are exclusive of losses in the steam pipes.

| Engine. | Lbs. steam per I.H.P. hour. | | |
|---|---|---|---|
| | Full load. | Normal load. | Light load. |
| 1 | 41 | 46 | 58·7 |
| 2 | 40 | 44 | 47·0 |
| 3 | 70 | 96 | 95·0 |
| 4 | 34 | 33 | 48·5 |
| 5 | 35 | 32 | 32·0 |

It is probable that in many cases, more especially where the engines are old, in bad condition, with leaky valves and pistons, badly packed glands, no drainage, and inefficient lagging, it will be found that the consumption of steam is nearer to the largest of the above figures than to the smallest. (I need not remind the members of this society that modern compound, or triple expansion condensing engines should not use more than 13lb. to 16lb. of steam.)

* Abstract of a Paper read before the Gloucestershire Engineering Society, February 19.

*Class 3.*—In this category are included works where separate engines may be comparatively large, each having its own boiler, or they may be small, such as are the engines and boilers found on steam cranes. If the engines are large the probability is that there is excessive loss in shafting, and the fact that the boilers are not banked in one place involves losses in the handling of the coal, and in the efficient working and management of the boilers, which are obvious. When the engines and boilers are small they are not only most wasteful in coal, but they involve great labour and attention, the upkeep is expensive; in fact, it is almost unnecessary to dilate upon the excessive cost of this system of operating a works.

ELECTRIC DRIVING.

We now come to the consideration of the chief subject of this Paper, and that is to ascertain how far electricity can assist in overcoming the losses we have discussed. In the first place, I am desirous that you should not misunderstand me, in that it is far from my intention to assert that electricity affords a panacea for all and every case of evil. I have occasionally examined works where there is little or no object in resorting to electric driving. More particularly is this the case where the engines and shafting are new and well designed and the works at the same time are compact. In such case the net gain might not pay a reasonable interest on the cost of making the alteration. There may even be exceptional cases where it would not pay to adopt electricity, notwithstanding that the consideration be made before the works are erected, but I have not yet seen or heard of such a case. Certainly, it is not possible to lay down a hard-and-fast rule on the subject, for each case must have its own due and full consideration. In order to facilitate this consideration, let us see what losses take place in the use of electric power, so that we may compare them with the losses already discussed. There is first the loss in the electric generator, which should have an efficiency of 90 to 96 per cent., depending upon the size. Next, there is the loss in the conductors between generator and motor, which depends upon the quantity of copper put into the conductors, on their length, and on the tension of the electricity. In an ordinary works using 200 to 400 volts the loss need not exceed 4 to 8 volts; it might average, say, 2 per cent. The loss in electric motors, stated as a percentage of full power, varies from about 8 to 25 per cent. The efficiency may be roughly stated as follows:—

| | | |
|---|---|---|
| 100 H.P. motors | 92 per cent. efficiency. | |
| 50 ditto | 90 | ditto |
| 25 ditto | 80 | ditto |
| 5 ditto | 85 | ditto |
| 2 ditto | 82 | ditto |
| 1 ditto | 79 | ditto |
| ½ ditto | 75 | ditto |

It will be seen that the efficiency varies considerably according to size, more especially in the case of the motors, but for the sake of comparison we may take the following as fair average efficiencies:—

| | | |
|---|---|---|
| Generators | 92 | per cent. |
| Conductors | 98 | do. |
| Motors | 85 | do. |
| Total efficiency | 76 | do. |

That is, at full load 76 per cent. of the power on the engine shaft is delivered at the shaft of the motor; deducting the friction of the engine, which will absorb, say, 10 per cent., we then have 68 per cent. of the I.H.P. of the engine delivered at the motor shaft; at three-quarter load it would be about 65 per cent., and at half load about 60 per cent. The efficiency of the electric machinery may vary slightly according to its design and the state of the load, but the above results may be taken as a fair average; you will not be far out if you take it that *two-thirds of the I.H.P. of the engine is delivered at the shaft of the motor.* We may now, I think, proceed to consider the saving possible in the various cases.

*Reduction of Loss in Shafting.*—In the case of heavy tools there should be no shafting necessary, as each tool would have its own motor. The light tools may also have each their separate motor, but this involves a heavy first cost, and very small motors, as we have seen, are less efficient. It is advisable and customary, therefore, to arrange the lighter tools in groups by means of a limited extent of shafting, operated by a larger motor. For example, whereas 20 machines, each using 1 H.P., require 20 motors, one motor of 10 H.P. may suffice to drive the whole group; thus the length of shafting through which the power passes is generally enormously reduced, while heavy driving belts or ropes, together with gearing, angle or otherwise, may be abolished. The loss, then, in shafting may be dispensed with in heavy tools and minimised in driving smaller tools. Further, it must be remembered that the motors may be easily switched on and off at will, and that while they are standing there is no loss, whereas in the case of shafting the loss is a continuous one. For machinery working intermittently this is a most important consideration. Take, for example, the not extreme case where 50 H.P. of machinery is running only half the full time, and that the shafting which drives it is absorbing continually 50 H.P., say, for 10 hours per diem, there would be 500 horse-power hours lost in the shafting, and 250 horse-power hours used by the tools, so that out of 750 horse-power hours two-thirds are wasted in shafting. There are many cases where the hours of use are less than one-half, and where the loss would be even greater. As we have already seen, the loss in transmitting the power from the engine shaft to the shaft of the motor is 24 per cent., or less than one-quarter, we are therefore in a position to estimate the saving which may be expected. In some cases it will be seen to be a large one, in others not so.

*Saving of Loss in Steam Pipes.*—The cables conducting the electricity from the generators to the motors take the place of the long steam pipes appertaining to Class 2. In the first place it must be remembered there is no loss incurred in these cables except during the time the motors are actually in use. Moreover, the loss which takes place is proportional, within limits, to the load on the motors. The actual loss may be made as small as you please by putting in plenty of copper. We have already seen that, at full load, the loss may average about 2 per cent., and for less than full load the loss would be smaller; so that it would appear to be almost negligible. It may be noted that the loss in the steam pipes cannot be minimised by increasing their size, for whilst increasing the diameter will reduce the loss of pressure at the distant end of the pipe, yet it increases the radiating surface and therefore the condensation, in the same proportion as the diameter is increased.

*Saving of Loss in Engines.*—I have already given data as to the consumption of steam in first-class engines, such as would be used in driving the generators. I put it from 13lb. to 16lb. of steam per I.H.P. per hour. You have also seen that 68 per cent. of the I.H.P. will be delivered at the shaft of the motors, so that the steam required per H.P. on the motor shaft would be from 19lb. to 24lb. per hour. We have further seen that the steam required by separate small engines varies from 50lb. to 250lb. per I.H.P. per hour, say from 55lb. to 275lb. per B.H.P. per hour, so that the saving of steam by the use of electricity on this score would be anything from 30lb. to 250lb. per horse-power-hour. When it is remembered that the amount of water evaporated per pound of coal is from 6lb. to 9lb., after making allowance for boiler feeding, &c., it will be seen that the saving in coal per horse-power-hour may vary roughly from 3lb. to 40lb. It is true that a consumption of 250lb. of steam is an exceptional one; I have only taken so outside a figure because of the authority of Mr. Bryan Donkin, who, as I have already pointed out, has found the average of 100 engines to be no less than 150lb. As a rule, I should expect to find the saving in coal nearer the smaller figure and somewhere between 3lb. and 10lb. per horse-power-hour. That the saving is considerable has been already demonstrated in a large number of works. At Sir Thomas Richardson's the steam which is now used for driving by electricity is generated by two boilers which have replaced no less than eight main boilers, and 23 auxiliaries that had been necessary on the old system. At the Bristol Waggon Works, five Lancashire boilers were required on the old system, whereas one boiler suffices to drive the works on the electric system.

*Saving of Water and Stores.*—I have pointed out that with small scattered engines it is generally the practice to work non-condensing, so that the whole of the feed water is probably lost, while we have already discussed the waste of steam in the steam-pipes and engines; it will suffice, therefore, to point out that in the case of electric driving by the use of a surface condenser, practically the whole of the water, hitherto used, will be saved, provided always there is a sufficiency of cooling water. The stores, oil, &c., used by one or two large engines are, of course, less than those used by a number of small engines, and the motors should use less oil than the shafting they displace.

With regard to Class 3, the individual losses in the shafting or in the engines may be less, but the total saving should in many cases be quite as much as in Classes 1 and 2. It is true that where the electric generators are working at considerably less than their full normal load, there will be an additional loss depending upon the state of the load. The amount thereof must be determined according to the works under discussion. With small works, or where the motors are large and the work very intermittent, it will be more necessary to consider this than in the case of larger works, where the variations in the loads in the individual departments tend to cancel each other, and produce an even load. One case I have in mind where it was found that, in replacing separate engines aggregating 1,000 H.P., the power of the electric generator, owing to this levelling, was only required to be 250 H.P. I should also remark that, where the load is variable, it is well to specify that the engine and generator shall give its maximum efficiency at somewhat less than full load, say at three-quarter load.

*Saving of Labour.*—In Class 1 this may be neglected, but in Class 2 it is obvious that more men are required to attend to a number of engines than to one, while in Class 3 there is the further saving of labour involved by the use of boilers scattered over the works, since the firemen are not utilised to their full extent, and there is a further loss of labour in distributing coal and dealing with ashes, &c.

*(To be continued.)*

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861–1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON.

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher "*THE ELECTRICIAN,*" Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to "*THE ELECTRICIAN*" Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in "*THE ELECTRICIAN,*" or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above.*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. ... | 13s. 6d. ... | 7s. 0d. | Post free, payable in advance. |
| Postal Union ... | 30s. 0d. ... | 15s. 6d. ... | 8s. 0d. | |

*New Volumes of "*THE ELECTRICIAN*" commence in April and October.*

## STEAM ENGINE SHIBBOLETHS.

A recent Paper read by Mr. J. S. RAWORTH before the Manchester section of the Institution of Electrical Engineers brought forward several points in connection with "The Application of Steam Power to the Generation of Electrical Energy." Some of these points appear to be fairly novel, embodying, as they do, the personal experience of an engineer of considerable prominence; other matters dealt with are trite and obvious enough. It is rather late in the day, for instance, to proclaim that "in a two-crank vertical [high-speed] engine it is better to set the cranks opposite than at right angles." Where is the steam engineer who seriously thinks otherwise? But Mr. RAWORTH is not always serious; much of his Paper, in common with much else that he has said and written, is in a jocular style that is only something more than a joke to those who know almost or quite as well as he does what is the serious meaning. Except as occasion for tittering, much of it is usually caviare to the general. Take, as an example, his concluding remarks, which bear upon the serious and important question of the flywheels of electric railway generating plants. "The great flywheel craze," he assures us, "has burnt itself out; English engines built for electric lighting purposes are driving tramcars most successfully; the appalling descriptions of 'destructive stresses' invented to frighten English buyers into purchasing American engines are to be found lying in the *Journal* of the Institution. There let them be." There are three general ways of trying to convince people about anything: the first is to argue the matter, the second is to bully them, and the third is to cajole them. Mr. RAWORTH's favourite method is the last of these three. He raises a giddy laugh, and in the whirling excitement of the moment the unthinking listener allows logic to fly off at a tangent, and drops helplessly into the humorist's expectant embrace. Conversions thus made are apt to be volatile; they rarely outlive emancipation from the vitiated atmosphere in which they are usually made. Some time ago, as an engineering preacher, Mr. RAWORTH advanced what he described as a doctrine of faith. Apparently, he has overlooked the fact that faith without works is dead, and that the deadest of all is that faith which has no more solid foundation than airy humour. It is certainly a new gospel that the arguments, which he says are to be found "lying" in the *Journal* of the Institution, were advanced in the interest of American engines or against the interests of English engines. There are plenty of English steam engine builders who are competent to provide engines on the lines of American practice. It is not at all a question of high versus low speeds. The English high-speed engineer can and does undertake electric traction work satisfactorily. But, with all deference to Mr. RAWORTH, we believe that, whether by high speed or by low speed, every English steam engine builder who would cater for large traction jobs, comparable with what is being done in the largest cities of America, must seriously tackle the flywheel problem. If ever this problem was a "craze" that has

"burnt itself out," it is a Phœnix that will arise out of its own ashes at the conjuring of every large traction job.

Turning to another part of Mr. RAWORTH's Paper, we find an interesting *résumé* of the history of the development of high-speed engines in this country. He notes the curious yet undeniable fact that the question, "How shall we drive a dynamo?" was almost ignored by "the established builders of large engines in Lancashire and Yorkshire," the solution being left to the skill of "comparative outsiders," such as WILLANS, BELLISS, BRUSH, BROWETT, FERRANTI, and MACLAREN. Mr. RAWORTH plumps for high speed. He likes Swiss engines, it is true, but not for the sober reason that any ordinary expert engineer might like them; "if I had a cotton mill and a large family of girls," he says, "I would have one of those engines just for a luxury, it would be quite as seductive as a picture gallery and less expensive." As an engineer, however, he plumps for high speed. Notwithstanding that the solution of the problem has been found in diametrically opposite ways in different countries, we are to believe that there is no salvation except in high speed. Now, high-speed steam engines have done, perhaps, more than anything else on the machinery market to advance electric lighting in the United Kingdom. But this has been because that type of engine better suited our local conditions than any other type, whether of English or of foreign design. Local conditions, however, which were operative in the days when electric supply from a given station was restricted to a short radius of urban dimensions or less, are not operative in the same sense or to the same degree nowadays, when we can place our generating stations far away from cities and equip them with sets counting a thousand horse power where formerly they counted half a hundred or less. The high-speed engine has been and should continue to be a most valuable servant to the electrical engineer; let him take heed, however, that it does not become his master. In the present condition, and in the immediate future prospects, of electrical industry in the United Kingdom there is more than one solution of the problem: "How shall we drive a dynamo?" There is room for both high-speed and low-speed; each has its own special merits, and cannot satisfactorily trench on the ground of the other. Let each individual undertaking be looked at in the light of its own special requirements; let there be no jocose shibboleths nor rigid creeds, and electrical engineering will all the more prosper in the land.

## THE APPARENT RESISTANCE OF A BALLISTIC GALVANOMETER OF THE MOVING COIL TYPE, AND A METHOD OF ALLOWING FOR THE DAMPING CURRENT.

BY DAVID ROBERTSON, B.SC.

When using a moving-coil galvanometer for measuring magnetic lines by the ballistic method it must not be forgotten that the motion of the coil itself alters the number of lines linked with the circuit, and that the deflection depends on the resultant of this change and that in the search coil. The induced current which causes the throw is generally of very short duration, the ordinary formula being based on the assumption that it has all passed before the moving system has travelled appreciably away from its position of rest, but the change in the galvanometer coil takes place throughout the whole swing. As a first approximation, however, we may assume that the effect of the damping current on the deflection is the same as if it were all produced in a very short time at the commencement of the motion.

Suppose that throughout the range within which the galvanometer coil moves the field is uniform in intensity but always radial in direction. This is very nearly the case in well-designed instruments. When the coil is moved so that the spot travels over unit scale distance, it will cut across a certain number of those lines, and this number will then be independent of the position from which its starts. Let $q$ denote the product of the number of lines cut by the coil in this distance and the number of turns which cut them—that is, $q$ is the product of the number of turns in the coil and the change produced by a unit deflection in the number of lines it embraces.

Now let a search coil of $n$ turns be joined in series with it, the total resistance of the circuit being $R+G$, of which G is the resistance of the galvanometer and R the remainder. Let a change of N lines be produced in those linked with the search coil, and cause an actual deflection $d$. The motion of the galvanometer coil will then have introduced $qd$ links into the circuit, and a simple corollary to Lenz's law shows that they must oppose the change in the search coil, and so make the deflection smaller than it would otherwise have been. Hence the net change in links is $Nn-qd$, and the quantity of electricity sent round the circuit is

$$Q=\frac{Nn-qd}{R+G}=kd,$$

where $k$ is the ballistic constant of the galvanometer, defined from the equation $Q=kd$, and may be found by means of a condenser, of a standard coil, &c.

Hence,

$$Nn=k(R+G)d+qd=k(R+G+q/k)d \quad . \quad . \quad (I.)$$

The correction thus takes the form of an addition $q/k$ to the total resistance, with the result that the galvanometer has an apparent resistance $G'=G+q/k$, which may be many times its actual resistance.

When the constant $k$ is found by means of a standard field, and the total resistance in circuit is the same for all our readings, the resistance of course cancels out and there is no need to find its apparent value. But when, as is usual for magnetic work, R is varied to give a sufficient range of sensibility, and also when $k$ is found from a condenser discharge, it is necessary to find it whether the actual resistance is known or not. It is best to determine it for each setting of the galvanometer, because in some instruments its value is influenced to a considerable extent by the adjustments of the level and suspension, which shift the coil into a different position in the field. It may be found by the half-deflection method, using a search coil in which a definite change may be repeated as often as may be required, instead of a battery. Find the deflection (momentary) with any convenient resistance, preferably as small as possible, in circuit, and then ascertain how much more resistance must be added to reduce this transient deflection to half its first value. The added resistance is then equal to the total apparent resistance of the circuit the first time.

Let G = Actual resistance of the galvanometer.
$q/k$ = Apparent increase described above.
$R_1$ = Total external resistance in circuit the first time.
$R_2$ = Resistance which must be *added* to half the deflection.

Then, $R_2=G+q/k+R_1$ . . . . . . . . . . . . (II.)

This enables us to determine $q/k$ if the others are known, or are measured in the usual way, but it is not really necessary to separate them if the search coil used for this experiment is the one to be used throughout.

A slightly different method, which has the advantage of showing whether the apparent resistance varies, and which does not require the exact adjustment of the deflection to any particular value, is to observe the throws produced by a definite change with a number of different resistances in the search-coil circuit. These should be chosen so that they cover the range of resistance to be employed when using the galvanometer. We may re-write equation (I.) in the form

$$Rd=Nn/k-(G+q/k)d=Nn/k-G'd. \quad . \quad (III.)$$

The term $Nn/k$ is constant for this experiment, R and $d$ being the variables. Hence this equation shows that the two

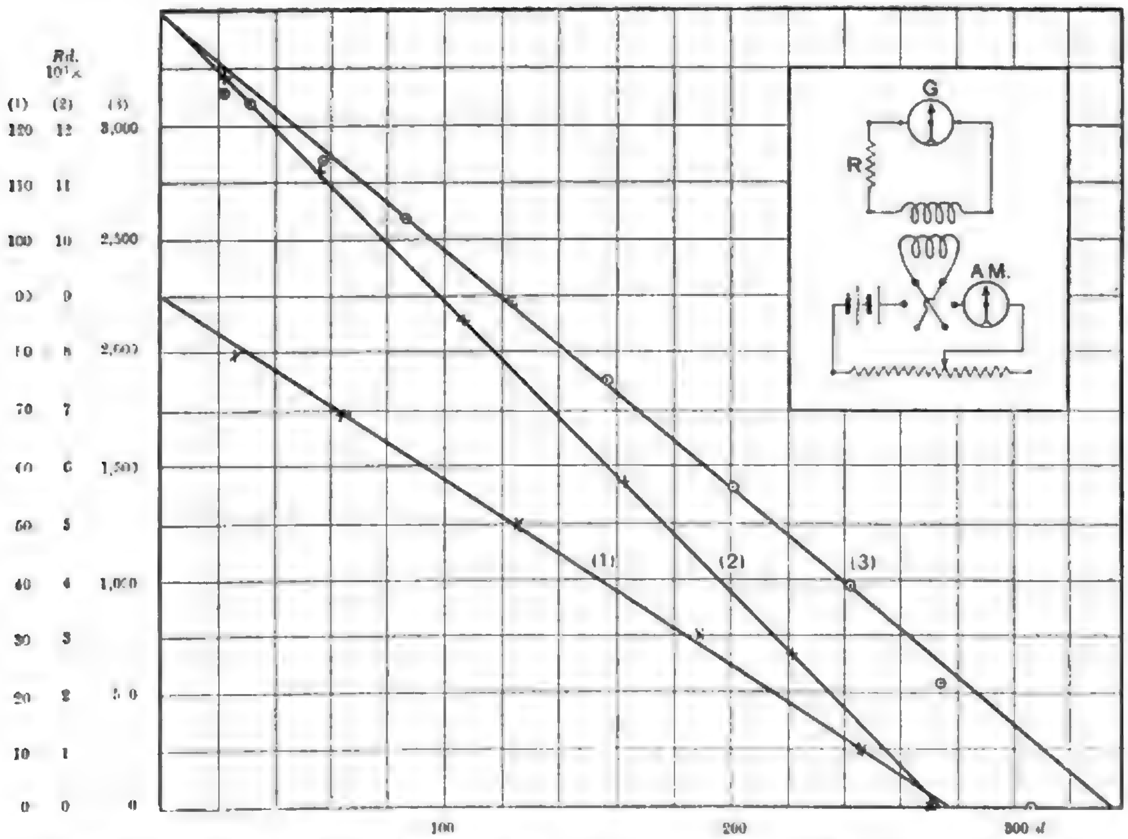


FIG. 1.—Curves of $Rd$ and $d$ from Experiments with Search Coil for finding the Apparent Resistance of a Ballistic Galvanometer (see Equation III.).

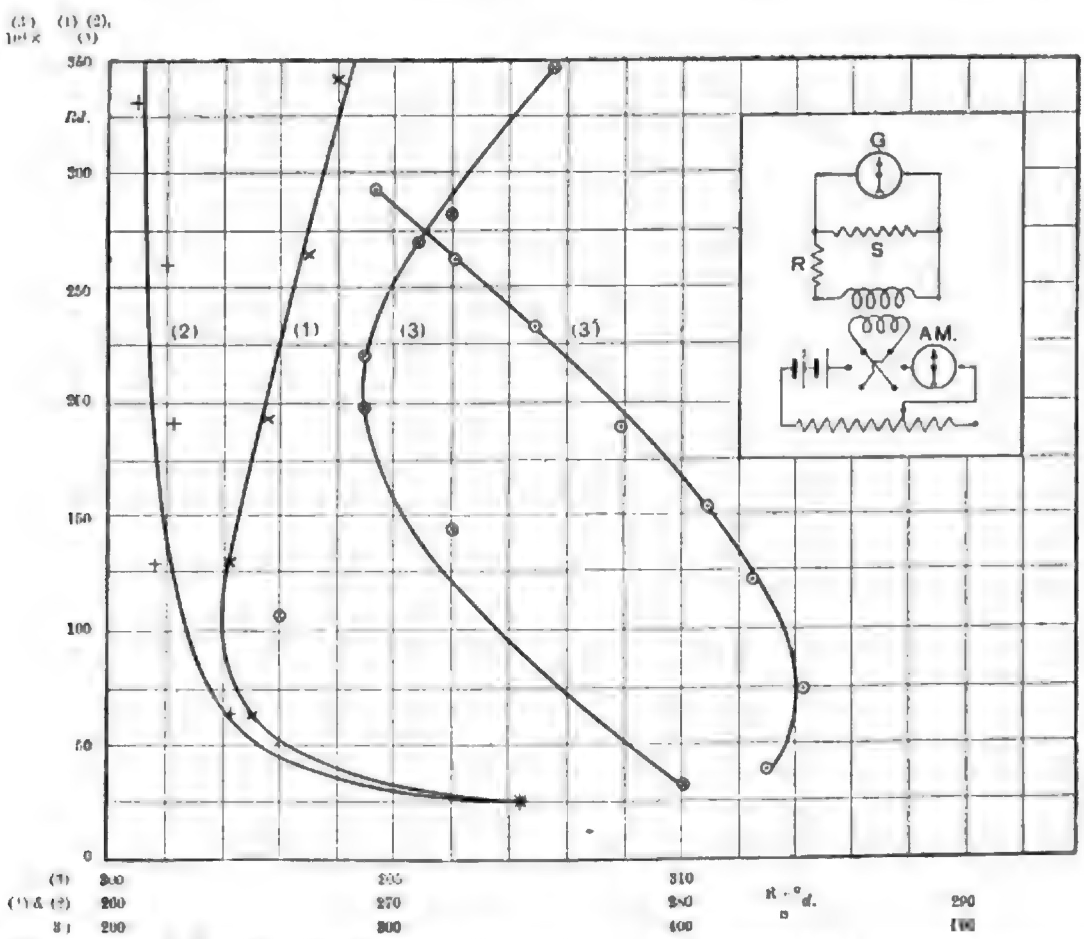


FIG. 2.—Curves of $Rd$ and $\frac{R+S}{S}d$ from Experiments with Shunted Search Coil (see Equation VIII.). Values of R:—(1) and (2) 1·27 ohms; (3) 1·13 ohms; (3') 10,000 ohms.

variables R$d$ and $d$ follow a linear law, and will be represented by a straight line if G′, the apparent resistance of the galvanometer, is constant. Also, that the slope of this line will give us G′. We can plot out a curve from our experimental data, having R$d$ as ordinates, and $d$ as abscissæ. In doing so it is convenient to include all the resistances except that in the box along with the galvanometer resistance in G′, to simplify the arithmetic, and then to make any necessary allowance afterwards. The deviation of the plotted points from the straight line will show how far our assumptions are justified for that particular instrument. The mean value for G′ is equal to the difference of the ordinates of any two points on this line divided by that of their abscissæ.

The writer has applied these principles to several instruments to see how far they may be safely used. Table I. gives some particulars of these instruments, and Fig. 1 gives the results of experiments like that just described made with each. It will be seen that the variation from the linear law for the low resistance coils (1) and (2) is very little indeed, while for discharge, yet owing to its very high apparent resistance it does not give such a large deflection with a given change of lines in a low resistance search coil.

Three values of the constant $k$ are given in the table. The first is that found by discharging a condenser of known capacity K microfarads, charged to a known potential V volts, through the galvanometer. For it

$$k = \mathrm{VK}/d \times 10^{-7} \quad . \quad . \quad . \quad . \quad . \quad (\mathrm{IV.})$$

The next is that found by reversing a known current of C amperes in a standard induction coil, and using the value of G′ previously found. If the primary has $p$ turns per centimetre of length, and the secondary $n$ turns in all and an effective area of A square centimetres, the other letters meaning the same as before, then

$$k = \frac{8\pi p \mathrm{CA}n}{(\mathrm{G}' + \mathrm{R})d} 10^{-10} \quad . \quad . \quad . \quad . \quad (\mathrm{V.})$$

The third value is that obtained from a knowledge of the steady current constant of the instrument, the time of vibra-

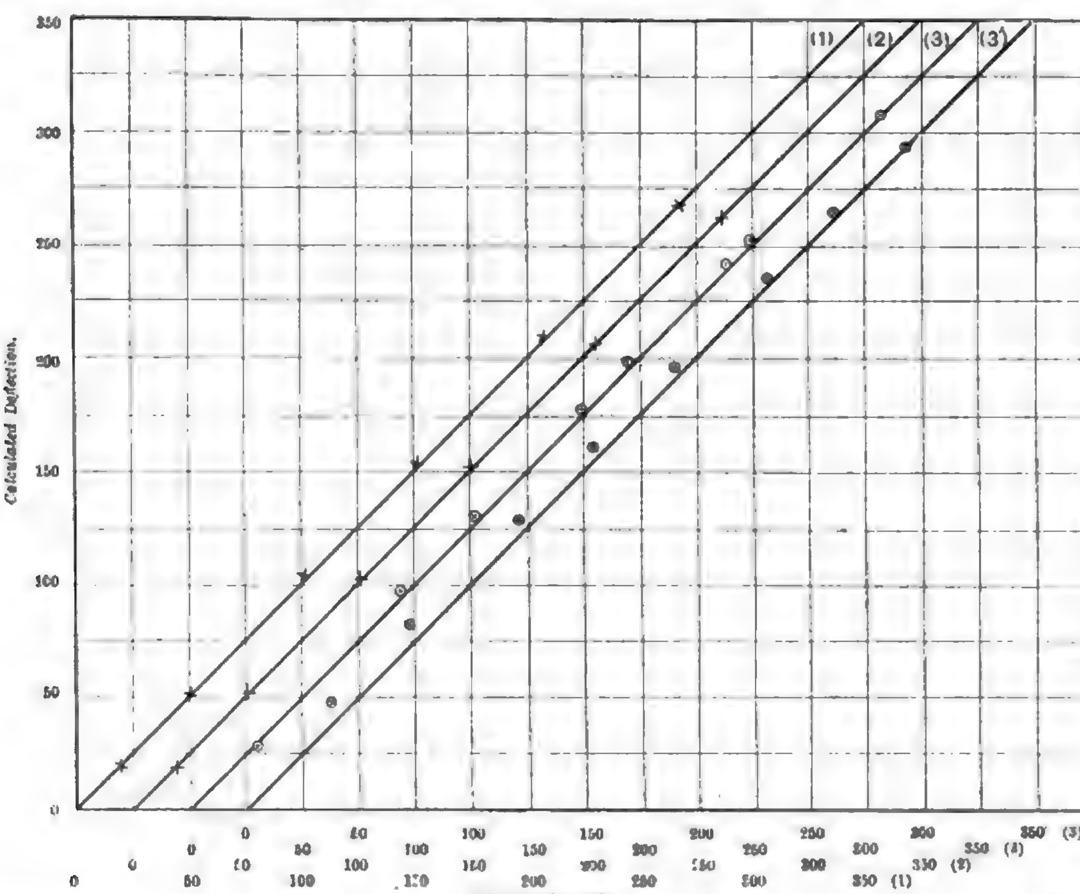


FIG. 3.—Shunted Search Coil Experiments. Comparison of Observed Deflections with those Calculated from Equation VIII. Values of R:—(1) and (2) 1·27 ohms; (3) 1·15 ohms; (3′) 10,000 ohms.

the other (3), it is only marked with very high and low resistances. They all do show a little concavity towards the origin. As we shall see, this is what we should expect when we take account of the fact that the damping current is distributed throughout the whole swing.

These results show that for some instruments this method of correcting for the damping comes well within the limits of experimental error, and for general work where the utmost accuracy is not required it is exceedingly handy. All the coils consists of wire only, without any metal frame, and so no currents are induced except in the coil itself. The damping on open circuit was small for coils (2) and (3) as will be seen from the logarithmic decrement given in the table. It is constant and may be allowed for in the usual way when necessary.

It is interesting to note that although No. (3) gives a much greater deflection than the others with a given condenser

tion of its moving system, and its logarithmic decrement. Let a cell of electromotive force, E volts, in circuit with the galvanometer and a resistance R ohms produce a deflection $\theta$. Let the coil make a complete oscillation to and fro in T seconds, and the logarithmic decrement be $\lambda$.

Then, if no shunt is used,

$$k = \frac{\mathrm{T}\left(1 + \frac{\lambda}{2}\right)\mathrm{E}}{2\pi(\mathrm{R} + \mathrm{G})\theta} 10^{-1} \quad . \quad . \quad . \quad . \quad (\mathrm{VI.})$$

These, of course, should all be alike, but it will be seen that the one which involves the apparent resistance—viz., that using the standard coil—is a little higher than the other two. This is because we have used the mean value of G′ instead of its value for the bottom part of the curves on Fig. 1. The factor involving the power of 10 in the above equations is to reduce to C.G.S. measure, and so give $k$ in C.G.S. units of quantity per division.

Table I.—*Particulars of Galvanometers.*

| Galvanometer. | Form of coil. | Dimensions of coil, outside and inside. Cms. | Suspension. Bronze ribbon. | No. of turns in coil. | Resistance at 12°C. Ohms. | Apparent resist. Search coil method. Fig. 1. Ohms. G'. | Apparent resist. Condenser method. Fig. 4. Ohms. G''. | Steady current constant. C.G.S. per division | Time of complete vibration. Secs. T. | Ballistic constants. C.G.S. pr.div. 1 scale div. = $\frac{1}{40}$in = 0·0635cm. Scale dist. = 100cm. = 1,575 div. Logarithmic decrement. λ. | Condenser method. Equ. IV. $k_1$. | Standard coil. Equ. V. $k_2$. | Absolute method. Equ. VI. $k_3$. | Highest resistance with which it is deadbeat. Ext. $R_e$. Ohms. | Total $G+R_e$. Ohms. | $\frac{G}{G+R_e}$ | Corresponding value of F from Fig. 5 | Reference number in text. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crompton Midget No. 15. | Circular | 3·25 diam. × 0·4 2·7 diam. × 0·4 | Bifilar. | Ab'ut 600 | 126·5 | 327 | 344 | 1·72 $\times 10^{-9}$ | 5·14 | 0·0336 | 1·35 $\times 10^{-9}$ | 1·46 $\times 10^{-9}$ | 1·43 $\times 10^{-9}$ | 12 | 139 | 0·910 | 0·344 | (1) |
| Nalder N.C.S., No. 7,896. Coil I. | Rectangular | 6·4 × 2·8 × 0·7 5·8 × 2·2 × 0·7 | Top: Single ribbon. Bottom: Spiral. | 20 | 18·36 | 50·6 | 51·8 | 4·05 $\times 10^{-9}$ | 7·3 | 0·824 | 6·54 $\times 10^{-9}$ | 7·14 $\times 10^{-9}$ | 6·64 $\times 10^{-9}$ | 23 | 42 | 0·437 | 0·196 | (2) |
| Ditto Coil II. | Rectangular. | 6·35 × 2·55 × 0·6 5·3 × 2·2 × 0·6 | Ditto | 1,000 | 887 | 10,500 | 10,200 | 38·4 $\times 10^{-12}$ | 22·4 | 0·155 | 146 $\times 10^{-12}$ | 154 $\times 10^{-12}$ | 147 $\times 10^{-12}$ | 5,200 | 6,087 | 0·145 | 0·070 | (3) |

We may apply the same method when we are using a shunted search coil, but the experimental results are not quite so satisfactory.

Let $d_1$ = Deflection which would be produced by the change of lines in the search coil if there were no damping currents.

$d_2$ = Deflection which would be produced by the alteration of the lines in the galvo coil alone on the former assumptions.

$d$ = Actual deflection = $d_1 - d_2$.

S = Shunt resistance (see diagram on Fig. 2).

And the other letters have the same meaning as before.

Then, $$kd_1 = \frac{Nn}{R + \frac{GS}{G+S}}\left(\frac{S}{G+S}\right) = \frac{NnS}{GR+RS+SG},$$

and $$kd_2 = \frac{qd}{G + \frac{RS}{R+S}} = \frac{qd(R+S)}{GR+RS+SG},$$

$$\therefore \quad kd = k(d_1 - d_2) = \frac{NnS - qd(R+S)}{GR+RS+SG};$$

$$\therefore \quad Nn = \frac{k(GR+RS+SG)d + qd(R+S)}{S},$$

$$= k\{(G+q/k)(R+S)+RS\}d/S. \quad . \quad . \quad . \quad \text{(VII.)}$$

Here again the correction appears as an addition $q/k$ to the resistance of the galvanometer.

From equation (VII.) we may obtain

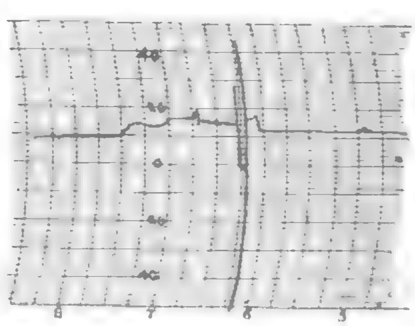
$$Rd = Nn/k - G'\frac{R+S}{S}d. \quad . \quad . \quad . \quad \text{(VIII.)}$$

This shows us that when S is varied the quantities R$d$ and (R + S)$d$/S follow a linear law if R and G' are constant. Fig. 2 gives the results of a set of experiments in which the search coil had a variable shunt. It will be seen that the plotted values of these two quantities do not lie on a straight line, and, indeed, they do not seem to follow any definite law at all, as in some experiments which were made the curves sloped in one way, and in others it was entirely different. One reason for this is that the quantity (R + S)$d$/S does not vary very much, and so any error in $d$ makes a great difference on the curve. But matters are really not so bad as they seem, for if we compare the observed deflections with those we would calculate from equation VIII., writing $(G'+R)d_0$ for N$n$/$k$, $d_0$ being the deflection when there is no shunt, the variation is seen to be much smaller, and for the low-resistance coils at least, quite negligible. The points on Fig. 3 are plotted with the observed deflections as abscissæ, and the calculated deflections as ordinates. The straight line in each case shows where they would lie if they agreed; a separate origin has been taken for each set in order to keep them distinct, and an extra one (3') has been drawn for the high-resistance coil with 10,000 ohms in the search-coil circuit. It does not agree so well as the others, but still is not far out.

(*To be concluded.*)

## AN INCIDENT WITH BARE COPPER MAINS.

We are indebted to Mr. C. H. Wordingham for the following interesting particulars of a recent incident on the mains of the Manchester electric supply works. An objection frequently urged against bare copper mains, even by those who admit their many points of superiority over any other class of main, is that in the event of a water-pipe bursting they may be short-circuited and greatly damaged. It may not be uninteresting, therefore, to give particulars of an instance in which such a mishap has occurred in Manchester. About 6:25 a.m. on the 28th ult. a 16in. cast-iron water main laid in Miller-street burst. Along the same street there runs a concrete culvert, containing five ½ sq. in. conductors, laid on



the Crompton system. Manholes about 3ft. 6in. × 3ft. 6in. × 5ft., provided with ventilating covers, are fixed at each end of the culvert. The main was not cut off until 7:30 a.m. No effect was felt at the station, and there was very little disturbance in the earth current, as will be seen from the accompanying figure, taken from the recording ammeter through which the connection to earth from the middle wire is made. The current rose from 12 amperes, the normal, to 17 amperes, then fell off to the extent of 2 amperes, and momentarily attained a sufficient value to throw a circuit breaker set for about 80 amperes; this circuit-breaker was restored within about 3 min., when the earth current was found to be only 14 amperes, remaining at this value until the main was cut off.

On opening out the culvert it was found that the water from the main had rushed through it, and the lower end—the street having a considerable gradient—was actually filled up with soil carried in by the water. On inquiry it was found that the water had entered the culvert, and had actually put a very considerable pressure on it, a pressure sufficient to force off the covers from both manholes. It was through the open manholes that the soil was enabled to enter the culvert. The pressure of water in the water main would be approximately 90lb. per square inch, and the amount of damage done to the roadway and footpath was very considerable, a great

deal of soil being washed away into the basements of the houses. The culvert was found to be uninjured, and after being thoroughly cleaned out was covered in again and the supply re-established by about 6 p.m.

## DIRECT-CURRENT GENERATORS.*

BY SIDNEY H. SHORT.

After briefly touching on the history of the dynamo and fully describing the construction of the modern machine, the author advocates the standardising of steam dynamos as follows :—

The mechanical construction of direct-current generators has been very well developed, and there remain, apparently, very few improvements to be made in it. We will, therefore, have to look in other directions for changes which will improve and diminish the cost of their manufacture.

Until recently multipolar generators were constructed with a limited number of poles, and to accommodate them to the various speeds and increasing capacities required, their proportions were distorted, as in the bipolar machines, with the unfortunate consequences always attendant on poor design. Recent machines are being built with an increasing number of poles, and generators of 1,000kw. with 14 poles, 1,600kw. with 16, and 3,000kw. with 24, are in successful operation with speeds ranging from 75 revs. per min. for the larger size to 90 revolutions for the smaller. It is apparent that modern design is tending to a greater number of magnets in the direct-current generator, and it is interesting to see that on the other hand the modern alternating-current machine is being made with fewer and fewer poles.

The frequency in modern direct-current generators is about 15 cycles per second, while in alternators for power transmission the frequency is as low as 25 cycles per second. Even in the mechanical construction and general appearance these two classes of machines are approaching each other, with this difference, that for the direct current the armature must revolve to carry on the process of commutation, while in the alternator the field magnets are made to revolve.

How far are these changes in design to be carried, and what are the causes acting to bring them about? Experience has taught us that there are certain mechanical, electrical and magnetic values, which, when strictly adhered to in the design of direct-current generators, produce the best working results.

We will apply the best average working values to a unit dynamo with one pair of poles, and for greater capacities add two or more of these units together in the form of multipolar machines to determine the best relation between speeds and capacities. The capacities of these machines thus made from unit dynamos will be fixed, depending on the capacity of the unit and the number of these units used in its design. The speeds of these machines will also be established, as we have in the unit dynamo adopted certain values depending upon speed.

I have taken for the unit dynamo a surface speed of 3,300ft. per minute for the armature.

For the commutator a peripheral speed of 2,500ft. per minute.

The teeth on the face of the armature have a pitch of 1in.

The commutator bars (550 volt generator) are 0·377in. wide, and the pressure between them is 10 volts.

Every inch of the periphery of the armature face carries at full load 500 amperes.

10·3 million magnetic lines pass through the magnetic circuit in this unit dynamo.

The density in the poles at full load is fixed at 95,000 lines per square inch, in the air it is 80,000, while in the teeth it reaches 120,000 lines. In the armature core the flux is reduced to 65,000 lines per square inch.

A fair average frequency for direct-current generators is 1,600 alternations, or 800 cycles per minute, therefore this unit must run when made into a bipolar machine 800 revs. per min. and deliver 137½kw.

The performance of this machine will in every way be good, for the various values taken are those most satisfactory.

Without making any changes in the dimensions of the parts or in the electrical and magnetic values, we will put two of these units together in the form of a multipolar generator. There will now be four poles, but they will have the same section and the same magnet spools. The armature will be doubled in circumference, also the slots and armature coils, commutator bars, brushes, brush holders, and various other parts, all being interchangeable with those of the unit machine. This four-pole machine will deliver 275kw. and the speed will be 400 revs. per min.

Applying these unit dynamos in the construction of an eight-pole machine, we find that it runs 200 revs per min., and has an output of 550kw. A ten-pole machine will run 160 revs. per min. and deliver 687kw. The following table gives the speeds, capacities and general dimensions of machines up to 30 poles, and in all of them we have not varied from our original data established for the unit dynamo.

*Unit Dynamo-Electric Machine.*

| *Mechanical Data.* | | *Magnet Data.* | |
|---|---|---|---|
| Pole pitch | 25in. | Induction air | 80,000 L. |
| Periph. speed armature | 3,300ft. | " teeth | 120,000 " |
| Tooth space | 1in. | " armature | 65,000 " |
| Periph. speed commutator | 2,500ft. | " poles | 95,000 " |
| Thickness bar | 0·377in. | " yoke | 35,000 " |
| Section pole-piece | 125 sq. in. | Altnations per min. | = 1,600 " |
| " yoke | 150 sq. in. | | |

*Electrical Data.*

| | |
|---|---|
| Kilowatt capacity | 137 |
| Amperes per inductor | 125 |
| Volts per bar | 10 |
| Pressure of machine | 550 V |

| Poles. | Revs. per min. | Amp. | Kw. | Arm. Dia. Feet. | Com. Dia. Feet. | Kw./100 Revs. |
|---|---|---|---|---|---|---|
| 2 | 800 | 250 | 137½ | 1·3 | 1·0 | 17·2 |
| 4 | 400 | 500 | 275 | 2·7 | 2·0 | 68·8 |
| 6 | 267 | 750 | 412½ | 4·0 | 3·0 | 154 |
| 8 | 200 | 1,000 | 550 | 5·3 | 4·0 | 275 |
| 10 | 160 | 1,250 | 687½ | 6·7 | 5·0 | 430 |
| 12 | 133 | 1,500 | 825 | 7·9 | 6·0 | 619 |
| 14 | 114 | 1,750 | 962½ | 9·2 | 7·0 | 844 |
| 16 | 100 | 2,000 | 1,100 | 10·6 | 8·0 | 1,100 |
| 18 | 90 | 2,250 | 1,237½ | 11·9 | 9·0 | 1,375 |
| 20 | 80 | 2,500 | 1,375 | 13·2 | 10·0 | 1,720 |
| 22 | 73 | 2,750 | 1,512½ | 14·6 | 10·9 | 2,070 |
| 24 | 67 | 3,000 | 1,650 | 15·9 | 11·9 | 2,460 |
| 26 | 61 | 3,250 | 1,787½ | 17·3 | 12·9 | 2,930 |
| 28 | 57 | 3,500 | 1,925 | 18·6 | 13·9 | 3,380 |
| 30 | 53 | 3,750 | 2,062½ | 19·9 | 14·9 | 3,820 |

A study of this table reveals the fact that when we have established certain running values to be used in the construction of multipolar generators, we must let the speed of the machine depend upon the output. In making up this table of speeds the unit dynamo adopted works out well for capacities up to 1,000kw. or 1,200kw. For the larger machines, however, it is possible to load the armature with 600 amperes or even 700 amperes per inch of periphery, thus lowering the number of poles, decreasing the diameter of the armature, and increasing the speed. A considerable variation in speed for a given output may be secured by varying the section of the magnetic circuit of the unit dynamo and the number used ; the range through which this change in speed can be made is, however, limited.

The advantages of a standard system of design as outlined here will be appreciated by manufacturers as well as by users of electrical apparatus, because of the interchangeability of parts and the certainity of uniformly perfect operation of every machine regardless of capacity. In all sizes of machines the same size pole-piece would be used. The magnet spools would all be interchangeable. The armature coils would all be alike. The brushes, brush-holders, and all the connecting parts would be made after the same patterns. The slots in all the armature laminations would have the same width and depth. These conditions, if existing, would greatly cheapen the cost of manufacturing dynamos ; therefore the prices charged the purchaser.

The steam engine stands in the way of accomplishing these results. The speeds and capacities of engines have been established by their makers without reference to the best conditions for the successful operations of the generators they are to drive.

For the smaller dynamos, as you will see by the table given above, speeds of from 300 to 800 revs. per min. are permissible and entirely proper, but when the larger capacities are reached, the speed must be lowered in order to obtain good performance, especially for traction generators. I hope therefore, that the builders of engines and the manufacturers of direct-current generators will co-operate in establishing a satisfactory scale of speeds and capacities for steam dynamo sets.

* Abstract of a Paper read before the Manchester Section of the Institution of Electrical Engineers, on March 26.

**Electrical Barge Canal for New York State.** An important system of State canals is projected, the boats to be run by electricity and to be 150ft. long by 25ft. wide, with a draft of 10ft., and to travel in fleets, going from Albany to Buffalo in less than three days. The canals will be able to carry 15,000,000 tons of freight in a season of seven months. For building an Erie barge canal on the route favoured the cost will be $49,000,000 ; for deepening the Oswego canal to 9ft., $859,026 ; for deepening the Champlain canal to 6ft., $5,472,000 ; total cost of canal improvement, $55,331,026.

# SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.*

BY A. C. EBORALL.

*(Continued from page 859.)*

## II.—Some Features of Working.

With regard to asynchronous motor generator sub-stations there is practically nothing to be said, on account of the simple character of the equipment and its operation. Two points must be kept in mind, however—the sets must be run as fully loaded as possible, and the motor air-gaps must be watched. As the power-factor of the motors will be less than 90 per cent. below three-quarter load, running the machines well loaded becomes even of greater importance than with other classes of electrical machinery in order to avoid heavy, lagging currents in the feeders. As a matter of fact, it is a good thing to overload such motor generators (in moderation) before adding a machine to the 'bus bars, for then a high power-factor over a wide range of load is assured; the risk is very small, on account of the rapidity with which another set can be started up and put on the circuit. The other point just mentioned—relative to the air-gaps—is of some importance on account of the small clearance in the motors. As with all induction motors, the air-gap length is determined wholly by mechanical considerations; being made as small as possible in order to get high power-factors, it becomes necessary to check it from time to time in order to make sure that the gap at the bottom has not decreased to a dangerous extent. With large induction motors the gap (iron to iron) will be originally about $\frac{1}{450}$th of the rotor diameter—a 200 B.H.P. motor would thus have a clearance of 0·1in. with a rotor diameter of $3\frac{3}{4}$ft., so it will be seen that no considerable diminution of this length can be allowed on account of the magnetic pull, even assuming exceptionally stiff shafts. The stator case of such motors should never be cast with the bed-plate, for if it is separate a thickness or two of metal foil can be inserted between the feet of the case and the bed-plate seatings, by removing which the gap at the bottom can be increased when the brasses have worn to such an extent that something must be done, and yet not enough to justify their replacement altogether.

With sub-stations employing synchronous machinery, such as synchronous motor generators or rotary converters, several highly interesting and important features of working present themselves. The first is the regulation of the power-factor, and has already been mentioned in connection with rotary converters—the power-factor at any load on the machine can be regulated to the extent necessary in practice by adjusting the field excitation. The curves shown in Fig. 4 give a good idea of the practical case—they are curves taken for the purpose of this Paper from the 650 H.P. Kolben three-phase motor forming part of the motor generator illustrated in Figs. 5 and 6, and whose test curves are given in Fig. 8. The shape of the no-load "V" curve of a synchronous machine is an indication of its performance—a very broad curve indicates, for instance, a motor of but moderate over-load capacity, and one that will require but small alterations in the excitation for varying loads; while a very steep curve indicates a machine that must work always with its excitation properly adjusted, otherwise its overload capacity will be small and its parallel running properties inferior; at the same time this latter type of curve is a characteristic of machines with close pressure regulation.

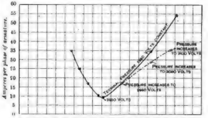


Fig. 4.—"V" Curves for 650 B.H.P. Three-Phase Synchronous Motor. Constant Speed. Constant Load.

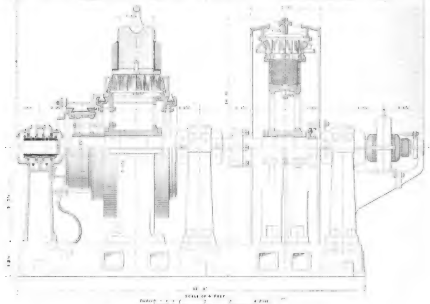


Fig. 5.—450kw. Three-Phase Synchronous Motor-Generator for Prague Tramways.
Speed, 240 revs. per min.; frequency, 48 ∼ per sec.; volts, 3,000/600-650. Constructed by Kolben & Co., Prague, Austria.

---

* Paper read before the Institution of Electrical Engineers, March 14.

When the machine is loaded the "V" curve alters somewhat with regard to position and shape on account of the increased armature leakage, as indicated in Fig. 7. The amount of this alteration is an indication of the quality of the armature design in this respect—the smaller the alteration in shape, and the less the inclination of the axis *ab* from the vertical, the smaller the pressure drop, and the smaller the increase of excitation necessary for the motor from no load to full load in order that it may work under the best conditions.

Synchronous machines, whether motors or generators, should be so designed that the shape of their "V" curves lies between the two limits mentioned above, for then excellent parallel running, high over load capacity, and good pressure and excitation regulation will all be attained; otherwise one or other of these necessary good qualities will be attained at the expense of the remainder. Running as generator, then, the full-load drop of the machine at constant speed and excitation should be in the neighbourhood of 5 to 6 per cent. with 100 per cent. power-factor, and 18 to 20 per cent. with 80 per cent. power-factor. Better regulation than this is not asked for in modern practice, with units of medium and large output; nor is it desirable, especially when sub-stations employing synchronous machinery are fed from them; with better regulation abnormal synchronising currents may pass between the main units, inviting

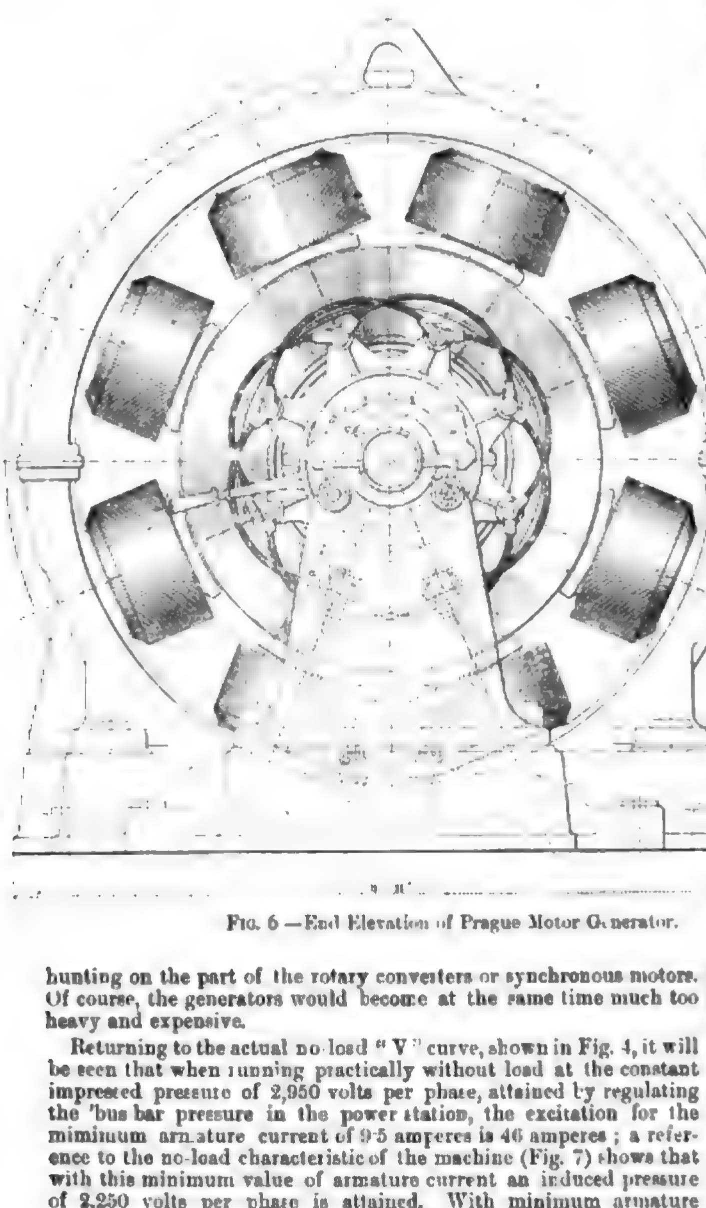


FIG. 6.—End Elevation of Prague Motor Generator.

hunting on the part of the rotary converters or synchronous motors. Of course, the generators would become at the same time much too heavy and expensive.

Returning to the actual no-load "V" curve, shown in Fig. 4, it will be seen that when running practically without load at the constant impressed pressure of 2,950 volts per phase, attained by regulating the 'bus bar pressure in the power station, the excitation for the minimum armature current of 9·5 amperes is 46 amperes; a reference to the no-load characteristic of the machine (Fig. 7) shows that with this minimum value of armature current an induced pressure of 2,250 volts per phase is attained. With minimum armature current at a given load, the difference between the impressed pressure and the back pressure—that is, the difference between 2,950 and 2,250 volts in this case—is a measure, among other things, of the quality of the motor from the point of view of pressure regulation; the difference between the two pressures under those circumstances is due to the impedance of the armature and to the pressure and current beats which occur with all synchronous machinery with a constant load and excitation on a synchronous motor or rotary converter, the back E M F. is continually changing its phase relative to the impressed pressure, a result directly due to variations in the angular velocity of the generators, assisted by the momentum of the machine itself. At constant impressed pressure a decrease or increase of excitation, corresponding to a decrease or increase in the back E.M.F., causes a fairly rapid increase of the armature current (and apparent watts) taken by the motor. At a given load, for any value of the motor excitation, a definite value of back E.M.F. takes such a (mean) position in the vector diagram that the resultant of it and the impressed pressure has a value equal to the impedance pressure of the armature. If the excitation be increased above the value corresponding to maximum power-factor, the impressed pressure at the terminals of the motors must of necessity lag behind the current in order that the above-mentioned relations are maintained; for the impedance pressure has a constant phase angle relative to the current in a given machine. On the other hand, if the excitation is less than the critical value, then the impressed pressure must lead the current for the same reason.

From the "V" curve, and knowing the various losses and constants of the machines, it is possible to make an approximate calculation of the amount of lead or lag that can be given to the current. For this 650 H.P. motor running light, the maximum lead works out to be about 75deg., while the maximum lag is about 70deg. In general, it is not possible to obtain more of the "V" curve than shown in Fig. 4, for, if pushed much farther, the running of the motor becomes unstable, hunting is set up, and the machine drops out of step.

The two legs of an experimentally obtained no-load "V" curve always differ—one is invariably straight, the other convex (cf. Fig. 4). In this respect the curves thus obtained from well designed commercial machines differ somewhat from the theoretical curves, in which, as Steinmetz has proved,* one leg is convex, the other concave. This difference between theory and practice in this respect is due to armature reaction and to the influence of the highly saturated armature teeth when the current is greatly leading or lagging.

The dotted curve to the right of the "V" curve (Fig. 4) illustrates clearly what happens in a transmission plant when the impressed pressure on the synchronous machinery is not maintained constant, but is left to take care of itself; the pressure at the ends of the feeders rises steadily with increased excitation of the synchronous machines. In this case the 1,000kw. generator supplying current to the motor (through a long three-core cable) had its excitation adjusted once for all at the beginning of the second test to such a value that the impressed E.M.F. on the motor was the same as before—namely, 2,950 volts, *when the armature current had its minimum value.* The excitation of the synchronous motor was then increased, the dotted curve showing the increase of (leading) armature current; the effect of this was to raise the impressed pressure on the motor, that is, the pressure at the ends of the long feeder, from 2,950 to 3,100 volts. That is to say, the drop in the feeder (which possessed a considerable inductive drop, owing to the presence of a choking coil in series at the station end) was first wiped out, and then the pressure at the sub-station end was gradually increased to the extent of over 5 per cent., simply by increasing the excitation of the motor. The frequency, of course, was constant throughout the tests, and consequently the motor speed also.

A little consideration of the above described characteristic of synchronous motors will show at once how valuable machines of this class become in connection with any transmission plant, on account of their condenser action; it will also show the great superiority of synchronous motor generators and rotary converters over an asynchronous machine for sub station purposes, from the point of view of the regulation of the system, and the line losses, &c. Instead of having a lagging idle current throughout the system, wasting energy and impairing the regulation at all points, the power-factor of the system can be kept practically at or above unity throughout the effect of pressure drop in the feeders can be nearly annulled, if desired, and there will be no other losses except those corresponding to the load, unless it is desired to work with a considerable leading current in order to raise the pressure at the sub-station ends of the feeders, as described.

It is not possible to get a power-factor of *exactly* unity in the circuit, by adjusting the excitation of a motor running light, so as to obtain minimum armature current. That is to say, the bottom of the "V" curve does not mean that the current running into the armature of the motor is in phase with the impressed pressure; it is very nearly in phase, but not quite, owing mostly to the difference in the E M.F. waves of line pressure and motor pressure. Large synchronous motors, when well loaded, and if of good design, generally have full load power-factors of 96 to 98 per cent. when working at the excitation corresponding to minimum armature current.

In practice the utilisation of the phase rectifying properties of synchronous (motor) machinery works out as follows:—With rotary

* See "Alternating Current Phenomena," by C. P. Steinmetz. (Whittaker & Co., London; W. J. Johnston Co., New York.)

converter sub-stations, if the machines are compounded, the power-factor of the system will be nearly unity at about half load, the current lagging somewhat before this, and leading afterwards, in accordance with what has already been said in this connection; at full load the drop in the feeders supplying the sub-station will be considerably reduced. If the rotaries are shunt wound, or if synchronous motors are employed, the field current is so adjusted that the power-factor is highest at about three-quarter load—at both lighter and heavier loads the current is somewhat out of phase, the minimum power-factor being, say, 0·95. Or, if heavy overloads are expected, the machines had best be somewhat over excited at full load in order to increase the impressed pressure, especially if synchronous motors, for the overload capacity is thereby increased, the torque being proportional to the square of the impressed pressure. Thus with a synchronous motor generator sub-station, if the motors are well designed, it is not necessary to alter the excitation continually with the load; but two adjustments between no load and full load will be generally advisable, in accordance with what has been said above. The small amount of field regulation required in practice with well-designed synchronous motors is well illustrated by Fig. 7.

If a sub-station equipped with synchronous machinery has to work in parallel with large inductive loads, such as large induction motors, or another station arranged with asynchronous motor generators, it is as well to arrange for the lagging current to be balanced by the synchronous machines. That is to say, the synchronous motors or rotary converters will be liberally designed, in order that they may carry the balancing leading currents (and increased excitation) in addition to the load.

A word or two may be said here regarding the overload capacity of the three classes of sub-station equipment. With motor generator sub-stations, what may be termed the permanent overload capacity depends only on the direct-current machines, that is to say, it will be in general about 20 per cent. for two hours, the position of the brushes on the direct-circuit machines remaining unaltered. With rotary converters the corresponding overload capacity is of course greater, and in practice is determined, as a rule, by the commutator heating. The commutators of rotary converters invariably have peripheral speeds bordering upon the upper limit of good practice—say 3,000ft. per minute—consequently an overload of about 30 to 40 per cent. for two hours is about as much as can be furnished without overheating the commutators. If it were not for this, and provided the field system was well over-excited, the over load capacity could be safely taken to be 50 to 60 per cent. for the time stated; it would be determined by the permissible safe temperature rise of the armature coils and step-down transformers. It is hereby assumed that these latter are artificially cooled by means of cooling pipes in the oil, or by forced draught, the normal temperature rise being 35°C., conforming in these respects to good modern practice.

What has been called the "permanent overload capacity" above is, however, really of minor importance in practice, for the plant would not be subjected to such treatment except when being taken over, or when a breakdown occurs. The important point, particularly with sub-stations feeding tramway or railway systems, is the momentary overload capacity, that is to say, the effect of short circuits of brief duration has to be considered. Regarding this point, it may be at once stated that the three classes of equipment are perfectly satisfactory, and, moreover, from this point of view, there is but little to choose between them. Well-designed asynchronous and synchronous motors and rotary converters fed from a well-designed power station will all stand overloads of 100 per cent. for a few seconds without falling out of step, the two classes of synchronous machines behaving in a very similar manner to the asynchronous machines. This is about the safe limit of overload capacity for standard machinery—the short circuit, or whatever it may be, causing the momentary overload is naturally unexpected, and consequently the plant, as a rule, cannot be stiffened up by field regulation to stand more, or to stand this amount for a longer period with safety. It does not follow that the machines will drop out of step, although asynchronous motor generators designed for high efficiency would probably pull up; the synchronous motors or rotaries would generally become unstable in their running, and start hunting.

With regard to the falling out of step of synchronous machinery, it may be observed here that once this happens the inherent tendency of a machine to pull itself in again is determined by the torque it can exert in a very short time, namely, half a cycle; consequently, if there is any load on the machine, it must necessarily pull up. Should a momentary short circuit pull out the circuit breakers in the power station, or otherwise break the circuit on the alternating current side of the converting machinery, it is always necessary to give the sub-stations time to shut themselves down rather than immediately replace the circuit breakers while the converting machines are still turning. Under these latter circumstances even induction motors will not run up to speed, while the synchronous machinery forms simply a pulsating short circuit across the mains, a synchronous motor or rotary acting alternately as motor or generator relative to the transmission lines and gradually pulling up. Before this happens, the circuit breakers will be out again; apart from this, it would, in general, be impossible to keep in the circuit breakers on the direct-current sides of the converters.

One of the most important questions to be considered in connection with the design and operation of a synchronous sub-station equipment is that of parallel running. The converting machines have not only to run perfectly in parallel with one another, but the various sub-stations have to run perfectly in parallel with one another and with the power station also. In most modern installations this requirement has been easily attained, but in others great difficulties have arisen, and have had to be got over at great cost before satisfactory working

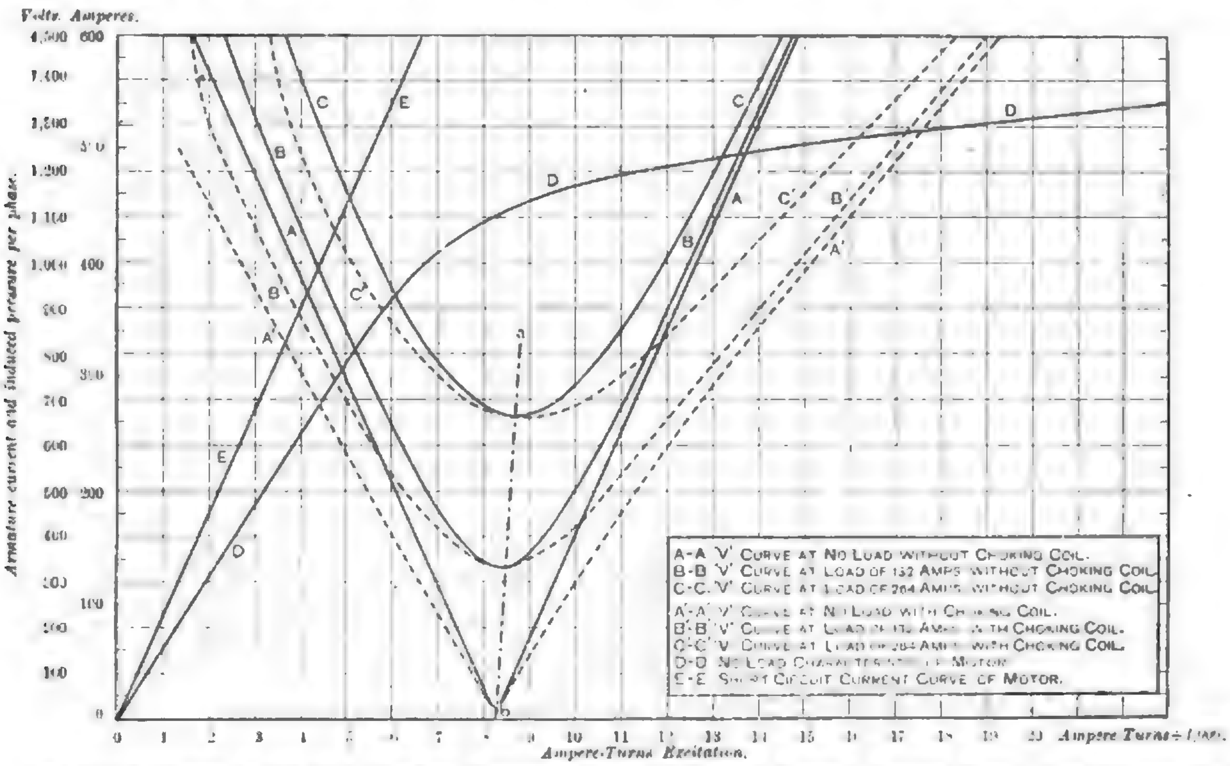


FIG. 7.—"V" Curves for 725 B.H.P. Two Phase Synchronous Motor at Constant Pressure. Constant Speed. Three Different Loads.

over the whole system was attained. It is, therefore, of interest to discuss as briefly as possible the leading features of the question.

With a rotary converter sub-station, for instance, unless every detail of the system is thoroughly well designed, from the engines in the power station to the rotaries themselves, there will be trouble with regard to the parallel running of the machines—that is to say, they will hunt. The term hunting, as applied to synchronous machinery of this character, means that while running at synchronous speed (as measured by a tachometer) the machines oscillate between themselves—that is, during a revolution they increase and decrease their angular velocity above the mean velocity, corresponding to exact synchronism, causing the armatures to swing backwards and forwards from a fixed point (in a precisely similar manner to the swing of a pendulum) while still keeping in step. The effect of this is to cause the pressure on each side of the rotary to fluctuate more or less badly, so that working at constant pressure

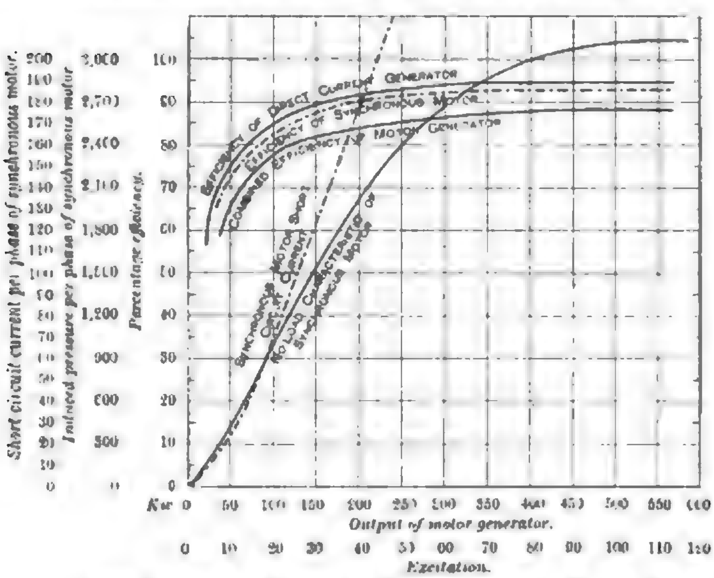


FIG. 8.—Results of Tests on 450 kw. Synchronous Motor-Generator, Prague Tramways. Speed, 240 revs. per min.; frequency, 50 cycles; volts, 3,000/600-650 per phase.

on the direct-current sides becomes impossible. Once a rotary has started hunting, unless the small oscillations are immediately checked, they will invariably continue to increase in amplitude until the armature swings over and loses synchronism.

*(To be continued.)*

## CORRESPONDENCE.

### 200-VOLT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We notice that at the Board of Trade inquiry into the question of the change of electrical pressure several expert witnesses brought forward the subject of the inefficiency of the 200 volt lamp. It may be of interest to state that we have lately been carrying out tests on both 200 and 100 volt lamps, and we may mention that we have found, taking an average number, that the 200 volt lamps of one maker consumed at start 4 watts per candle, increasing to 4·3 watts per candle after 500 hours, whereas the same maker's 100 volt lamps consumed 3·5 watts per candle at start, increasing to 3·7 per candle after 500 hours. In the case of another maker the 200 volt lamps had an efficiency of 2·8 watts per candle at starting, increasing to 3·2 watts per candle after 500 hours, whereas the 100 volt lamps by the same maker consumed 3·1 watts at first, increasing to 3·7 watts per candle after 500 hours.

Of course, it is not our place, as independent testing authorities, to offer opinions on results, but we give these results for what they are worth, hoping that they will be of interest.—Yours, &c.,

THE ELECTRICAL TESTING LABORATORIES (LTD.).

Westminster, March 30.

### ALUMINIUM AS AN ELECTRODE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to the Contemporary Science Note in your Journal of to-day, p. 864, I should like to point out that the film formed in alum solution, and which produces the high resistance spoken of, is basic aluminium sulphate. See *Proc.* Roy. Soc., Vol. LXIII., p. 329, in which the effect of variation of temperature and current density upon the resistance of these films, as well as other matters, is dealt with.—Yours, &c.,

London, March 29. ERNEST WILSON.

### RECENT WORK ON DIFFUSION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There are one or two slips in your notes on Dr. Brown's recent lecture at the Royal Institution, which should, I think, be corrected. The process he employed was one of intermittent diffusion of a solution of sodium sulphate into a jelly containing a solution of barium chloride. His equidensity lines were shown to be identical, not with the equi-potential lines for two equal charges placed at a short distance apart, but for a charged *disc* having the same area as the orifice through which diffusion takes place.

It is hardly necessary to point out that the stream lines corresponding to a series of equidensity confocal ellipses are confocal hyperbolæ, not "rectangular hyperbolæ."—Yours, &c., E. W. MARCHANT.

London March 29.

## PARLIAMENTARY INTELLIGENCE.

### FALKIRK AND DISTRICT TRAMWAYS BILL.

The commission appointed under the Private Legislation (Scotland) Act, 1899, has considered the Falkirk and District Tramways Provisional Order. Power is sought to incorporate the Falkirk and District Tramways Co., and to empower the company to construct and maintain electric tramways within the burgh. The capital is £150,000 in £10 shares.

The tramway route is a circular one, starting at Falkirk, going to Carron, thence to Stenhousemuir, passing Larbert, and through Camelon to Falkirk again. Five petitions were presented against the order. The petition of the North British Railway Co. has been withdrawn.

The Caledonian Railway Co. complained that the overhead trolley wires would obstruct the passage of vessels with masts along the canal. The Carron Company and two sets of frontagers made up the list of objectors.

The CHAIRMAN (Lord Clifford of Chudleigh) said the commission wished for evidence to show the obligations or advantages the promoters were getting for the payment of £100 per mile per annum to the burgh and £40 per mile per annum to the County Council.

Mr. D. RONALD, C.E., burgh surveyor, Falkirk, thought the contribution of £100 per mile per annum by the company to the town for the upkeep of the road was fair. After five years the contribution would be £125. For that they must keep in repair the roadways, excepting the tramway rails.

Mr. J. MORE, jun., C.E., engineer for the promoters, said the total cost of the undertaking was £59,878. As to the objection of the two frontagers that there would be less than the statutory 9ft. 6in. between the rails and the kerb, there were many cities and towns where this was the case. He said the Caledonian Company wished the promoters to take the risk of the Bainsford and Camelon bridges in perpetuity, but this the promoters could not do. The bill gave powers to the proposed company to supply electric current to other consumers. The canal bridges had to be built to the satisfaction of Falkirk Council, and if the Council wished one kind of bridge and the Caledonian Company another, they would find a way of accommodating all parties. The company might carry their feeders in the old roadways under the canal, on the bridges themselves or overhead. If the feeders were on the canal bridges and the latter were both opened at the same time the circuit would be broken and the cars would stop, but the stoppage would be only momentary.

Mr. STEPHEN SELLON said if Parliament made it an absolute condition that there should be 9ft. 6in. between the tramrails and the kerb, the whole tramway industry of this country would be stopped. He was surprised at the attitude taken up by the Caledonian Company with regard to the electric feeders at the canal bridges. If it were necessary to obtain the consent of the Caledonian Company to placing the feeders in the old roadways under the canal at the bridges, and they refused it, the promoters would get over the difficulty caused by stopping the cars in consequence of the opening of the bridges, and the breaking of the circuit. All they would require to do was to put down a storage battery, which would supply current as long as the bridges remained open, for half a day if necessary. The battery would supply the section of the system that was cut out when the bridges were open for the passage of vessels. The battery would be connected by a feeder to the trolley wire.

Counsel asked Mr. Sellon if the storage battery theory had just dawned upon him?

Mr. SELLON said that owing to the obstinacy of the Caledonian Company a difficulty has arisen with reference to the continuous supply of electric energy, and he was asked to find a way out of that difficulty.

Mr. D. A. MATHIESON, engineer for the Caledonian Railway Co., said the traffic on the canal amounted to a million tons per annum. Vessels of 100 tons, fishing boats and yachts used it, the height of the masts reaching in some cases to 70ft. The present bridges at Bainsford and Camelon were sufficient for the traffic, and cost little for maintenance. The new bridges would cost very much more for maintenance and working. The practice was for undertakers putting up new bridges to undertake the burden of maintenance, and the promoters should undertake that burden in the present case. It was perfectly fair the promoters should not only reconstruct these bridges, but be liable for their maintenance in perpetuity.

After hearing further evidence the CHAIRMAN said there were two points on which there was serious opposition. The first was the maintenance of the bridges, and on that question the commission suggested a compromise—that the cost of maintenance of the new bridge might be divided. As regarded the working of the bridges, they understood the promoters were prepared to pay the increased cost of working the new bridge, but the liability should remain with the Caledonian Company.

The chairman's suggestions were agreed to, and the preamble was found proved.

## ELECTRIC POWER BILLS AND THE GAS COMPANIES.

The Court of Referees of the House of Commons on Monday considered objections to the *locus standi* of several gas companies who desired to appeal in opposition to the Caledonian Electric Power Bill and the Clyde Valley Electric Power Bill.

In the case of the Caledonian Electric Power Bill, the petitioners whose *locus* was objected to were the Corporation of Glasgow, the Barrhead Gas Co., the Bothwell and Uddington Gas Co., and the Leven Gas Light and Renton Gas Light Companies.

Mr. BALFOUR BROWNE, K.C., for Glasgow Corporation, said the district proposed to be supplied by the bill surrounded Glasgow, and as he read the bill carried Glasgow also. If that were so there would not be any question about the *locus* of the Corporation; but the promoters said they did not intend to include the city.

Mr. CLAUDE BAGGALLAY, K.C., for the promoters, said he was prepared to give an assurance that Glasgow would be excluded, and that the bill should be altered accordingly.

Mr. BALFOUR BROWNE accepted the assurance, but said if the bill passed in its present form the promoters would have power to lay their electric mains all round Glasgow, not in the districts belonging to Glasgow but in districts where the Corporation were in the position of the gas, water and tramway authority. Their gas and water pipes and the tramways ran outside the city, and he wanted protection for them. It was not enough to say that the general act gave the Corporation that protection. Counsel claimed he had the right to be heard as to the physical interference with the roads as well as from possible electrolytic action. Glasgow was in an extraordinary position. No other authority, except the Postmaster General, had the right to break up their streets.

Mr. BAGGALLAY said under the bill the promoters had no authority to lay down electric lines in any street except within the area of supply. They had not the slightest intention of going through the city of Glasgow for the sake of laying mains or for supply. They had incorporated in their bill the general provisions of the Electric Lighting Act, as recommended by Lord Cross's Committee, for the prevention of electrolytic action or fusion. He submitted that, as to the gas and water mains, the Corporation were in no better position than an ordinary gas or water company, and that they should have no *locus standi* if all the provisions of the general act were incorporated in the bill.

Mr. W. M. ACWORTH, on behalf of the gas companies, said they wished to appeal against the bill and to get a protective clause. The risk of electrolytic action was very much increased by the high voltage at which the current would be worked. The competition would be greater in this case than in the case of an ordinary electric light company. The electric light company would have the right to charge a maximum of 6d., whereas this company only charge a maximum of 3d. They sought power in their bill to supply any customer with power, and any person taking power could use the power for lighting purposes within his premises. It was thus possible for a factory to take the power to drive a sewing machine, and could at the same time use the power to light the whole of their premises. In the Ferndale case the Court had granted a *locus* to a statutory gas company against an electric company, and the learned counsel submitted that they were entitled to a general *locus* on the ground of competition, and because of the likelihood of interference in various ways, apart from the risk of electrolysis.

Mr. JOHN KENNEDY, Parliamentary agent, said the gas companies would accept the decision of the Court in this case as applying to the Clyde Valley Electric Power Bill.

Mr. BAGGALLAY, in replying, contended that it had not been proved that they would injuriously affect the gas companies. Any person at the present time could establish electric lighting or power for himself; and all they proposed was that where a customer took power from them he should be allowed to use it for lighting purposes. They would have no power to go to any person with light unless he took power. He submitted it would be a dangerous thing for Parliament to allow a number of inconsistent provisions to be inserted in these bills.

Mr. H. D. GREENE (one of the referees) asked if in any case a *locus* had been granted to a non-statutory company.

Mr. BALFOUR BROWNE said he did not know of any. He believed the Ferndale case was the first.

The Court ultimately decided to allow a *locus* to the Corporation of Glasgow, but disallowed the *locus* of the gas companies.

This decision involved the application against the Clyde Valley Electric Power Bill, and the *locus* of the companies was accordingly disallowed in that case also.

## LIGHT RAILWAYS BILL.

In the House of Commons on Monday the President of the Board of Trade (Mr. Gerald Balfour) asked for leave to bring in a bill to continue and amend the Light Railways Act, 1896, which will lapse on Dec. 31 next. Among the clauses of the new bill was one extending the powers of the Commissioners until Dec. 31, 1906, and changes were also made in the provisions relating to the advance of moneys. Under the 1896 Act the Commissioners have power to advance money either on ordinary loan or by way of special advance, for the purpose of benefiting agriculture or any other approved industry. The total amount that could be advanced under the 1896 Act was £1,000,000, and of this, £250,000 was advanceable under the head of "Special advances." The new bill does not alter the total amount available, but increases the sum which can be specially advanced to £750,000. The bill was read a first time.

## WEST AND SOUTH LONDON JUNCTION RAILWAY BILL

On Friday last the Standing Orders Committee had before them the West and South London Junction Railway Bill, which seeks power to construct an electric underground railway, about 5 miles in length, from Paddington to Kennington-park, joining up the termini of the Great Western, Central London, London, Brighton and South Coast, and London and South-Western Railways. The examiner had reported the bill as failing to comply with Standing Orders, and notice was not given to the Duke of Northumberland, Lord Iveagh, and the Hon. W. F. D. Smith, owners of property in Grosvenor-place, within the line of deviation. The Committee decided to allow the bill to proceed on the condition that the protective clause offered by the promoters should be inserted with the addition of the words, "subsoil in such cellars or vaults."

## L.C.C. TRAMWAYS AND STREET WIDENINGS BILL

The Standing Orders were dispensed with in the case of this bill, on the condition that the tramways to which the consent of the local authorities interested had not been obtained should be struck out, with the exception of tramway No. 6, which is to pass along the Farringdon-road. It was mentioned that, in connection with this line, which closely approaches the City boundaries, an arrangement had been come to with the City Corporation which would involve a reduction in the length of the line.

## PARLIAMENTARY RETURNS.

On the motion of Mr. BILL, the House of Commons have ordered a return to be made showing the number of applications for orders and the number of orders passed by the Light Railway Commissioners and confirmed by the Board of Trade in each year since the passing of the Light Railway Act, 1896, and also the loans which the Treasury have agreed to advance in each year under secs. 4 and 5 of the act.

Returns were also ordered relating to electricity supply undertakings in the United Kingdom belonging to local authorities and to companies respectively for 1899.

# LEGAL INTELLIGENCE.

### J. Gibbs & Co. v. Chloride Electrical Storage Syndicate (Ltd).

Mr. Justice Bigham on Monday and Tuesday heard an action in which plaintiffs claimed £457, balance of price of goods sold and delivered to defendants. Defendants stated that, owing to some of the sulphuric acid supplied by plaintiffs being of greater strength than that contracted for and to the fact that certain carboys contained hydrochloric acid, damage was done to the batteries, and on this account defendants counter claimed for £579. 9s. 5d. The only point in dispute was the defendants' counter claim.

Mr. T. TERRELL, K.C., for defendants, said they had, since 1896 purchased sulphuric acid from plaintiffs, and contracted for acid which was not to be higher or lower than 1·250 specific gravity, and which was to be pure brimstone acid. Plaintiffs knew the acid was used for storage batteries and that it must be of that exact strength. In December, 1899, defendants had a very large order for storage batteries for Prince Hatzfeldt, and ordered 56 carboys of acid to be delivered to the firm of contractors who were putting in the installation. The 56 carboys were delivered, but contained 0·3 per cent. of hydrochloric acid, and this 0·2 per cent. of hydrochloric acid, beyond all shadow of doubt, as analysis had shown, had got there by common salt having been put into the acid. On analysis the exact quantity of sulphate of soda was found which would correspond with common salt. The contents of the carboys were poured into the storage cells, and the result was their immediate destruction. Everything had to be taken out and put into the melting pot. The damage resulting from that was £725. 5s. 4d. For another installation defendants were putting in storage batteries, and directed plaintiffs to deliver in November, 1899, 36 carboys of acid of the specific gravity of 1·215. Owing to carelessness, as defendants contended, acid of the specific gravity of 1·750, the strength used for manure, was supplied. Two of the carboys were poured into the cells, and the result was the destruction of two cells.

the damage being £24. This error, it appeared, was made by the railway company, and plaintiffs had made a claim against the railway company. There was another claim for 30 carboys ordered in October, 1899, where the acid delivered was of the specific gravity of 1·740 instead of 1·250. The plaintiffs had paid £9 into court on the claim, and £65 generally.

Mr. BOUSFIELD, K.C., for plaintiffs, said with regard to the item of £24 he could show that the railway company had mixed two consignments. With regard to the larger claim he denied there was any hydrochloric acid contained in the acid supplied, and further said that if there was it could not do the slightest harm. In this case the acid was left for months, and it was the defendants' own fault if any harm was done.

Evidence was given by Mr. G. A. GRINDLE, manager of the Chloride Syndicate, who said the presence of hydrochloric acid was fatal, and the effect was immediately apparent on the plates. The plates were tested in February and March after they had been rejected, but only for the sake of information. The hydrochloric acid attacked the peroxide of lead on the positive plates, which were gradually disintegrated. The disintegration would make itself obvious by the smell and by clouds of chlorine being given off. In the course of manufacture chloride pellets were used to obtain porosity, and it was of vital importance that the chloride should be extracted from the lead before use. If it was not extracted, however, the use of sulphuric acid would not cause chlorine to be given off in fumes.

Mr. BOUSFIELD: Taking a new pair of your plates and putting them into pure acid they gave off fumes of chlorine. Can you explain that?—He could not explain it, and he doubted it. He had never come across a case of their plates containing chlorine. The batteries for Prince Hatzfeldt were left for what they were worth, and supplied light for some months.

Mr. JAMES SWINBURNE said he had analysed the sulphuric acid and found 2½ in 1000 of hydrochloric acid. He was of opinion that it would be hopeless to save a battery into which this impure acid had been poured.

Mr. H. BALLANTYNE gave similar evidence with regard to analysis.

Replying to his lordship, Mr. BOUSFIELD said plaintiffs had tested the acid in the carboys and found hydrochloric acid, but they could not tell whether the acid had not been poured back into the carboys from the cells.

WITNESS said that could not have been because there was no lead present in the acid.

At the close of the defendants' case on the counterclaim,

Dr. MESSEL, for plaintiffs, said he was a partner in the firm of Spencer, Chapman & Co., who were responsible for the manufacture of the sulphuric acid supplied to plaintiffs. The firm took every precaution to free the stuff from arsenic. They supplied plaintiffs with the 86 carboys of sulphuric acid. He knew it was suggested that the acid as used contained hydrochloric acid and sulphate of soda. In their works there was no possibility of salt getting into the stuff. Their order was to supply sulphuric acid at a certain strength. He was not aware plaintiffs had made a claim against his firm in respect of the sulphuric acid. His firm were the largest makers of sulphuric acid in London. He did not think it was possible in their works for the hydrochloric acid to have got mixed with the stuff.

Mr. P. QUIN, foreman to Messrs. Spencer, Chapman & Co., said it was his duty to see to the manufacture of the acid. It was reduced down to strength 1·215 by water. For that they used a closed tank. He did not see any way by which 30lb. of salt could have got into the stuff. If it got in it must have got in outside the process of manufacture.

HENRY OVERGAGE, sampler to Messrs. Spencer, Chapman & Co., said he dealt with the sulphuric acid, and reduced it to the dilute state. He did not think it possible for a carboy which had been used for hydrochloric acid to be used for sulphuric acid. The carboys used for both stuffs were properly labelled.

Mr. WOOD said he was in charge of the batteries at Prince Hatzfeldt's. It was his duty to run the battery and keep it clean and to look at the plates from time to time. He did not see any difference between the first battery, the second battery, and the last battery. The first battery lighted the house properly. He was, however, not an expert electrician.

In giving judgment his LORDSHIP said that the conclusion he had arrived at was that the damage done to the batteries was not due to the acid supplied by the plaintiffs whatever other cause it might be attributable to. The defendants had failed to discharge the onus which devolved upon them of satisfying him that the damage was caused as they alleged. The plaintiffs, however, in his opinion, had been guilty of a breach of contract. They had not delivered the acid which they undertook to deliver. They undertook to deliver an acid with no admixture of hydrochloric acid, and he thought the defendants had not been unreasonable in setting up their counter-claim. The conclusion he had come to was that the plaintiffs must bear part of the blame, and, therefore, he proposed to deprive them of their costs on the counterclaim. There would, therefore, be judgment for the plaintiffs on the claim and for the plaintiffs on the counterclaim without costs.

---

We understand it is the intention of the defendants to appeal against Mr. Justice Bigham's decision.

---

### Metropolitan Electric Supply Co. v. Ginder.

In the Chancery Division, on Tuesday, Mr. ASTBURY, K.C., on behalf of the plaintiffs, applied to Mr. Justice Buckley for an injunction to restrain defendant until the trial from taking energy for lighting his premises in Holborn from any other electric supply company. Counsel explained that the defendant entered into an agreement with the Metropolitan Company to take the whole of the electric energy required for his public-house for a period of five years. The charge was to be 4½d. per unit. Notwithstanding that agreement defendant had entered into an arrangement with the County of London Company for a supply. The affidavits filed contained certain rather gross statements as to the energy supplied by the plaintiffs. The plaintiff company's usual charge for electric energy was 5d. per unit, but a reduction was made if the supply was taken for a number of years. In September, 1900, the defendant, in breach of his agreement, ceased to take supply from the Metropolitan Company and began to take it from the County of London Company. On notification from the plaintiffs he resumed taking current from them until February last, when he asked plaintiffs to remove their meter from his premises. The meter was not removed. Defendant's affidavit declared that when he entered into the arrangement with the plaintiffs his attention was not called to the clause setting forth that the agreement was to be for five years, and he was not aware of it until November, 1900. Counsel thought his lordship would come to the conclusion that there was no cause for complaint by the defendant. The superintendent of the canvassing and contract department of the plaintiff company, in his affidavit, said no complaint had been made to him by defendant concerning the supply of electrical energy. He also alleged that defendant had told him that the canvasser of the rival company had represented that if he agreed to take the supply of energy from the County of London Company, they would see him through in the event of litigation. Mr. Todd, the chief engineer to plaintiffs, stated in his affidavit that during the time defendant received his supply the pressure had been uniformly good. He was quite unable to understand the various failures of energy alleged by the defendant. No complaint had ever reached the works of such failure. The plaintiff company (counsel urged) contracted to supply an article of commerce for five years at 4½d. per unit, and if the company had within that time disconnected the supply of energy for some other reason than non-payment defendant would have been clearly entitled to an injunction to restrain the company from ceasing to supply. Defendant could not plead that he did not require electric energy because he was now getting it from another company.

Mr. SARGEANT, also for the plaintiffs, said he quite agreed that they should not require the defendant to take a single unit of electric energy from them if he chose not to use electric energy in his premises, but if he required such energy the Metropolitan Company was the only company which should supply it.

Mr. STEWART SMITH, for the defendant, said his case was that the supply of energy from the plaintiff company was so defective that it had to be discontinued.

His LORDSHIP thought the action should be set down for trial at once.

Mr. ASTBURY, K.C., thought his learned friend ought to give particulars of the dates on which he was going to allege deficiencies of supply.

Mr. SMITH said he would give the best particulars he could.

His LORDSHIP ordered the case to be set down for trial on or before May 24.

---

### National Telephone Co. v. M'Donald and Son.

At Edinburgh Mr. Sheriff-Substitute Henderson heard an action brought by the plaintiff company against defenders, a firm of auctioneers in Montgomery-street, Edinburgh, for the sum of £3. 5s. as telephone rental for one year. The defenders original contract with the company was for £10s. 5s. a year for the use of a telephone connected with the exchange, and a supplementary agreement was signed for a telephonic connection with the private business premises at Albert-place. In May, 1900, the defenders removed from the private premises, and asked the company to take away the private telephone, which they did.

The objection raised by the defenders was that, in respect of the company having removed the telephone, the latter ceased to give the defenders the use of it, and they were thereby precluded from the necessity of paying the hire of £3. 5s. per annum.

Pursuers said they had offered to come to a settlement, but had not been able to do so.

The SHERIFF held that if the instrument had not been removed from defenders' premises pursuers' claim would have been a good one, but as it had been removed the contract terminated with its withdrawal. He therefore found for defenders, with expenses.

---

### Carroll v. New British Incandescent Electric Lamp Co

A debenture holder's motion, made before Mr. Justice Buckley, on Tuesday, for the appointment of a receiver in the New British Incandescent Electric Lamp Co. Counsel said that on Nov. 15, 1900, defendant company executed a mortgage on leasehold premises at Willesden Junction, and that such mortgage took priority of the debentures.

The application was granted.

---

## BOOKS RECEIVED.

**Copies of any of the undermentioned works can be had from *The Electrician* Office post free, on receipt of published price.**

"Spon's Architects' and Builders' Price Book." By W. Young. 28th edition. (London: E. and F. N. Spon.)

"Proceedings of the Royal Society." No. 443, Vol. LXVIII. (London: Harrison & Sons.) 2s.

"A Treatise on Physics," by Prof. Andrew Gray, F.R.S. Vol. I.: Dynamics and Properties of Matter. (London: J. & A. Churchill.) 15s.

"Differential and Integral Calculus for Beginners." By Edwin Edser. (London: Thomas Nelson & Sons.) 2s. 6d.

"Twentieth Century Inventions." By George Sutherland. (London: Longmans, Green & Co.) 4s. 6d.

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

The British Electric Traction Co. (Ltd.) require an assistant engineer with experience in cable laying. Application forms may be obtained from the engineering manager, Donington House, Norfolk-street, London, W.C. See advertisement.

There is a vacancy for a switchboard attendant at the Bradford electricity works. Applications to city electrical engineer (Mr. R. A. Chatteck), Town Hall, Bradford. See advertisement.

Mr. Stanley Clegg, of Darwen, has been appointed city electrical engineer at Lincoln, in succession to Mr. C. S. Vesey Brown. Previous to his appointment at Darwen Mr. Clegg was assistant at Burnley.

Mr. A. B. Rigby, A.M.I.C.E., A.M.I.E.E., has been appointed manager of the Electrical Transmission Co., of Hammersmith, London.

The Heywood Council received 117 applications for the position of electrical clerk of works, and this number has been reduced to the following for final selection:—W. J. Baker (Bolton), Wm. Johnson (Sheffield), B. Mills (Heywood), W. A. Parsons (Wavertree), C. L. Stewart (Rochdale), and J. W. Turner (Huddersfield).

**Aix-la-Chapelle.**—The municipal authorities have voted £12,500 for extensions of their electricity works.

**Alfreton.**—The Board of Trade notify that they will not grant an electric lighting provisional order applicable to the whole parish of Alfreton unless it is intended to light the whole parish. It was only intended to apply the scheme to the Alfreton Ward, and the order is, therefore, to be restricted to this area.

**American Tramways.**—The reports submitted to the Massachusetts Railway Commissioners are published in the *Street Railway Review* for March 15. There are now 118 companies in the State, operating a total of 2,038 miles of single track. The capital expended amounts to $48,971,168, the income for the year 1900 was $21,387,641, the expenditure (including $2,109,874 dividends) was $20,760,012. The fatalities for the year were 18 passengers, 3 employés, and 48 others, besides the following who received injuries:—1,695 passengers, 84 employés, and 756 others. The total passengers carried was 395,027,199, and the car miles run 81,750,768.

**Ancona (Italy).**—This Italian province has a population of 270,000. Only four towns in the whole district are provided with the electric light—Ancona, Jesi, Loreto and Osimo. Ancona has 23 arcs for public lighting and 20 arcs and 1,300 incandescents for private illumination; Jesi 18 arcs and 1,480 incandescents; Loreto 4 arcs and 320 incandescents; and Osimo 5 arcs and 375 incandescents. The price of gas is 5s. 4d. per 1,000 for private, and 4s. 10d. for public lighting.

**Argentina Electrical Imports.**—According to the *Review of the River Plate* the imports of electrical machinery, appliances, and goods for 1900 were as follows:—

| | Quantity. | Value. | Inc. or dec. on 1899. |
|---|---|---|---|
| Telephone apparatus | 661 | $4,576 | + $4,576 |
| Dynamos | 648 | 80,025 | − 21,116 |
| Electrical material | 4,405 boxes | 236,165 | − 104,879 |
| Cable and wire | 773,079 kilos | 375,225 | − 136,484 |
| Electric bells | 6,096 | 3,048 | + 3,048 |
| Meters | 1,579 | 19,849 | + 19,848 |
| Ventilators | 1,288 | 13,059 | + 13,059 |
| Insulators (china and porcelain) | 131,903 kilos | 16,869 | + 16,869 |
| Glass insulators | 9,017 do. | 541 | + 541 |
| Arc lamp carbons | 144,143 do. | 21,632 | + 1,802 |
| Arc lamps | 399 | 5,836 | + 5,825 |
| Incandescent lamps | 33,738 doz. | 95,376 | − 5,737 |
| Telephone material | 437 boxes | 20,817 | + 674 |
| Telegraph material | 493 do. | 21,720 | − 12,273 |

**Association of Chambers of Commerce.**—In our issue for February 22, page 671, was set out a number of resolutions to be submitted to the meeting of the Association of Chambers of Commerce, to be held at the Hotel Metropole, London, on March 12, 13 and 14. The resolutions forming paragraphs 1, 2, 4 and 6 of the list were approved by the Conference.

**Birkenhead.**—The sub-committee recently appointed to consider the practicability of framing a scheme for assisted wiring of premises report that, as the Corporation do not possess powers to supply electric fittings on hire, it is inadvisable to prepare a scheme, but the Council are recommended to introduce a clause in their next Parliamentary bill authorising the Corporation to supply and deal in electric fittings, to wire premises, &c.

**Brighton.**—An inquiry was held here last week into the application of the Council to borrow £19,000 for electric lighting extensions. Of this £6,400 was required for arc lighting. It is proposed to erect 107 arcs, to displace 133 incandescent lamps and 48 gas lamps. The lamps are to be erected along the electric tramway routes, and will be attached to the trolley poles. The balance (£13,200) was for tramway generating plant. There was no opposition.

**Cheltenham.**—The Corporation have agreed to supply electric current to the Cheltenham-Cleeve light electric railway at 1½d. per unit for a minimum of 200,000 units per annum, and 1d. per unit over that quantity up to a total of 300,000 units per annum, and ¾d. per unit in excess of 300,000. The salary of the assistant engineer (Mr. H. E. Soper) has been increased from £182 to £200 per annum.

**Cleckheaton.**—An inquiry was held on Friday into the application of the Council to borrow £25,000 for electric lighting and refuse destructor works. The consulting electrical engineer (Mr. A. H. Gibbings) gave technical details of the scheme, which does not provide for public lighting. There was no opposition.

**Customs Tariffs.**—The duty on copper, brass or bronze wire, of any thickness, imported for use in the manufacture of wire gauze in Spain from the United Kingdom has been fixed at 16s. 3d. per cwt. (40 pesetas per 100 kilogs).

**Dover.**—The receipts from the Corporation electric tramway for the year ended March 31 amounted to £10,776, an increase of £713 on the previous year, when the net profit amounted to £2,0 0.

**Dublin.**—The Local Government Board have given formal sanction to a loan of £254,500 for electric lighting, repayable in 25 years.

**Electric Railway Extensions in Germany.**—The construction of an electric railway between Siegen and Geisweid is projected.

**Electric Transmission of Power through the Simplon Tunnel.**—The Italian Government has granted a concession to the Simplon Railway Co. for the utilisation of the water power of the River Diveria. Plant for about 600 H.P. is to be put down for the electrical operation of trains through the tunnel.

**Georgetown (British Guiana).**—An electric tramway route over 10 miles in length has (writes a *Times* correspondent) been opened for traffic at Georgetown, and is receiving extensive patronage. The only tramway line previously existing in this part of the world was about one mile in length, and mule drawn. The new line is owned by the Demerara Electric Co., which also owns a concession for supplying electric current for public and private lighting purposes. The line has cost about $25,000 per mile. The equipment includes 14 motor cars.

**Glasgow.**—Additional electric tramway routes are now ready for opening, the official inspection having taken place on Tuesday. Practically the conversion of the whole of the tramways from horse to electric traction is now complete, and as soon as the Pinkston power station is ready, all the cars will be propelled electrically.

**Glasgow Exhibition.**—The Irish section of this exhibition is to be lighted on the "E.L.B." system. The scheme will include the outlining of the hall and many decorative devices, such as shamrocks, &c. The apparatus, &c., is provided by the Electric Lighting Boards Co., and is being installed by Messrs. Wm. Coates & Son.

The date of the opening of the Exhibition has been fixed for May 2.

**Glasgow Telephone Service.**—It is announced that the telephone service of the Glasgow Corporation was started on Tuesday last. It is further announced that nearly 5,000 subscribers have been secured. The switchroom is equipped for 12,000 subscribers. The telephone area contains 143 square miles.

**Hammersmith (London).**—The salary of the borough electrical engineer (Mr. G. G. Bell) has been increased to £450, rising to £500 per annum, and that of the assistant engineer (Mr. F. Hill) has been increased to £250, rising by yearly increments of £25 to £300 per annum. A further extension of street arc lighting has been decided upon by the Council.

**Havre and District.**—In a report on the trade of this district reference is made to delays in telegraphic communication between Havre and Liverpool during 1900. A costly remedy was found in the transmission of messages between the two cities via New York, but this practice was stopped by the French postal authorities, and inquiries had led to a cessation of the delays. The new telegraph cable between Havre and Beachy Head for the Anglo-American Company was completed in March, 1900, and the company's Brest station was then removed to Havre.

The Westinghouse Manufacturing Co. has established a factory at Havre, and at these works the electrical apparatus for the moving platform at the Paris Exhibition was made. The factory now provides employment for 500 men.

Complaints are made of the dilatoriness and general want of energy shown in the construction of electric tramways in Caen to replace the deficient omnibus service of the town.

At Dieppe the electric light has entirely superseded the use of gas.

An electric tramway is being constructed between the towns of Tréport and Eu by the Compagnie de Traction de Paris. This line supplements an irregular omnibus service.

There is also talk of substituting the electric light for gas in the town at Trouville-Deauville. The construction work for lighting the town electrically is about to be begun. A proposal to establish electric tramways in this town, which has been before the local authorities since 1899, has not yet been sanctioned.

**Horsham**.—The Council have received sanction to borrow £14,006 for electricity works. The Local Government Board have, however, refused to grant a loan of £1,500 for wiring premises.

**Ilfracombe**.—The Council have decided to transfer their provisional order to Edmundson's Electricity Corporation.

**Jamaica**.—In a report recently to hand, it is stated that an annual allowance of £100 is paid to the West India Electric Co. by the postal telegraph department of Jamaica to cover the cost of carrying letter carriers and telegraph messengers, and it is stated that the electric car service has proved of great utility for this purpose.

**Kingston-on-Thames**.—The Corporation have sealed the agreement with the London United Tramways (Ltd.) for the construction and working of electric tramways in the borough. The agreement provides that the company shall pay to the Corporation £15,000 towards street widenings, that the Corporation can purchase the lines at 25 years, the company paying a yearly rental of £250 for the first five years, £450 for the next 10, and £700 for the following 10 years. The line will be 3½ miles in length. The company agree also to contribute £10,000 towards the widening of Kingston Bridge.

**Light Railways**.—Objections to the confirmation of the Blackpool and Garstang Light Railway order were heard by Sir Courtenay Boyle on Tuesday, at the Board of Trade. Mr. H. Lloyd, for Blackpool Corporation, objected to the promoters taking power to work the railway by steam or other motive power when it was distinctly stated before the Light Railway Commissioners that it was to be worked by electricity only. The promoters had got power to make junctions with the Lancashire and Yorkshire and London and North-Western Railway Companies, and as the gauge was the same as those railways the Corporation did not wish the light railway to fall into the hands of the railway companies which had a monopoly in the district. Mr. Balfour Browne, K.C., protested against the promoters being hampered when the original object of these light railways was to be feeders to the great trunk railways. Sir Courtenay Boyle said that before the Board would sanction the working of the line by steam, the whole matter would have to be submitted. The amended order was then approved.

**London County Council**.—At Tuesday's meeting it was agreed to loan £10,000 to Stepney for electric lighting.

Discussion took place on a report of the General Purposes committee with regard to the suggested alteration of the standing orders relating to contracts. A difficulty arose at the Horton Asylum in consequence of the casing and capping in connection with the electric light installation being fixed by wiremen, the Amalgamated Society of Carpenters claiming that the work should be done by carpenters. It was suggested that to meet similar cases the Council should specify in contracts the trades to be employed in the more important sections of the work. The committee, however, considered it inexpedient to amend the standing orders in the direction referred to. The Council agreed with the committee.

Replying to a number of questions, Mr. Benn said the Highways committee were considering the question of motor cars. They would arrange for another view of the system of electricity to be adopted. With regard to criticisms on Prof. Kennedy's system, that gentleman would be able to meet them, but the committee were collecting the criticisms to lay before him.

**Ludlow**.—The Council have approved the electric lighting and refuse destructor scheme which has been prepared by Mr. John Parker, of Hereford. The scheme provides for the equivalent of 2,450 8 c.p. lamps for private lighting, and 16 arcs of 2,000 c.p. each and 32 incandescents for street lighting. The capital expenditure is estimated at £7,350, the income at £1,013 per annum, and the up-keep (including interest and sinking fund) at £868. 14s. 3d.

**Motherwell**.—Thirty arc lamps are to be erected. A reduction in price of electric current for power has been decided upon.

**Municipal Telephony**.—At a recent conference of local authorities in the Manchester area the following scheme for a municipal telephone exchange was approved :—

A joint board to be formed consisting of representatives appointed annually by the municipal and urban district councils within the area, as follows—viz.:—Manchester Corporation ten members, Salford Corporation five members, Eccles Corporation and the Urban District Councils acting jointly three members. The capital to be provided by the Manchester and Salford Corporations. Profits not exceeding 5 per cent. on the capital expenditure (less bona fide renewals) to be divided between Manchester and Salford Corporations proportionately to the capital provided by each. All profits above 5 per cent. to go in reduction of telephone charges. The respective councils to grant underground wayleaves without payment. No differential charges for telephones.

**Newcastle-on-Tyne Tramway Dispute**.—It is announced that the Tramways committee have decided, subject to the approval of the Council, to stop the city tramcar service on the 13th inst., owing to the refusal of the local tramway company to agree to certain conditions of the new lease.

**Nuneaton**.—The gross revenue of the electricity works for the past year was £868. 15s. 6d. Interest and sinking fund instalment amount to £1,169.

**Opportunities for Engineers in Spain**.—A recent Foreign Office report on the trade of Spain from the British Commercial Attaché at Madrid states that many openings offer in the electrical business in Spain for young men to fit themselves for more important posts in that industry. Young English engineers and mechanics with good recommendations, who would not object to pass a few years in the quiet towns and villages of Spain, would probably find ready employment with the large firms interested in the electric light and power business in that country.

**Patent Extension**.—The petition of the British Aluminium Co. (Ltd.) for an extension of the term of M. Héroult's patent for "An Improved Process for the Preparation of Aluminium by Electrolysis" (7,426 of 1887), will be heard by the Judicial Committee of the Privy Council on May 15.

**Plymouth**.—The official inspection of the Compton electric tramway route took place last week, and the line was opened for traffic on Wednesday.

**Poplar (London)**.—The Electricity committee recommend the Council to light the Isle of Dogs electrically. It is estimated that 100 arcs will be required and the capital cost is put at £3,227, with an annual expenditure in excess of the present cost of gas lighting of £877.

**Portsmouth**.—An inquiry has been held into the application of the Corporation to borrow £327,134. 14s. for the purchase of the undertaking of the local tramways, and for converting the lines to electric traction, &c. The cost of the power station was put at £11,400, car equipment £49,000, reconstruction work £202,000, overhead work, £18,000, and car sheds £30,000. The engineer and manager of the electricity department (Mr. E. Rotter) said the total length of line would be equivalent to 28 miles, and nearly the whole of the lines would be double track; 4 miles of extensions are also to be constructed. There was no opposition.

**Presentations**.—At the Dickenson-street electricity works, Manchester, on Friday last, the members of the staff and workmen of the electricity department presented to Mr. C. H. Wordingham an illuminated address, accompanied by a microscope and accessories, as a token of their appreciation and esteem, and in recognition of the great services which Mr. Wordingham has rendered to the department. The address was signed by the whole of the staff and workmen, and recognises the straightforward and honourable principles which have actuated Mr. Wordingham in his business relations during the lengthy period of his association with the department, and places on record the extreme courtesy and friendly feeling manifested to the staff during this time. Sincere regret is expressed at the retirement of Mr. Wordingham, and hearty wishes for his future welfare. The presentation was made by Mr. W. F. Long, the senior assistant engineer remaining at the works. Mr. Wordingham expressed his gratification at this unanimous expression of the goodwill of the large staff which has so long worked under him.

On Saturday last Mr. W. S. Toplis, mains superintendent at South Shields, who is leaving to take up a more important appointment at Manchester, was presented with a black marble timepiece by the staff, workmen and contractors connected with the works. The presentation was made by the borough electrical engineer, Mr. J. A. Jeckell.

**Private Bills in Parliament**.—The Metropolitan Railway Co.'s bill has been read a second time in the House of Commons.

The Bury Corporation Tramways Bill for authority to construct 9 miles additional electric tramways at an estimated cost of £132,000, and to supply electric current outside the borough has been reported for third reading.

**Royal Institution Exhibits**.—On Friday last the Gilbert Arc Lamp Co. exhibited at the Royal Institution Gilbert arc lamps and various apparatus connected therewith. A feature of the exhibit was the alternate-current solid carbon long-burning arc lamps. The Electric Lighting Boards Co. also demonstrated the "E.L.B." system with all its latest improvements, including flexible strips and many new accessories.

**St. Helens**.—The Electric Supply and Tramways committee recommend the Council to sanction the carrying of goods on the local electric tramways.

**Sheffield**.—The Crookes electric tramway route was opened for traffic on Monday and the Darnell electric tramway route is to be opened on 11th inst.

**Stafford**.—Application has been made for a loan of £600 for coal bunkers at the electricity works.

**Telegraphs in the Ottoman Empire**.—A recent issue of the *Levant Herald* announces that the Turkish Administration of Posts

and Telegraphs is about to put down a new overhead line to place the Ottoman telegraph system in direct communication with India, and for this purpose a credit of 308,118fr. is being sought.

**Telephone Trunk Extension.**—Bury St. Edmunds has been added to the telephone trunk system of the country.

**Trolley-Wire Accidents** *Precautionary Rules.*—A set of instructions has been prepared by Mr. R. A. Chattock (city electrical engineer) and Mr. C. J. Spencer (manager of the Corporation tramways), and has been adopted by the Tramways committee of the Bradford Corporation for posting up in the tramcars, dealing with the steps to be taken in the event of tramway, telegraph, or telephone wires charged with electricity being found loose in the streets. These rules had already been adopted by the Watch committee for the use of the police force :—

1. In the event of telephone or telegraph wires falling and making contact with the overhead trolley wire, or in the event of the trolley wire or its guard wires falling, all traffic should be stopped, and the public prevented from approaching the fallen wires.

2. The fallen wires should on no account be interfered with by the police or any unauthorised person unless for the purpose of saving life or protecting persons from being injured, as explained in Rule 5.

3. Notice should be at once given to the nearest cardriver, who will take steps to cut off the current. If one is not available notice should be at once sent to the nearest tramway depôt by telephone, or messenger in a cab, with a request for someone of authority to proceed at once to the spot to deal with the fallen wires. These depôts are as follow :—Forster-square, Tyrrel street, Horton Bank Top, Bolton, Whetley Hill, Thornbury, and Fairweather Green.

4. Drivers of cars should not be called upon to interfere with the fallen wire unless it is for the purpose of saving life or preventing persons from being injured.

5. If the fallen wire is in contact with any person, and it is necessary to remove it at once in order to save life or prevent injury, the following points should be remembered : The person removing the wire should (a) never touch it with his hands ; (b) never touch the skin of the person in contact with it ; (c) use a dry stick, dry rope, or article of dry clothing* to drag the wire away with, or to drag the person away from the wire ; (d) use indiarubber gloves for pulling the person away from the wire, it being safest not even to touch the wire with them ; (e) in case it is impossible to get the wire away from the person, the wire should be dragged to the nearest tram rail and held down upon it in order to discharge the current from it, or the wire should be cut by means of insulated shears, which can be procured from the car. Gloves should be worn when these are used. [* Note that it is very important that any article used for this purpose should be dry ; a wet article will convey the current, and probably give the person handling it a shock.]

6. Each car will carry a pair of indiarubber gloves and a pair of insulated shears, which will be kept in a glass-fronted box in a prominent position. The same will be kept at each tramway depôt, each police station and each fire station. Gloves should always be used where possible.

**Wallasey.**—An inquiry will be held on Wednesday next into the application of the Council to borrow, among other sums, £12,500 for electric lighting extensions.

**Water Power Utilisation in Austria.**—A concession has been granted for the working of an extensive electricity generating station at Narburg, for which the waters of the river Drau will be utilised.

**West London Tramways.**—Col. Yorke made the final Board of Trade inspection of the electric lines of the London United Tramways from Shepherd's Bush to Acton and Goldhawk-road and Hammersmith to Kew Bridge on Saturday last. According to a telegram from Mr. Clifton Robinson, manager of the London United Tramways, all difficulties between the company and the Observatory authorities have been adjusted, and traffic on the electric lines commences to-day (Thursday) at 7 a.m.

**Worcester.**—The agreement with the local tramway company for the conversion of the lines to electric traction and for the extension of the system has been sealed.

## NEW BOOKS AND EDITIONS

*The following New Books and Editions can be obtained of the Booksellers, or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet-street, London :—*

### READY.

Price 12s. 6d., by post, 13s. 3d. ; Colonies, 14s. ; abroad, 14s 6d. United States, 15s.)

**"The Electrician" Electrical Trades' Directory and Handbook for 1901** (corrected to February 4, 1901).—In addition to the well-known features of this Directory and Handbook (all of which have been carefully revised and brought quite up to date), a large addition has been made to the Handbook Division, including a Digest of the Law of the Telegraph and Telephone, for the use of municipalities and companies contemplating applying to the Postmaster-General for a Telephone Licence. The latest developments of State and Municipal Telephone enterprise are set out from official sources, as well as the progress of the National Telephone Co.'s service. In the division of "Electric Light, Power and Traction," the valuable Digest of the Law on these subjects by Mr. A. C. Curtis-Hayward, B.A., solicitor, has been much extended ; the full text of the Electric Lighting Acts and the Board of Trade Accounts Forms have been added ; and Sketch Maps and particulars of the Electric "Bulk" areas are also given, together with a coloured sketch map of the Electric Railways and Tramways of the United Kingdom. The huge sheet tables of Electric Light and Power and Electric Railway and Tramway undertakings of the United Kingdom have been made complete up to Feb. 11. These sheets form a most complete record of electrical engineering progress in connection with electricity supply and power and traction applications. The Directory Division has been carefully extended and corrected up to Feb. 4, and is the most reliable list of firms and persons engaged in the electrical and allied industries ever compiled. A number of additional sketches of the careers of well-known electrical experts have been added to the Biographical Division, together with many new portraits. The new volume is, we claim, the most complete and correct book of its kind ever published in any language. An analytical digest of the contents of this volume can be obtained post free.

---

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables ; and the various methods of insulation testing are here collected and discussed.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

"Wireless Telegraphy : Signalling across Space without Wires by Electric Waves." A Review of the Work of Hertz and his Successors.—By Dr. O. J. Lodge, with a large number of illustrations, bringing this latest application of electrical science quite up to date. New and Enlarged Edition, 5s. nett. *Now ready.*

"Electric Lamps and Electric Lighting," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., is handsomely bound, and full of original illustrations, designs, initials, &c. *New and Cheaper Edition*, 6s., post free.

"Electrical Engineering Formulæ," a pocket book, by Messrs. W. Geipel and H. M. Kilgour ; price 7s. 6d. ; by post, 7s. 9d. ; abroad, 8s. *New Edition ready in a few weeks.*

"The Incandescent Lamp and its Manufacture."—By Gilbert S. Ram. Price 7s. 6d., post free. The principles underlying the manufacture of the incandescent lamp are carefully and fully dealt with in this volume.

"Magnetic Induction in Iron and other Metals."—By Prof. J. A. Ewing. Price 10s. 6d. net. *New Edition (Third) now ready.*

"Electric Motive Power," by Albion T. Snell, contains the latest information respecting the application of electric energy to mining and general power transmission purposes, in which the author has had much experience. Price 10s. 6d., post free ; abroad, 11s.

"Electro-Chemistry."—By Dr. G. Gore. Third Edition. Price 2s., post free.

"The Alternate Current Transformer."—By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. Vol. I.—*New Edition.* Price 12s. 6d., post free, Vol. II., price 12s. 6d., post free, is also ready.

"The Potentiometer and its Adjuncts": A Universal System of Electrical Measurement.—By W. C. Fisher. Fully illustrated. Price 6s., post free.

"The Electrician" Primers.—In Two Volumes. Vol. I., Theory. Vol. II., Practice. Price, stout paper cover, 2s. 2d. each, post free ; cloth, 2s. 9d. Single Primers, 3d. each, post free.

"The Centenary of the Electric Current, 1799-1899."—By Dr. J. A. Fleming. Price, paper covers, 1s. net, post free 1s. 3d. ; strong cloth, 2s. 6d., post free.

"The Electrician" Reading Case.—To hold four numbers of the journal. Strongly bound, 1s. net ; post free, 1s. 4d.

### IN THE PRESS.

"Handbook for the Electrical Laboratory Testing Room."—By Prof. J. A. Fleming. *Nearly ready.*

"Secondary Batteries, their Design and Manufacture."—By E. J. Wade.

"Primary Batteries : Their Construction and Use."—By W. R. Cooper.

"Practical Telephony."—By Dane Sinclair and F. C. Raphael.

"'The Electrician' Wireman's Pocket-book."—Edited by F. C. Raphael. *Nearly ready.*

---

# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office no later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Poplar* (London) Guardians invite tenders for steam exhaust, heat and cold water pipes, valves, water meters, &c. Further particulars are set out in an advertisement, and specifications can be obtained, after April 12, from the consulting engineer (Mr. F. J. Warden-Stevens), 34, Victoria-street, Westminster, S.W. Tenders to the clerk (Mr. G. H. Lough), Upper North-street, Poplar, E., by 6 p.m. May 1.

*Southwark* (London) Works and Depot committee invite tenders for the supply and erection of incandescent lamp brackets, switches and fittings to 168 gas lamp poles. Specifications, &c., after 9th inst. from the consulting engineers (Messrs. Kincaid, Waller and Manville), 29, Great George-street, Westminster, and tenders to the town clerk (Mr. J. A. Johnson), Walworth road, London, S.E., by noon, April 19. An advertisement contains further particulars.

*Wakefield* Electric Light committee invite tenders for arc lamps, transformers, switches, &c. Specifications from the city electrical engineer (Mr. Robert Blackmore), Electricity Works, Calder Vale-road, Wakefield, to whom tenders must be sent by April 16. An advertisement contains additional particulars.

*Hornsey* District Council invite tenders for boiler-house and engine-house plant, condensing and water cooling apparatus, pipe-work, switchboard and instruments, accumulators, overhead travelling crane, electricity supply mains, and arc lamps, &c., for public lighting, meters and workshop equipment. Tenders to clerk by 4 p.m. April 11.

*Portsmouth* Corporation invite tenders for the supply and erection of additional boilers, feed pumps, mechanical stokers, economiser, steam, feed, and other pipes, chequer plating, and sundry ironwork. Tenders to Town Hall, Portsmouth, by 4 p.m. April 16.

*Battersea* (London) Borough Council invite tenders for electric pumps, pipe work, &c., for condensing water, and pipes and pits for condensing water supply. Tenders to Mr. W. Marcus Wilkins, Municipal Buildings, Lavender-hill, London, S.W., noon of April 30.

*Middlesbrough* Electric Lighting committee invite tenders for boiler and engine-house plant and condensing apparatus, further particulars of which are set out in an advertisement. Tenders to town clerk by April 30.

*Leeds* Lighting committee invite tenders for steam, feed water, exhaust, overflow, blow-off, and other pipes, valves, hot-wells, feed-water pumps, economiser, &c., in connection with engines of 4,000 I.H.P. Tenders to town clerk by April 15.

*Dublin* Lighting committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, overhead crane and workshop equipment. Tenders to town clerk by 4 p.m. April 22.

*Kircaldy* Corporation invite tenders for the supply, delivery, and erection of engines and dynamos, storage battery and overhead travelling crane. Tenders to town clerk (Mr. Wm. L. Macindoe) by 10 a.m. April 15.

*Edinburgh* Corporation invite tenders for arc lamp carbons and cast-iron pipes, pavement and road box frames an dcovers for electricity department for one year from May 15. Tenders to town clerk by April 20.

*Metropolitan Asylums Board* invite tenders for supply and erection, at Tooting Bec hospital, of electric generating and heating plant. Tenders to Board, Embankment, London, E.C., by 10 a.m. April 24.

*Aylesbury* District Council invite tenders for the construction and maintenance, for a term of years, of electricity supply works. Tenders to clerk by 4 p.m. April 22.

*Colwyn Bay* District Council invite tenders for a water-tube boiler, feed pump, injector, steam exhaust and feed pipes, &c. Tenders to clerk by April 13.

*Burnley* Electricity committee invite tenders for two boilers and economisers and accumulators. Tenders to chairman by April 9.

*Motherwell* Electric Light committee require steam dynamo and switches, steam, feed, and exhaust pipes, &c. Tenders by April 29.

*Manchester* Rivers committee invite tenders for electrical and hydraulic appliances for one bacteria bed. Tenders by April 13.

*Woolwich* Borough Council invite tenders for erecting electric light and refuse destructor buildings. Tenders by noon 25th inst.

*Roumanian* Direction of Posts and Telegraphs require tenders for 20 tons of galvanised steel wire (2mm. diameter) until 9th inst.

The *French* Minister of Posts and Telegraphs invites tenders until April 18 for 270 tons of bronze or copper wire. Tenders to Le Sous Secretariat d'Etat des Postes et de Telegraphes, 103, Rue de Grenelle, Paris.

## TENDERS RECEIVED AND ACCEPTED.

Worthing Town Council have accepted the tender of Messrs. Page and Miles (Ltd.) and Messrs. Bostel Bros. for wiring premises in the district at the following rentals:—Single lamps, 9d. per quarter per lamp of 8 c.p., 16 c.p., 25 c.p., or 30 c.p.; clusters of lamps, 9d. per lamp per quarter for the first lamp and 3d. for additional lamps, where the cluster is controlled by one switch. If more than one switch for any cluster not exceeding three lamps, 9d. for each lamp per quarter; if more than two switches for any cluster above three lamps, the full charge of 9d. for each lamp.

Hornsey District Council have acccepted the tender of the Alphous Custodis Chimney Construction Co. for the erection of a 180ft. shaft at the electricity works at £3,300. The lowest tender for a brick shaft was £3,500.

The Bermondsey Borough Council have received the following tenders for main switchboard and instruments and battery of accumulators and accessories:—

*Main Switchboard and Instruments.*

| | | | | | |
|---|---|---|---|---|---|
| Crompton & Co. (*accepted*) | £1,573 | 0 | British Schuckert Co. ... | £1,853 | 0 |
| Walsall Electrical Co. ... | 2,109 | 0 | Siemens Bros. & Co. ...... | 1,852 | 0 |
| Thames Ironworks Co. ... | 2,050 | 0 | Cowans Limited ......... | 1,739 | 0 |
| General Electric Co. ...... | 2,045 | 0 | Haydn Harrison & Co. ... | 1,713 | 0 |
| Bertram Thomas ......... | 1,983 | 0 | Williamson & Joseph ... | 1,573 | 10 |
| Mechan & Sons ............ | 1,978 | 0 | Brook, Hirst & Co. ...... | 1,515 | 0 |
| Nalder Bros. & Thompson | 1,904 | 0 | | | |

*Battery of Accumulators and Accessories.*

| | | Maintenance. | | | No. of |
|---|---|---|---|---|---|
| | | 3 years. | 5 years. | 7 years. | cells. |
| Tudor Co. (*accepted*) ......... | £2,180 | £95 | £95 | £95 | 280 |
| Sutherland & Marcuson | 2,736 | 75 | 141 | 225 | 276 |
| Chloride Syndicate | 2,463 | 122 | 133 | 156 | 290 |
| Electrical Power Storage Co. | 2,059 | 140 | 140 | 140 | 282 |
| Brit. Power Trac. & Lightg Co. | 1,934 | 100 | 150 | 165 | 280 |
| Ashmore, Benson, Pease & Co. | 1,800 | 54 | 90 | 135 | 281 |
| Marquand Co. ......... | 1,762 | 90 | 95 | 106 | 281 |
| Hart Accumulator Co. ...... | 1,761 | 88 | 123 | 158 | 281 |
| D. P. Battery Co. ............ | 1,720 | — | — | — | 279 |
| Pritchetts & Gold ............ | 1,595 | 100 | 120 | 120 | 284 |

Southampton Corporation have received the following tenders:—

*Insulated Electric Cables, Frames, and Covers.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| St. Helen's Cable Co. (*accepted*) ............ | £868 | 9 | 4½ | Johnson and Phillips Electric Cable Works | £1,034 | 5 | 1 |
| Electrical and General Contracting Co. ... | 1,236 | 14 | 5½ | British Insulated Wire Co. ............ | 951 | 8 | 10 |
| Telegraph Manufacturing Co. ............ | 1,508 | 5 | 0 | Siemens Bros. & Co... | 919 | 15 | 6 |
| Western Electric Co... | 1,055 | 15 | 8 | W. T. Glover & Co. ... | 917 | 17 | 5 |
| | | | | Callender's Co. ......... | 891 | 13 | 4 |

*Three Motor Omnibuses.*

| | | |
|---|---|---|
| Daimler Motor Co. (to seat 12 persons and driver) (*accepted*) ... | £490 | each |
| T. Coulthard & Co. ......... | 600 | " |
| Motor Manufacturing Co. (12 persons excluding driver) ......... | 565 | " |
| Motor Manufacturing Co. (11 persons including driver) ......... | 468 | " |
| Wolverhampton Cycle and Steam Motor Co. (steam) ......... | 365 | " |
| Julius Harvey & Co. (steam) ......... | 650 | " |
| Simpson and Bibby (steam) ......... | 600 | " |

Bristol Corporation have accepted the following tenders:—

| | | | |
|---|---|---|---|
| Babcock and Wilcox (boilers, economisers, &c.) ... | £10,467 | 8 | 0 |
| W. H. Allen, Son & Co. (condensing plant) ......... | 3,746 | 0 | 0 |
| Bumstead and Chandler (induced draught plant) | 1,870 | 0 | 0 |
| Doulton & Co. (water-softening plant) ......... | 1,227 | 15 | 10 |
| G. and J. Weir (pumps) ......... | 415 | 0 | 0 |
| Steavenson & Co. (water storage tank) ......... | 195 | 0 | 0 |

Newcastle-upon-Tyne Corporation have accepted the tender of Mr. Brims for the erection of a siding and staith at the Manors electric power station at £940, and that of Messrs. Vaughan and Diamond for steel rails at £3,453. 2s. 11d.

The Hart Accumulator Co. have secured the contract for the supply of a storage battery for the Llanrwst electricity works.

Aberdeen Corporation have accepted the tender of Messrs. E. Green & Son for a fuel economiser, at £1,293. 17s., and that of Messrs. Alley and Maclellan for surface condensers, air, and circulating pumps. The tender of Mr. L. Smith for the mason work at Dee Village station at £7,553 has also been accepted.

Burnley Corporation have accepted the tender of the Barrow Hematite Steel Co. for steel rails required in the construction of the tramways at £16,387. The Council are also recommended to accept a tender for the supply of 24 electric tramcars complete at £740 each.

Leeds City Council have accepted the tender of Mr. Paul Rhodes for excavators', masons', bricklayers' work, &c., in constructing subways for electric cables at £9,697. The tender of Mr. L. Cooper, for smiths' and ironfounders' work at £2,076 has also been accepted.

Cheltenham Corporation have accepted the tender of Messrs. S. Z. de Ferranti (Ltd.) for a switchboard at £1,032, less 2½ per cent. The Corporation have also accepted the tender of Messrs. Channon & Son for the erection of a boiler-house at the electricity works at £1,855, and a chimney-stack at £725.

Glasgow Tramways committee have accepted the tender of Messrs. Bolckow, Vaughan & Co. for 2,000 tons of 60ft. steel rails at £7. 10s. per ton, and for fish-plates at £9. 10s. per ton, the whole to be delivered within six weeks. Trolley poles for 150 cars have been ordered from Messrs. R. W. Blackwell & Co. at £14 each.

Cardiff Town Council have accepted the tender of Messrs. Clark & Co. for the erection of a chimney shaft at the tramway power station at £1,563. The tender of the Maxim Electrical and Engineering Export Co. has also been accepted for the supply of steam pipes at £6,658.

On Wednesday evening the Fulham Borough Council accepted the tender of the Lighting Corporation (Ltd.) for wiring the central library at £154.

## BUSINESS NOTICES.

Mr. J. E. Austin, electric light engineer, has removed from 23, York-place to larger premises, 40, Upper Baker-street, London, W., where all future communications should be sent.

Mr. G. H. Wailes has retired from the partnership hitherto existing between himself and Messrs. G. P. and R. Wailes (trading as Geo. Wailes & Co.), electrical and mechanical engineers, 258, Euston-road, London, N.W.

Messrs. A. H. F. Ward and J. Harrison (trading as Allen, Ward and Harrison), electrical engineers, &c., 181, Warstone-lane, Birmingham, have dissolved partnership. Debts by Mr. Ward, who continues as Allen and Ward.

## BANKRUPTCIES, LIQUIDATIONS, &c.

A second and final dividend of 1s. 6½d. is payable on 17th inst. at 3, Crosby-square, London, E.C., in the bankruptcy of E. J. Paterson and C. F. Cooper, electrical engineers, &c., of Dalston and Westminster (London) and Glasgow.

A first and final dividend of 2s. 1$\frac{1}{10}$d. is payable at 8, King street, Norwich, in the bankruptcy of Leonard Francis, electrical engineer, 13, Corporation-street, Southwold, Suffolk.

Claims against the Electric Exploitation Co. (Ltd.) must be in by 22nd inst. to Mr. G. S. Barnes, 33, Carey-street, London, W.C.

It has been resolved to wind-up the Bute Electrical Manufacturing Co. (Ltd.) voluntarily, and to appoint Mr. R. Leyston, 12, Mount Stuart-square, Cardiff, as liquidator.

It has been resolved to wind-up voluntarily the Auto-Electro Feed Water Purifier Co. (Ltd.) and to appoint Mr. H. P. Smith, C.A., Wolverhampton, as liquidator.

The examination of Wm. George Higgs, electrical engineer, Glasgow, takes place at Sheriff Strachan's chambers, Glasgow, on 14th inst.

A receiving order has been made against G. I. Lloyd (trading as G. I. Lloyd & Co.), electrical and mechanical engineer, late 109, Chesterfield-road, and Castle Mill-street, Bristol. The first meeting of creditors takes place on 12th inst. at the O.R.'s, Baldwin street, Bristol, and the public examination on 19th inst. at the Guildhall, Bristol.

In the bankruptcy of A. E. Earle, electrical engineer, 7, Theatre-street and Dial-yard, St. Miles, Norwich, the trustee has been released.

The trustee in the failure of H. L. Howard (trading as Thompson, Howard & Co.), electrical and mechanical engineer, Wyvestow, Dragon-parade, and 16, Stonegate, Harrogate, and 17, Carlisle-street, Hull, has been released.

---

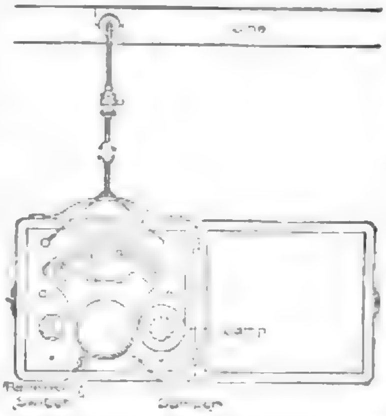
**Correction.**—By an error in our last issue, the address of the Lahmeyer Electrical Co. (Ltd.), was printed 11, New Oxford-street, London. The numbers should have been given 109 111.

**Messrs. Siemens Bros. & Co.**—We learn that this firm has secured an important site near Stafford for the erection of extensive new works. The land acquired is 51 acres in extent, less than a mile from the county town, and adjoining the main line of the London and North-Western Railway, and negotiations are progressing for the acquisition of a further 7½ acres. In this connection the statement made by Mr. A. Hills at the Thames Ironworks meeting of shareholders, reported on another page, is interesting.

**Electric Measuring Instruments, &c.**—Messrs. Joseph Levi & Co. of Hatton Garden, London, E.C., British agents for M. Jules Richard, Paris, have prepared an exhaustive list of electric measuring instruments which are fully stocked in London. The list includes ammeters and voltmeters of various patterns for direct and alternating currents. In addition to a large and varied assortment of electric measuring instruments, there is a comprehensive selection of instruments for use in the engine room and other places where records have to be made for many purposes. The stock of meteorological instruments, pressure gauges, tachometers, speed indicators, hydrometers, &c., is large, and a useful form of electric alarm thermometer is shown. The firm stocks largely photographic apparatus and accessories of all kinds.

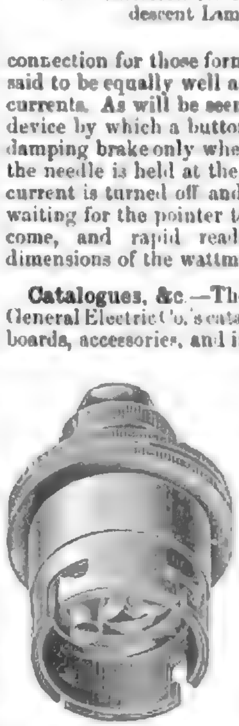
**"Cupron-Element"**—Accumulator Industries (Ltd.), who are sole licensees for Great Britain, the Colonies, and North America of "Cupron-Element" (system Umbreit and Matthes), forward a new catalogue, and claim that this is a constant current primary battery consuming very little material and having no local action when cells are not in use, and that the battery is always ready for use. It is pointed out that many attempts have been made to improve the Lalande and Chaperon element, but that failure has hitherto followed these attempts, especially with regard to the copper oxide plate anode of the element. This difficulty, however, has now been overcome in the Cupron-Element. The illustrations in the catalogue include a portable set, and sets for lighting and plating. Instructions for installing the cells and for mixing the material accompany the catalogue.

**Incandescent Lamp Testing.**—The British Thomson-Houston Co., in their pamphlet No. 88, describe and illustrate a form of indicating wattmeter for incandescent lamp testing. The illustration below shows the method of connecting the instrument for these tests. The wattmeter combines all the merits of the Thomson inclined coil-measuring instruments, and the present design of wattmeter was adopted with a view of facilitating rapid testing of lamps. The instrument indicates the energy used by a small fan motor, and is therefore claimed to be particularly useful in comparing the relative amount of energy required by a fan motor and an ordinary incandescent lamp. The wattmeter is supplied with two special plugs (screw base and bayonet), providing a ready means of connection for those forms of sockets most generally in use. It is said to be equally well adapted for use in either direct or alternating currents. As will be seen, the wattmeter is provided with a damping device by which a button releases the needle or pointer from the damping brake only when depressed. When the button is released the needle is held at the point of last indication. Therefore, if the current is turned off and then on again or reversed the necessity of waiting for the pointer to swing from zero to a state of rest is overcome, and rapid readings may thus be taken. The external dimensions of the wattmeter are 7½in. by 7½in. by 4½in.



B.T.H. Wattmeter for Testing Incandescent Lamps.

**Catalogues, &c.**—The tenth edition of the "S" section of the General Electric Co.'s catalogue is issued, dealing with switches, switchboards, accessories, and incandescent lamps. The list contains many novelties, some of which have recently been referred to in our columns. Amongst these may be mentioned a new watertight switch for incandescent lamp posts mounted in a cast-iron case, tapped to take the barrel and provided with a lever arm for manipulation from the pavement. There are also shown a good series of watertight houseservice and tramcar cutouts for 110 volts and 500 volts. There is also a special form of Robertson lamp for traction and tramcar work, for which the General Electric Co. are the sole selling agents. Amongst the accessories sent out by the General Electric Co. for tramcar work may be mentioned an anti-vibration lamp-holder similar to the usual bayonet cap type, but provided with an additional interior ring having a small projection engaging in a bayonet catch. This type of fitting is shown in our illustration. It is recommended for street car, train, ship, and mill lighting, in colliery installations, or to any position where incandescent lamps are subject to vibration.



G.E. Co.'s Anti-Vibration Holder.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from March 27 to April 2, with the ports of destination :—

*Africa*—Cape Town, £179 (including £80 telegraph material); Chinde, £42, Delagoa Bay, £91; Durban, £742; East London, £526; Port Said, £17. *Australasia*—Brisbane, £68; Hobart, £258; Melbourne, £250; Perth, £135; Sydney, £1,791 (including £1 654 telegraph wire). *Brazil*—Rio Janeiro, £68 (telegraph material). *Ceylon*—Colombo, £177 (including £54 telegraph material). *Channel Islands*—£17. *Chili*—Valparaiso, £61 (telegraph material). *China*—Shanghai, £214; Taku, £108 (telegraph instruments). *Denmark*—Copenhagen, £34 (telegraph wire). *France*—Calais, £58; Paris, £65. *Germany*—Hamburg, £250 (telegraph material. *Gibraltar*—£15. *Holland*—Amsterdam, £35. *Hong Kong*—£120 telegraph material). *India*—Bombay, £97; Calcutta, £818; Madras, £766. *Japan*—Kobe £6,534 (telegraph cable); Yokohama, £170 (telegraph apparatus). *Norway*—Christiana, £150 (including £91 telegraph wire). *Russia*—Kure, £2,554 (including £2,471 telegraph cable); St. Petersburg £300 (telegraph material). *Spain*—Bilbao, £30; Vigo, £252 (telegraph paper). *Sweden*—Gothenburg, £226 (telegraph wire); Stockholm, £691 telegraph wire). *Uruguay*—Monte Video, £24 (telegraph material). Total, £19,480, against £11,486 in the corresponding week last year (March 28 to April 3).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* Messrs. J. C. Chapman & Co. *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 22, 1900.

23,448. A. Whalley. Warrington. Improvements in telephone switch-board cords.

23,461. Wayss and Freytag. Germany. New method of impregnation and isolation of endless protecting pipes, tubes or cylinders, to lay under ground cables, electric wire, and other conductors, or liquid acid, &c.

23,462. Wayss and Freytag. Germany. Moulding machine for manufacture of protecting underground conductors, cables, electric wires, or liquid acid made of cement, concrete beton, or any other artificial stone or material.

23,484. E. H. Tyler and C. A. Carus-Wilson. London. Improvements in the means of controlling electric motors.

23,485. E. H. Tyler and C. A. Carus-Wilson. London. Improvements in electric motor control.

23,487. E. von Planta. London. Electro-mechanical emergency brake for tramcars driven by electricity. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 23, 1900, being date of application in Switzerland.)*

23,490. F. H. Headley. London. Improvements in or relating to electric switches.*

23,491. T. H. Minshall. London. Improvements in means for extinguishing arcs formed on the breakage of electric circuits.

23,492. T. H. Minshall. London. Improvements in and relating to methods for testing electric circuits.

23,514. W. T. Burbey and A. J. Clarke. London. Improvements in electric house service or fuse boxes.*

23,523. B. Cruvellier. London. Improvements in electric block signalling and in supplying electric current to trains in connection therewith.*

December 24, 1900.

23,543. W. E. Ayrton and A. W. Fithian. London. Improvements in plates for secondary or storage cells.

23,549. J. N. Maskelyne, jun., and A. Marr. Manchester. Improvements in and relating to telegraphic transmitting apparatus.

23,556. W. Courtenay. London. Third rail insulator and support.*

23,571. J. S. Highfield and S. Beeton. Manchester. Improvements in apparatus for indicating and (or) recording the speed of electrically-propelled vehicles and (or) the distance travelled thereby.*

23,583. H. H. Lake. London. Improvements relating to supporting devices for electrically insulating telegraph and similar wires. (E. Renault, United States.)*

23,584. W. Rowbotham and K. A. Rowbotham. Birmingham. Improvements in and relating to arc lamps and the like.

23,586. R. Pearson. London. A fusible electric circuit-breaker for fire-alarm purposes.*

23,592. A. Wright and The Reason Manufacturing Co. (Ltd.). London. A method of and apparatus for actuating devices on public electric supply or distribution systems.

23,593. A. Wright and The Reason Manufacturing Co. (Ltd.). London. A method of and apparatus for actuating devices on public electric supply or distribution systems.

23,610. L. M. Ericsson. London. Improvements relating to signalling jacks for multiple telephone exchanges.*

23,611. F. Lux, jun. London. Improvements relating to maximum electric meters.

### SPECIFICATIONS PUBLISHED.

Note.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

13,966. British Thomson-Houston Co. (Ltd.) (Thomson). Rontgen-ray tubes and other vacuum tubes.

14,054. Julius Sax & Co. (Ltd.) and Aird. Indicators for electric bells and the like.

14,104. Lauckner (Vogelsang). Electrodes for use in electro-chemical processes.

14,769. Lake (Earle). Coin-freed apparatus for the supply of electric power.

14,798. Braban. Attachment to ceiling roses for raising and lowering central hole weights or fixing electrical fittings.

14,943. Baird. Switch-boards for telephone stations.

15,073. Boissier. Electro-plating apparatus.

15,332. Wise (Skodawerke Actiengesellschaft). Apparatus for stopping, starting, and reversing electric motors.

15,721. Cederghen and Piltz. Telephone systems.

15,774. Clar. Electric signalling apparatus for fire alarm and other purposes.

16,082. de Kandó. Combined reversing switch and automatic maximum current interrupter for multiphase current motors.

16,159. Clark. Lifting magnets.

16,248. Davies, Kent and Stewart. Electric wall or floor coupling sockets.

16,290. Campbell. Electric circuits for the transmission of energy by variable currents.

16,529. Mills. (General Electro-Chemical Co.) Process of manufacturing abrasive materials from bauxite or other hydrous oxides of aluminium.

16,408. von der Poppenburg. Electrodes of electro-chemical accumulators.

16,699. The British Thomson-Houston Co. (Ltd.) (Bell). Lightning arresters.

16,702. British Thomson-Houston Co. (Ltd.) (Rice). Dynamo electric machines.

16,704. The British Thomson-Houston Co. (Ltd.) (Reist). Adjusting brush holders for electric machines.

16,706. British Thomson-Houston Co. (Ltd.) (Buck). Means for preventing limiting of dynamo-electric machines.

16,845. Ricard and Gary. Electric igniters for explosion motors.

17,110. Siemens Bros. & Co. (Ltd.) (Siemens and Halske Aktiengesellschaft). Arrangement of connections for sets of electric glow lamps in series, so as to maintain the circuit in case of the extinction of one or more of the lamps.

17,436. Paramore. Combined relays and repeaters.

18,099. Porsche. Electrically-driven road vehicles.

## COMPANIES' MEETINGS AND REPORTS.

### Brush Electrical Engineering Co. (Ltd.).

The twelfth annual general meeting of this company was held on Friday last, Mr. J. B. Braithwaite, jun., M.I.E.E., presiding.

Mr. B. Broadhurst (secretary and assistant manager) read the notice calling the meeting, and the directors' report was taken as read.

The Chairman said: With regard to the balance-sheet now presented, the most noticeable changes are those resulting from the issue of capital which we made last year. The result is that our issued share capital has increased from £350,000 to £424,600, an increase of about £65,000. On the other side of the balance sheet the most notable change is an increase in the shares and debentures held by us, from £70,953 to £87,602, and the increase of our depreciation reserve fund from £15,000 to £17,500. That is due to the shares we have taken up in the Electrical Power Distribution Co., a company in the future of which we have a considerable degree of confidence. One of our Directors, Mr. Raworth, is the chairman, and the company is interested in electric lighting stations in different parts of the country. We look on these shares as likely to be a satisfactory investment, and are getting large orders for plant from that company, so that I think the arrangement is one which is mutually satisfactory. Then the amount that we are owed has increased from £129,930 to £141,674, showing an increase of £11,700, due to the increase in our business and the turnover during the past year caused by the erection of our new shops. On the other side of the account a considerable increase has taken place in the amount we owe. The total of this amount, including bills payable, has risen from £54,624 to £81,847. That sounds a very large increase, and is rather a larger figure than the relative increase of the business would bring about; but included in that amount are several sums which at the date of the balance-sheet were a little overdue; so that it is rather an exceptional amount, and probably in the next balance-sheet it will be considerably less. With regard to the item of Workmen's Compensation Act Insurance Fund, the same figure of £1,000 stands on the balance-sheet as on previous occasions. We have found, as I have told you before, that the policy of insuring our own workmen has proved to be more profitable to the Company than doing it through any insurance office. There may come a time when insurance companies have had more experience of the working of the Act, when they may be able to quote us rates which will make it desirable for us to insure through one of them. When that time comes this £1,000 we took out of the reserve some little time ago can go back and be used for any other purpose. In the meantime, we are paying the actual cost of any claims made, out of our profit and loss account. The claims under the Workmen's Compensation Act have been £275 for the year, and that is debited to revenue in the usual way, the same as our other charges. I do not think there is any other feature in the balance sheet I need call attention to. Turning to the profit and loss account, you will notice that the gross profit on trading, after making a reserve for doubtful debts, is £50,115. 19s. 2d., to which we add the £6,496. 9s. 6d. received by way of dividends on our securities, and the profit realised on sales of some of them, bringing a total credit to revenue of £56,600. That is, I think, a fairly satisfactory figure, considering the difficulties under which we have had to labour to some extent during the past year. These difficulties have been twofold; in the first place, we have had to pay very high prices for iron, steel, copper, and other raw materials that we use; in the second place, we have paid exceptionally high prices for coal, which have affected our profits to the extent of about £1,000 for the year. Then the most serious interruption to our work and diminution of our profit during the past year has been the completion of our extensions at Loughborough and the bringing of our tools into the new shops and setting them to work. Those extensions and the unsettlement resulting therefrom are practically at an end, therefore you may look forward to reaping the benefit of our

capital expenditure on new works during the coming year. We had already begun to reap that during the last three months of 1900, but for the greater part of the year we suffered seriously from disorganisation of work, which was unavoidable in shifting from one shop to another, simultaneously with conducting manufacturing operations. We have also suffered from the change of managership at the works, likewise rendered unavoidable by circumstances occurring which obliged our previous manager (Mr. C. E. Hodgkin) to resign his position and take up another post, which he was bound to do, for family reasons. I am glad to say, however, that we still retain the benefit of his services, because he has accepted a seat on the Board, which will, no doubt, be of considerable advantage to us. We took a great deal of pains naturally to endeavour to secure a first-class successor to Mr. Hodgkin, and I believe that in Mr. Leeson we have secured a gentleman who will be able to show you what your new works are capable of doing in the way of manufacturing at a satisfactory profit for the Company. He has not had an opportunity of showing what he can do in that way on the past year's accounts; but during the present year, if we are able to keep the works fully supplied with orders, I have little doubt that we shall show figures which will be extremely satisfactory to you as to the gross profits earned. The new car shops, which I mentioned on the last occasion, are now completed and are fully equipped for work. They cover about 5 acres of ground, and they have a capacity for turning out a large number of electric cars, completely equipped. I mentioned, when we met on the occasion of approving the agreement with the British Electric Traction Co., that we were now in a position to turn out electric cars of British manufacture throughout—that is to say, we manufacture at our works not only the car bodies, but the motors, the controllers, the underframes and the trucks themselves, which hitherto have been almost exclusively of foreign manufacture. So that we are now in a position to turn out the whole article completed from our own works, which puts us in a very satisfactory position for the undertaking of traction work in this country. The other important event which has occurred during the past year is the agreement into which we have entered with the British Electric Traction Company, and to approve which we called a special meeting of shareholders last January. That agreement has only been in force for a short time, but there is every indication that our Expectations with regard to it are to be realised, and that the agreement will be one which will be of mutual benefit to the two companies. I believe it will bring a large and increasing stream of orders for engines and generators, and also for electric tramway rolling stock, into our works at satisfactory prices, and I have no doubt, when we meet you this time next year, that I shall be able to tell you the agreement has had no unimportant share in bringing about the satisfactory results which I think we shall have to report to you when we meet on future occasions. Then with regard to the announcement in our report as to a further issue of shares, you will remember I told you last year that, in order to complete our works and carry out all the extensions we had in contemplation, we should require to issue about 30,000 preference shares and 30,000 ordinary shares, which at par would represent £120,000 of additional capital. We offered them to the shareholders, and almost exactly one half was taken up by them—that is to say, about £60,000 of the £120,000 which we estimated we should require—and that was all we wanted for the time being. Now that our works are completed it becomes necessary to obtain the remaining £60,000 which we originally estimated would be necessary, and for that purpose we are proposing to issue a further 12,500 preference shares, which, at par value, would represent £25,000, and a further 20,000 ordinary shares, which at par value would mean £40,000, making a total additional capital issue of £65,000; so that our original estimate has in this case been pretty accurately borne out by facts. There is only a difference of £5,000 between the amount proposed to be issued now and the amount we estimated a year ago as being necessary to close the capital account for the time being and to pay for all the extensions and additions to the works which have been rendered necessary. I now move the adoption of the report and accounts as presented.

Mr. C. E. HODGKIN seconded the resolution, which was carried.

A resolution approving the payment of the dividends set out in the report was also approved

Mr. J. B. Braithwaite, jun., Lord Vaux of Harrowden, Mr. C. Shireff B. Hilton, and Mr. C. E. Hodgkin were re-elected directors; and the auditors, Messrs. Cooper Bros. & Co., were re-appointed.

At an extraordinary meeting which followed alterations were approved in the articles of association to bring them into line with the new Companies Act.

## National Electric Wiring Co. (Ltd.).

The fourth ordinary general meeting of this company was held on Monday under the presidency of Mr. R. STEWART BAIN, C.A.

The MANAGER and SECRETARY (Mr. W. B. Cownie) having read the notice calling the meeting.

The CHAIRMAN said: I can congratulate you upon a comparatively successful year's working. You will recollect that last year we made a commencement as a dividend-paying company. The dividend, it is true, was small, being 3 per cent., but it was a beginning, and I expressed the hope that it might be a promise of larger dividends in the future. Well, in the accounts before you we have advanced to 4 per cent.—not a large increase, you may say, but still it is an increase, and I might point out that it is even better than it looks, because the 4 per cent. is paid upon a capital of £75,000, and earned upon the workings of one year, after making adequate provision for depreciation, &c., whereas the dividend of 3 per cent. last year was upon a paid-up a capital of £50,000, and was made from the accumulated earnings of two years. If our increase is slow, I think I may say that it is sure, and there is an old Spanish proverb which says, "He goes far who goes slowly." If you turn to the report you will see that our business is a steadily increasing one. During the year we completed 2,240 installations, with an aggregate of 57,519 lamps of 8 c.p., as compared with 1,970 installations, with an aggregate of 51,774 lamps of 8 c.p. during the previous year, being an increase of 270 installations and 5,745 lamps. Of this total 777 installations, with 19,973 lamps of 8 c.p. power, were free-wired, and 1,453 installations, with 37,546 lamps of 8 c.p., per contract, while we had orders on hand at the end of the year amounting to 590 installations, with an aggregate of 33,031 lamps of 8 c.p., being an increase of 195 installations and 20,072 lamps, as compared with last year, and during the first three months of the present year additional orders have been received for 577 installations, with an aggregate of 16,897 lamps of 8 c.p., the value of contract work taken being about double the value of that taken in the corresponding period of last year. These figures all point to a steady increase in the Company's business. The installations, however, have not only increased in number, but they have increased in importance. I have here a list containing the names of over 100 of the most important installations which have been carried out, and I am glad to say carried out with every satisfaction. Many of these installations are for the complete equipment of large works, with plant for power and lighting. I shall not weary you by reading out the names of these installations, but should any shareholder wish a copy of the list he can have it. I am glad to say that the prospect for a continuance of this class of work during the present year is very hopeful. Our free wiring portion of the business has not increased in the same ratio as our contract portion, but this is only for the reason that our policy is to sink our capital only in remunerative installations which are well secured. During the year we have entered into free-wiring contracts and opened branches in Swansea, Poplar, and Coatbridge, all of which promise to be profitable undertakings, both as regards free wiring and contract work. If you will now turn to the accounts it will be seen that the gross profit for the year was £9,636. 0s. 2d., as compared with £5,643. 11s. 3d. for the previous 12 months. Of this amount £2,120. 0s. 9d. was from free-wired installations, as compared with £1,439. 18s. 11d. for the previous year. Our total capital expenditure on free wired installations has been £33,761. Over £12,000 of this was expended during the past year, so that the £2,120 of revenue was really derived from the expenditure upon which we started the year—namely, about £21,000. This works out to a revenue of about 10 per cent., and, in the opinion of the Directors, this is satisfactory. We took over some free-wired contracts from the old syndicate which were not remunerative, but the whole of our later contracts have been satisfactory, and we expect that our revenue from the new contracts will exceed that shown in these accounts, namely, 10 per cent. Our profit from contract work is £6,864. 5s. 2d., as compared with £3,363. 11s. 10d. for the previous year, or more than double. The receipts from interest, discounts, &c., amount to £651. 14s. 3d., as compared with £840. 0. 6d. for the previous year. Our total expenses were £5,612. 4s. 8d., as compared with £3,852. 18s. for the previous year, so that while our gross profits show an increase of over 75 per cent. our expenses only show an increase of 45 per cent. The amount written off as allowances on contracts and bad debts—namely, £573. 17s. 11d.—is nearly double what it was last year, but I may state that the increase is in connection with contracts made prior to the present management, which, I am glad to say, have now all been satisfactorily settled. The balance left is £3,933. 15s. 6d., which, after making adequate provision for depreciation, &c., enables us to pay a dividend of 4 per cent. on the paid-up capital and to carry forward to next account £334. 5s. 9d., being about £100 more than we carried forward last year. Turning now to the balance-sheet, you will see that our paid-up capital has increased from £50,000 to £75,000. This is owing to the call of 5s. we made during the year. There still remains 5s. per share to be called up on the subscribed capital, and the probability is that, owing to the satisfactory increase in the business, we may call this up during the present year. The comparatively small amount (considering the amount of business done) due to creditors—namely, £4,417—shows, I think, that we pay our accounts promptly. On the other side, the first item is the purchase of the business, which stands as at last year. You will remember that this amount does not represent the purchase of the free-wired installations solely, but it also represents the sole rights of using our lead covered cable. Of this £27,621, £18,851 was paid in deferred shares, which do not rank for dividend until the subscribed shares have received 6 per cent. for two consecutive years, so that the balance of a little over £8,000 is practically all that is represented in these accounts upon which we have to pay a dividend at present, and this is represented by assets in connection with the formation of the business. The amount expended on contracts in course of completion—namely, £11,133. 8s. 4d.—also shows a satisfactory increase, being nearly double the amount shown in the last balance-sheet. The stock at head offices and branches has been reduced from £8,400, as per last balance sheet, to £6,839. This I look upon as satisfactory, as it shows the economical manner in which the business is managed. The amounts owing to us at the end of the year have increased from £9,722, as shown in the last balance-sheet, to £16,593, all of which we believe to be good. These figures alone show the progress we are making; but it is not only the amount of business we are doing which is satisfactory, but, what is of far greater importance, it is the efficient manner in which we are carrying out our work, and which is causing us to be entrusted with some of the most important work in the country, including valuable Government contracts. For this efficiency we are greatly indebted to our energetic and capable manager, Mr. Cownie, and to his excellent staff of district managers and engineers. I now move the adoption of the report and accounts.

The motion was carried unanimously.

The retiring directors (Mr. R. Stewart Bain and Mr. Bernheim) and the retiring auditors were re-elected, and a hearty vote of thanks to the chairman, directors and manager having been passed, the proceedings terminated.

## County of London and Brush Provincial Electric Lighting Co. (Ltd.).

The seventh ordinary meeting of this company was held on March 23, under the presidency of Lord RATHMORE.

The SECRETARY (Mr. H. B. Renwick) having read the notice,

The CHAIRMAN said: It is a great satisfaction to the directors to meet you on an occasion when we have reached the stage to which we have looked forward through some years of difficulty and disappointment—the stage at which we are able to recommend the payment of a dividend to a large extent provided out of the earnings of our London stations. These metropolitan stations have always been, and must remain, the backbone of your business. I desire on this occasion to call your attention to some of the salient features appearing in the report. First, as to our associated companies. At *Bournemouth* the number of applications for the supply of current received in 1899 amounted to more than 10,000 lamps, but this year they have gone a shade better. There is also the work upon the construction of the tramways between Bournemouth and Poole, which is now completed, and the Bournemouth and Poole Supply Co. will presently have to provide current for working those tramways. The revenue account of the Bournemouth and Poole company has also advanced in a very satisfactory way, in spite of the high price of coal during the greater part of the year. The result is that they have been able this year to pay a dividend of 6 per cent. on their ordinary shares, instead of 5 per cent., as in the previous year. The *Dover* company, too, has shown substantial progress, and the number of lamps supplied has increased, as has also the demand for current for power purposes. The dividend paid has increased to 3½ per cent. from 3 per cent. in 1899. At *Coatbridge* up to the present the company has been the least successful of our ventures; but during last year a great change for the better has occurred there. The number of consumers has more than doubled, and the number of lamps applied for has increased by nearly 90 per cent. Terms have been arranged with Airdrie for the transfer of their lighting order to the Coatbridge company, and a contract completed for the supply of current for both public and private lighting in Airdrie. The interest of the Airdrie and Coatbridge Tramways Co. has also been acquired; and a provisional order is being applied for, with the consent and assistance of the Corporation, for constructing tramways in Coatbridge. A new prospect is thus opened up for the Coatbridge station, which has rather languished for want of enough work to do. Turning to London, when I last addressed you I mentioned that the Western Holborn and Camberwell districts were comparatively unproductive. Since that time those districts have turned out extremely well. The revenue figures for Western Holborn are £2,206 for 1900, against £470 for 1899, and for Camberwell £4,750 for 1900, against £941 for 1899. At *City-road* the profit for 1900 shows an increase of 98 per cent. over 1899, and the average works cost has been reduced from 3·8d. per unit in 1898 to 2·4d. in 1899 and 1·8d. in 1900, and this notwithstanding the abnormally high price of fuel. The increased demand for current for power is very striking, the increase for the year being equivalent to 798 H.P., making the total to the end of 1900 equivalent to 1,171 H.P., while the applications now represent 1,641 H.P. It has therefore been necessary to provide additional plant at City-road. The increase of profits from our *Wandsworth* station may not seem quite as great as at City-road, but there is an increase of 40 per cent. there, and when we remember that during 1899 one-fourth the total output was for current supplied in bulk to the South London Co., while during 1900 we did not supply a single unit to any other company, an increase of 40 per cent. is a result which entitles us to regard the progress at Wandsworth as most satisfactory. Speaking of the two districts together (City-road and Wandsworth) the number of applications received for current during 1900 amounted to the equivalent of 102,000 8 c.p. lamps, which, I believe, is the largest number received by any one of the London companies during that year; and the units sold were 2,990,138, against 1,766,515. The net revenue of the company, excluding profits on investments realised—that is, the revenue produced from the two London stations—has shown extraordinary progress during the last two years, having risen from £7,285 in 1898 to £13,441 in 1899, and to £27,526 in 1900, and I am advised by Mr. Sparks, our engineer, and Mr. Renwick, our secretary—two officers to whom we owe much of these satisfactory results—that, assuming a normal price of fuel, there is reasonable probability that our net profits may this year further expand by some such amount as they did last year. With reference to the items depreciation, repairs and renewals, we have carried £3,815 to debit of this account, and have credited it with £6,000 premiums we received on the issue of £100,000 debenture stock last summer. We feel thoroughly justified in this course, without establishing a special reserve, in view of the greatly appreciated value of our investments in our outlying stations—investments which, if they were realised at the present time, would produce a very large sum indeed in profits. In regard to the future of this company, there are some influences disadvantageous, no doubt, and some which give ground for sanguine hopes. It is necessary to bear in mind what appears to be the ever growing cost of materials, and you must also take into account the interference, which does not seem to grow less, of the local authorities —sometimes as rivals, sometimes as obstructives. But I think we can confidently rely on the rapidly growing popularity of electricity as an illuminant, and also on what is already a very important matter, and which I believe will grow more and more so in the future—the rapidly increasing demand for current for power. I now move the adoption of the report and accounts.

Mr. J. B. BRAITHWAITE, jun., seconded. Referring to the satisfactory state of the company's finances, he said: You will see that at a time when some companies have had great difficulty in preventing works costs from going up—and in some cases they have gone up considerably—Mr. Sparks has succeeded in reducing our costs from 2·4d. in 1899 to 1·8d. last year, or a reduction of 25 per cent., in spite of the high price of coal. The unit, which two years ago cost us 3·8d., now costs us only 1·8d.—a clear saving of 2d. per unit, and that worked out on 3,000,000 units will show the difference in our profits.

Mr. J. A. ROWE: How do we stand for engine-power at our stations with respect to the demand made for increased current?

Mr. SPARKS (the engineer): The machinery at Wandsworth was increased last year, and is being increased during the present year by a further 800 kw. At City-road last year we increased our boiler power but not our actual steam machinery. This year we are increasing the steam machinery by putting in further continuous-current machines for power and alternating-current machines for lighting. We shall not have to increase our buildings for probably another two years. At one of our stations we have considerable land available for building when the time comes.

The CHAIRMAN having replied to various questions, the resolution was carried unanimously.

Resolutions approving the dividends set out in the report, the reelection of the retiring directors (Mr. F. E. Savory and Mr. Joseph Shaw) and the retiring auditor (Mr. R. H. Marsh), were then carried.

An extraordinary general meeting followed, at which the special resolution set out in the report was adopted.

A vote of thanks to the chairman, deputy-chairman and directors, and to the secretary and the staff, was then carried unanimously, and the proceedings terminated.

---

**BELL TELEPHONE CO. OF CANADA.** At the recent annual meeting it was announced that it was contemplated to increase the capital from $5,000,000 to $10,000,000. The present capital has all been issued and additional money is required for construction and general extensions. An additional bond issue of $2,550,000 will be placed upon the market as funds are required. The annual report stated that 3,437 subscribers have been added during the year, the total number of sets of instruments now earning rental being 38,360; the company owns and operates 345 exchanges and 494 agencies; about 2,430 miles of wire have been added to the long-distance system in 1900; the long-distance lines now owned and operated by the company comprise 21,350 miles of wire on 6,525 miles of poles. The gross revenue for the year was $1,614,262, expenses $1,229,977, net income $384,285.

---

**BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD).**—The directors' report for the past year shows that the equivalent of 8 c.p. lamps connected has increased from 7,337 in 1899 to 13,395 in 1900, while 4,937 lamps were being supplied in Chislehurst, and the revenue from the sale of current had gone up from £2,358 to £4,044. The amount available for dividend is £835. 6s. 3d. A 4 per cent. dividend is recommended, and £400 is placed to reserve for renewal of plant.

---

**FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)**—The annual meeting was held on Saturday. The directors' report stated that the company continued to make satisfactory progress. At the end of 1899 there was an equivalent of 17,834 8 c.p. lamps, and on Dec. 31, 1900, of 24,190 lamps. The profit on revenue account was £2,930. 5s. 2d., which, with £149. 3s. 1d. from last year, and after payment of debenture interest, &c., showed a net balance for distribution of £2,345. 2s. 4d. A dividend of 4 per cent. was declared. The chairman (Ald. Spurgen) said that they had expended about £12,000 on capital account. Their income from private lighting was £443 more, and from public lighting £110 more, although the balance for distribution was only £97 more than last year, owing to the high price of coal. When the company was started they had no idea current would be taken up so freely as it had been, and so they started on what they thought prudent lines; but the increase had been very rapid, and they had extended their works greatly this year. On their second year's working the company paid a 4 per cent. dividend, and in the first year they made a profit of about £400. In addition to the increased cost of coal another cause had depreciated their receipts—the economies made by consumers in using the light, the result being that instead of getting 6s. 8½d. per lamp, as they did the first year, they only now got 6s. 1d. That was due to consumers taking extra care in turning out their lights. They were extending their buildings, and had a large amount of machinery on order. They were also putting down condensing plant, and anticipated saving something like 25 per cent. on their coal bill. They would shortly have to ask for another £25,000 of capital.

---

**LIVERPOOL DISTRICT LIGHTING CO. (LTD.)** The directors' report for 1900 states that the supply of electricity at Waterloo still shows constant and satisfactory progress, the number of lamps connected to the mains at the end of the year being 6,234, against 4,243 in 1899, an increase of nearly 50 per cent. The revenue increased from £1,504 to £2,368. The company have sold the Gateacre portion of their business to the Garston Electric Supply Co. (Ltd.) for £20,000. At the annual meeting, Col. A. H. Holme congratulated the shareholders upon the improved state of the company's business, and upon having disposed of an unremunerative portion of their undertaking (the Gateacre section). The costs of working were heavy last year, owing to the enhanced price of coal, but the company stood in a better position by £2,000 or £3,000 than last year, and their business was increasing. A committee of the Waterloo Council had been appointed to make some proposition to the company regarding the acquisition of the company's undertaking, but no sum had been named, and he assumed the committee were seeking to get the undertaking at less than its value. The shareholders might be quite certain that they would sell the undertaking if they made a profit sufficient to reimburse them for the long time they had waited, but they would not sacrifice the property. There had been no profit on their contract and manufacturing business.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ANGLO-AMERICAN ALUMINIUM CO. (LTD.)**—Registered March 19, with a capital of £1,500 in £1 shares, to carry on the business of aluminium manufacturers, metallurgical, electrical and mechanical engineers, metal workers, &c.

**LA SOCIEDAD ELECTRO CENTRAL.**—This company has been formed at Zaragoza (Spain) to light electrically the town of Epila by water power generating plant.

**MANUAL OF ELECTRICAL UNDERTAKINGS (LTD.)**—Registered March 13, with a capital of £5,000, in £1 shares, to carry on the business of newspaper proprietors, printers, publishers, &c. The subscribers are: E. Garcke (managing director), W. L. Madgen (electrical engineer), W. A. Smith, R. Doyle, W. F. Cox, H. A. Stagg and A. G. Sewell. First directors: E. Garcke and W. L. Madgen.

**NEW ORLEANS MOTOR CO. (LTD.)**—Registered March 22, with a capital of £20,000, in £10 shares, to take over the business carried on by Burford, Van Toll & Co., as engineers, motor car manufacturers, electrical, oil and other motor engineers, suppliers of electrical and other power, &c. The first directors are F. A. Rolewald, Count J. de Liederkerke, Count M. de Bousies and A. Vyvinus.

**SHERRIN AND PARTNERS (LTD.)**—Registered March 11, with a capital of £25,000, in £1 shares, to carry on business as manufacturers, engineers, electro and manufacturing chemists, makers of electrical, chemical, and scientific apparatus, wire drawers, &c. Mr. J. Vaughan-Sherrin is first managing director.

**T. C. WILLIAMS & SONS (LTD.)**—Registered March 23, with a capital of £20,000, in £1 shares (4,000 preference), to acquire and carry on at Reading the business of ironmongers, mechanical and electrical engineers, &c. The first directors are W. W. Williams (chairman), A. S. Williams, W. G. Millar, W. Haynes and C. A. Rollason.

---

**ARGENTINA ELECTRIC TRACTION CO. (LTD.)**—In the annual return to Jan. 11 the capital is given as £500,000 in £5 shares, all of which have been taken up. No mortgages or charges.

**KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.)**—The annual return to Feb. 27 states that the capital is £350,000 in 50,000 ordinary, 10,000 first preference and 10,000 second preference shares of £5 each, of which 21,000 ordinary, 10,000 first preference, and 10,000 second preference have been taken up. £5 per share has been called up on 15,958 ordinary, 10,000 first preference, and 10,000 second preference shares. Mortgages and charges, £90,000. Debt in respect of debenture stock issued by the company in conjunction with the Notting Hill Electric Lighting Co. £100,000.

**MEXICAN GAS AND ELECTRIC LIGHT CO. (LTD.)**—In the annual return to Feb. 25 the capital is £100,000 in 5,000 shares of £20 each, all of which have been taken up. £100,000 is considered as paid. Mortgages and charges, £95,000.

**ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO. (LTD.)**—According to the annual return to Feb. 25 the capital is £300,000 in 20,000 preference and 40,000 ordinary shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £150,000.

**SOUTH LANCASHIRE ELECTRIC TRACTION AND POWER CO. (LTD.)**—The annual return to Feb. 18 gives the capital as £850,000 in 600,000 preference and 250,000 ordinary shares of £1 each, of which 51,133 preference have been taken up. 6s. has been called up on each share. Mortgages and charges £500,000.

**TELEGRAPH CONSTRUCTION AND MAINTENANCE CO. (LTD.)**—The annual return to March 12 gives the capital as £449,280 in 37,350 shares of £12 each, all of which have been taken up and paid for in full. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 26⅜d. per oz. (April 3). Consols (2¾ per cent.) 95¼—95⅜ for money, 95⅝—95¾ for account; 2½ per cent. 96—97 (April 3). Stocks and Shares Continuation Days, April 10 and 24. Ticket Days, April 11 and 25; Pay Days, April 12 and 26; Mining Share Carry-over Days, April 9 and 23.

---

**A. U. ALCOCK ELECTRIC LIGHT AND MOTIVE POWER CO. (LTD.)**—This Melbourne company has gone into voluntary liquidation, its undertaking having been acquired by the Electric Supply Co. of Victoria (Ltd.).

**ANGLO AMERICAN TELEGRAPH CO. (LTD.)**—After placing £6,000 to renewal fund, an interim dividend for the quarter ended March 31 of 15s. per cent. on the ordinary and £1 10s. per cent. on the preferred stock (less tax), has been declared, payable May 1.

**ANGLO ARGENTINE TRAMWAYS CO. (LTD.)**—The directors' report states that the permanent way renewals have been reduced to a minimum, only absolutely necessary work being undertaken in view of the entire renewal of the system for electric traction. It has been decided that the unissued portion, amounting to £36,600, of the permanent 6 per cent. debenture stock, 1888, shall be issued, and the proceeds paid to the Argentina Electric Traction Co. towards the total cost of entirely renewing the 40 miles of this company's lines. The conversion of the company's system to electric traction is proceeding.

**BABCOCK AND WILCOX (LTD.)**—The directors' report states that the net profit for 1901, after deducting depreciation on plant, &c., amounts to £155,764. The directors recommend a final dividend of 6 per cent. on the preference and 15 per cent. on the ordinary shares.

**CITY OF BIRMINGHAM TRAMWAYS CO.**—At the meeting on Thursday last the chairman (Mr. J. Ross) announced that in the course of a few weeks it was expected the Bristol-road electric route would be open for traffic. Last year the company carried 44,000,000 passengers, compared with 31,100,000 in 1896, an increase of 43 per cent. The directors were promoting a bill authorising the construction of five short lines of tramway. A dividend of 10 per cent. was declared.

**GATESHEAD AND DISTRICT TRAMWAYS CO.**—At the meeting on Friday the chairman (Mr. C. R. Greene) explained that the loss on the year's working was due to disorganisation caused by the transition from steam to electric traction. The electrical equipment was now well in hand, and at the next annual meeting the directors would have a different balance-sheet to lay before the shareholders. Plans have been prepared for the new construction work under the company's light railway order (1900).

**GREAT NORTHERN TELEGRAPH CO. (LTD.)**—The ordinary general meeting will be held at Copenhagen on 30th inst.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee have appointed April 17 a special settling day in 34,601 ordinary £10 shares (fully paid and £6 paid, within Nos. 1 to 34,601) and 66,000 4 per cent. preference £10 shares (fully paid and £6 paid, within Nos. 1 to 65,000) of the *Baker Street and Waterloo Railway Co.* The committee has also ordered the further issue of 5,000 £5 fully paid ordinary shares (Nos. 30,001 to 35,000) and 5,000 4½ per cent. cumulative preference £5 fully-paid preference shares (Nos. 30,001 to 35,000) of *W. T. Henley's Telegraph Works Co. (Ltd.)* to be quoted in the official list.

**SUBMARINE CABLES TRUST.**—Notice is given that the coupon due April 15 will be paid on and after that date by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C.

**THAMES IRONWORKS, SHIPBUILDING, AND ENGINEERING CO. (LTD.)**—At the annual meeting, held on Wednesday, the chairman (Mr. Arnold Hills) said that contracts of considerable magnitude for the Admiralty had occupied the greater part of the company's energies in the shipbuilding department during the period under review. He believed their electrical department would become a big feature of the whole of their industrial system. They had arranged with Messrs. Siemens Bros. & Co., Mather and Platt, and the Brush Company to form an English combination which would successfully hold its own with German and American combinations. He felt some time ago that the difficulty for English electrical engineering firms was that they were so much split up and divided amongst themselves that they scarcely had a chance when competing against big American syndicates and the strong German combinations. Now that the combination to which he referred had been formed in this country he saw no reason why electrical engineers here should not hold their own successfully against all competition. At all events they had prepared designs for the electrical equipment of the Metropolitan District Railway and the Great Northern and City Railway, and they also had a scheme in hand for a railway from the north-east of London to the Monument, on to Piccadilly. If these schemes bore fruit, there was no doubt of their electrical department being full of business. The profits of the company for the year amounted to £39,500, making, with the sum brought forward, £53,431, and it was decided to pay 5 per cent. on both the preference and ordinary shares.

---

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways | Mar. 30 | 3,939 | - 34 | 12 | 48,420 | + 619 |
| *Blackburn Corporation.. | „ 29 | 426 | + 50 | 13 | 5,039 | + 491 |
| Blackpool Corporation... | „ 28 | 202 | + 46 | 52 | 30,579 | + 8,014 |
| Blackpool and Fleetwood | „ 30 | 147 | − 54 | 13 | 1,883 | - 190 |
| Bolton Corporation ...... | „ 31 | 1,216 | ... | 52 | 70,685 | ... |
| Bradford Corporation... | „ 29 | 502 | ... | 52 | 32,330 | +12,616 |
| Brisbane Trams ......... | Feb. 13 | 1,989 | + 155 | 6 | 12,653 | + 1,897 |
| *Bristol Trams & Carriage | Mar. 29 | 3,531 | +1,029 | 13 | 46,864 | +13,237 |
| *Buenos Ayres & Belgrano | „ 3 | 2,753 | + 375 | 9 | 24,783 | + 3,544 |
| Carlisle Trams. Co. ...... | „ 30 | 122 | ... | 13 | 1,459 | ... |
| Central London Railway | ... | ... | ... | ... | ... | ... |
| City & South London Ry. | „ 31 | 2,115 | + 755 | 13 | 26,351 | +10,412 |
| Cork Elec. Trams ........ | „ 23 | 339 | + 25 | 12 | 4,241 | + 435 |
| Dover Corporation ...... | „ 31 | 155 | + 8 | 52 | 10,780 | + 715 |
| Dublin & Lucan Rly. .. | „ 30 | 78 | + 5 | 13 | 923 | + 160 |
| Dublin United ............ | „ 29 | 2,920 | − 6 | 13 | 30,293 | + 3,547 |
| Dublin Southern Dist.... | „ 29 | 631 | − 33 | 13 | 9,054 | |
| *Dundee Corporation ... | | | ... | ... | ... | ... |
| *Glasgow Corporation ... | „ 30 | 8,000 | − 470 | 13 | 103,292 | + 2,326 |
| Halifax Corporation ... | | | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 30 | 701 | + 99 | 52 | 35,814 | + 3,181 |
| Hull Corporation ......... | „ 30 | 1,513 | + 821 | 39 | 56,450 | +30,548 |
| *Liverpool Corporation... | ... | | | ... | ... | ... |
| Liverpool Overhead Rly. | „ 31 | 1,452 | + 185 | 13 | 19,236 | + 1,069 |
| Portsmouth Corporation | „ 30 | 453 | − 67 | ... | ... | ... |
| *Sheffield Tramways ...... | „ 31 | 2,927 | +1,037 | 13 | 35,432 | +12,883 |
| Southampton Corporat'n | „ 28 | 550 | + 243 | | ... | ... |

* Partly electrical. † 5 days.

**WILLANS AND ROBINSON (LTD.)**—The half-yearly meeting of this company was held at the Cannon-street Hotel, London, on Wednesday, too late for insertion in current issue. A full report will appear in our next issue.

**WINCHESTER ELECTRIC LIGHT AND POWER CO. (LTD.)**—The annual meeting was held last week, when the directors' report for 1900 was presented and adopted. The report stated that the progress of the company during the year had been satisfactory. An equivalent of over 5,000 8 c.p. lamps had been added making the total 15,126 lamps. Including the balance forward (£121. 5s. 8d.) the account showed a net profit of £1,609. 1s. 7d. After payment of debenture interest (£933. 17s. 9d.) and writing off preliminary expenses (£197. 17s. 4d.), there was £477. 6s. 6d. available for dividend, and the directors recommended a dividend at the rate of 3 per cent. per annum on the ordinary shares, absorbing £333. 16s. The system of "free" wiring introduced had proved a success, especially since the introduction of the shilling-in-the-slot meter.

**WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)**—At the annual meeting last week the report of the directors, which appeared in our issue of Feb. 22, was adopted and a dividend of 8 per cent. declared.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Mar. 27. | | Price Tuesday, Apr. 2 | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Six Days Ending Apr. 2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ½ | ½ | ½ | ½ | ... | ... | ... | ... |
| £100,000 | Stock | [illegible] | Do. 4½ 1st Deb. Stock Pre. Certs. (red. & con.) x i | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 15 0 | Bournemouth and Poole Elec. Supply Ord. ........ xd | 13½ | 13½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/5 | Do. 4½ per Cent. Cumulative Pref. ........ | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ...... | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3 6 | Brompton & Kensington Elec. Supply Ord ........ | 7½ | 8½ | 7½ | 8½ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference ........ | 8½ | 8½ | 8½ | 8½ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 1 6 | Calcutta Elec. Supply Ordinary (fully paid) ........ | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 50,000 | 5 | 4/9 | Charing Cross & Strand Electricity Supply Corp. ... | 9 | 10 | 9 | 10 | 4 10 0 | February and August | 9½ | 9½ |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference ........ | 5½ | 6½ | 5½ | 6½ | 3 18 3 | " " | ... | ... |
| 34,000 | 5 | 3 0 | Chelsea Electricity Supply Ordinary ........ | 5½ | 6½ | 5½ | 6½ | 4 8 0 | March ........ | 6½ | 5½ |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) ... | 109 | 112 | 104 | 112 | 4 0 4 | June and December... | ... | ... |
| $1,300,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.)... | 100 | 110 | 100 | 110 | 4 10 11 | April and October...... | ... | ... |
| 70,579 | 10 | [illegible] | City of London Electric Lighting Ord. ........ | 7 | 8 | 7 | 9 | 5 0 0 | February and August | 7½ | ... |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. ........ | 13 | 14 | 12½ | 13½ | 4 8 11 | January and July...... | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) ...... | 121 | 126 | 121 | 126 | 4 0 4 | June and December ... | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) ........ | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary ........ | 8 | 9 | 8 | 9 | 5 13 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference ...... | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ Deb. Stock (all pd.) (red.) ........ | 106 | 102 | 106 | 102 | 4 2 7 | ... | ... | ... |
| 10,000 | 5 | ... | Folkestone Electricity Supply Co. Ordinary ........ | 5½ | 5½ | 5½ | 5½ | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary ........ | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 13,000 | 5 | 10% | Kensington and Knightsbridge Ordinary ........ | 10½ | 11½ | 11 | 12 | 4 7 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. ........ | 6½ | 7 | 6½ | 7 | 4 5 7 | January and July...... | ... | ... |
| £73,000 | Stock | 4 | Kensing. & Knightsb. & Notting Hill Co. (Jt. Stk.) 4% (red.) | 103 | 105 | 101 | 103 | 3 17 8 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary ........ | 1½ | 1½ | 1½ | 1½ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference ........ | 3 | 4 | 3½ | 4½ | 6 13 4 | ... | ... | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures ... | 91 | 101 | 95 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6 0 | Metropolitan Elec. Supply Ord. ........ | 12 | 13 | 11½ | 12½ | 4 16 0 | April and October ...... | 12½ | 12 |
| 13,769 | 10 | [illegible] | Do. (£7 10s. paid) ........ | 9 | 10 | 9 | 10 | ... | ... | 9½ | ... |
| £330,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage ... | 110 | 113 | 110 | 113 | 3 19 5 | June and December | ... | ... |
| £260,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) ... | 97 | 100 | 97 | 100 | 3 10 5 | ... | 97½ | ... |
| 6,452 | 10 | 6 0 | Notting Hill Electric Ordinary ........ x | 15½ | 16½ | 15½ | 16½ | 4 13 4 | March ........ | ... | ... |
| 10,000 | 5 | 5 0 | Oxford Electric Ordinary ........ | 6½ | 6½ | 6½ | 6½ | 3 16 11 | " | 5½ | ... |
| 200,000 | 1 | 1 6 | Rand Electric ........ | ½ | ½ | ½ | ½ | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 6% 1st Mor. Deb.... | 65 | 75 | 65 | 75 | ... | January and July ...... | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares ... | 200 | 210 | 200 | 220 | 3 12 9 | April and October...... | ... | ... |
| £115,600 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures x | 103 | 105 | 102 | 104 | 4 6 2 | " " | ... | ... |
| 40,000 | 5 | 9 6 | St. James's and Pall Mall Electric Ordinary ...... | 13½ | 14½ | 13½ | 14½ | 5 0 0 | February and August | 11½ | ... |
| 20,000 | 5 | 3 6 | Do. 7 per Cent. Preference ........ | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £ 50,000 | Stock | 29 0 | Do. 3½ per Cent. Debenture Stock (red.) ...... | 94 | 101 | 95 | 101 | 3 9 4 | ... | 100½ | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary ..... | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures ........ | 40 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary ........ | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 19,[illegible] | 5 | 5 6 | Westminster Electric Supply Ordinary ........ | 11½ | 12½ | 11½ | 12½ | 4 4 0 | March and September | 12½ | 11½ |
| | | | **ELECTRIC RAILWAYS TRAMWAYS, &c.** | | | | | | | | |
| 200,027 | 5 | 2 0 | Anglo-Argentine Shares (1 to 200,027) ........ | 3½ | 4½ | 3½ | 4½ | 4 17 0 | April and October | 4½ | 3½ |
| £[illegible] | Stock | 6% | Do. Permanent 6% Deb. Stock ........ | 123 | 125 | 123 | 125 | 4 16 10 | ... | ... | ... |
| 18,000 | 10 | 9 0 | Blackpool and Fleetwood Tramways ........ | 14 | 15 | 14 | 15 | 6 0 0 | ... | ... | ... |
| 75,000 | 5 | ... | Brazilian Electric Trams Investment Ord. ........ | 2 | 3 | 2½ | 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 6% Cum. Pref. ........ | 4½ | 5 | 4½ | 4½ | ... | ... | 4½ | ... |
| £[illegible] | Stock | ... | Do. 4½ Deb. Prov. Certs. ........ | 99 | 101 | 99 | 101 | ... | ... | 99½ | ... |
| 10,000 | 10 | 5½% | Bristol Tramways and Carriage Ordinary ........ | 23½ | 24½ | 23½ | 24½ | 2 6 0 | February and August | ... | ... |
| 25,000 | 10 | 6% | Do. Cumulative Preference (fully pd.) ........ | 10½ | 10½ | 10½ | 10½ | 3 15 4 | ... | ... | ... |
| £110,000 | Stock | 4% | Do. 4 per Cent. Debentures ........ | 111 | 113 | 111 | 113 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary ...... | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 13,000 | 10 | 7/0 | Do. 5% Pref. ........ | 10 | 10½ | 10 | 10½ | 4 15 3 | May and November .. | 10½ | ... |
| £[illegible] | 10 | ... | Do. 4½% 1st Mort. Debs. ........ | 100 | 102 | 100 | 102 | ... | ... | ... | ... |
| 60,000 | 10 | 6 0 | British Elec. Trac. Ord. ........ | 15 | 16 | 15 | 16 | 5 6 3 | ... | 15½ | 15½ |
| 60,000 | 10 | 6 0 | Do. 6% Cum. Pref. ........ | 11½ | 12½ | 11½ | 12½ | 4 16 0 | February and August | 12½ | ... |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures ... x i | 121 | 123 | 119 | 121 | 4 2 0 | ... | 122 | 119½ |
| 40,000 | 5 | 3 0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. ...... | 5 | 5½ | 5 | 5½ | 5 14 3 | ... | 5½ | ... |
| 27,500 | 5 | ... | Do. "B" ........ | 4½ | 5 | 4½ | 5 | ... | ... | 4½ | ... |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures ........ | 104 | 107 | 104 | 107 | 4 13 6 | ... | 106½ | 104½ |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Stk Prov. Certs. (all pd.) ... | 96 | 99 | 96 | 99 | 5 1 6 | ... | 97½ | ... |
| 31,000 | 10 | 2 0 | Calcutta Trams (Nos. 1 to 31,000) ........ | 10½ | 11½ | 10½ | 11½ | ... | ... | 11 | 10½ |
| £[illegible] | 100 | ... | Do. 4½ 1st Deb. Stock (Red.) ........ | 102 | 104 | 102 | 104 | ... | ... | 103 | ... |
| 400,000 | 1 | ... | Cape Electric Trams Shares ........ | 1½ | 1½ | 1½ | 1½ | ... | ... | 1½ | ... |
| 200,237 | 10 | 2 6 | Central London Ordinary ........ | 8½ | 9½ | 8½ | 9½ | 2 19 4 | June and December | 9 | ... |
| [illegible] | 5 | ... | City of Birmingham Tram. Co. 5% Cum. Pref. ........ | 5½ | 5½ | 5½ | 5½ | 4 6 11 | ... | ... | ... |
| £[illegible] | 100 | 4 | Do. 4% 1st Mort. Debs. ........ | 101 | 103 | 101 | 103 | 3 16 9 | ... | ... | ... |
| £856,[illegible] | Stock | 1½% | City and South London Railway Con. Ordinary | 45 | 50 | 45 | 50 | 2 10 0 | February and August | 45 | ... |
| 37,500 | 10 | 2½ | Do. Ordinary (Nos. 22,501 to 60,000) ...... x i | 4 | 6 | 4 | 5 | ... | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) . | 131 | 137 | 131 | 137 | 3 13 0 | " " | ... | ... |
| £290,000 | Stock | 5% | Do. (1898) ........ | 122 | 127 | 122 | 127 | 3 15 9 | ... | ... | ... |
| £245,315 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture ........ | 112 | 117 | 112 | 117 | 3 9 5 | May and November .. | ... | ... |
| 60,000 | 10 | 6 0 | Dublin United Tramways (1896) Ltd., Ordinary ...... | 13 | 14 | 13 | 14 | 4 5 9 | ... | ... | ... |
| 53,981 | 10 | 6/0 | Do. 6 per Cent. Preference ........ | 15 | 16 | 15 | 16 | 3 15 0 | ... | ... | ... |
| £[illegible] | 100 | 4½ | Do. 4½ per Cent. Mort. Debs. (red.) ........ | 99 | 102 | 99 | 102 | ... | ... | ... | ... |
| [illegible] | 5 | ... | Electric Light & Traction of Australia 6% Cum. Pref. | 1½ | 1½ | 1½ | 1½ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Imperial Tramways Ordinary ........ x i | 2½ | 2½ | 2½ | 2½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference ........ x i | 14½ | 15 | 14½ | 15 | 3 14 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | Do. 4½ per Cent. Debentures ........ | 112 | 114 | 112 | 114 | 3 18 11 | January and July...... | ... | ... |
| 30,000 | 10 | 1 3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | 1½ | | ... | | ... | May and November .. | ... | ... |
| 37,500 | 10 | 2½% | Liverpool Overhead Railway Ordinary ...... x i | 7½ | 7½ | 7½ | 7½ | 4 1 9 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ........ x i | 13 | 13½ | 13 | 13½ | 3 15 6 | " " | ... | ... |
| £135,000 | Stock | 4% | Do. 4 per Cent. Debentures ........ | 102 | 104 | 102 | 104 | 3 17 2 | January and July ...... | ... | ... |
| $[illegible] | $1,000 | 5% | London Street Railway (Toronto) Mor. 5% Debs. (red.) | 101 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £[illegible] | Stock | 2½ | Lond. Utd. Trams. 4% Ir. Deb. Stk Prov. Certs. (all pd.) | 102 | 104 | 102 | 104 | ... | ... | ... | ... |
| £100,000 | 100 | 5% | Montreal Street Railway Sterling Mor. Debs. (1908) . | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) ........ | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary ........ | 3 | 3½ | 3 | 3½ | 3 5 8 | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference ........ | 4½ | 5½ | 4½ | 5½ | 6 0 0 | May ........ | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord...... | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference ........ | ... | | ... | | ... | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary ........ | 11½ | 12½ | 11 | 12 | ... | ... | ... | ... |
| 10,000 | 10 | 5/0 | Do. 5 per Cent. Cumulative Preference ...... | 10 | 11 | 10 | 11 | 4 10 11 | February and August | 11½ | ... |
| £125,000 | Stock | 37 0 | Do. 4½ per Cent. Debenture Stock ........ | 107 | 109 | 107 | 109 | 4 3 1 | ... | ... | ... |
| £[illegible] | Stock | 3% | Waterloo and City Ordinary ........ | 94 | 97 | 94 | 97 | 3 2 2 | June and December | ... | ... |

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Prices, Mar. 27. | | Price Tuesday, Apr. 2. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Six Days Ending Apr. 2: Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | | |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 16 5 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 6% | Do. 5 per Cent. Debentures | 65 | 65 | 55 | 65 | ... | ... | ... | ... |
| £[illegible],720 | Stock | 17/6 | Anglo-American | 59 | 53 | [illegible] | 64 | 5 15 9 | Feb., May, Aug., Nov. | 62½ | ... |
| £3,0[illegible],640 | Stock | 30/0 | Do. Preferred | 94 | 96 | [illegible] | 97 | 6 3 0 | " " | 94½ | 9½ |
| £3,0[illegible],640 | Stock | 5/0 | Do. Deferred | 9 | 9½ | 9½ | 9½ | 2 17 2 | " " | 9½ | 8½ |
| 13,333,300 | $100 | 8¼ | Commercial Cable Capital Stock x d & [illegible] | 145 | 175 | 160 | 170 | 4 [illegible] 2 | Jan., Apr., July, Oct. | ... | ... |
| £1,7[illegible] | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 102 | 104 | 101 | 103 | 3 17 8 | " " | 101½ | ... |
| 15,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | " " | ... | ... |
| 13,[illegible] | 5 | 2/0 | Direct Spanish Ordinary x d | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference x d | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £80,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 101% | 104% | 100% | 101% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable x d | 9½ | 10½ | 9½ | 10½ | 6 16 7 | Jan., Apr., July, Oct. | 9½ | 9½ |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. [illegible] | 90 | 102 | 93 | 102 | 4 8 3 | June and December | ... | ... |
| £1,000,000 | Stock | 25/0 | Eastern Ordinary (to 1,200) (red.) | 141 | 145 | 141 | 145 | 4 11 10 | Jan., Apr., July, Oct. | 143½ | 143 |
| £1,836,488 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 91 | 96 | 93 | 95 | 3 12 9 | " " | 94 | 94 |
| £1,432,368 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 117 | 113 | 117 | 3 9 0 | May and November | 115 | ... |
| 350,000 | 10 | 2/6 | Eastern Extension | 14½ | 14½ | 14½ | 14½ | 4 14 11 | Jan., Apr., July, Oct. | 14½ | 14½ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) [illegible] iss'd at 63pm, all pd | 13½ | 14½ | 13½ | 14½ | ... | ... | 13½ | ... |
| £320,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 114 | 3 8 3 | February and August | 112½ | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 | 104 | 99 | 103 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 17 8 | May and November | ... | ... |
| 180,227 | 10 | 1/9 | Globe Telegraph and Trust | 9½ | 10½ | 9½ | 10½ | 5 2 5 | Jan., Apr., July, Oct. | 10½ | [illegible] |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 14 8 | " " | 15½ | 14½ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 32 | 31 | 31 | 31 | 3 12 6 | January and July | ... | ... |
| £32,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (within Nos | 99 | 103 | 90 | 104 | 4 3 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European (1 to 1,200) (red.) | 47 | 51 | 47 | 51 | 4 [illegible] 0 | May and November | ... | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 103 | 99 | 102 | 3 15 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 124 | 129 | 4 16 0 | " " | ... | ... |
| 16,600 | 10/0 | ... | West African Telegraph | 3½ | 3½ | 3½ | 3½ | 4 9 8 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 | 101 | 97 | 101 | 5 0 0 | March and September | ... | ... |
| 30,000 | 2½ | ... | West Coast of America | ½ | ½ | ½ | ½ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 103 | 3 14 6 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ | ½ | ½ | ½ | ... | May and November | 1½ | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | " " | ... | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 108 | 103 | 105 | 4 11 4 | January and July | ... | ... |
| 207,400 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) x d | 13½ | 14½ | 13½ | 14½ | 4 15 3 | Mar., June, Oct., Dec. | 14½ | 1[illegible] |
| £78,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd series, 1906) | 101 | 104 | 101 | 104 | 4 15 2 | June and December | ... | ... |
| £345,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | 102½ | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | 25 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 234,651 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/3 | 2/9 | 2/3 | 2/9 | 11 [illegible] 2 | April and October | ... | ... |
| 72,680 | 1 | 3½% | Monte Video Telephone Ordinary | ½ | ½ | ½ | ½ | 5 0 0 | November | ... | ... |
| 96,493 | 1 | 1/0 | Do. 5 per Cent. Preference | ½ | 1 | ½ | 1 | 5 0 0 | " | ... | ... |
| 590,000 | 5 | 2/0 | National | 3½ | 3½ | 3½ | 3½ | 7 17 2 | February and August | 3½ | 3½ |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 13 | 11 | 11 | 4 12 4 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 | 12 | 10 | 12 | 5 0 0 | " " | ... | ... |
| 260,000 | 5 | 2/6 | Do. 5 per Cent. Non-Cumulative 3rd Pref. | 4½ | 4½ | 4½ | 4½ | 5 9 7 | " " | 4½ | ... |
| £[illegible],000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 90 | 93 | 90 | 93 | [illegible] 15 11 | June and December | 9[illegible] | 9[illegible] |
| £[illegible],000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 97 | 100 | 96 | 99 | 4 1 8 | " " | ... | ... |
| 171,504 | 1 | 0/6 | Oriental | ½ | 1½ | ½ | 1½ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | ... |
| [illegible],000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 16 3 | June and December | ... | ... |
| £179,947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 103 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 6% Cum. Pref. | ½ | ½ | ½ | ½ | 6 14 3 | ... | ... | ... |
| 125,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. x d | ½ | ½ | ½ | ½ | 6 17 2 | March and September | ½ | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 60,000 | 1 | ... | Do. 6 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £60,000 | 100 | 4½% | Do. First Mortgage Debentures | 8[illegible] | 90 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 6 15 4 | July and February | 10½ | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5½ | 6½ | 6½ | 6½ | 4 16 0 | January and July | ... | ... |
| 10[illegible],000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | 4½ | 4½ |
| 90,000 | 2 | 1/2½ | Brush Electrical Engineering | 1½ | 1½ | 1½ | 1½ | 6 17 11 | September | 1½ | 1½ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2½ | 2½ | 2½ | 2½ | 5 9 8 | ... | [illegible] | [illegible] |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | " | ... | ... |
| £115,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 105 | 103 | 105 | 4 3 2 | March and September | ... | ... |
| £1[illegible],000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 5 | January and July | ... | ... |
| 30,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 | 16 | 15 | 16 | 4 11 9 | " " | 15½ | 15 |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | " " | ... | ... |
| £[illegible],000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 10[illegible] | 113 | 109 | 111 | 3 1[illegible] 1[illegible] | November and May | ... | ... |
| [illegible],000 | 1 | 0/9½ | Castner-Kellner Alkali Co. (fully paid) | ½ | 1½ | ½ | 1½ | 7 2 3 | ... | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½ First Mort. Deb. (red.) | 95 | 95 | 95 | 95 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ½ | 1 | ½ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference x d | ½ | 1½ | ½ | 1½ | 5 6 8 | ... | ... | ... |
| 5[illegible],000 | 3 | 1/9½ | Crompton and Co. Nos. 1 to [illegible] | 3½ | 3½ | 3½ | 4 | [illegible] | January and July | ... | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 6 | " " | ... | ... |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. x d | ½ | 1 | ½ | 1 | 6 0 0 | ... | ... | ... |
| 99,231 | 2 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1½ | 2 | 1½ | 2 | 9 0 1 | February and August | ... | ... |
| 17,139 | 5 | 2/6 | Do. (£5 paid) | 3 | 4 | 3 | 4 | 6 1[illegible] [illegible] | " " | ... | ... |
| £344,[illegible]23 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 | 89 | 87 | 89 | 4 0 6 | June and December | [illegible] | ... |
| £[illegible],000 | Stock | [illegible] | Do. 3½ [illegible] Pr. [illegible] (all pd) x d | 96 | 100 | 94 | 94 | [illegible] 2 0 | " " | ... | ... |
| 35,000 | 5 | 2/[illegible] | Edmundson's Electricity Corporation Ord. | 1½ | 2½ | 1½ | 2½ | 8 1 11 | Half-yearly | 2½ | ... |
| £2[illegible],000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | 10[illegible] | ... |
| 11[illegible],000 | 2 | 1/[illegible] | Electric Construction Co. (Limited) | 1½ | 2½ | 1½ | 2½ | 5 0 3 | January and July | ... | ... |
| 2[illegible],000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2½ | 3 | 2½ | 3 | 4 13 4 | July | ... | ... |
| £18[illegible],000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | 101½ | ... |
| 1[illegible],000 | 1 | ... | [illegible] Electric [illegible] | ½ | | ½ | | ... | ... | ... | ... |
| [illegible],000 | 5 | 18/0 | Henley's Telegraph Works Ordinary | 15 | 16 | 15 | 16 | 8 5 0 | February and August | 15 | 15½ |
| [illegible],000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | " " | ... | ... |
| £[illegible],000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | " " | ... | ... |
| [illegible],000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 2[illegible] | 2[illegible] | 21 | [illegible] | 4 10 11 | " " | 2[illegible] | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 10[illegible] | 104 | 10[illegible] | 104 | 3 17 [illegible] | March and September | ... | ... |
| 37,350 | 12 | [illegible] | Telegraph Construction and Maintenance | 37 | 41 | 37 | 41 | 5 2 5 | March and July | 3[illegible] | [illegible] |
| £1[illegible],000 | 100 | 4% | Do. 5 per Cent. Debenture Bonds, 1899 | 101 | 104 | 101 | 104 | 3 17 [illegible] | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 | 12 | 11 | 12 | 6 8 4 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 6 per Cent. Cumulative Preference x d | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 3[illegible],000 | 5 | 5/0 | Willans and Robinson Ordinary | 11½ | 12½ | 11½ | 12½ | 4 1[illegible] [illegible] | April and October | 12½ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6½ | 7½ | 6½ | 7½ | 4 2 [illegible] | " " | [illegible] | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 [illegible] | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.
† The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

**No. 1,195.** [No. 25. Vol. XLVI.] FRIDAY, APRIL 12, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

CONTENTS OF THE CURRENT NUMBER.

# NOTES.

The new system for the new era is gradually becoming manifest: the age of large electric power schemes is developing in this country the use of the three-phase system, with which our transatlantic cousins and Continental neighbours have long been familiar. It is only in its use in the United Kingdom that the three-phase system can be called new. We describe in an illustrated article this week its application to the supply of electricity to greater Manchester. The newness of the polyphase system in this country is justified by the newness of its necessity, a fact which is well illustrated by the Manchester example. The early days of electric supply were well provided for by low pressure continuous currents, for the areas of supply were small. Later came the age of single-phase alternating currents, with house transformers and—later still—with large substations, these satisfying the demand for electric light over larger areas than the earlier system could cope with. Then gradually was developed the demand for electric power for motors, and almost concurrently the electric tramway became acclimatised. For these purposes the single-phase system offered no attractions, and further changes therefore became necessary. At one time it certainly looked as though the new system for the new era, in this country, would be the high-pressure continuous-current transformer system. But, although this has taken root in a few isolated localities, the general consensus of opinion and the general trend of practice seem to be in favour of polyphase generation and transmission with continuous current distribution.

The successful and extensive use of the Marconi system of wireless telegraphy during the tour of T.R.H. the Duke and Duchess of Cornwall and York is effectively advertising to the civilised world the startling possibilities of etheric signalling. When royalty can go a progress round the world by water and yet keep in touch almost continuously with the land, through a chain of well-placed warships fitted with Marconi apparatus, the lay mind is apt to conjure up a vision of the speedy advent of a similar—though, in his case, probably not so advantageous—accommodation for the ordinary globe-trotter. The delivery of telegrams in one's berth by the steward's boy, in mid-Atlantic, is a luxury that most people who are not millionaires can afford to dispense with. Civilisation, however, needs not yet to be concerned about its realisation, since the elaborate arrangements for the royal tour are not such as many subjects can command, nor shipping companies find it paying to provide. Wireless telegraphy has its uses, immediate and valuable, and in course of time such as these may perhaps be added to them.

We note, too, that even on a royal scale wireless telegraphy can exhibit a troublesome perversity of temper. Whether it be the fault of the coherer or no we are unable to say; for, the sulkiness with which that ingenious instrument was at one time credited, and which our own experience quite bears out, has been declared to have been eliminated from the amiable coherers of Mr. Marconi. At any rate, some curious failures and complications have occurred in the Mediterranean. Some of these, at all events, were not the fault of the coherers, but appear to have been due to the absence of quite the latest thing in wireless telegraphy—successful "syntony." The incidents are described in the following words by *The Times* correspondent, who was on board H.M.S. "Andromeda":—

> But the standard of wireless telegraphy in the Mediterranean Fleet is very high indeed, and, deficiencies notwithstanding, the system is nearer to perfection in the Mediterranean Fleet than anywhere else. There is, however, still much to be learned, still room for a thousand improvements. We have been able to exchange notes of congratulation at great distances, to pick up scraps of news about complications in China, riots in St. Petersburg, battles in South Africa, naval promotions, and the like, but it has very often come in a scrappy way. Sometimes, when the "Diana" could not hear us because her receivers were out of order, we could hear her asking the "Theseus" or "Vindictive" where on earth or sea the "Andromeda" might be, sometimes the instruments have simply babbled, owing to one or two messages crossing one another; sometimes we have the tail end of a message without the beginning, sometimes vital words are omitted. For example, to-day (it is March 29th by this time) we are perplexed by a message obviously referring to a battle in South Africa of which, since it begins in the middle, we know no more than that the

English have lost fewer men than the Boers, from which we presume that they had won. But to say this is not by any means to suggest that the whole system is not already marvellous and capable of practical use. In fact, we are putting it to very practical use already, and it tells us all sorts of things useful to know which we could not have known without it.

THE annual account of receipts and expenditure relating to the Telegraph Service, from the year of its transfer to the State down to March 31, 1900, has just been published—for the benefit, we suppose, of that extremely limited public who take any interest in these dry and exceedingly discouraging figures. Year after year we have drawn attention to the salient facts which this return unfailingly discloses when the annual accounts are made up; but, so far as we know, ours is the only journal that takes the trouble to make any comment upon them, though they would furnish material for sensational articles galore to distressful journalists in search of copy at this dull season of the year. For example, there is the startling item as touching capital expenditure, interest on which amounts in the aggregate to over £9,000,000, and of which only £58,000 has been repaid. And this after 30 years' of uninterrupted business prosperity, the revenue of the Telegraph Service, as everybody knows, increasing year by year in a quite remarkable way! But this is not the worst; despite the wonderful growth of revenue, it has not only failed for many years past to contribute anything in payment of interest on the original outlay, it has also run up a very large deficiency on the expenditure account—a deficiency which threatens to grow with the growth of business. No explanation is offered; and, strange to say, Parliament never asks for any.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Bonny—Cameroon | Mar. 31, 1901 | April 7, 1901 |
| Marseilles—Barcelona | Jan. 7, 1901 | April 9, 1901 |
| Fao—Bushire | Mar. 7, 1901 | April 11, 1901 |
| Perim—Obock | Mar. 22, 1901 | — |
| Sierra Leone—Conakry | April 2, 1901 | — |

**Errata.**—Mr. Addenbrooke points out to us that an error has crept into Mr. Drysdale's article on dielectric losses in our last issue. In the table on p. 892 the power factor for Dr. Muirhead's condensers placed against Mr. Addenbrooke's name should be 0·01, and not 0·1.——We are sorry to have spoiled Mr. Raworth's little joke in the quotation in our leading article last week, by printing the phrase "there let them be," instead of "there let them lie" (see p. 900, col. 2, line 38).

**Failure of Electric Automobiles in Chicago.**—The *Electrical World* of New York for March 16th announces the failure of the hire system of electric automobiles in Chicago, owing to the small use made of the vehicles by the public and the heavy cost of maintenance due to the bad condition of the streets. The total money received by the company on stock subscriptions has been $798,700, the gross expenditure up to Feb. 1st was about $643,588; the gross income between Sept. 18, 1899, and Feb. 1, 1901, was $137,106; and the operating expenses during the same period have been $265,885. The company at the later date had $205,458 in cash, and owned 109 vehicles.

**Automatic Telephone Exchange.**—In a recent issue of the *Electrical World* of New York, Mr. Alton D. Adams describes the automatic telephone exchange at New Bedford, Mass. The exchange is adapted for 10,000 subscribers, and 500 out of a total of 900 automatic instruments are already connected. The Strowger system is employed, similar to the one described in our columns some time ago. Only a single attendant is employed to look after the machines. The rate charged is $24 per year in private houses and $36 per year in business houses.

**French Cable Enterprise.**—Reports (says Reuter) received at Hong Kong from Amoy are to the effect that the French c.s. "Diolibah," in the guise of a transport, has laid a submarine telegraph cable from Amoy seawards, without consulting the authorities, and a second cable ship was rumoured to be outside the harbour to connect up the cable in some unknown direction. The "Diolibah" subsequently returned and cut the cable, taking the cable on board again. Later advices state that the French cable is connected at Chapel Island, and is thence taken on to Saigon. The shore end connection at Amoy has not been made, but everything is in readiness for this connection to be made.

**Imperial Telegraph Communication Committee.**—A meeting of this Parliamentary group was held at the House of Commons last week, when Sir Edward Sassoon presided, and referred to what he described as "the result of the Committee's work during the past year." Sir Edward apparently claimed for the Committee the reduction in the Australian cable rates from 4s. 9d. to 3s. 6d. per word, and of the South African rates from 5s. to 4s. There is, of course, no justification whatever for any such claim, the reduction in both rates being the result of the automatic working of the arrangements between the various Government and Company Administrations concerned. Mr. Henniker Heaton must look to his laurels.

**Edison's Crushing and Magnetic Separator.**—Mr. J. Lawrence, chairman of the Edison Ore-Milling Syndicate, has recently written a long letter to the *Financial News* stating that 52 out of the 55 capitalists who have bought the extensive iron-ore deposits in Norway are Englishmen. Dr. Theodore Lehmann, of Freiburg University, has been conducting explorations in Norway for several years, but up till lately too large a proportion of specular hæmatite has been present; Mr. Edison has, within the last eight months, however, solved the problem of separating specular hæmatite. Mr. Lawrence writes that by the new process 2 tons of low-grade non-Bessemer ore produce 1 ton of high-grade Bessemer ore averaging 65 per cent. of metallic iron, and it is the intention of the syndicate to erect works and ship the ore exclusively to British ironmasters.

**An American Review of Engineering Progress in Europe.**—At a meeting of the American Institute of Electrical Engineers, New York, held on February 28th, Mr. Wm. J. Hammer read a Paper on "Important European Electrical and Engineering Developments at the Close of the Nineteenth Century." Amongst electrical inventions the author described Poulsen's telephonograph, the Nernst lamp, and the osmium lamp. Electrical engineering enterprise was represented by the Langen mono-rail suspended railway, the Ganz three-phase system, and the Jungfrau three-phase railway, whilst in general engineering the author considered the question of whether in the future internal or external heat engines would be employed as a motive power. Several types of high-furnace gas-engines were described, as were also the de Laval-Parsons steam turbine, whilst the author evidently considered that the Behrend sulphur di-oxide engine has a future, used in conjunction with steam plant.

**Works Managemement.**—The fifth lecture of the course on "Works Management" was delivered at the Institution of Junior Engineers by Mr. A. H. Barker on the 3rd inst. The method of calculating piecework prices was considered, figures relating to the product of lathes, shaping, and other machines being given, and diagrams were exhibited embodying results from actual practice. The necessity for exact records being kept relating to each process of a job was urged. Time sheets and books were described, and the system of keeping them dealt with in detail. Reference was made to the advantages to be derived from a special rate-fixing department where devices could be submitted for executing standard jobs in the most expeditious manner in the works proper. The premium system was further alluded to, and the lecturer proceeded to the question of cost-keeping, the respective operations of the estimating and costs' office being traversed, including tabulating, book-keeping, indexing, &c. Considerations with respect

to invoices in both directions were entered into, and systematic methods for the avoidance of errors, and of unbusinesslike occurrences in connection therewith, were indicated.

**Ohm's Law.**—There is scarcely any proposition, says the *Electrical World*, so generally recognised among electricians, and so generally ascribed to one and the same individual, as that law of electric-current strength in continuous-current circuits dependent upon their E.M.F. and resistance which bears the name of "Ohm's law." It may surprise electricians, therefore, to learn that in the field of acoustics there is another and totally different Ohm's law; namely, that a complex harmonic musical tone is only recognised by the ear by first analysing it into its harmonic constituents, and that the sensation is the sum of the sensations of the individual simple component tones. To an acoustician, therefore, who had no knowledge whatever of electrical matters, Ohm's law would stand for an entirely different conception to that recognised in the electrical world. It is a curious fact that in the electric transmission of waves, either in wireless telegraphy through the ether or in the transmission of electric energy to long distances over wires, the attempt is made to restrict the electric pulses to simple harmonic tones. In music, however, simple tones are comparatively uninteresting, and complex harmonic tones are greatly preferred for their richness. But in electric telephony, in order to transmit the vocal tones with any approach to faithfulness, the transmitted waves have to be of many different frequencies, and harmonics have to be cultivated and fostered.

**An Electrolytic Arc Light.**—Herr Ewald Rasch describes in the *Elektrotechnische Zeitschrift* for February 14, an arc light obtained by the use of solid refractory electrolytic electrodes which have to be heated to start with as in the case of the Nernst lamp. With electrodes 2·5mm. diameter a pressure of 50 volts and a current of 2 amperes, 630 Hefner candles (horizontal) was obtained, and with electrodes 5mm. diameter and 5·3 amperes at about 42 volts, 900 candles was given out, or about 4 candles per watt in each case. Experiments were made with 2·5mm. electrodes, varying the current; with 1·1 amperes at 65 volts the candle-power was 146, the current was then gradually increased to 5 amperes when the voltage dropped to 45 and the candle-power increased to 1,012, but at this stage the electrodes fused; in fact, it was advisable for steady working to keep the efficiency down to from 3 to 4 candles per watt. The author points out that Tumlirz, in his Paper "On the Mechanical Equivalent of Light," gave the ideal efficiency as 5·21 candles per watt, and as a result of these experiments it was found that the highest efficiency obtained was 5·2 when the metal fused. It must, however, be pointed out that the electrodes become convex so that probably the greatest illumination would be horizontal, and no tests of the spherical candle-power are given in the Paper. Dr. W. Nernst, referring to this article in the *Elektrotechnische Zeitschrift* of March 21, attaches considerable importance to this point, which he considers militates against the practical employment of Dr. Rasch's electrolytic arc, and makes its efficiency no longer phenomenal. He further remarks that no figures are given in Dr. Rasch's article for rate of comsumption of the electrodes. His own experiments, with electrodes of a material similar to that employed in his incandescent lamp, showed that the negative and not the positive electrode burns away the quicker (a phenomenon which he thinks may have an important bearing on the theory of the arc), and that the quick consumption would prevent the construction of a practical lamp on these lines.

**Storage Battery Competition.**—The Automobile Club de France is inaugurating another competition for motor-car accumulators on the same lines as those described in *The Electrician*, Vol. XLII., p. 354. The tests will take place at Levallois, commencing on June 1st., and an entrance fee of 500fr. will be required up to May 1st, or double that amount up to May 25th. The number of batteries is not limited, but two sets of each type must be sent, and the tests will last for a year. Each battery must have a capacity of 120 ampere-hours, with a discharge of 20 amperes, the terminal E.M.F. being not less than 8·5 volts, and if the E.M.F. falls below 6 volts the battery will be removed from the circuit. They will be divided into two classes—(1) batteries of large capacity, with slow rate of charge, having a maximum weight of 60kg.; and (2) batteries of small capacity, with quick rate of charge, and weighing up to 90kg. The trials will last for periods of six days, separated by one day's rest. Each day the test will last for five hours the batteries being automatically shaken in imitation of the treatment they would receive on ordinary thoroughfares, and subjected to varying rates of discharge by means of a commutator which reproduces the cycle every half-hour, the current varying from 100 amperes for half-a-minute to 20 amperes for six minutes, whilst for the last 10 minutes of each half-hour the current is switched off. The last day of the trial the batteries will be discharged at a constant current of 24 amperes for five hours. The charge for energy will be 1fr. per kilowatt-hour, and the current will be supplied at a constant potential of 12·5 volts for five hours. For class (1) resistances may be inserted to regulate the charge, but for class (2) the current must be taken direct from the 'bus bars. A detailed report on the batteries will be made by the Commission dealing with (1) the commercial efficiency; (2) the frequency, importance and facility for maintenance; (3) the nature of the repairs with frequency and duration of the same; (4) the weight compared with output and power; (5) the net cost per kilowatt-hour, taking into account sinking fund as well as cost of maintenance and repairs.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), April 12th.**

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Meeting at the Westminster Palace Hotel. Paper to be read: "Iron Lined Tunnelling Construction," by A. Woodroffe Manton.

**SATURDAY, April 13th.**

INSTITUTION OF JUNIOR ENGINEERS.

*3.30 p.m.* Visit to the Great Northern and City Railway Co.'s Works to inspect the plant described in Mr. Manton's Paper.

**TUESDAY, April 16th.**

ASSOCIATION OF TECHNICAL INSTITUTIONS.

Annual General Meeting at the Fishmongers Hall, London. The President-Elect, The Right Hon. Sir William Hart Dyke, M.P., will deliver an address.

**WEDNESDAY, April 17th.**

ROYAL METEOROLOGICAL SOCIETY.

*7.30 p.m.* Ordinary Meeting at the Institution of Civil Engineers, Great George-street, Westminster, S.W.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.

*8 p.m.* Ordinary meeting at the University, Birmingham, when the discussion on "Polyphase Equipment in Factories," by W. Wyld, will be resumed. If time permits, Mr. Eborall's paper, "Some Notes on Polyphase Substation Machinery," read in London, will be discussed.

INSTITUTION OF MINING AND METALLURGY.

*8 p.m.* Ordinary General Meeting at the Museum of Practical Geology, Jermyn-street, S.W. Included in the business of the evening is the adjourned discussion on Mr. E. H. Davies' Paper: "The Electric Power Station at the Pierrefitte Mine."

**THURSDAY, April 18th.**

RONTGEN SOCIETY.

*8 p.m.* Discussion evening at 20, Hanover-square, W. Subject: "X-Ray Therapeutics."

INSTITUTION OF ELECTRICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting. Papers to be read: (1) "Test Room Methods of Alternate Current Measurement," by A. Campbell. (2) "Note on the Use of the Differential Galvanometer," by C. W. S. Crawley. The replies of Mr. Ravenshaw and Mr. Walker to the discussion on their Papers read at the last meeting will also be given. At this meeting the announcement of the nominations for the Council 1901-1902 will be made.

**FRIDAY, April 19th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting, when the President's Address will be delivered.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. J. J. Thomson, F.R.S. Subject: "The Existence of Bodies Smaller than Atoms."

# ELECTRICITY SUPPLY FOR GREATER MANCHESTER.

Consequent upon the recently augmented scope of the municipal electricity supply works at Manchester, important new works have had to be projected, and these are now being pushed forward with vigour. The principal factors which have lead to this expansion have been the inclusion of a number of outlying boroughs within the area of the Manchester undertaking, together with the conversion and extension of the tramways acquired by the Corporation of Manchester. These additions to the burthen of duties of the electricity works involve a system of mains covering an area of 45 sq. miles—more than double the original area of 20 miles. It became necessary, therefore, largely to increase the generating

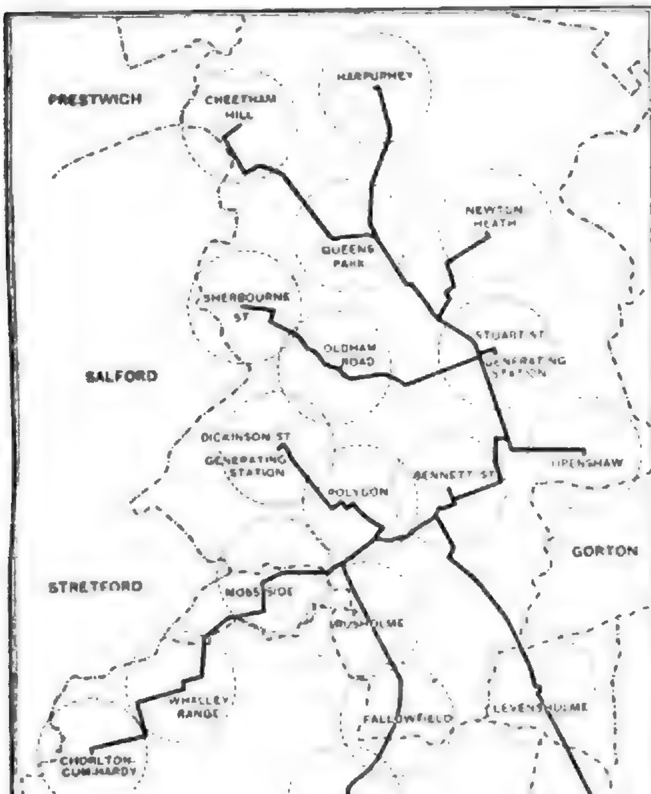


FIG. 1.—MAP OF THE GREATER MANCHESTER ELECTRIC SUPPLY SCHEME.

plant, and to introduce a more suitable system of transmission than the five-wire continuous-current system adopted by the late Dr. John Hopkinson.

Upon Mr. C. H. Wordingham, the chief electrical engineer to the Corporation, devolved the task of designing a system suitable to meet the new requirements; and, though the major portion of his scheme remains yet to be materialised, it is satisfactory to note that, prior to resigning his official position, he developed the scheme far enough to justify it and to establish its success, if only it is carried out effectively on the lines he laid down.

The accompanying map (Fig. 1) indicates the enlarged area of electricity supply. The original generating station is at Dickinson-street (see *The Electrician*, Vol. XXXI., p. 613, for an illustrated description of this station shortly after its inauguration). Close to the Dickinson-street station—separated from it, in fact, by a narrow canal—the new city power-station is being erected, the generating plant now awaiting the completion of the buildings. A third generating station is to be erected at Stuart-street. The supply to consumers throughout the whole area will consist of continuous current, distributed from a five-wire network in the central part of the city, and from a three-wire network in the remainder of the area, with a pressure of 400 volts across the outers in each case. The network is to be so arranged that it may be either connected up as one continuous whole or may be split up into a number of small portions. The tramway network will be supplied at a pressure of 500 volts, and also arranged either to work as a continuous whole or to be split up. Both networks will be fed partly by current generated at low pressure, and partly by three-phase current generated at extra high pressure, the arrangements being as follows:—The present generating station at Dickinson-street, in which current is generated at 440 volts or thereabouts, will be retained and be supplemented by an additional generating station at Bloom-street, adjoining Dickinson-street. The capacity of Dickinson-street station is 12,000 I.H.P., and of Bloom-street is to be 14,000 I.H.P. These two stations together will eventually supply the demand within a half-mile radius, this comprising the densest portion of the lighting, and by far the densest portion of the tramways. The remainder of the network will be supplied from a single generating station at Stuart-street, on the eastern border of the city. Here three-phase current will be generated at a pressure of 6,500 volts, and be transmitted to sub-stations pitched about a mile apart (Fig. 1). In each of these substations the current will be transformed down by means of static transformers to a suitable pressure, and passed through rotatory converters which will transform it into continuous current, when it will be fed into the distributing networks. The static transformers will have their winding so arranged as to give two distinct pressures, the lower being such as to give 420 volts or thereabouts for the lighting network, the higher giving 500 volts or thereabouts for the tramways. After being converted into continuous current, the Stuart-street generating station is intended to have an eventual capacity of 50,000 H.P.

It may be pointed out that the use of different pressures for lighting and traction was practically unavoidable, since it was imperative to have uniformity throughout the whole area for lighting consumers, and it would have been out of the question to alter the pressure from 400 to 500 volts, when so large an amount of plant was installed for the lower pressure, and when some 3,700 consumers, having lamps and apparatus aggregating the equivalent of 882,000 8 c.p. lamps were installed. Moreover, the lower pressure was distinctly more advantageous to consumers than the higher. On the other hand, it was equally imperative that the traction network should be supplied at the pressure which has become standard in this country, not only because the standard pressure rendered stock equipments available, but also because in the future it is practically certain that traffic will be interchanged between various large towns, and the inconvenience of a different pressure would have been very great.

In drawing up this scheme Mr. Wordingham has been very largely influenced by considerations relating to possible difficulties in connection with electrolysis on the tramway system, and his principal object in spacing the sub-stations at so short a distance apart has been to keep down the loss of pressure in the rails to a very low figure. It is hoped that in most cases the maximum drop will not exceed 1 or 1½ volts.

Though the general scheme for Stuart-street has been worked out, the specifications have not yet been drawn up. Much work, however, has been done in connection with acquiring sites for sub-stations, and laying the extra high-pressure mains and the low-pressure networks. A few words respecting the Bloom-street generating station may be of interest. The difficulties of the site are considerable, and have been greatly increased by the necessity for getting the maximum possible capacity of plant on to the space. The area of

the site is 1,950 sq. yd., and on this are accommodated the whole of the plant, including boilers, economisers, chimney for naturally draught, engines, dynamos, surface-condensing plant, switchboards, &c., for developing 14,000 I.H.P. Briefly, the arrangement is as follows:—The site is roughly oblong, but wider at one end than the other, no one corner being square. The engine room is parallel with one long side, the boiler-house is parallel with the other, the two touch at one end. At the base of the triangle formed by their sides is placed the chimney. The engine room will contain four generating sets, each comprising a compound condensing engine directly coupled to a continuous-current dynamo running at 75 revs. per min. The machine is compound wound, giving 4,400 amperes at 410 to 440 volts when running as a shunt-wound machine, and a proportionately reduced current at 500 volts when running as a compound machine. The plant is thus interchangeable for lighting or traction. It will give an output 33 per cent. in excess of this for one hour and

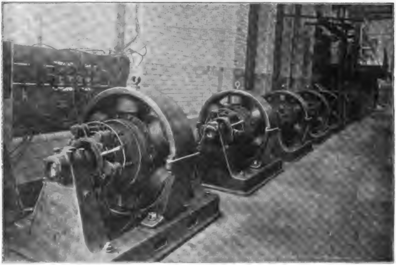


FIG. 2.—THE EXPERIMENTAL THREE-PHASE PLANT: VIEW OF THE SIX 100KW. ROTATORY CONVERTERS.

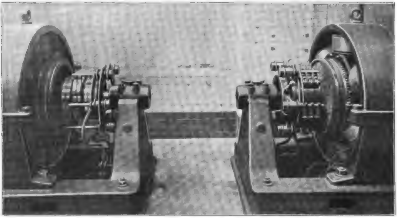
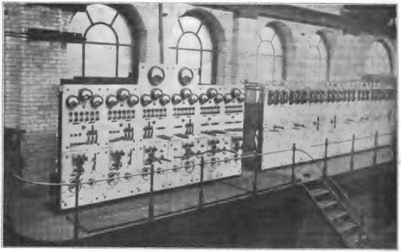


FIG. 3.—NEARER VIEW OF THE ROTATORY CONVERTERS (Showing Slip Rings on the Left and Commutator on the Right Machine).



*Continuous-Current Panels.* *L.T. Three-Phase Panels.* *H.T. Three-Phase Panels.*

FIG. 4.—SWITCHBOARDS FOR THE THREE-PHASE PLANT.

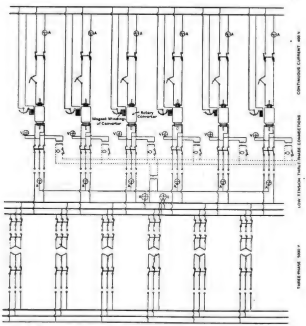
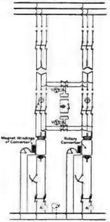
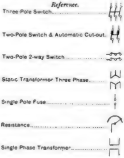
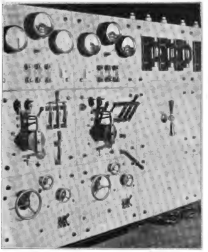


FIG. 5.—DIAGRAM OF CONNECTIONS AT DICKINSON-STREET FOR THREE-PHASE TRANSFORMING PLANT.



CONNECTIONS IN EACH SUB-STATION.





*Low Tension.* *High Tension.*

FIG. 6.—THREE-PHASE SUB-STATION SWITCH PANELS.

50 per cent. momentarily. The boiler-house will contain eleven Babcock boilers, each having a heating surface of 5,140 sq. ft., to produce 200,000lbs. of steam per hour at a pressure of 160lbs. per square inch. All the boilers are to be fitted with superheaters. Above the boilers will be fixed the economisers, each boiler having its own economiser, and a reserve flue being provided for each pair of boilers. The main flues will thus discharge into the chimney at a level of 80ft. from the ground. The chimney is to be octagonal, 230ft. high, and 12ft. across the octagon inside, but is not yet completed. It was expected that the Bloom-street station would be running in time for the winter now passed, and the first instalment of generating plant has actually been warehoused since May, 1900, but the buildings are very greatly behindhand.

In view of the importance of these extensions, Mr. Wordingham wisely decided to erect an experimental three-phase plant, in order to test the local applicability of this system.

FIG. 7.—SECTION OF THREE-PHASE CABLE (Half Scale).

The plant for this experiment has been erected at the Dickinson-street station, and was put into operation about a month ago. At the present time it is supplying current, through two feeders and converting sub-stations, to two distant portions of the network. Not only, therefore, does it serve an experimental purpose, but it also enables supply to be commenced in these districts before the permanent plant has been erected. Through the courtesy of Mr. Wordingham, we were recently given facilities for inspecting this interesting plant, and to him we are also indebted for the information embodied in this article.

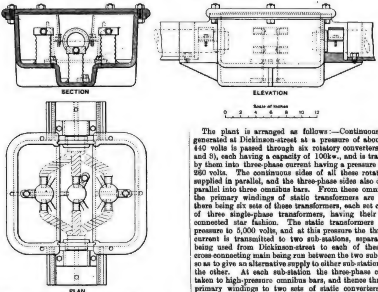


FIG. 8.—DISCONNECTING BOX FOR THREE-PHASE CABLE.

The plant is arranged as follows:—Continuous current generated at Dickinson-street at a pressure of about 420 to 440 volts is passed through six rotatory converters (Figs. 2 and 3), each having a capacity of 100kw., and is transformed by them into three-phase current having a pressure of about 260 volts. The continuous sides of all these rotatories are supplied in parallel, and the three-phase sides also deliver in parallel into three omnibus bars. From these omnibus bars the primary windings of static transformers are supplied, there being six sets of these transformers, each set consisting of three single-phase transformers, having their winding connected star fashion. The static transformers raise the pressure to 5,000 volts, and at this pressure the three-phase current is transmitted to two sub-stations, separate mains being used from Dickinson-street to each of these, and a cross-connecting main being run between the two sub-stations, so as to give an alternative supply to either sub-station through the other. At each sub-station the three-phase current is taken to high-pressure omnibus bars, and thence through the primary windings to two sets of static converters. As at Dickinson-street, each set comprises three single-phase transformers, but the low-pressure winding has attachments made at 10 different points, thus giving 10 different pressures at will. From the low-pressure side of these static transformers the current is passed into the slip rings of two 100kw. rotatory

converters, the continuous sides of each supplying into the distributing network. The high-pressure windings of all static transformers are connected star fashion.

The switchboard arrangements (Figs. 4 to 6) are such that every rotatory converter is controlled by an automatic cut-out. The high-pressure switches are insulated wholly with porcelain, and give two breaks on each phase. The whole of the high-pressure connections are made with bare copper on porcelain insulators without oil, and at Dickinson-street are completely enclosed by wire guards, the switchboard being fixed above the converters. Especial care has been taken to earth thoroughly every part of the framework and guards as well as the handles of the high-pressure switches.

The rotatory converters are started up from the continuous-current side in all cases, and means are provided for varying the field excitation if desired. The arrangement has been at work for about a month with results satisfactory in every way, no hitch or difficulty of any kind having occurred. It is noteworthy that one of the sub-stations is supplying a load in which motive power largely preponderates, there being large engineering works close by taking some 350 H.P. Before the sub-station was got to work this portion of the network was supplied at low pressure from Dickinson-street, with the result that the pressure in place of being about 406 volts was only from 320 volts to 330 volts. The sub-stations are supplying in parallel with the low-pressure generating station, the network forming one continuous whole. It should be noted that the above arrangement is only a temporary one, as of course it would never be contemplated permanently to use a four-fold transformation such as that described.

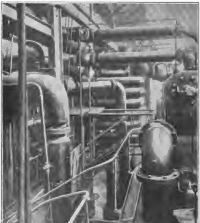


FIG. 9.—EXPANSION JOINTS ON THE MAIN STEAM RANGES.

The efficiency of the system is most satisfactory. Mr. Wordingham specified that the plant should be run at the maker's works connected in such a manner that continuous current was taken in by a rotatory converter converted to low-pressure three-phase current, stepped up by a static transformer, stepped down again, passed through a second rotatory and the continuous current from this absorbed by an artificial resistance. In this manner measurements of continuous current only had to be made. When run under these conditions after six hours the mean of the efficiencies at full load, three-quarter load, and half load was to be not less than 78 per cent. The actual tests of a combination run in this way gave an efficiency of 79·7 per cent. Other combinations were tested by a modification of the Hopkinson method, the continuous current being returned to the first rotatory, and the efficiencies of the combinations measured in this manner varied from 78 to 80 per cent. Full particulars are given in the annexed table :—

| — | 1st set. Per cent. | 2nd set. Per cent. | 3rd set. Per cent. | 4th set. Per cent. | 5th set. Per cent. | 6th set. Per cent. | Required by specification. Per cent. |
|---|---|---|---|---|---|---|---|
| Full load......... ... | 81·1 | 79·2 | 80·9 | 80·7 | 80·3 | 80·6 | — |
| Three-quarter load | 80·3 | 80·6 | 80·8 | 80·0 | 78·9 | 80·6 | 78 |
| Half load ......... | 77·6 | 80·0 | 78·3 | 78·0 | 75·3 | 79·0 | 74 |
| Mean efficiency ... | 79·7 | 79·9 | 80·0 | 79·2 | 78·0 | 80·0 | 78 |

The method of balancing the continuous-current three-wire network is one that does not appear to be generally known in this country, and as it is extremely successful and satisfactory it may be worth describing. As already stated, the static transformers have their windings connected star fashion. To the middle point of the low-pressure winding of the step-down converters a connection is taken from the middle wire to the ordinary three-wire network, and the rotatory supplies current directly across the outer conductors of the network. The whole of the balancing is done on the alternating side of the combination. Experiments show that the results obtained are quite as good as with the ordinary methods by means of balancing motor generators, if not better, and the elimination of this apparatus is a material gain in every way. It may be mentioned that the middle point of the star on the high-pressure side at Dickinson-street station is connected to earth.

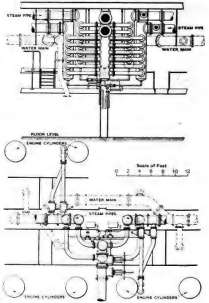


FIG. 10.—PLAN AND ELEVATION OF THE MAIN STEAM RANGE CONNECTIONS.

Beyond the area shown in Fig. 1, additional sub-stations will be required for other districts, the orders of which have recently been taken over—viz., Denton, Audenshaw, Droylsden, Prestwich, Failsworth, Whitefield, &c. The lines on the map show the routes of the high-pressure three-phase mains serving to connect the sub-stations to the generating

station at Stuart-street. The number of mains will be very large, as many as 30 leaving the generating station. This is owing to the absurd requirements of the Board of Trade, who could not be persuaded to allow any single main to have a larger capacity than 1,000kw. The general scheme of the arrangement of the mains is that there shall be a direct main from the generating station to each sub-station, and that there shall be an alternative means of reaching each sub-station. All the feeders are to be of uniform size (Fig. 7), each comprising three conductors 0·15 sq. in. section, the conductors being stranded and made into the shape of a segment of a circle with rounded corners, thus enabling the conductors to lie more compactly together in the cable. The three conductors are laid up to form what is sometimes called a clover-leaf cable, the insulation employed being impregnated paper, the impregnating material being practically dry. The insulation is enclosed within lead in the usual way, and over the lead is an armouring of round steel wires. The cables were supplied by the British Insulated Wire Co., of Prescot, and were laid by the Corporation's own staff. Owing to their large size they could not be made in greater lengths than 110 yards, hence a considerable number of joints were necessitated. The cables are all laid on Callender's solid system in cast-iron troughs. The troughs are in 9ft. lengths, and contain either two or three cables. Ordinary wooden bridges are used, but in addition to these one bridge in every length of troughing is of malleable iron secured to the bottom of the trough by set screws, and a malleable iron clamp is placed over the cable so as to secure efficient contact between the armouring and the length of troughing. By this means the cast-iron trough is rendered electrically continuous throughout the length of the cable. The troughs are covered by pitch pine boards 1¼in. thick, treated with Stockholm tar all over.

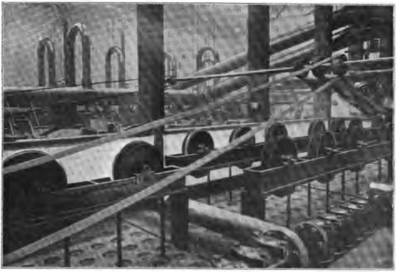


Fig. 11.—View of Main Steam Ranges over Lancashire Boiler House.

The joint boxes (Fig. 8) were specially designed by Mr. Wordingham for the work. They are of such a shape that the three conductors can be bent outwards from the centre of the cable, and have not to be brought into the same plane as one another. The brass connecting pieces are carried on porcelain insulators, giving very high insulation in air. These insulators are gripped at the bottom of the box by two wedge-shape lugs cast in the bottom and a third similarly shaped fixed by a set screw, while the brass connecting pieces which they support are rigidly held by means of a kind of bayonet joint. The box is filled up with Callender's box compound, so that although the insulators are amply sufficient to insulate the conductors in dry air this is not relied upon, but is supplemented by the compound, which has a very high dielectric strength. Another feature of these boxes, suggested by Mr. F. E. Procter, who was responsible to Mr. Wordingham for the laying of the mains, consists in clamping together the armouring and the lead by means of clamps on the box itself, thus very neatly and simply ensuring the efficient connection between these and avoiding any want of continuity in the earthed shield round the conductors.

A large proportion of the mains required for the permanent scheme has now been laid, and three have been utilised for the temporary supply above described. As already stated, the mains brought into use comprise one from Dickinson-street to Moss Side station, another from Dickinson-street to Bennett-street sub-station, and a third from Moss Side to Bennett-street sub station. These mains were all tested with a pressure of 13,000 volts between each conductor and earth, the other two conductors of the cable under test and the armouring being connected to earth during the test, each conductor being tested in this manner in turn. The capacity of the conductors was similarly tested, and tests were made of the conductivity of the cables. These are set forth in the accompanying table, and in all cases the joint-boxes are included in the test. The result of the equality of capacity between the conductors of the cable is most noteworthy, this being of great importance in working with rotatory converters. The requirements of the specification were severe, but the result actually obtained is seen to be better even than that specified. It is most satisfactory to know that the cables withstood a pressure test of 13,000 volts without the slightest

hitch or mishap of any kind the first time the test was applied, a fact which speaks well both for the makers of the cables and for the staff engaged in laying them.

TESTS OF HIGH-PRESSURE THREE-PHASE FEEDER MAINS LAID ON THE SOLID SYSTEM.

(1) *Dickinson-street Station to Bennett-street Sub-station.*

| | Copper resistance per mile. | Insulation resistance per mile. | Capacity test per mile. |
|---|---|---|---|
| A. | 0·291 ohms. | 1,100 megohms. | 0·240 mfd. |
| B. | 0·291 " | 336 " | 0·243 " |
| C. | 0·291 " | 205 " | 0·245 " |

(2) *Dickinson-street Station to Moss Side Sub-station.*

| | Copper resistance per mile. | Insulation resistance per mile. | Capacity test per mile. |
|---|---|---|---|
| A. | 0·289 ohms. | 1,540 megohms. | 0·241 mfd. |
| B. | 0·294 " | 1,200 " | 0·239 " |
| C. | 0·289 " | 1,850 " | 0·241 " |

(3) *Bennett-street Sub-station to Moss Side Sub-station.*

| | Copper resistance per mile. | Insulation resistance per mile. | Capacity test per mile. |
|---|---|---|---|
| A. | 0·293 ohms. | 265 megohms. | 0·243 mfd. |
| B. | 0·287 " | 434 " | 0·241 " |
| C. | 0·288 " | 535 " | 0·243 " |

Messrs. Thomas Richardson & Sons have supplied the generating plant, which is of the Brown-Boveri type, for which they are the English agents. They have also supplied the switchboards and the sub-station plant. As already mentioned, the cables were made by the British Insulated Wire Co.

During our visit to the Dickinson-street station we were shown by Mr. Wordingham a number of interesting details of the recent extensions and alterations. Our illustrations show some of these. Figs. 9 and 10 show the ingenious manner in which Mr. Wordingham, after almost endless trouble, solved the difficult problem of providing for expansion in long, straight steam ranges. Fig. 11 shows the expansion bends on the standpipes and steam ranges in one of the boiler-houses. Referring again to Figs. 9 and 10, which relate to the machinery ranges, it will be seen that two main steam pipes distribute steam along the entire length of the engine room. These are fed from the boiler mains, which are T'd into them near the middle. To provide for expansion in these circumstances, the ranges have been coupled up through a system of quarter-turn bends. The bent pipes, which are clearly shown in the illustrations, are connected to vertical drop-pipes below the ends of the steam ranges. The work has been carried out in rivetted wrought steel to Mr. Wordingham's designs, and presents a perfectly satisfactory solution of what is often a troublesome problem.

Before leaving the Manchester works for the present, we must take a passing glance at the continuous-current motor-generators which Mr. Wordingham put in experimentally before he finally decided upon a three-phase system. These are four in number, each of 60kw. capacity, for stepping-up the pressure, and an equal number for stepping-down the pressure. The step-down machines are provided with auxiliary magnets for regulating the feeding pressure at the network. In order to test the efficacy of continuous currents for high-pressure transmission, Mr. Wordingham designed these machines to work at 8,000 volts on the high-pressure side. The low pressure was about 420 volts. Thus built, the machines stood well the tests to which they were subjected, the results of which are given below for two of the sets:—

| | 1st set. | 2nd set. |
|---|---|---|
| Full load | 79·2% | 78·9% |
| ¾-load | 76·5% | 76·7% |
| ½-load | 70·8% | 71·3% |
| Mean | 75·5% | 75·6% |

Ere these machines were actually ready, however, Mr. Wordingham had quite resolved to adopt three-phase transmission. Their armature connections were, therefore, altered to give 1,500 volts on the high-pressure side, at which pressure they are now working quite satisfactorily.

## THE CENTRAL LONDON RAILWAY.

*(Concluded from page 541.)*

*Locomotives.*—Each locomotive has eight 42in. wheels, and is fitted with four 117 H.P. motors—that is, one motor to each axle. The motors are directly mounted on the axles, thus saving all gearing. They are described below. The body of the locomotive consists of a heavy steel girder framework, on which is raised an iron structure constituting the driver's cab (Fig. 56), and the forward and backward sloping protections for the apparatus. There is a flooring of wood the entire length of this framework, and on this is placed the controlling device and sundry other mechanism. The whole of this body rests on two bogies, which are free to swivel on turnplates, and measures 26ft. 7in. long by 7ft. 8in. wide. On each end there are buffers, making the total length over all about 30ft. The bogies have each two motors mounted rigidly on their frames, the only springs being introduced between the bogie frame and the turnplate on which the body of the engine rests. The distances between centres of the wheels of these locomotives is 5ft. 8in., thus permitting of going round sharp curves, while the total length of wheel base is 20ft. 4in. The part immediately over the bogies (Fig. 57) is occupied by the resistances used in starting and regulating the motors, while the centre of the locomotive is devoted to the driver's cab.

The current is collected from the third rail by means of two cast-iron shoes which rub along it, and is led through an automatic circuit breaker and switch to the controller, and thence to the motors, returning to the track rails through the wheels. This motor controller, by means of which the speed is regulated, is placed in the centre of the driver's cab. The instruments, a Weston ammeter and voltmeter, with pressure gauge for the brakes, &c., are placed in duplicate at both ends of the cab in clear view of the driver, so as to allow of the locomotives being driven in either direction. In one corner of the cab there is a little series motor, which drives a set of air-compressor pumps to fill the air reservoirs, from which Westinghouse air-brakes are operated. This motor is fitted with a device to start and stop automatically as the pressure of air in the reservoirs gets below or above the working mean of 80lb. per square inch. The reservoirs are situated close to the resistances, and warning whistles are operated from the same. The total weight of the locomotive is 97,000lb., and is capable of exerting a draw-bar pull of over 30,000lb.

*Motors.*—The motors, which are series wound for 117 H.P., are mounted directly on the axles of the locomotives, and for this purpose the armature is built up on a brass sleeve, into which the axle is afterwards forced (Figs. 58 to 60). The case also forms the yoke of the magnetic circuit, and is made of high permeability soft cast steel, in two halves, so arranged that when in place the lower half can be dropped to expose the armature for examination (Fig. 60). This steel yoke has four laminated magnet cores and pole-pieces bolted to it internally, and is rigidly fixed to the bogie frame, which carries the bearings. All the magnet cores are wound, two having large coils and two small ones. The large coils, which are situated horizontally, each have 76 turns of strip copper 2·125in. by 0·11in., the small ones having each 15 turns of strip copper 0·875in. by 0·22in. The coils are wound on formers, and thoroughly insulated before being put in place, afterwards being held in position by brass castings bolted to the steel magnet yoke. The principal insulation used for these coils is asbestos. At full load the current density in the small coils is 1,000 amperes per square inch, and in the large ones 820. The armature is built up of slotted punchings assembled directly on the brass sleeve. It has 61 slots, each 1·73in. deep by 0·52in. wide, and has a single circuit series drum winding. The construction is of the bar type, the conductors being 0·6in. by 0·1in. There are six such conductors per slot, making in all 183 total armature turns, the current density at full load being 2,100 amperes per square inch. The winding is held in place by hickory strips and steel binding wire. The magnetic density at full load in the armature teeth is 127,000 lines per square inch. The commutator is

Fig. 56.—Interior of Central London Railway Locomotive.

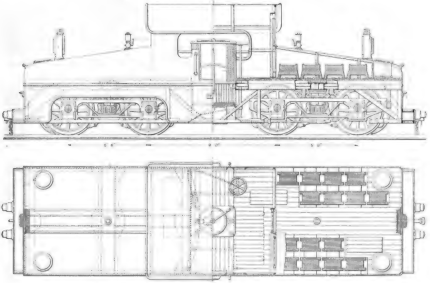


Fig. 57.—Central London Railway Locomotive.—Longitudinal Section and Plan.

19in. diameter, and has 188 segments—one per turn; it is 8in. long, and has two sets of carbon brushes—four in each set. The commutator segments are held in place by steel core-shaped rings, being insulated therefrom by mica, which are mounted directly on the previously-mentioned brass sleeve.

Curves of core loss, speed, tractive effort and efficiency are given in Figs. 61 and 62.

**Controllers.**—Control of the motors is effected by the series parallel arrangement. There are two sets of two motors to be regulated, the entire operation being performed by one handle.

Figs. 63 and 64 give views of this controller, which, as already mentioned, is placed in the centre of the driver's cab, being bolted to the floor and also to the locomotive framework. On each side will be noticed a vertical handle, by means of which the motors can be made to go ahead or reversed, the centre position being neutral, while the main regulating handle on top is common to both the regulating speed ahead or astern. These reversing and regulating handles interlock so as to prevent accidents happening by putting on current when the regulating handle would be in the full-speed position, a condition which would practically amount to short-circuit. The contacts of hard copper are carried on a cylinder of specially-prepared wood, which, being revolved into position by the aforementioned regulating handle or lever, makes or breaks the different combinations with other stationary contact fingers which press against this cylinder. A solenoid blow-out is provided at every contact, by which any arcing is instantly blown out.

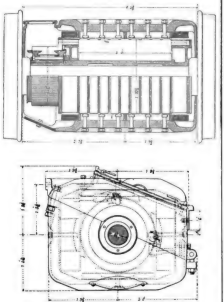


FIG. 58.—175 H.P. CENTRAL LONDON RAILWAY MOTOR.

**Locomotive Tests.**—Tests have been made upon the locomotive over a level section of track on the surface. This differs from the conditions in the tunnel, firstly, in the absence of the grades, and secondly, from the less air friction. The results of a representative test with a high rate of acceleration are given in Fig. 65. This was with an experimental train whose total weight is 333,000lb., made up as follows:—

*Dimensions of General Make-up of the Train.*

| | |
|---|---|
| Seven standard N.Y.C. flat cars. | |
| The length of the train overall up to the bumper of the locomotive was | 271ft. 3in. |
| Length of each car over sills | 35ft. 1in. |
| Length of draw heads | 1ft. 10in. |
| Total length of car overall | 38ft. 9in |
| Width of car over sill | 9ft. 0in. |
| Wheel base | 5ft. 4in. |
| Truck centres | 25ft. 5in. |
| Weight of empty car | 24,700lb. |
| Weight of pig iron on each car | 8,400lb. |
| Weight of seven cars loaded with pig iron | 231,500lb. |
| Weight of test car | 4,500lb. |
| Weight of locomotive | 97,000lb. |
| Total weight of train | 333,000lb. |

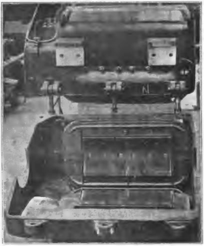


FIG. 59.—VIEW OF MOTOR, SUSPENDED OPEN TO SHOW MAGNETS.

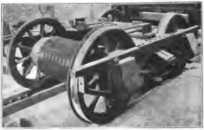


FIG. 60.—VIEW OF MOTOR TRUCK.

The values of the "Pounds draw-bar pull" to which the curve is plotted, do not correspond to the total pounds torque developed by the motors on the locomotive, since the motors have, in addition, to propel the locomotive itself. Hence the "Total pounds pull" are obtained by increasing the "Pounds draw-bar pull" in the ratio of weight of train complete to weight of train without locomotive, a ratio of 1·41. In 28 sec. from the start, the controller was moved to the last position,

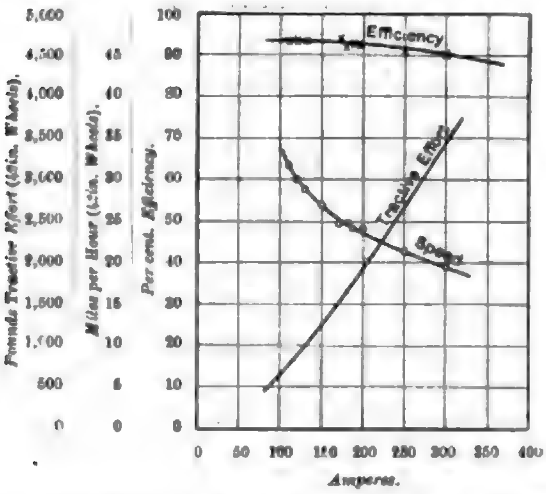


FIG. 61.—CURVE OF SPEED, TRACTIVE EFFORT AND EFFICIENCY FOR A G.E. 56A 500 VOLT GEARLESS RAILWAY MOTOR.

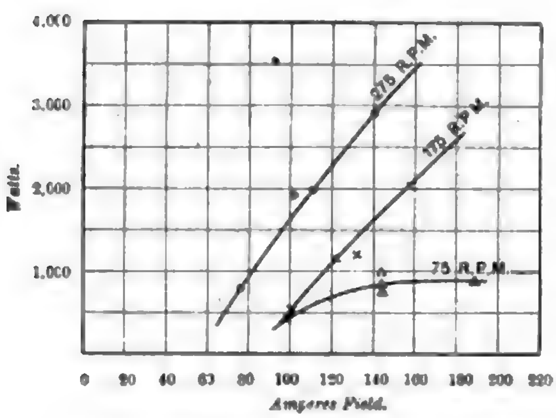


FIG. 62.—CORE LOSS FOR G.E. 56A RAILWAY MOTOR.

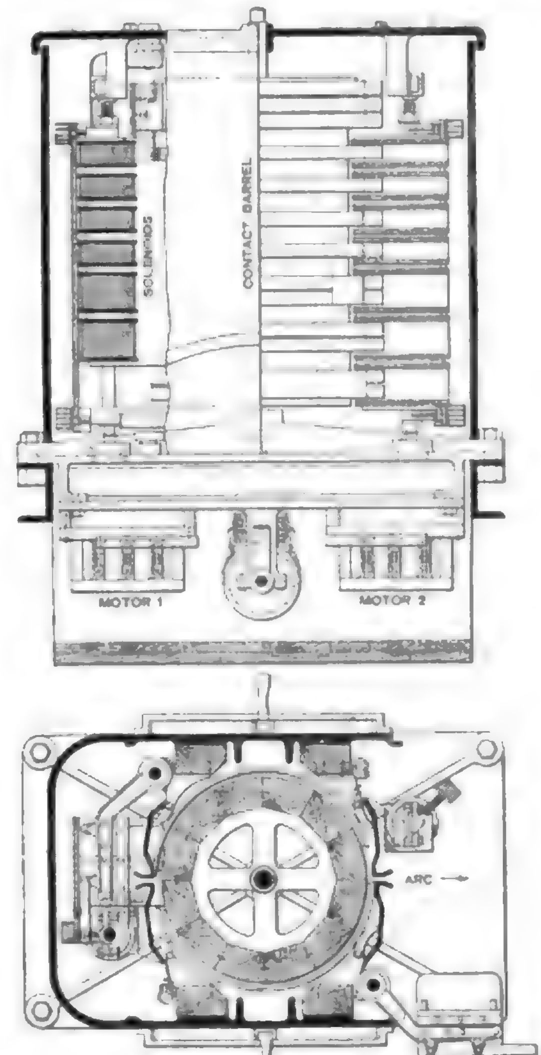
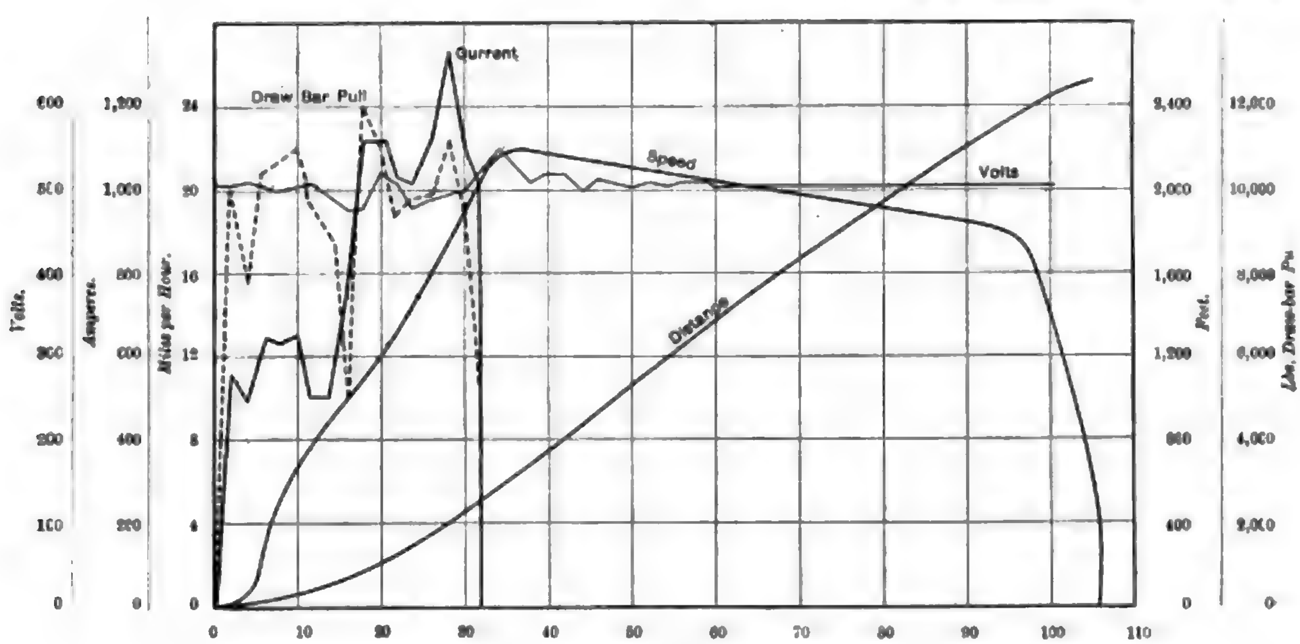


FIG. 63.—PLAN AND VERTICAL SECTION OF LOCOMOTIVE CONTROLLER.



| Average Current for 32 seconds 351·2 | Kw. Hours for acceleration period 3·78 | Average Voltage 500. |
|---|---|---|
| " " " entire run 200·7 | " " per train mile 7·93 | |

* Inc. 20 sec. stop.

FIG. 66.—TESTS WITH CENTRAL LONDON LOCO. AND 7-CAR TEST TRAIN. Total Weight 333,000lbs.

corresponding to four motors in parallel directly on the line. At this point the following calculation of the efficiency has been made :—

| | |
|---|---|
| Time from start | 28 sec. |
| Pounds draw-bar pull | 11,200lb. |
| Total pounds pull | 15,800lb. |
| Speed | 17·6 miles per hour. |
| do. | 1,550ft. per min. |
| Output | 24,450,000 ft. lbs. per min. |
| do. | 740 H.P. |
| Voltage at terminals | 494 volts. |
| Current input | 1,330 amperes. |
| Kilowatts input | 656kw. |
| Horse-power input | 880 H.P. |
| Commercial efficiency | 84 per cent. |
| Current per motor | 332·5 amperes. |

The commercial efficiency of this motor at 332·5 amperes should be 85 per cent.

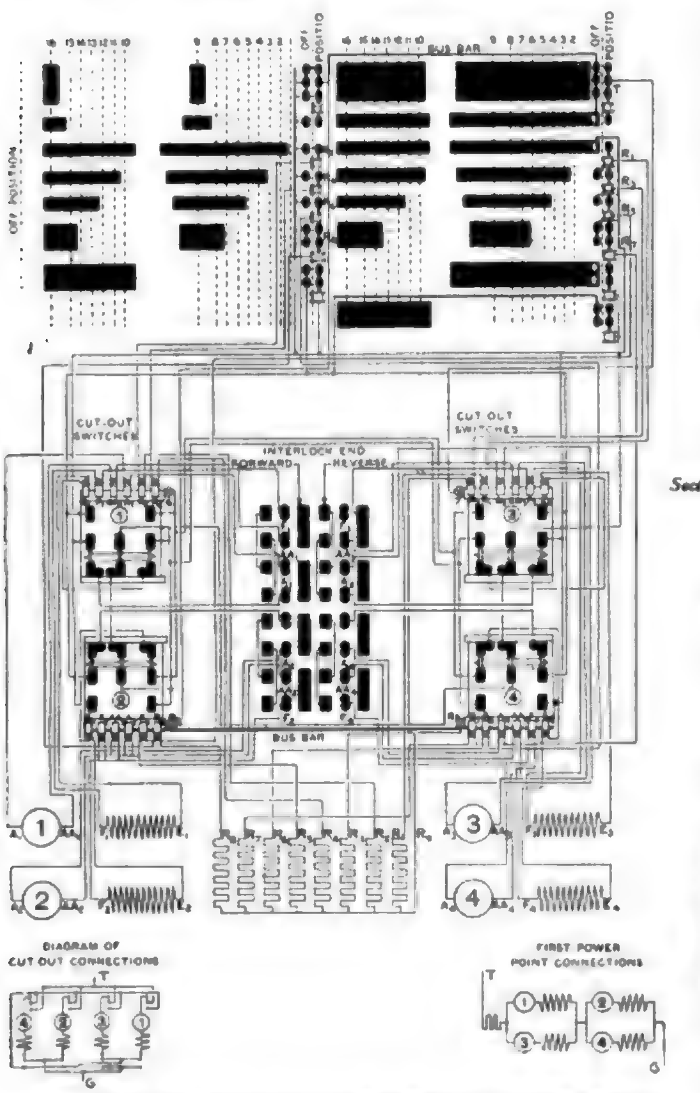


FIG. 64.—CONNECTIONS AND DEVELOPMENT OF L6 CONTROLLER FOR FOUR 175 H.P. MOTORS.

Now, in actual practice, the locomotive will have attained a higher speed if the controller is brought to the last point in 28 sec., for not only shall we have the 15,800lb. total pull, but we shall have the accelerating effect of the down grade, which, amounting to 22·4lb. per ton per cent. grade, comes to the equivalent of a pull of

$$22{\cdot}4 \times \frac{333{,}000}{2{,}240} \times 3 = 10{,}000\text{lb.},$$

which brings the equivalent total pull up to 15,800 + 10,000 = 25,800lb. This will enable the current to be cut off much earlier, and, although the increased air friction due to running in a closed tunnel will partly offset this, there will, nevertheless, be a very material reduction in the required input, which will probably be reduced to about six kilowatt-hours per train-mile. The average current per train, throughout the run (including stops) is 170 amperes, or probably 180 amperes, when allowance is made for air compressors and lighting. As there are 22 trains in service (allowing for one at each end being shunted) the average output from the rotary converters for running trains will be about 4,000 amperes, but the running of the lifts probably increases this to an average output of 5,400 amperes, or 2,700kw. The output from the rotary converters, at frequently recurring intervals, reaches a maximum of 8,000 amperes or 4,000kw. The losses in transmission, corresponding to the *average* load of 2,700kw. from the rotatory converters, will be 375kw.

## COMBINED TROLLEY AND CONDUIT TRAMWAY SYSTEMS.*

BY A. N. CONNETT.

In many cities where the overhead trolley is or will be admitted on surface tramways, there often exists a street or a central zone where it is or will be expressly prohibited. Again, other cities prohibit absolutely the trolley within their limits, but penetrating lines from the suburbs come to the limits with the trolley, and from there a change of cars must be made to enter the city, or the cars must be equipped so as to be able to use another system of traction. The general engineering problem in these two cases is about the same. Broadly speaking, it is that the electric motors, with which the car is equipped, must be furnished with current from a source

FIG. 1.—SIDE SLOT SWITCH.

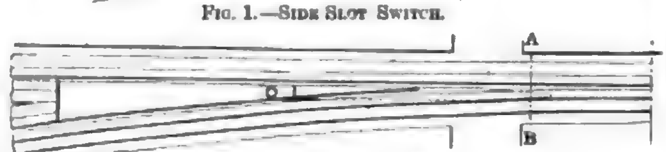


FIG. 2.—CENTRE-SLOT SWITCH.

other than the overhead wire along a part of its route. There is no one well-defined system or method of solving the difficulty upon which engineers are agreed as being the best. It is natural that this should be so, local conditions being such an important factor that each individual case must be carefully studied by itself, so that what would be a correct solution in one place might not be justified in another. The three means of solving the problems are by :— 1. Accumulators. 2. Surface contact. 3. Open slot conduit.

It is not the purpose of the author to discuss the first two systems. As the result of his experience with accumulators he would advise that, if in a given case their installation should seem to be advisable, the contract should be drawn in the form of a rental for the batteries, on the terms of paying a fixed sum per automobile car-mile for their use; this sum should include the entire cost of maintenance and renewal of the batteries for a fixed period. Penalties should be inserted in the agreement for each trip lost, due to failure in working of the batteries; and their electrical efficiency should be guaranteed up to a certain standard, below which the excess waste of energy should be paid for at an agreed rate per ampere-hour. This method has been employed in France and in Germany with good results. It seems the best devised to protect the user from a poor form of battery for a given work, and at the same time to insure the upkeep of the batteries in the best possible conditions; this last is to the evident advantage of both buyer and seller. The batteries should be placed under the car-body if possible; if this is not done, the acid fumes are disagreeable to passengers, and the effect will be a diminution of receipts and numerous complaints.

If a surface contact system should be decided upon, the choice of one of the many systems will require careful study. If the number of cars using the portion of track to be equipped with this system is large, and the comparative length of such portion of track is small, it will be found that the cost of the car-equipments for a system where the cars carry the magnets is relatively excessive, and that a system

* Paper read before the Institution of Mechanical Engineers, March 15

employing a magnetic switch for each contact-point will be much cheaper. With the condition of a relatively great importance to the surface-contact portion of a line, this conclusion as to first cost might easily be reversed. The vital questions of working, maintenance, and safety, have to be given the most careful consideration, with the disadvantage that there is at present very little to be learned from

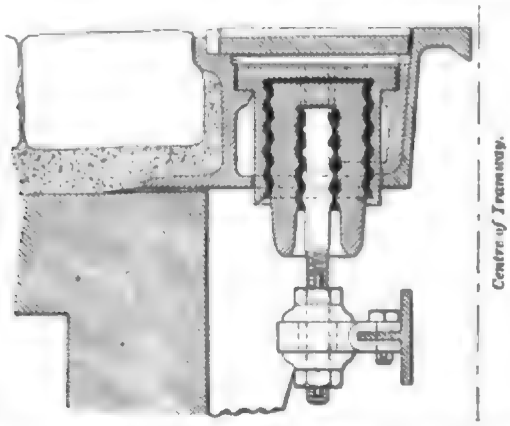


FIG. 3.—INSULATORS AND SUSPENDED CONDUCTOR RAILS (CENTRAL CONDUIT), IN WASHINGTON.

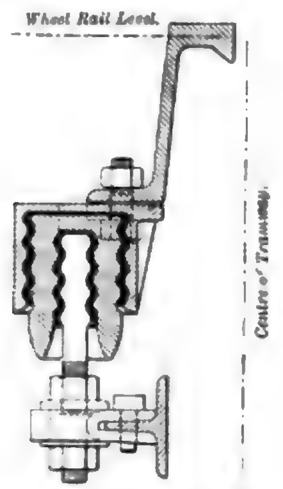


FIG. 4.—INSULATORS AND SUSPENDED CONDUCTOR RAILS (CENTRAL CONDUIT), IN PARIS.

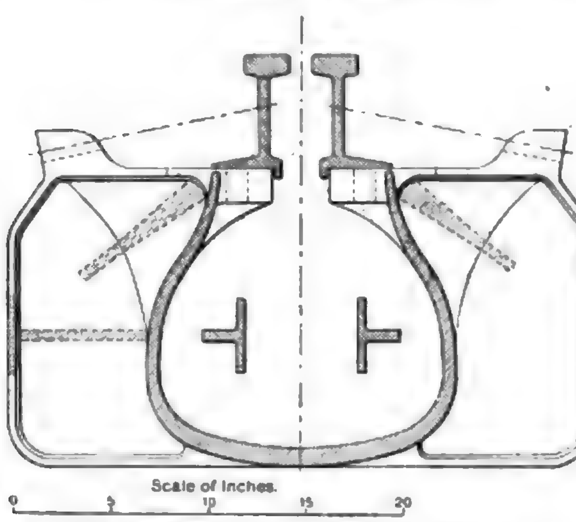
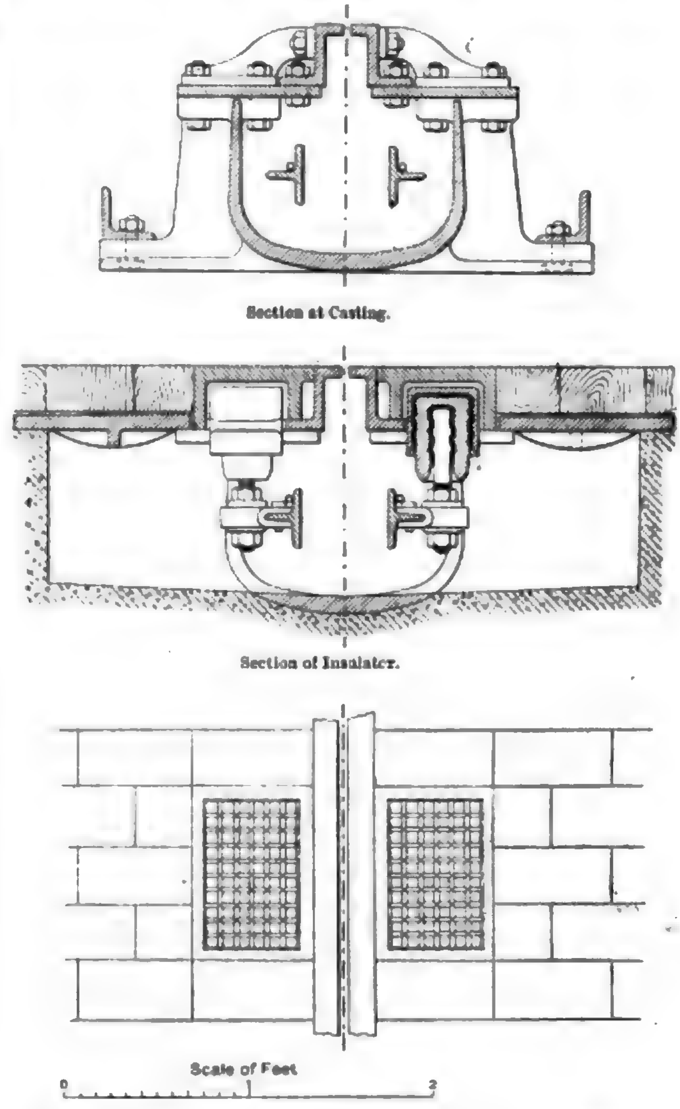


FIG. 5.—FOR CONDUIT WHERE DEPTH IS RESTRICTED, PONT DE L'ALMA, PARIS, &C.

experience on actual working lines, which are either too few or too recently installed. There should be no hesitation about adopting the conduit, where financial and constructional conditions make it possible, for this system has proved itself to be workable. It has passed entirely beyond the experimental and uncertain period, and can now be adopted without hesitation as an electric tramway system for the propulsion of cars. It can fail completely, but even partial failure will be the fault either of design or of construction, or of both.

The problem of adapting the plough and track mechanism, to change from the overhead line to the conduit system, or vice versa, has been satisfactorily and carefully worked out on several different general principles. In America, where the conduit has been generally adopted in the cities of New York and Washington, the problem of a mixed line has received very little attention. In Washington, on two unimportant trolley lines, the cars run directly into the city on the conduit tracks, but the manner of making the change is crude and not worthy of attention. On the Continent there are a number of cases of this kind, and they are all worthy of attention, the problem having received in each case careful study. This, in the author's opinion, is only one instance in several, where European tramways offer now a much more fruitful field for study



FIGS. 6, 7, 8.—SPECIAL SHALLOW CONDUIT, PONT DE L'ALMA, PARIS.

than American tramways, especially so to the engineer called upon to instal a system in Europe under European conditions and requirements.

The subject will now be considered in the following order:— 1. The general type of conduit to be adopted. 2. The mechanical and electrical bases on which to construct conduit. 3. The special apparatus necessary for a mixed conduit and trolley line.

*General Type of Conduit.*—The first question to be solved in a conduit construction is the conductor system, to which is intimately connected the manner of making contact. With the limited clearances in a conduit, there can be no other practical method than the one of installing rigid conductor-bars, to which the original Buda Pesth conduit owes its success. Apart from that, it had no special feature which was of enough importance to make this line a success where others had failed. The conservatism, not unnatural under the circumstances, shown in the construction of this road may be

judged by the fact that 300 volts distribution was adopted, while now engineers have no hesitation in using 550 volts under similar conditions.

The next question is whether the conduit shall be side-slot or centre-slot construction. If the engineer has his choice, he will undoubtedly adopt the latter type of conduit. On the Continent there is an objection in some of the cities on the part of the municipal authorities to the centre-slot. Therefore, in Buda-Pesth, Berlin, and Brussels only the side-slot is allowed, while in the cities of Lyons, Nice, and Bordeaux the centre-slot has been or is being installed. There are some short stretches of centre-slot in Paris, but the reasons for this were exceptional, and in general this city may be classed in the first category also, 95 per cent. of the conduit mileage there being side-slot. Of the 45 miles of conduit electric railway constructed in four European cities and one American city with which the author has been associated as chief engineer, 30½ miles are of the centre-slot, and the remaining 14½ miles are of the side-slot type. His original opinion of the greater advantages of the centre-slot construction has been somewhat modified by experience, but he still believes that from an operating standpoint the centre-slot is the better construction.

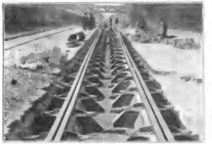


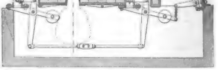
FIG. 9.—SPECIAL SHALLOW CONDUIT, PONT DE L'ALMA, PARIS. (Under Construction.)

The inherent difficulty with the side-slot is the switch at the junction of two slots. Figs. 1 and 2 show the two cases. With the centre-slot a comparatively light movable tongue can be hung or pivoted to the fixed tongue, its use being simply to guide the plough. With the side-slot the tongue is much stiffer and heavier, because it must also guide the wheels of the car and support them in one position; that is, the entire tongue is movable, and its upper surface from point to heel must be level with the wheel rail. At its point it should have a certain thickness to give mechanical strength. This should be not less than ½in., which, added to the 1in. minimum width of slot, gives an opening of 1½in., which is gradually reduced to 1in. in a length of about 3ft. In the centre-slot construction the normal slot width of, say, ¾in. is increased in a length of about 8in., and the maximum increase is about ¼in. Another objection to the side-slot is that the flanges of the wheels throw water and mud into the conduit and on to the plough. Another is that the slot-rail, being also a wheel-rail, should have a vertical web, which diminishes the distance across from rail to rail on the line of their base-level, thus limiting the plough construction and also making the conductor bars invisible from above, which renders the finding of faults more difficult. The principal trouble with the side-slot conduit is that connected with the switch, and it can be avoided by a special construction, which will be explained later. The advantages of the side-slot conduit are that the additional band of iron in the street required by the centre-slot rails is avoided, and that the maintenance of the paving is thereby simplified, every joint of a rail with the paving being a source of weakness in the life of the latter.

FIG. 10.—SPECIAL CONSTRUCTION OVER STEEL RAILWAY BRIDGE, PARIS.

*Mechanical and Electrical Details to be considered in the Construction of a Conduit.*—With the broad question of type of conductors and of position of the conduit settled, the design in detail of a conduit can be undertaken. The first matter is that of insulators and their mode of fastening. In the present state of the art there can be no question about adopting a porcelain insulator, or at least a material which has the same general characteristics. The first line equipped in New York City used a built-up insulator, a bolt being covered with an insulating compound; it failed, and the type of insulator which had proved so successful at Washington was adopted. In Brussels the type of insulator used is a bolt surrounded by a rubber compound. This is subjected to a severe piercing test with a Rhumkorff coil before being accepted. These insulators have been fairly successful, but they are expensive, and they may also deteriorate by exposure to the atmosphere. The ironclad porcelain insulator is strong, durable and cheap. There can be no hesitation about its use. The insulators should be vertical, so that they may not offer the chance for the accumulation of dirt, which can easily happen with one horizontally placed. The first Buda-Pesth road had this fault, but it was rectified in the later construction in that city.

FIG. 11.—SIDING WITHOUT CONDUIT, PARIS.



For Centre-Slot.

For Side-Slot.

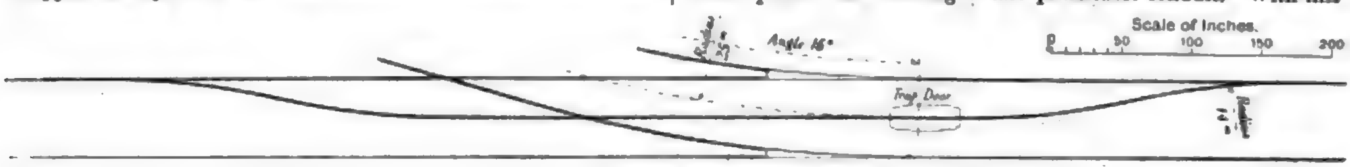
FIGS. 12, 13.—COUNTERWEIGHT MECHANISM FOR CLOSING RAIL-SWITCHES AUTOMATICALLY, PARIS.

Assuming a vertical ironclad porcelain insulator, the method of attaching it to the conduit construction becomes important, the depth of the tube being somewhat dependent upon this. For the sake of simplicity they should be fastened to the metallic structure, which has the further advantage of keeping the conductor bars at

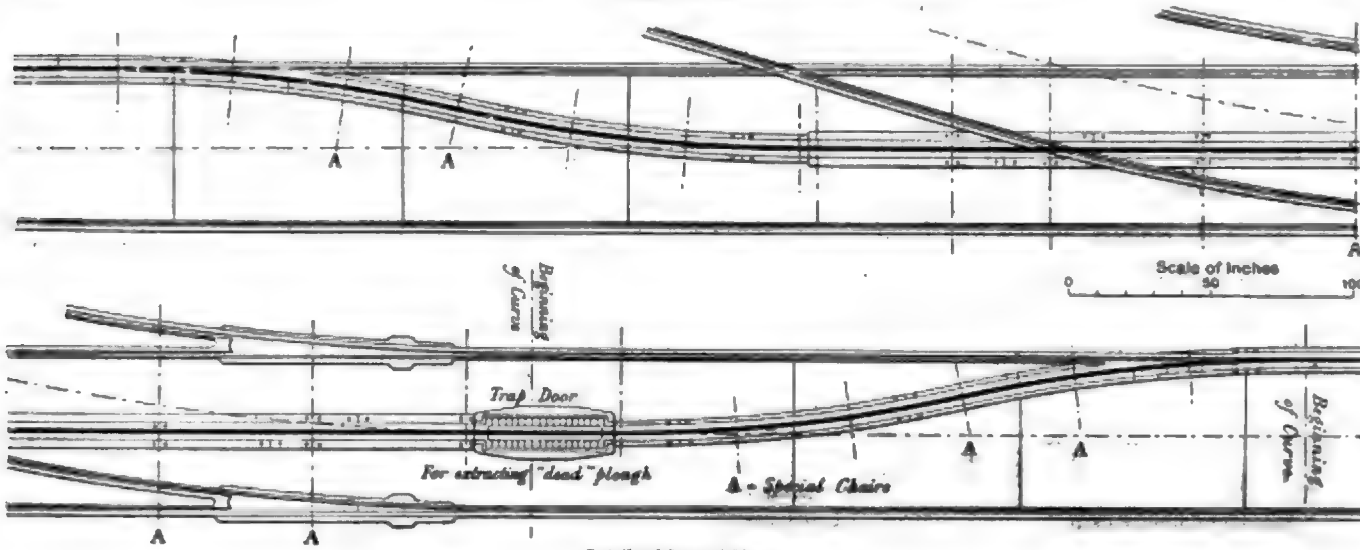
the same distance from the wheel rails, except in the special case of a centre-slot conduit where the yoke construction does not permit the carrying of the wheel rails. The extreme positions of the insulator are, first, with the upper surface of the insulator as near the street surface as it can be for mechanical protection, or, say, 2in.; secondly, with the upper surface of the cast-iron insulator cover bolted directly to the bottom flange of the slot-rail. Fig. 3 is an example of the former case. The insulator could have been reduced in vertical height so as to have carried the conductor bars higher, but this height is limited by the safe insulation distance required between these bars and the slot-rail. Assuming this distance 8½in.—the depth of yoke-seat diminishes it by about 1½in., leaving 2in. of air-gap—the top of the conductor bars will be 10½in. from top of a 7in. high slot-rail. Fig. 4 is an example of the second case with the same slot-rail. The insulator has been reduced in vertical height to the safe limit of mechanical strength. The corresponding distance to top of conductor bar is 14in., or a gain of 3½in. in the conduit depth for the first method of construction.

If the insulators are carried close to the street-level they must be protected by metallic covers, which in Europe are considered objectionable, and in some cases they are absolutely forbidden by the authorities, as in Paris. Therefore the second method is the only one that can be used in such cases. Perhaps it should be said that the insulators are protected by metallic covers in the second case, but these are paved over so that the street surface is in no way altered in appearance by their use.

cover in the street. This construction, while entirely practicable, had the inconvenience in this particular instance of a different carrying height of conductor-bars from the regular construction of the conduit. Special means would have been necessary to raise the plough on this stretch of the road. A careful examination showed that the construction given in Fig. 5 was practicable by slightly cutting the masonry arches, which was adopted. The conduit construction in this last case has a total depth of about 22in., with a 6in. slot rail and insulators bolted to their bottom flanges. The conduit shown is in actual operation, and it can be safely recommended for special cases where the depth available is restricted. Fig. 9 is a view of this conduit during construction. One side of the cast-iron tubes is here shown specially curved to fit the centre longitudinal arch, so as to avoid excessive cutting of the masonry. Fig. 10 is a view of another special construction over the steel railway bridge of the new line from the Gare St. Lazare to the Invalides. This conduit construction rests directly on the steel beams of the bridge, and spans from one to another of them; it therefore had to be in the form of a bridge itself, and a built-up beam construction was adopted. Where the regular yoke construction is used these project from 6in. to 8in. below the tube depth, which is normally from 24in. to 28in., depending upon method of insulator suspension, as already explained, giving, roughly speaking, extreme depths of metallic structures between the limits of 17in. (Fig 6) and 36in. A careful examination of a proposed route should be made to see if the sub-surface constructions would permit the building a safe practicable conduit. With this



General Plan.



Details of General Plan.

FIGS. 14, 15.—DEFLECTION OF SIDE-SLOT TO CENTRE-SLOT AT SWITCH, PARIS.

The limiting conduit-depth being often a vitally important matter for the crossing of immovable sub-surface constructions, it will not be amiss to take up this question more in detail. As just explained, the conductor-bar carrying height is arrived at by adding the depth of yoke-seat and the air-gap to the height of slot-rail. It is possible that the height so arrived at will not give the necessary distance for a vertically-hung insulator and its mechanical protection. In this case the insulator determines the conductor-bar carrying height. When this distance is determined, the height of bar itself, with the necessary clearance to the bottom of the tube, is added. The distance so determined gives the conduit depth. The clearance should be from 9in. to 10in., to allow considerable room for water and dirt accumulation, which might otherwise endanger the operation of the road; but for relatively short distances the clearance can be reduced to 4in., where the conduit must be reduced in height from any cause. The author has used this distance in a number of instances, and knows from experience that it is practically acceptable. Such lengths of conduits need cleaning often.

Fig. 6 is an example of a shallow conduit, which was designed for use on the Pont de l'Alma in Paris. The depth to top of conductor bars is 8in., the height of bars 4in., the clearance 4in., and the thickness of the cast-iron continuous tube 1$\frac{3}{16}$in., or a total height of about 17in. Fig. 7 shows a section of the insulator at the same construction, and Fig. 8, a plan view, gives the appearance of insulator

broad question settled in the affirmative, there is no good reason why the expense and annoyance due to the removal and lowering of many sub-surface obstructions should not be avoided by taking advantage of the possibility of varying the depth required for the conduit. This only becomes a grave matter where the question may involve the complications due to changing the carrying height of the conductor-bars to get the minimum depth of conduit. It may be suggested that the conductor-bars could be carried at this minimum height for the entire construction, but an examination of Fig. 6 will show that it is only possible with a slot-rail of about 4in. high, which is only practicable with asphalt paving.

It may not be amiss to say a few words about the switches, because in practice they are responsible for most of the interruptions in service. A misplaced switch has the result of guiding the car in one direction and the plough in another. The latter can become twisted in the conduit in a variety of ways, but with the too sure result of interrupting the traffic for a time, which, in the author's experience, may vary from 15min. to 2 hours. This bare statement is sufficient to demonstrate the necessity of so designing the switches as to reduce to the strictest minimum the possibility of such accidents.

There are two distinct cases to be considered. The first is where the track is alone switched, the slot being continuous. Fig. 11 is a photographic view of such a switch for a centre-slot construction. Fig. 12 is a sectional view of a counter-weight mechanism which

can be adjusted to close the switches automatically, so that the track should be always open for the passage of the cars using the conduit track. Fig. 13 is a section of the same mechanism for the case of a side-slot conduit. This precaution should always be taken, but it may fail. When this happens, it is usually due to something solid having fallen into the switch, and in consequence the tongues fail to return to their normal position. In the case of the centre-slot construction, the danger of an accident can be avoided if the ploughs are hung on slides, which permit their travelling completely across the car. If the ends of these slides are left free of all obstruction from the truck or otherwise, the plough will drop off when the car has reached a certain distance on the wrong track. But the motorman generally perceives his error before that occurs, and simply stops and reverses the car, with the result of no interruption worthy of mention. Even in the worst case of losing the plough the car is simply "dead," and can be pushed in by the succeeding one. A trap should be placed conveniently at each such switch so that the plough can be taken out with no loss of time. If the accidents are only of this nature, they are not worthy of any serious attention. But in the case of the ordinary side-slot conduit, this result cannot be attained. The tongue there in one position covers the slot. In case of a false position of the switch, an accident will happen which almost surely must result in a serious interruption of the car-service. To avoid this difficulty, the author suggests that before the switches are reached, the slots should be deflected to the central position. Figs. 14 and 15 show how it may be accomplished.

FIG. 16.—DEFLECTION OF SIDE-SLOT TO CENTRE-SLOT, PARIS.

FIG. 17.—TRAMWAY AND CONDUIT SWITCH, PARIS.

In the second case, with a slot switch, the slot-tongue is a necessity. The author recommends for the side-slot conduit the same deflection of the slot to the central position. This serves the purpose of being able to avoid the side-slot slot switch, the constructional difficulties of which were enlarged upon in the first part of the Paper. The danger of an accident with this switch is limited to the case where the point of the slot-tongue is directly in the slot. A "head-on" collision can then take place. But if the tongue is not thrown in the same direction as the track tongues, the same slight interruption may happen as above explained, providing of course that the system of plough slides there mentioned is in use. Fig. 16 shows the case of a side-slot conduit deflected to the centre of the track at a slot switch. There are no mechanical or electrical difficulties in this case, the results of actual operation in Paris having demonstrated this statement. Fig. 17 is a view of a slot-switch operating mechanism. With one movement of the handle the three tongues are thrown in unison. For a dense traffic it is advisable to put a switchman at such slot-switch points, to reduce to a minimum the danger of accidents and of interruptions of service. The author feels confident that the accidents at switching points will be almost negligible if the construction above indicated is followed.

(*To be concluded.*)

## NOTES ON WIRING RULES.*

BY F. BROADBENT.

It is well-nigh impossible, now-a-days, to read one's daily paper, weekly technical journal, or monthly magazine, without finding some reference to the decay of England as an engineering nation. America is held up to us, Germany is preached at us, and Japan is dangled before us as reminders that we are being left hopelessly behind, and that speedily, whilst statistics are compiled with a zest worthy of the cause to support the alleged facts. Among these prophets of evil are all sorts and conditions of men, from statesmen to politicians, from scientists to amateurs, from scholars to newspaper correspondents, nor are there lacking councillors and guides to inform and direct us into the ways of safety.

From the babel of voices that reaches us, one cry persists, the cry of "standardisation." This cry has "caught on," and its ever increasing intensity is drowning all other cries. "Standardise at all costs; let not wholesale scrapping deter you; standardisation means repetition, and repetition means cheap production; heed not that repetition begets tradesmen rather than professionals, slaves instead of free men. Count all these things as nothing—simply standardise." Such is the burden of the cries that reach us; and there is some danger of standardisation being set up as a fetish, for a kind of golden calf worship, the effect of which will be to stifle invention and scientific research, and instead of hastening will impede the march of progress.

May the time be far distant when "wholesale scrapping" should be looked upon as virtue, or when the true spirit of progress and research shall be sacrificed upon the mean altar of a cast-iron standard. Between such a state of things and that in which there is absolutely no recognised standard—a state where every man is a law unto himself—there exists a wide gulf, both extremes being equally unsatisfactory. No right thinking man can or will deny that uniformity of general principles, that is to say, method, is absolutely essential for the successful and economic prosecution of any industry, and that anarchy is just as fatal in the industrial as in the social sphere.

Probably no industry in this kingdom was ever so hampered and harassed by rules and regulations as is the electrical industry at the present time, and the very people who were loudest in their complaints as to the stringency of the original Board of Trade regulations, are, now that these restrictions have been somewhat removed, the worst offenders. Rules, however stringent, can be tolerated if it be possible to work to them, for at most they but raise prices. It is the want of uniformity that is so exasperating and irritating.

The Phœnix Fire Office, in 1882, issued a set of "Rules for Electric Light Installations," and every other fire office of importance has since thought fit to issue a set of rules of its own. As the Phœnix rules are copyright, perhaps the other companies tried to make their rules as unlike the Phœnix set as possible. As though this were not enough for the contractors to bear, it has become the fashion now for every station engineer to invent a set of rules of his own, differing as much as possible from any other known rules, which, besides worrying the contractor, must, one would think, often deter a householder from becoming a "consumer," as he must naturally think electricity is a very dangerous thing to have in the house if it requires such an array of rules and regulations to be complied with. Why station engineers take the trouble to issue rules which they cannot enforce is somewhat a puzzle. Glasgow and Manchester possess powers to enforce their rules, and other municipalities have been urged to seek similar powers. Let them not do so by any such "slim" method as the sandwiching of an innocent looking clause into a Public Parks Act, nor a Ship Canal Act, nor yet a Workmen's Dwelling Act, but, until some definite set of approved rules is agreed upon, let them do so in such a manner that manufacturers and contractors may oppose, tooth and nail, any proposal that would give unlimited power to every fledgling station engineer to make and impose such harassing and iniquitous rules as some of those now existing. The only merit which all these rules possess in common is the doubtful one that they are a free gift, and cost nothing. Probablyif a price had been put on them, they would never have run into a second edition.

Just two years ago three Papers were read on the subject before a meeting of this Institution—by Mr. Crompton, Mr. Wordingham,

---

* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers, Feb. 11.

the electrical engineer of the Manchester Corporation, and Mr. Pigg. At the end of a two nights' debate, the following resolution was unanimously and enthusiastically carried :—"That this meeting is of opinion that the Institution should take such steps as it thinks best to secure uniformity in rules, by pressing on supply companies, municipal engineers, and fire offices the advantages of adopting rules to be drawn up by the Institution, based on the present ones as a standard, with such modifications only local conditions may necessitate." It was not unreasonable to suppose that before two years had expired not only would the new rules have been issued, but that they would have been in general use throughout the country. Instead of this, however, rules multiply and become more and more dissimilar.

Comparing these rules with themselves and each other, it is soon evident how hopeless it is to attempt to standardise anything until these rules themselves have been standardised. Take the Phœnix rules first. These rules have now run into 30 editions, and had the first edition never been issued we should in all probability never have heard anything about fire office rules, and should not at this time be wasting precious time in discussing them. After reading carefully the 39 pages of which the rules consist, one has no more idea of what would satisfy the technical officer of the Phœnix Co. than he has of the inhabitants of Mars. They are not rules: they are exceptions and contradictions. In the 43 so-called rules there are over 50 exceptions or cases requiring special permission.

For instance, as regards enclosing conductors, the first part of rule 5 reads that conductors in non-hazardous risks should be enclosed in "iron or other approved metal tubes" (by which one understands that iron is approved), or in other approved fireproof tubes, or in wood casing. In the next paragraph we are told that "No tube of *any* kind will be allowed that is not approved by the technical officer of the fire office," which gives the impression that tubes generally are not approved, whilst in a later paragraph of the same rule we find that "a number of conductors may be placed in a single iron or steel tube."

For the purposes of this Paper it will be more convenient to compare the rules and requirements of various companies or corporations on specific subjects rather than comment upon the whole of one set of rules after another.

On almost every supply the consumer must provide a switch on both poles of the mains, but not in every case a cutout or fuse. In some rules a fuse is specified, but in others no mention is made of a cutout to be fixed by the contractor. In other rules, however, it is clearly stated that the consumer must on no account provide a cutout. Some rules specify the position in which this fuse shall be fixed in reference to the main switch, and in some cases this is fixed on the supply side of the main switch instead of on the consumer's side. This, surely, is not as it should be, as it is necessary in replacing a fuse to replace this in live wires which cannot be cut off, and in the case of 400-500 volts' supply there is some risk of shock being felt. Not content with specifying a double-pole switch, some companies go into details of manufacture and specify that the two switches should be rigidly joined together by a connecting link, and also specify the lengths of break and the distance between the poles.

In almost every case copper is specified for conductors. The insulation resistance required for cables varies in different rules from 300 megohms per mile to 2,500 for vulcanised rubber. In some cases other materials may be used by special permission. Lead-covered conductors are advocated for damp situations in many towns, but are objected to in others, notably in Edinburgh. Tynemouth Corporation specify not only the size, the insulation, the density, and the maximum drop to the farthest lamp, but also specify that two different colours of wire must be used, viz., red for positive and black for negative, though what on earth this has got to do with Tynemouth or any other corporation is a mystery. As regards the sizes of solid and stranded conductors to be used, the Institution of Electrical Engineers' rule is adopted by a large number of supply companies and municipalities, but not all, whilst some companies make no mention of this whatever, and rightly so; it has nothing whatever to do with them. It well known that the Phœnix Company have from their very first edition specified a current density of 1,000 amperes per square inch, and whilst this is a fairly convenient rule to work to, it is not pretended by anyone that it is at all a scientific rule. The rules of the Institution of Electrical Engineers specify the temperature rise permissible in conductors, and give a table of currents and sizes corresponding with this rule The London, Liverpool, and Globe Insurance Companies, who have certainly the best rules in existence, both from a practical and a scientific standpoint, and rules, as to the interpretation of which there is very little doubt, do not specify the temperature rise for conductors, but give a varying density for incandescent work, and a different scale for arc lamps, motors, heating, &c., for which the current density is to be lower. The reason, of course, for this is that there is the possibility of the current varying in the latter case, and occasionally becoming considerably more than the normal. Very few lists of rules appear to take note of this fact.

Not only is the nature of the casing or tubing specified by supply companies, but some even go further than this, and specify the sort of nails which must be used to fix the casing. Liverpool may be instanced as one of the companies that go to this extent, and it will be found that, besides asking for casing to be painted, they ask also that it may be fixed to walls by steel nails of oval section.

An iniquitous rule, which one is sorry to see in the Sunderland list, is found also in the rules of Blackpool and Salford, to the effect that the Corporation has the right to demand that the contractor shall open joints, take down casing, &c., for inspection, and re-instate it at his own cost. The contractor is certainly entitled to compensation if no fault be found.

The first people to really systematise wiring were ship lighting contractors. When a ship once leaves port, all repairs, whether jointing a damaged wire or merely replacing a fuse, must be carried out by the engineers, many of whom may have never been shipmates with electric light before, and have to find out for themselves all they need to know. It soon became recognised that the simple tree system, with its fuses dotted up and down the ship like so many limpets, and often quite inaccessible during a voyage, was not the ideal system. A distribution system was devised in which the main circuit cable from the dynamo room fed distributing fuse boxes placed in accessible positions, and from which circuits of about 5 amperes were taken, no reduction in the size of the branch conductors being made between the distributing points and the lamps. Five-ampere circuits were fixed upon because a 7/21½ stranded cable or its equivalent is a very convenient size to use, and as the average lengths of run between the distributing board and the lights is not great, the extra cost of the wire is more than counterbalanced by convenience, the reduction of waste, and the saving in individual fuses (as none are fixed after leaving the distributing centres).

This system was soon adopted for land installations, but modified of course to suit the different conditions, as it would be very expensive in the majority of cases to use so large a conductor for single lamps. The average supply station engineer, however, seems to think the distributing system was intended for his especial benefit, and is trying to insist upon circuits, not of the carrying capacity of 7/21½ conductor, but of 1½-ampere circuits in many cases, and even less than 1 ampere in the case of Edinburgh.

On the subject of branch switches and cutouts, and small wiring accessories, such as ceiling roses, wall sockets, and the like, there is a perfectly appalling variety of opinion among the powers that be, or might we not say, the powers that would be. Manufacturers of such appliances must often be at their wits' end to decide what to stock and what to scrap, and it is scandalous that they should have to make so many varieties of almost every article to meet the fads of station engineers, when it would pay them far better and enable them to reduce prices if they could standardise more, and cut down the number of stock patterns.

One still sees distributing boards fitted up with a dozen or so round type fuses with fluted brass covers, but the tendency is right towards the use of distributing boxes containing clip type fuses mounted on slate or china. These, however, raise other points, viz., that in Blackpool, slate is not permitted as an insulator, whilst in many other places, including York, Grimsby, Carlisle and West Hartlepool, fuses with metallic covers are not allowed. Under the same set of rules the main switches must also be provided with non-conducting covers. It is not obvious why main switches should be treated differently in this respect to branch switches; if a metal cover is good enough for a "tumbler" switch, in which the working parts are very close to the cover, it is equally good for a main switch in which there is a greater distance between the covers and the working parts. In Salford and Blackpool, however, sockets, fuses and switches must have covers of vitrite or porcelain, or an equivalent, whilst in Tynemouth switches in damp places have both covers and handles of non-conducting material.

It would seem to be somewhat outside the province of the supply company to specify the position or precise arrangement of individual switches, but the Tynemouth Corporation have views on this subject which are thus expressed in their rules :—"Tumbler switches to be *on* when the handle is *downwards*." Now this is a matter that neither affects the fire risk nor the conditions of supply, but is an argument for uniformity, and on that account the rule is not without merit. But other people may also have views on this subject, and, if the North-Eastern Railway Co. wire any of their stations or premises and became customers of the Tynemouth Corporation, the Corporation engineer will probably find all the tumbler switches arranged upside down. The North-Eastern Railway Co.'s rule is :—"Switch up, light up; switch down, light down"; and a very convenient rule it is. Probably the railway company foresaw that an "absent-minded" passenger might hang his overcoat on a switch handle, and, as this would probably switch the light off, he would be gently reminded that a switch handle is not a clothes-peg.

It is not necessary to refer in detail to all the minor differences that occur in the various rules. The differences in the requirements concerning motors and their regulation, the earthing of motors and heating appliances, and the insulation resistance required for a com-

plete installation are important, however. According to the Institution rules, dynamo and motor starting and regulating resistances and switches must be spaced 12in. horizontally and 4ft. vertically from woodwork or inflammable material. This rule is copied verbatim into the Glasgow rules, and is, of course, understood to be embodied in all those rules, which are stated to be additional to those of the Institution. Notwithstanding this, in many of the rules the figures are varied in accordance with the fancy of the engineer for the time being. Blackpool rules, after stating distinctly that the rules of the Institution are to be strictly adhered to, give the distance as 18in., and this distance would presumably pass the Corporation inspector, who, however, would prefer to see the resistances hung outside of the building! The Edinburgh rule is to the effect that resistances must not be fixed on or near woodwork, but should be fixed to brick or stone walls, and be so mounted that they stand 6in. from the wall. Surely there is no risk of a resistance burning a brick or stone wall down! The Liverpool Corporation rules stipulate that resistances shall be 6in. from woodwork, whilst the Reading Supply Co. specify 18in., although the Institution and fire office rules are also to be complied with.

Arc lamp resistances are more leniently dealt with by the Institution, although it is not obvious why they should be considered less dangerous than motor resistances. Probably the argument is that motor resistances are generally larger than those for arc lamps. On the other hand, arc lamp resistances are frequently grouped in one place, whereas a motor starting resistance is generally fixed singly alongside the motor; so if this be the argument it is not a very strong one.

Now it is pertinent to ask why the Institution rules should be more stringent upon a purely fire risk question than are any of the fire office rules. Surely the fire offices, with all their experience, have fixed a safe limit. Now what are the fire office rules on this subject? The Phœnix rules stipulate that any woodwork near a dynamo, motor, or resistance, should be protected by fireproof material, but no distance is named. The Liverpool, London, and Globe Insurance Co. prefer that resistances should be on a brick or stone wall, isolated from inflammable material, no distance being stated. The London and Lancashire Fire Insurance Co., whilst giving the same distances as the Institution rules recognise the absurdity and practical impossibility of the latter; they realise that in practice neither a dynamo nor a motor can be raised 4ft. above the floor (if the latter happen to be wood), except in rare cases, so the word "unprotected" is inserted, making the rule read commonsense. Thus: "Dynamo to be placed 4ft. vertically from any *unprotected* woodwork." But the obvious course is to protect it, so the next rule reads: "Dynamos to be placed on a sheet of metal of sufficient size to protect the floor when fixed on a non-fireproof floor." The same rule applies to *all* resistances, whether for motors or arc lamps. These rules, whilst being based on those of the Institution, are amplified and made more definite. The Hand-in-Hand Fire Office requires that dynamos shall not be placed within 12in. of any *unprotected* combustible material *other than their seating*, thus recognising what apparently the Institution forgot—viz., that a dynamo could not be fixed in mid-air, but must have a seating of some kind. The same rule applies to resistances. The Royal Insurance Co.'s rule on the subject is practically the same as that of the London and Lancashire Company, and these are the only rules the writer has seen which give diagrams of connections and photographs of apparatus to illustrate and amplify the text.

It will be seen from the foregoing remarks how diverse and unpractical are the requirements both of the Institution and supply rules, and how very wide of the mark they are in dealing with simple questions of fire risk. What could be more absurd than the rule that all motor resistances should be on brick or stone walls, except the suggestion that they should be placed "outside of the building." Imagine for a moment a large printing establishment, employing upwards of 100 motors, each provided with a starting switch, and separate regulating switch. It is necessary that the starting and controlling switches should be near the machines, and, assuming the switches to have on the average 10 steps, it would be necessary, if the resistances are placed on the walls, to run at least 2,000 connecting wires between the machines and the walls. Apart from the practical difficulties involved the fire risk from 2,000 wires would have also to be considered. In Glasgow and Edinburgh only four wires are allowed on one tube, so that in addition to the tube carrying the supply wires, there would be at least five other tubes radiating from each machine to the sides of the building, or say about 600 tubes altogether.

If placed outside, as suggested in Blackpool, the resistances might be specially designed so as to form an architectural feature of the building, and, as Blackpool, the queen of watering places, is always on the look-out for novelties to attract the holiday seeker, this idea may be worth developing. Erected upon the roof of the building, in the form of an Eiffel Tower, quite an imposing display might easily be made of 200 sets of resistances. Coloured lamps and other such details could be added according to the artistic feelings of the resident engineer.

Another rule, made only to be broken, is that which limits the temperature of the resistance coils of starting switches and arc lamps to 212°F., "even if left continuously in use." Now a starting resistance never is left continuously in use unless it is designed to act also as a regulating resistance. Why, therefore, should it be designed to meet conditions that will never occur, or why should a consumer be forced to pay double the necessary price for a starting switch? Starting switches are generally so designed that it is impossible to leave them in an intermediate position—that is to say, in a position in which a current could pass through the starting coils. And, it is safe to say, that any of the regular patterns of starting resistances, of which there are many thousands in use, would burn out if the normal motor current were passed through for, say, 10 minutes, and most of them would burn out in less than three minutes.

Many people seem to lose sight of the fact that the function of a resistance coil is to dissipate energy in the form of heat, and that it would be, if not impossible, exceedingly inconvenient to provide space in most cases for the enormous coils that would be required if low temperatures are insisted upon. Why, the temperature of *unprotected* steam pipes and connections in central generating stations is very considerably higher than is permissible for *protected* resistance coils in the same room by this rule.

In connection with motor work there are quite a number of rules that need standardising. First, is the question of the maximum starting current permissible. It is apparent from the rules that the distributing mains in many towns are cut so fine that any current over 5 amperes suddenly switched on to one circuit is sufficient to disturb the pressure in neighbouring circuits. It does not seem quite fair to the motor user that he should have to pay for complicated and expensive apparatus for the sole purpose of enabling the suppliers to cut down capital outlay in cables for lighting purposes.

But to come back to the want of uniformity in the requirements. These vary from a starting current not exceeding the normal full load current on the City of London mains, down through various stages to a starting current not exceeding 5 amperes on the Glasgow and some other towns' mains. Nor are the rules always consistent even in the same district. One, the Chelsea supply, a 3 H.P. motor may, on starting, exceed its full-load current by 25 per cent., say 16½ amperes. On the same supply, if a motor exceed 3 H.P., its starting current must not exceed 10 amperes, nor increase in steps exceeding 5 amperes each. On the Manchester supply no motor must take more than 10 amperes when first switched on, nor increase in steps exceeding 10 amperes. On the same circuit a 10-ampere arc lamp may, on starting, take 18 amperes, and a 15-ampere arc 27 amperes, whilst an arc requiring normally more than 15 amperes must have a graduated starting resistance limiting the starting current to 15 amperes, and any additional current to 10-ampere steps. A fair proportion of the rules call for a mechanical device or overload cut-off to prevent too rapid starting. Any ordinary overload device would fail to pass the Manchester test of pushing the starting switch suddenly over all the contacts to "full on," as the current will considerably exceed the limit before the inertia of the knock off permits the switch to break circuit; nothing, therefore, but a slow motion gear will meet the case. But, when all the above conditions have been complied with, nothing can prevent the motor current, during normal working conditions, from continually varying through far wider ranges than 10 amperes. A motor driving a printing machine will not only suddenly fall from full load current to zero, but will at times actually fall beyond this, and act as a dynamo and put current back into the mains, owing to the inertia of the machine connected with it. A motor driving a pair of cotton-spinning mules will vary instantly from light load, say 10 amperes up to 200 amperes, and then quickly fall to 40 amperes, and then back to light load, and will repeat this cycle every few seconds. A motor driving a heavy planing machine may vary between 30 and 90 amperes every few seconds, yet in both the latter cases the starting up could comply even with the Glasgow conditions, as the motor would start on a loose pulley. Or, take the case of a newspaper printing machine absorbing 50 H.P. It must be possible to stop the machine instantly from any part of the machine, and it is not obvious why starting should be more detrimental to neighbouring lamps than stopping. To the unitiated it would seem that the opposite is the case.

Without referring to the question of insulation resistance, with which subject Mr. Pigg has dealt so exhaustively, the writer hopes he has said enough to awaken in the members some sense of the great need that exists for one definite and comprehensive set of rules, rules which shall be self-luminous, needing no interpreter, rules that the wayfaring man, though a jerry wireman, can understand and work to, and rules, therefore, that may be enforced. Newcastle has ever been in the van in the march of progress, and we of this section of the Institution must see to it that we worthily uphold the tradition. We must aim at being foremost among the local sections in everything that makes for the advancement either of the commercial or scientific interests of the industry with which we are all so proud, and justly proud, to be associated. If, by our voice and influence, we can hasten the day when uniformity shall reign, even only in the matter of wiring rules, we shall have done not a little to justify our existence.

## SOME NOTES ON ELECTRIC WIRING.*

BY GEORGE A. CLARK.

The existing state of matters in this important branch of the electrical engineering industry is extremely unsatisfactory, and the object of the Paper is to point out a few of the more serious defects, and where possible suggest a remedy. There should be no difference in the wiring of a building taking current from the public mains and a similar building with the generating plant on the premises. Concentric systems of wiring with earthed return, though possessing some important advantages cannot come into general use until the existing Board of Trade regulations be modified, and such systems will not, therefore, be considered in this Paper.

Before considering the various systems individually, it might be stated that the majority of faults are due not so much to the inherent defects in the system used as to the neglect of the proper and necessary precautions to ensure safety. In metal-clad systems the electrical continuity of the entire sheathing must be ensured, and this sheathing must be effectively earthed. To use wood casing in wet places, or to use lead-covered cables in the presence of certain fumes, or iron tubes in the presence of others, is merely to court disaster, while no system is proof against the use of defective material or careless workmanship. For purposes of comparison the following table has been prepared, in which an effort has been made to represent by figures the value of the different properties of a perfect system, and the extent to which these properties are realised in the systems under consideration:—

| Property. | Perfect system. | Screw'd tubes. | Simplex wires. | Lead-covered twin. | Wood casing. |
|---|---|---|---|---|---|
| 1. Watertightness ............... | 20 | 20 | 10 | 20 | ... |
| 2. Safety from internal condensation .. ............... | 10 | ... | 5 | 10 | 10 |
| 3. Mechanical protection ...... | 15 | 15 | 10 | ... | ... |
| 4. Certainty of electrical continuity in metal sheathing | 15 | 15 | 5 | 15 | ... |
| 5. Accessibility of cables in a completed job .............. | 7·5 | 5 | 5 | 2·5 | 7·5 |
| 6. First cost...................... | 10 | 5 | 10 | 10 | 10 |
| 7. Ease in making additions ... | 5 | ... | 2·5 | 5 | 5 |
| 8. Freedom from cutting away in old buildings ........... | 5 | ... | ... | 2·5 | 5 |
| 9. Difficulty of wilfully concealing bad work ...... ........ | 5 | ... | ... | 2·5 | 1 |
| 10. Safety from danger of injuring cables during erection | 7·5 | 5 | 5 | 7·5 | 7·5 |
| Total ...................... | 100·0 | 65 | 52·2 | 75 | [illegible] |

Although it is a most interesting and instructive comparison, it should be pointed out that this table is of less practical use, for the value of the different properties depends entirely on the class of building to be wired, and differs in nearly every case.

The defects in a system, as a system, may oftentimes be overcome without much trouble. For instance, the mechanical weakness of twin wiring can be readily got over by passing the cables through short lengths of gas barrel, where exposed to injury, by a careful arrangement of the tubes in a screwed tube job, or by lining the tubes internally with a suitable substance the danger of internal condensation may be modified. By the use of special devices the electrical continuity of the sheathing in the Simplex system may be improved. In one system of twin-wiring now in use a mechanical method of jointing is used. The wires, after soldering together, are insulated with mica discs from each other and from the top and bottom of the metal box in which the joint is made. Such a joint is electrically and mechanically safe, and as durable as the insulation of the vulcanised cable itself, and much more so than the ordinary unvulcanised lapped joints. The introduction of a similar arrangement in the tubing systems will be a step in the right direction. At the present time the use of pinching screws as a method of making electrical joints is increasing. This is a cheap but not a reliable method, and should be discouraged, and as far as possible all joints should be soldered.

An installation of wiring should be complete in itself without the fittings, and the fittings attached so that they may be taken down at any time when painting or papering, or for cleaning the fittings themselves. In twin wiring this has been done. The conductors of the twin cable are soldered to special sockets passing through an insulating piece contained in a fitting attachment box, so arranged that the end of the cable is hermetically sealed; the fitting is wired to a special plug. By this simple arrangement electroliers are as easily removed as table standards, and all loose ends of wires where fittings are not erected are dispensed with. The wiring is complete in itself, and absolutely watertight from beginning to end.

A contractor carrying out an installation in Glasgow is subject to the terms of the specification prepared by the consulting engineer. The consulting engineer has to frame his specification to meet the requirements of the city engineer's "Conditions of Supply," and the city engineer has in turn to conform to Board of Trade requirements. Doubtless the consulting engineer, the city engineer, and the Board of Trade are all actuated by the same worthy object of ensuring a high standard in electrical work; but the question arises, have not important points been sacrificed to secure a questionable benefit. Take for instance a switchboard for use in Glasgow. Not only has each pole of a switch or fuse to be on a separate base, but even the panel to which the two middle wires in the three-wire system are connected has to be divided. The advantages thus obtained are not apparent, but the additional difficulties thereby caused in the arrangement and construction of the board are real. Electrical engineers have now had a very considerable experience of what is required to ensure a satisfactory and safe installation at from 200 to 250 volts, and it is surely now time that a committee, which might well be chosen from the Association of Municipal Engineers, be appointed at once and for all to frame definite rules for the wiring of buildings, which rules would be officially recognised by the Board of Trade and be universally used. The first thing which will cheapen the cost of wiring is the standardising of all electrical accessories, and this remains an absolute impossibility so long as each city engineer and fire office superintendent is the author of his own regulations. There is surely no reason why a fuse has to be twice as long in Edinburgh as in Glasgow, or why, if fuses in ceiling roses are dangerous in one town they can be considered safe in another. It being once definitely decided that a certain fuse be 1in., 2in., or 3in. long, that ceiling roses are to be made with fuses or without, that switches are to have porcelain or brass covers, manufacturers will be able to produce accessories in larger quantities at cheaper rates. Wiring systems can be perfected in detail, and contractors will be able to keep a stock instead of a museum.

With the exception of incandescent lamps and motors, it is possible to standardise all other accessories. When this very desirable change has been accomplished the duties of the consulting engineer will be greatly modified. It will then be necessary for him only to select the system best suited to any particular case, specify the additional precautions necessary, prepare the scheme of distribution, satisfy himself as to the quality of all materials used, and see that the work of erection is properly carried out. It is surely not necessary for consulting engineers to specify the maker of the various accessories to be used. The practice of manufacturers' agents approaching consulting engineers with the object of having their products specified to the exclusion of all others is one which ought to be discontinued, and manufacturers only ought to deal with contractors, who are the purchasers.

A consulting engineer having selected a system, prepared a scheme, examined and approved of the material to be used, and superintended the work of erection, the responsibility rests with him, and it is hardly fair to the contractor to withhold his profit for a year in case something should go wrong. If it be necessary that something be withheld, might it not be better that this something be the consulting engineer's fee, and that out of this any necessary repairs be made. This would probably raise the standard of electrical work, resulting in the engineer paying more attention to the details, and giving more personal attendance to the work, as well as discontinuance of the very dangerous practice of always accepting the lowest tender, however disproportionate to the other prices it may be. Contractors in general will not object to a reasonable sum, say 2½ per cent. on the contract sum being withheld, and to such terms most of their sub-contractors would be perfectly agreeable. The common practice, however, of withholding 10 per cent. of a contract for twelve months might with very great advantage to contractors and manufacturers be discontinued.

Supply companies and fire offices should appoint inspectors to examine work during erection. Too much faith is put by supply companies in a final insulation test which, when all is said and done, is a very poor criterion of a job; and fire offices seem to expect that a contractor who has scamped a job will, in filling in their form, sign as it were his own death warrant.

It is now time that architects and measurers desist from preparing specifications for electrical work, and either employ a consulting engineer, or allow the contractors to prepare their own specifications. The efforts of these gentlemen are laudable in the extreme, but unfortunately the same cannot be said of the results of their labours. Architects might, however, render great service to the electrician by remembering that his cables or tubes require space as well as the pipes of the plumber and gasfitter, and by providing for these in his plans. Where tubes are used it is particularly important that, for the mains at least, straight runs be provided. There is perhaps no business more unnecessarily handicapped than this one in which we are all more or less directly interested, and we must bear in mind that to remedy the defects and difficulties which have been pointed out in this Paper will require a very great effort, and there is surely no body by whom this effort could be more appropriately made than the one of which we are members.

* Abstract of a Paper read last Wednesday before the Glasgow Local Section of the Institution of Electrical Engineers.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.

*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## WIRING RULES AND THE INSTITUTION.

"That this meeting is of opinion that the Institution should take such steps as it thinks best to secure uniformity in rules by pressing on supply companies, municipal engineers, and fire offices the advantage of adopting rules to be drawn up by the Institution based on the present ones as a standard, with such modifications only as local conditions may necessitate." This resolution was passed at a crowded meeting of the Institution of Electrical Engineers over two years ago—Feb. 9, 1899—after the hearing of three Papers deploring the non-uniformity of the various codes of wiring rules enforced in this country, and after two long evenings had been occupied by a one-sided discussion of them. The same complaint was repeated by every speaker: too many wiring rules and too great a divergence in the practice each set lays down. Reading the resolution after this lapse of time, without the discussion fresh in one's memory, it is not, perhaps, quite clear what the meeting wished the Institution to do. It would no doubt have been better if the resolution had been in the form of a direct instruction to the Council instead of merely a vague recommendation that the Institution should take such steps as it thought best. However, it must not be forgotten that the resolution was proposed impromptu at a late hour after the discussion had drawn to a close; if it had been put forward at the commencement of a meeting and its terms carefully weighed and discussed, something better might have been evolved. Nevertheless, whether the resolution meant that steps were to be taken to press supply companies, municipal engineers, and fire offices generally to follow the advice of the Institution in matters relating to wiring rules, or whether it desired the Council to issue a series of modifications of the then existing rules to meet each existing set of local conditions, one thing is clear: the desire was that definite and immediate action should be taken; yet, so far, practically nothing seems to have been done. A week after this resolution was passed the chairman announced that the old Wiring Rules Committee had been re-elected. Since then we believe that a few meetings have taken place, and that the constitution of the committee has been slightly changed, but no result has been announced. New fire office rules have been issued, new supply engineers' rules have been imposed, the electrical adviser to the Phœnix Fire Office has issued two new editions of wiring rules and still closes his eyes to the action of the Institution, but the Institution Wiring Rules Committee has shown no outward and visible signs of action. The Municipal Electrical Association, which also recognises the necessity of uniformity, decided to await the next move of the older

Institution instead of issuing rules of its own, but we fear its patience may soon be exhausted. Wiring contractors are once again showing their discontent by reading Papers at local sections of the Institution—we publish abstracts of two such Papers in this issue; and still the parent Institution does nothing. Mr. Broadbent's Paper begins and ends with plain speaking. What we want, as he says, is "one definite and comprehensive set of rules, rules which shall be self-luminous, needing no interpreter, rules that the wayfaring man, though a jerry wireman, can understand and work to, and rules, therefore, that may be enforced." He ably criticises the existing regulations and defects, even the Institution rules do not escape his sharp eye and his test of actual working experience. He cries for standardisation and "wholesale scrapping" of uselessly multiplied codes of wiring rules, and every wiring contractor will echo this sentiment. The Institution of Electrical Engineers is essentially the body to take this matter in hand. It should be easy for a committee of the Institution, formed of men with an actual practical experience in house wiring, to draw up in the form of regulations the essential points to be observed in good house-wiring practice. Nor should any difficulty be experienced in inviting the opinions of the various authors of existing wiring rules and issuers of specifications with regard to such a draft code, and, after finally perfecting it by making use of the most useful suggestions and criticisms, in obtaining the adhesion to it of those principally concerned and those who are now the principal delinquents. Perhaps the present Wiring Rules Committee is so constituted—the names of its members have not been published—and perhaps they have already proceeded in this way and have nearly brought their labours to a conclusion. Let us hope that things are in so advanced a state, and that when the new Institution rules are published the principal feature of them will be a list of the various bodies which have pledged themselves to accept them as the one and only standard.

## THE PARIS EXHIBITION.—XVI.*

(BY OUR SPECIAL CORRESPONDENT.)

To deal in detail with all the electrical measuring instruments exhibited in Paris last year would fill a volume in itself. Moreover, it would be a hard task, for probably the greater number of firms exhibiting instruments were satisfied to place them in elegant locked glass show-cases, beside which an attendant only appeared at those rare moments when the jury of the section was expected to make its hasty round. Other exhibits of instruments were frequently combined with exhibits of loud-speaking phonographs, loud-sparking Wimshurst machines, toy wireless telegraph apparatus and similar things to attract the public, with the result that crowds congregated and formed a barrier between electrical engineers and the instruments they might desire to inspect. Firms frequently complain of the small number of orders accruing from showing their manufactures at exhibitions, but they forget that the mere view of the finely polished brass exteriors of instruments, whether or not set off with a shower of 12in. sparks or the croaking of the latest music hall ditty through a big funnel, does not in itself attract purchasers. Those who had a technical attendant at their stand during the course of the exhibition probably had no cause to complain. The following notes, however, will convey an idea of the nature of some of the instruments exhibited, and occasional features of novelty.

One could not but be struck with the large number of instruments shown for testing iron—in fact, Continental makers have directed their attention largely to the design of such instruments in recent years. As, however, we are so well served in this country with Prof. Ewing's instruments of this class, it is needless to go into the detail of the foreign types of permeability and hysteresis testers here. The different types of "permeameters" and hysteresis meters exhibited by the firm of J. Carpentier were among the most interesting, and also the Du Bois magnetic balance made by Messrs. Siemens and Halske.

Considerable attention was paid by Continental visitors to the Kelvin instruments exhibited by Messrs. James White. The majority of these were of the patterns already well-known to the majority of our readers; but it was, nevertheless, interesting to see a collection of practically all the measuring instruments made by this firm. Among their newer instruments were a maximum cutout which could be converted to a minimum cutout by the motion of a handle and a three-phase wattmeter. The connections of the latter are shown in Fig. 107. In its general lines the wattmeter resembles the Kelvin single-phase engine-room wattmeter. It contains, however, two sets of fixed coils, mounted on the opposite side of a thick vulcanite slab. Suspended inside these coils are two sets of movable coils carried on the same spindle, the pointer being also carried on this spindle. The only opening in the vulcanite slab is for the spindle. The fixed coils are in two arms of the main circuit, and the shunt coils are connected across through non-inductive resistances, as shown in the diagram. With instruments for low pressures these resistances are included in the case, but for higher pressures they are separate.

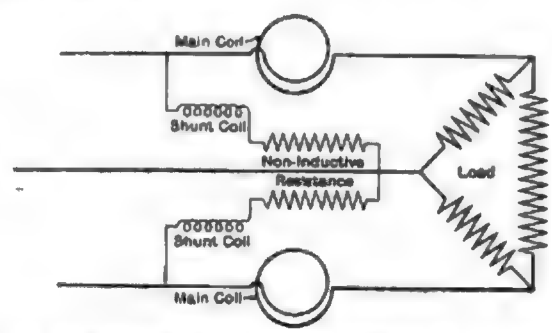


Fig. 107.—Connections of Kelvin Three-Phase Wattmeter.

Messrs. Crompton & Co. showed instruments only, and not any dynamos or heavy machinery. All the galvanometers, ammeters, and voltmeters were of the moving coil type. A particularly useful and practical form of d'Arsonval type galvanometer, with a pivoted coil and a palladium hair-spring, was included in the exhibit, deflecting 1mm. on the scale with $\frac{1}{10000}$th volt, and also a milliampere-meter of similar design. Besides the display of Crompton potentiometers and accessories, was also a thermometer consisting of a manganin and platinum coil connected to a differential galvanometer, and a fine engine-room voltmeter reading from 205 to 245 volts, with divisions about ¼in. wide. Another British maker was the Cambridge Scientific Instrument Co., which was represented by the Duddell oscillograph.

Messrs. Pirelli & Co. of Milan had a simple but effective electrostatic "kilo-voltmeter" on their stand, designed by their engineer, Mr. E. Jona, to measure directly the voltage on a 25,000 volt cable, which they exhibited under pressure. A plan and section of the voltmeter is given in Fig. 108. A fixed plate, A, exerts an attraction on the movable one, B. These two plates are enclosed in a cylindrical copper case, M, and the whole is placed in a glass cup, V, filled with vaseline oil. C is a glass shade, from the top of which the pole P' projects, this being connected to the movable plate by thin metal wire D. The apparatus rests on an ebonite stool T, whose legs, J, are also of ebonite. Two weights are provided. When one of these, weighing 0·350 grammes, is placed on the hook W, one scale division corresponds to 500 volts, and the range extends to 30,000 volts. With the other weight, weighing 1·400 grammes, one division corresponds to 1,000 volts, and a limit of 60,000 volts can be indicated. The principle

* Previous articles appeared in *The Electrician* of July 20 and 27; Aug. 3, 24 and 31; Sept. 14 and 28; Oct. 5, 12 and 26; Nov. 2, 16 and 30, 1900; Jan. 18 and Feb. 1, 1901.

is of course the same as the Kelvin kilo-voltmeter, but the instrument is more compact, taking up much less space, and it differs from the Kelvin instrument by having both plates insulated and by the surrounding of the plates with oil.

The 25,000 volts was produced by step-up transformers from the exhibition high-pressure three-phase mains, the cable shown under pressure being a three-core 3 × 20 sq. mm. cable intended for 30,000 volts pressure. As seen in Fig. 109, the cable is insulated with rubber and impregnated paper and jute. Around the copper comes a layer of indiarubber, over which are alternate layers of jute and paper, and the three

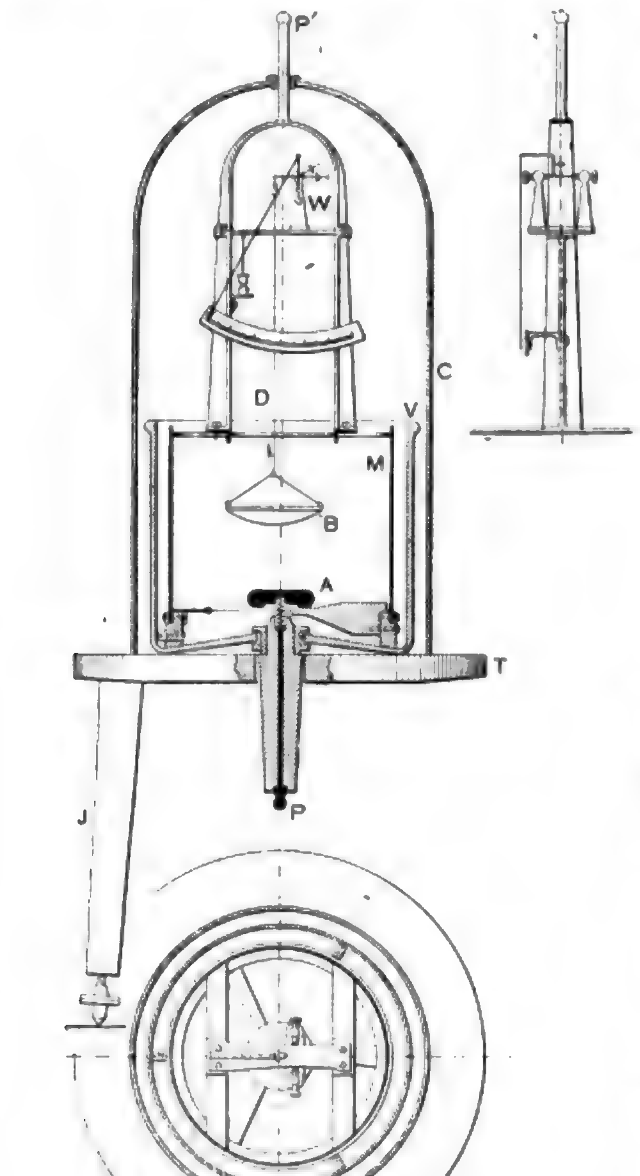


Fig. 108.—Pirelli & Co.'s Electrostatic Voltmeter. Scale: 2in. = 1ft.

cores thus formed are laid up and covered with some more jute and paper overall. Next the cable is dried and impregnated in a vacuum, as is done with paper cables, and is lead-covered and armoured in the usual way. The rubber, I was informed, is of special constitution to withstand oils and the various treatment to which it is subjected during the manufacture of the cable.

To show to the sceptical public that this pressure was really produced and was employed to charge the cable, two expedients were adopted besides the voltmeter already described. One was a glaring signboard of 400 incandescent lamps in three series, star-connected on the three-phase mains. These were mounted on an insulating base of ebonite and a simple device was employed for short-circuiting any lamp that burnt out. The two wires leading to each lamp had a piece of silk-covered wire wrapped round them. Normally, when the lamp was burning, the voltage across its terminals was not sufficient to spark through the silk covering of this extra wire, but as soon as the lamp burnt out, the full pressure became applied to the thin silk coverings and these burnt off leaving the lamp short-circuited by the wire which had thus become bared. The other device to show the high voltage was Prof. Arno's pretty experiment of a paraffin block which rotates when placed in the rotatory electrostatic field produced by three segments charged with a high three-phase voltage.

Other Continental makers seemed to follow more or less the same rule as in this country for radial thickness of insulation. For instance, the 5,000 volt three-core cable made by the Société des Téléphones for the Metropolitain railway, and shown at the exhibition, had three 180 sq. mm. conductors, each with 63 mm. radial thickness of paper and jute insulation. These cables had a diameter of 63mm. under the lead and were double-lead-covered and steel tape armoured. Two other exhibits of Messrs. Pirelli & Co. may be mentioned. One was

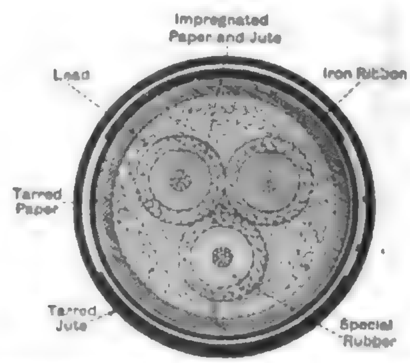


Fig. 109.—Pirelli 30,000-Volt Three-Phase Cable. Scale: Half-size.

a vulcanised rubber cable with a coating of tin-foil over the copper in place of the usual tinning, and the other a sample of some extremely thin ebonite which was as flexible as cloth and would seem to be adaptable to many useful purposes for insulating.

## ELECTRICITY WORKS ACCOUNTS.

### Oxford Electric Co. (Ltd.).

If due allowance be made for the adverse effect of the higher coal prices, the accounts of the Oxford undertaking for 1900 indicate a distinct general improvement on the results of the preceding year. What was, considering the position of the place, the moderate fuel cost of 0·634d. per unit in 1899 was increased last year by 0·126d. per unit. Notwithstanding this increased expenditure, however, the generating costs were, as a whole, reduced. Unfortunately, there was a much greater expenditure in maintenance of mains, which more than neutralised the improvement effected in the generating and management expenses.

The high repairs expenditure at the station continues to mar the aggregate generating and works cost figures. It is, however, a very promising sign to find this item of repairs so much improved.

With the total costs per unit remaining practically constant it is natural that a reduced tariff should be accompanied by a diminished return on the capital involved. The dividend of 5 per cent. was repeated, but the allocation to the reserve and renewal of plant account was only £250 as against £1,000 in 1899.

The year's output was 18·4 per cent. above that of 1899, the load-factor was 11·8 per cent., and the increase in the

| | OXFORD. | | | | CAMBRIDGE. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | Oxford Electric Co. (Ltd.) | | | | Cambridge Electric Supply Co. (Ltd.) | | | |
| *Date of Commencement of Supply* | June 1892. | | | | November, 1892. | | | |
| *System of Supply* | High press. continuous-current transformers. | | | | Alt.-cur. trans. sub-stations and house trans. | | | |
| *Chief Engineer* | P. J. Rea. | | | | John H. Barker. | | | |
| **YEAR ENDED** | DEC. 31, **1899.** | | DEC. 31, **1900.** | | DEC. 31, **1899.** | | DEC. 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 575,867 | | 657,051 | | 454,092 | | 508,121 | |
| „ **SOLD (TOTAL)** | 426,720 | | 483,699 | | 298,392 | | 357,435 | |
| „ sold to consumers | 380,489 | | 437,408 | | 297,204 | | 344,790 | |
| „ sold for public lighting, &c. | 46,231 | | 46,291 | | 1,188 | | 1,535 | |
| „ used on works | | | 175,352[e] | | 11,517 | | 11,110[f] | |
| **UNITS SOLD PER 8 C.P. LAMP CAPACITY** | 21·7 | | 18·1 | | 18·2 | | 12·2 | |
| Maximum supply demanded | 480 kilowatts | | 468 kilowatts[f] | | — | | 436 kilowatts | |
| Number of public lamps | 32 arc, 48 glow | | 32 arc, 40 glow | | 1 arc | | 1 arc | |
| Number of consumers | 500 | | 600 | | 383 | | 430 | |
| Connections to mains in 8-c.p. lamps | 29,538 | | 33,338 | | 22,123 | | 31,320 | |
| **CAPACITY OF PLANT IN 8-C.P. LAMPS** | 19,700 | | 26,700 | | 16,400 | | 29,350 | |
| **CAPACITY OF PLANT IN KILOWATTS** | 630 | | 855 | | 525 | | 939 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| **AUTHORISED (TOTAL)** | £150,000 | £238 | £150,000 | £175 | — | — | — | — |
| Share | 100,000 | 159 | 100,000 | 117 | £100,000 | £190 | £100,000 | £106 |
| Loan (including Debenture charges) | — | — | — | — | — | — | — | — |
| **RECEIVED (TOTAL)** | 95,200 | 151 | 100,500 | 118 | 57,572 | 110 | 62,025 | 66·0 |
| Share | 50,000 | 79·4 | 50,000 | 58·5 | 57,572 | 110 | 62,025 | 66·0 |
| Loan (including Debenture charges) | 46,200 | 71·8 | 50,500 | 59·1 | — | — | — | — |
| **AUTHORISED BUT NOT YET RECEIVED (TOTAL)** | 54,800 | 87·0 | — | — | 42,428 | 80·8 | 37,975 | 40·4 |
| Share (unissued) | 50,000 | 79·4 | 50,000 | 58·5 | 5,770 | 11·0 | 5,770 | 6·14 |
| Share (uncalled) | — | — | — | — | 36,658 | 69·9 | 32,205 | 34·3 |
| Loan (including Debentures) | 4,800 | 7·62 | — | — | — | — | — | — |
| **REPAID (TOTAL)** | — | — | — | — | — | — | — | — |
| **RESERVE OR SINKING FUND** | — | — | — | — | — | — | — | — |
| **DEPRECIATION FUND** | 1,750 | 2·78 | 2,000 | 2·34 | 1,750 | 3·33 | 2,500 | 2·66 |
| **EXPENDED (TOTAL)** | 95,682 | 152 | 101,210 | 118 | 59,185 | 113 | 68,571 | 73·0 |
| Lands and buildings | 7,585 | 12·0 | 7,585 | 8·87 | 11,267 | 21·5 | 11,877 | 12·6 |
| Plant | 47,182[a] | 74·9 | 49,179[i] | 57·5 | 26,713 | 50·9 | 33,614 | 35·8 |
| Mains | 36,548 | 58·1 | 39,596 | 46·3 | 19,372 | 36·9 | 21,810 | 23·7 |
| Miscellaneous | 4,351 | 6·91 | 4,861 | 5·69 | 1,833 | 3·49 | 1,270 | 1·35 |
| **BALANCE OF CAPITAL ACCOUNT** | −482[b] | −0·77 | −710[b] | −0·83 | −1,613[a] | −3·07 | −6,546[a] | 6·97 |
| **REVENUE—** | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold | Total. | Per unit sold |
| **TOTAL** | £10,684 | 6·010d. | £10,963 | 5·440d. | £8,694 | 6·990d. | £9,814 | 6·590d. |
| Revenue from supply | 9,711 | 5·462d. | 10,048 | 4·985d. | 7,716 | 6·205d. | 8,799 | 5·906d. |
| „ meters, &c. | 186 | 0·105d. | 220 | 0·109d. | 348 | 0·280d. | 391 | 0·263d. |
| „ public lighting | 475 | 0·267d. | 453 | 0·225d. | 18 | 0·014d. | 23 | 0·015d. |
| „ sale of lamps, &c. | 25 | 0·014d. | 182 | 0·090d. | — | — | 4 | 0·003d. |
| „ miscellaneous sources | 286 | 0·161d. | 60 | 0·030d. | 612[b] | 0·492d. | 597 | 0·401d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| **TOTAL COSTS** | £5,270 | 2·965d. | £6,047 | 3·000d. | £3,779 | 3·040d. | £4,087 | 2·745d. |
| **WORKS COSTS** | 3,672 | 2·065d. | 4,286 | 2·126d. | 2,710 | 2·180d. | 2,971 | 1·994d. |
| *Generation of electricity* | [illegible] | [illegible] | [illegible] | 1·851d. | [illegible] | 2·120d. | [illegible] | [illegible] |
| Fuel (including cartage, &c.) | 1,126 | 0·634d. | 1,531 | 0·760d. | 1,256 | 1·010d. | 1,509 | 1·014d. |
| Oil, waste, water, stores | 102 | 0·057d. | 126 | 0·063d. | 182 | 0·146d. | 240 | 0·161d. |
| Wages at station | 878 | 0·494d. | 946 | 0·469d. | 806 | 0·648d. | 799 | 0·536d. |
| Repairs and maintenance at station | 1,321 | 0·743d. | 1,127 | 0·559d. | 391 | 0·315d. | 340 | 0·228d. |
| *Distribution of electricity* | 243 | 0·137d. | [illegible] | [illegible] | 75 | 0·060d. | 83 | 0·056d. |
| Wages, &c. | 179 | 0·101d. | 153 | 0·076d. | 75 | 0·060d. | 83 | 0·056d. |
| Repairs, renewals of mains, &c. | 64 | 0·036d. | 403 | 0·200d. | — | — | — | — |
| *Public lighting* | — | — | — | — | — | — | — | — |
| Attendance | — | — | — | — | — | — | — | — |
| Renewals | — | — | — | — | — | — | — | — |
| **MANAGEMENT AND PROPERTY CHARGES** | 1,598 | 0·899d. | 1,761 | 0·874d. | 1,069 | 0·860d. | 1,116 | 0·749d. |
| *Royalties* | nil | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | [illegible] | [illegible] | 400 | 0·198d. | 457 | 0·368d. | 409 | 0·275d. |
| *Management* | [illegible] | [illegible] | [illegible] | 0·675d. | 612 | 0·492d. | 707 | 0·475d. |
| Salaries | 856 | 0·482d. | 835 | 0·414d. | 450 | 0·362d. | 443 | 0·297d. |
| Stationery, &c. | 55 | 0·031d. | 89 | 0·044d. | 60 | 0·048d. | 152 | 0·102d. |
| Establishment charges | 180 | 0·101d. | 181 | 0·090d. | | | | |
| Law charges, &c. | 185[c] | 0·104d. | 256[g] | 0·127d. | 102[c] | 0·082d. | 112[g] | 0·075d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| **WORKING PROFIT FOR YEAR** | £5,416 | 5·83% | £4,916 | 5·00% | £4,915 | 9·27% | £5,727 | 8·97% |
| Sum carried to Depreciation Fund | 1,000 | 1·08% | 250 | 0·254% | 750 | 1·41% | 750 | 1·57% |
| Sum carried to Reserve or Sinking Fund | 238 | 0·256% | 254 | 0·258% | — | — | — | — |
| Net interest on loans (incl. Debenture charges) | 1,742 | 1·88% | 1,966 | 2·00% | 68 | 0·128% | 194 | 0·304% |
| **BALANCE FROM LAST ACCOUNT** | 85 | 0·092% | 74 | 0·075% | 124 | 0·234% | 211 | 0·330% |
| **BALANCE AVAILABLE FOR DISTRIBUTION, &c.** | 2,573[d] | 2·77% | 2,656[h] | 2·70% | 3,822[d] | 7·21% | 4,295[h] | 6·73% |
| *Deficit* | — | — | — | — | — | — | — | — |
| **ORDINARY DIVIDEND PAID** | 5% | — | 5% | — | 7% | — | 7% | — |
| **PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE** | 49·3% | | 55·2% | | 43·5% | | 41·7% | |
| Expenditure per kilowatt capacity | £8. 7s. 5d. | | £7. 1s. 6d. | | £7. 4s. 0d. | | £4. 7s. 1d. | |
| **REVENUE PER KILOWATT CAPACITY** | £16. 18s. 10d. | | £12. 16s. 5d. | | £16. 11s. 0d. | | £10. 9s. 0d. | |
| Expenditure per 8-c.p. lamp capacity | 5s. 4d. | | 4s. 6½d. | | 4s. 7½d. | | 2s. 9½d. | |
| **REVENUE PER 8-C.P. LAMP CAPACITY** | 10s. 10d. | | 8s. 2½d. | | 10s. 7½d. | | 6s. 8d. | |
| **REVENUE PER 8-C.P. LAMP CONNECTED** | 7s. 2½d. | | 6s. 6½d. | | 6s. 2d. | | 6s. 3d. | |
| Price charged for lighting, per unit | 7d. | | 6d. | | 7d. to 5½d.[f] | | 7d. to 3½d.[i] | |
| Price charged for power, per unit | 4d. | | 4d. | | | | 3d. | |
| Price charged for public lighting | £652 per ann. contract price | | By contract | | £22. 18s. 6d. per arc | | £23 per arc per annum | |

OXFORD.—REMARKS.—*a* Includes £1,333 on public lamps, £2,965 on accumulators and £4,[illegible] on meters. *b* Over-expended. *c* £48 to insurance, £52 auditing, and £57 "carriage and cartage." *d* Inclusive of £52 premiums on debenture stock. *e* And in distribution. *f* Being 4,680 amps. at 100 volts. *g* Insurance £[illegible], "carriage and cartage" £45, auditing £52, and law £27. *h* Inclusive of £130 premiums on debenture stock. *i* Includes £1,333 on public lamps, £2,965 on accumulators and £4,787 on meters.

CAMBRIDGE.—REMARKS.—*a* Over-expended. *b* By cash discounts and sundry receipts. *c* Includes £26 to auditing, £25 to insurance, and £52 to law. *d* After deducting £250 written off preliminary expenses, and £150 written off suspense account. *e* By discounts. *f* Sold to the company at 3½d. per unit (being units used in works, offices and workmen's houses). *g* Auditing £33, law £41, and insurance £3[illegible]. *h* After deducting £250 to extinction of preliminary expenses, and £449 to extinction of suspense account. *i* On maximum demand system (one hour scale).

lamp connections 12·9 per cent. The following table shows the growth of the undertaking.

| Year. | Number of consumers. | Equiv. 8c.p. lamp connections. | Output, units sold. | Plant capacity, kilowatts. |
|---|---|---|---|---|
| 1893 | ... | 7,670 | 103,895 | 240 |
| 1894 | ... | 11,206 | 157,257 | 240 |
| 1895 | [illegible] | 15,003 | 207,633 | 340 |
| 1896 | 270 | 19,058 | 291,640 | 600 |
| 1897 | 340 | 21,364 | 343,567 | 630 |
| 1898 | 420 | 25,928 | 374,033 | 630 |
| 1899 | 500 | 29,638 | 426,720 | 630 |
| 1900 | 600 | 33,338 | 483,699 | 855 |

### Cambridge Electric Supply Co. (Ltd.).

In reducing the cost of electricity per unit in the face of the higher coal prices last year, Cambridge has done very well indeed. In fact, the fuel item for 1900 is practically the same as in 1899—at the somewhat high figure of 1·01d. per unit. This expenditure on coal was in excess of the average, even considering the moderate output and the low load-factor of 9·86 per cent. which obtained last year. The items of wages and of repairs at the station present most satisfactory figures—indeed, all the items of expenditure, excepting "Oil, waste, water, and stores," show excellent results in the circumstances.

At 6·6d. per unit the total revenue per unit is high, and we should say that the prices for current in force are acting prejudicially on the rate of expansion of the undertaking.

Last year the output was 19·8 per cent. above that of 1899, while the increase in the lamp connections was barely 11 4 per cent.

---

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.)(Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 28, 1900 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 13, 1900 |
| Cambridge (Company) | April 13, 1900 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Eastbourne (Company) | May 4, 1900 | Southport (Municipal) | July 7, 1899 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Exeter (Municipal) | Aug. 5, 1898 | Stafford (Municipal) | Aug. 17, 1900 |
| Folkestone (Company) | April 27, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan. 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | May 18, 1900 |
| Hanley (Municipal) | July 27, 1900 | Westminster (Company) | Mar. 29, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | Oct. 26, 1900 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Woolwich (Company) | Jan. 13, 1899 |
| Kens'gton & Knightsbr'(Co.) | Mar. 16, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Great Yarmouth (Mun.) | Dec. 29, 1900 |

---

**Long-distance Telephony.** — Telephonic connection has recently been effected between Berlin and Bordeaux, via Paris, a distance of 1,200 miles.—Nice, and probably other places on the Riviera, will be put into telephonic communication with Paris this month.

## SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.*

BY A. C. EBORALL.

(*Continued from page 909.*)

The running performance of synchronous (motor) machinery depends so much upon the variations in the velocity of the power-house engines during a revolution, and upon the oscillations set up by the engine governors, &c., that if these variations or oscillations exceed certain well-defined limits it becomes impossible to operate the sub-stations successfully. That this must be so becomes clear when it is considered that every variation in the supply frequency (during an engine revolution) has to be taken up by the sub-station machines against their own momentum, with the result that if the armatures get accelerated or retarded to any extent from this cause hunting is bound to occur, and operation of the plant becomes impossible until the engines are working properly. This is a case in which the hunting of the converters is due to a well-defined cause outside the machines themselves. But although hunting may be sometimes caused in this way, the speed variations in the engines are by no means a necessary accompaniment to it, for it may be started

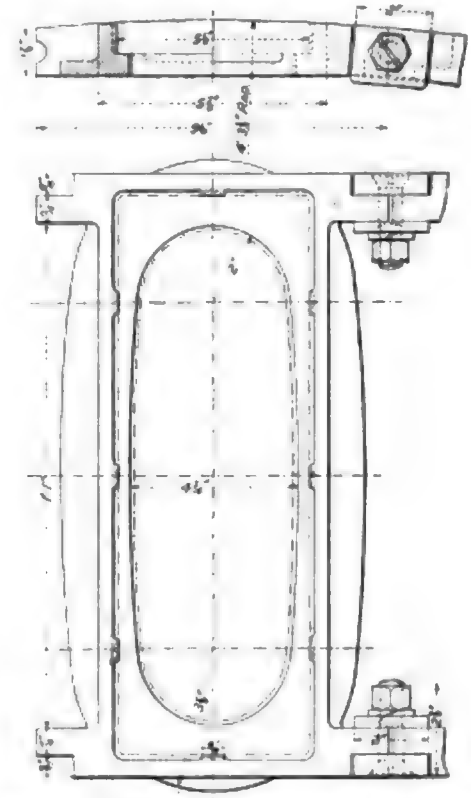


Fig. 9.—Combined Damping Coil and Field Coil Support for 725 B.H.P. Synchronous Motor. Speed, 212 revs. per min.; frequency, 50 cycles; peripheral speed, 5,500 ft. per min.

in a variety of ways (of which engine pulsation is one), and then increased by the action of the machines themselves. This latter case—that of hunting on the part of the rotaries when the power-house engines are entirely suitable—is of considerable interest.

A working explanation of what happens in this case is as follows:—Let a slight oscillation be set up between the machines by any little thing that may occur with the most perfectly designed plant it is possible to have, such as a sudden large change in the load, a short circuit, or faulty setting of the brushes on one machine, or an engine hunting in the power station (due to a small mishap, &c.). This slight oscillation is accompanied by a weakening and distortion of the field flux of the converter. The mere fact of there being an oscillation implies field distortion, for a fixed point on the armature during the swing is either a little ahead of or a little behind the true position (corresponding to exact synchronism) it should have at this instant. This means that the machine is acting either as a generator or motor, taking either a leading or a lagging current from the lines, and shifting the diminished field flux to one or other of the pole horns. The armature will now try to follow this change of field configuration, taking a large current in the reverse direction in order to do so. But this change of current immediately distorts the field

* Paper read before the Institution of Electrical Engineers, March 14.

flux in the opposite direction to a much larger extent, and the armature again tries to swing to the new position. Thus each oscillation of the armature gets larger and larger, and the field distortion is greater and greater, until finally the flux from the poles gets swept nearly entirely away from the pole faces to the pole horns and gaps between them, wrong times, causing them to start hunting also. The combined effect of the various machines in parallel is to increase the hunting originally set up, and if other sub-stations are in parallel the oscillations may also be taken up by the machines in these, the combined effect perhaps even reacting on the generators in the power station,

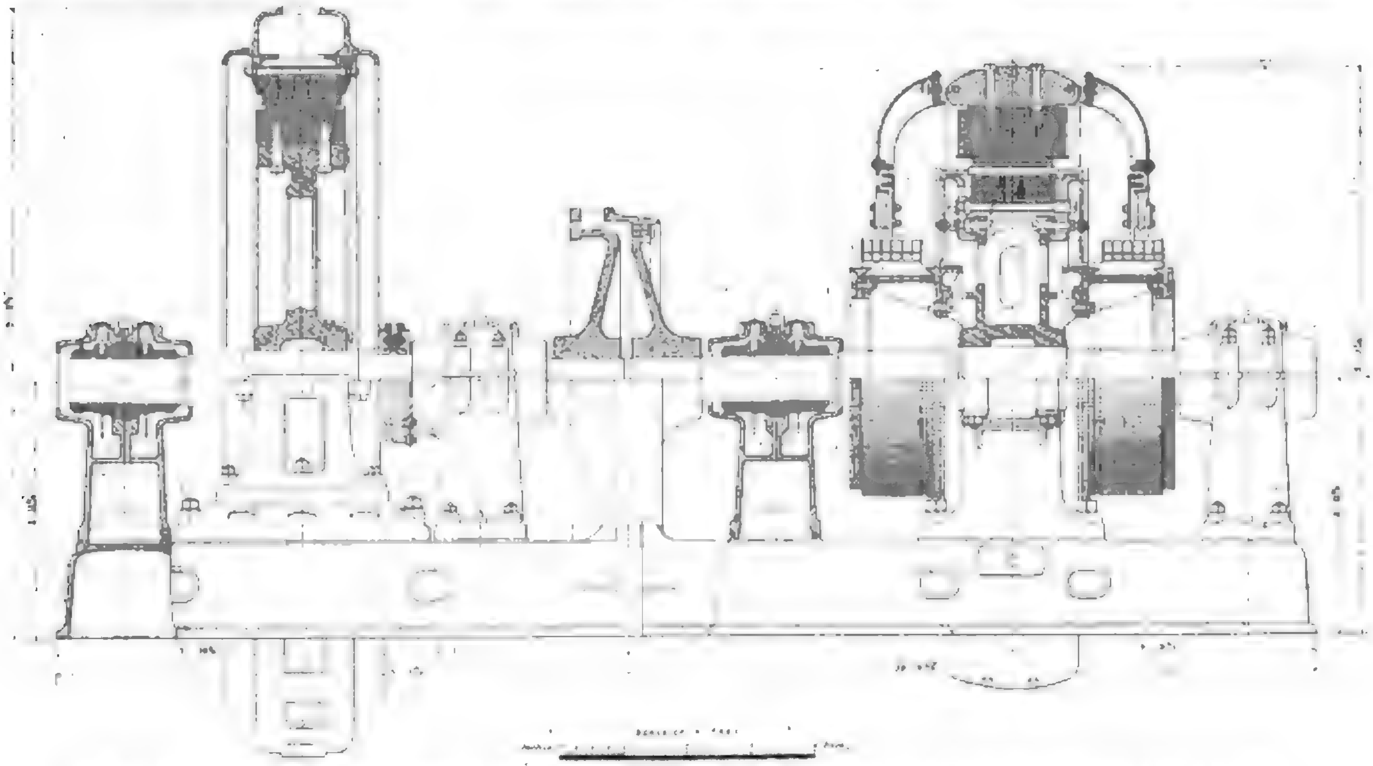


FIG. 10.—Front Sectional Elevation of 500kw. Two-Phase Synchronous Motor-Generator at the Manchester Square Sub-Station, London. Speed, 212 revs. per min.; frequency, 60 ∿ per sec.; volts, 1,100/200-230. Constructed by the Electricité & Hydraulique Co., Charleroi, Belgium.

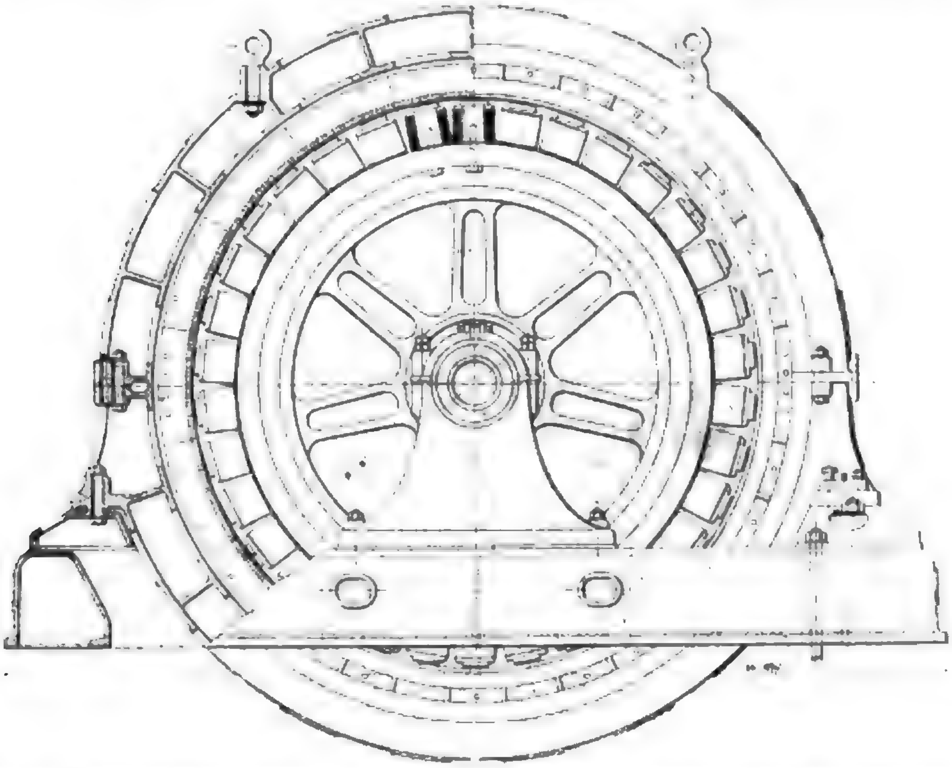


FIG. 11.—End Sectional Elevation of Alternating Current Motor of Manchester Square Motor-Generator.

the machine eventually swinging out of synchronism. During these oscillations the converter is acting alternately as generator or motor, giving up to, or receiving power from, the other converters in parallel with it, giving them in this way alternately a push and a pull at the causing them to start oscillating also. It is thus obviously necessary to provide means of checking the oscillations while they are still small, otherwise they will get out of control and spread over the whole system.

The sparking and flashing over which frequently takes place at the commutators of rotary converters when hunting is directly due to the pulsation of energy, and to the field distortion and fluctuation, for good commutation under these conditions naturally becomes impossible. The distortion of the field is really the root of the whole matter, and if this is prevented, or reduced to a minimum, hunting cannot occur. That the whole magnetic system of a rotary converter that is hunting is in a very disturbed state is made readily apparent during working. For instance, a spanner held in the hand between two field poles is strongly attracted with variable force. As a matter of fact, even when the machines are working properly there is a certain amount of field pulsation, it being sometimes easily possible to estimate the speed of the power-house engines from the small, quick movement of the pointer of the field amperemeter.

There are certain conditions of working which tend to cause hunting, or which make hunting worse should it be set up. An example of the former is difference in the form of the E.M.F. waves of generators and rotaries, which is in itself sufficient in some cases to start hunting, but such differences are, as a rule, not sufficient to give rise to serious trouble. On the other hand, machines with strong armature reaction, or working much under-excited, are more liable to hunt than those with strong fields, because the magnetic flux is more readily distorted. For this latter reason it follows that over-excitation of the rotaries is a condition favourable to good operation. Again, the momentum of the converters should be kept as low as possible, for this apparently indirectly assists hunting, and in any case impairs the action of any device that may be used for damping the oscillations in their early stages. Some engineers state that hunting on the part of the sub-station plant is increased by the impedance of the lines, but the author has not yet found this, and considers that a moderate amount of self-induction in the lines is directly beneficial. Capacity in the feeders, on the other hand, does appear to have some influence. In practice, however, it is generally difficult to separate the causes that assist hunting from one another. The main cause will generally be found to lie with the engines, and when this is removed, or when the effects of field distortion set up by it are neutralised, the troubles generally disappear.

Synchronous motor generators are far less likely to hunt (with a given generating plant and transmission system) than rotary converters. This is because there is considerable armature reaction in the synchronous motors, which tends to damp the pulsations in the armature current should hunting be set up, and also because the field system is fed at a steady pressure, which is totally independent of the pressure at the ends of the feeders. But with unsuitable engines synchronous motors will hunt badly, the pressure on the direct-current side being practically unaffected thereby, which is a point to be noted. The characteristic pulsations in the feeder pressure will, of course, occur to just the same extent as with rotary converters.

From what has been said above, it will be seen that to ensure the perfectly satisfactory operation of synchronous sub-station machinery, two points must be attended to. The first is to take great care with the selection and operation of the generating and sub-station plant, particularly the former, so that the tendency to set up hunting will be as small as possible; and the second is to provide means for getting rid of the hunting—that is, damp the armature oscillations in their earlier stages—should it be set up.

Some considerations relating to the design of the generating plant will be given later, while regarding the means for damping the oscillations a few remarks may be made here. As these oscillations are actual speed variations, it is evident that it might be possible to reduce them considerably by mechanical means; but the cost of devices for this purpose would be out of the question, to say nothing of other objectionable features. On the other hand, the oscillations are accompanied by, and intimately connected with, the field distortion as described above, and consequently if this distortion could be done away with, hunting would be prevented. Happily, very simple and effective means are available for suppressing the distortion of the field flux. All that has to be done is to fit the synchronous motors or rotary converters with "damping coils." This device, which is one of the many excellent ideas in polyphase working which have reached this country from the Continent via the States, is of the greatest value in such cases, and rarely fails to stop the worst cases of hunting. All that has to be done is to bridge the poles of the synchronous motors or rotaries from horn to horn by copper plates or strips. These will have the effect of wiping out the distortion of the main magnetic flux, and therefore damping the armature oscillations, by reason of the eddy currents produced in them by the flux due to the large leading and lagging armature currents—that is to say, as soon as the armature of the rotary or synchronous motor starts swinging, accompanied by the field distortion described above, the opposing flux produced by the eddy currents in the copper strips blows it away from between the pole-horns, and the oscillations are thus damped out magnetically directly they commence to form. It will be observed that the damping coils produce their effect just where it is wanted—namely, between the pole-horns. It is relatively of little use to put damping coils *round* the pole-pieces. The metal is wanted at the horns of each pole and between the horns of adjacent poles.

The dimension of the copper strips connecting the poles of the motor or rotary can be varied within wide limits without making much difference to the damping action. The losses in them with actual rotary converters are found to vary from 0·5 to 1·5 per cent. of the output of the machine, depending upon circumstances. An idea of the actual dimensions of damping coils used in practice is given by Fig. 9, which illustrates the bronze damping coils, combined with the outside cheeks of the field bobbins, for the synchronous motor of the 500kw. two-phase motor generator shown in Figs. 10, 11, and 12. The damping strips bridging the pole-horns of the rotating magnet wheel are cut away centrally, partly because the centre portion is not very effective, but principally in order to prevent the ventilation of the magnet wheel and armature being impaired. As rotary converters will hunt upon slight provocation, such machines should always be fitted with damping coils, whatever the nature of the engines. They need only be used with synchronous motor generators when the power-station engines are badly designed, unless lighting is done from the same feeders. In this case it will generally pay to use them. With water-power plants they are generally unnecessary for either class of plant. On the other hand, if the engines are very

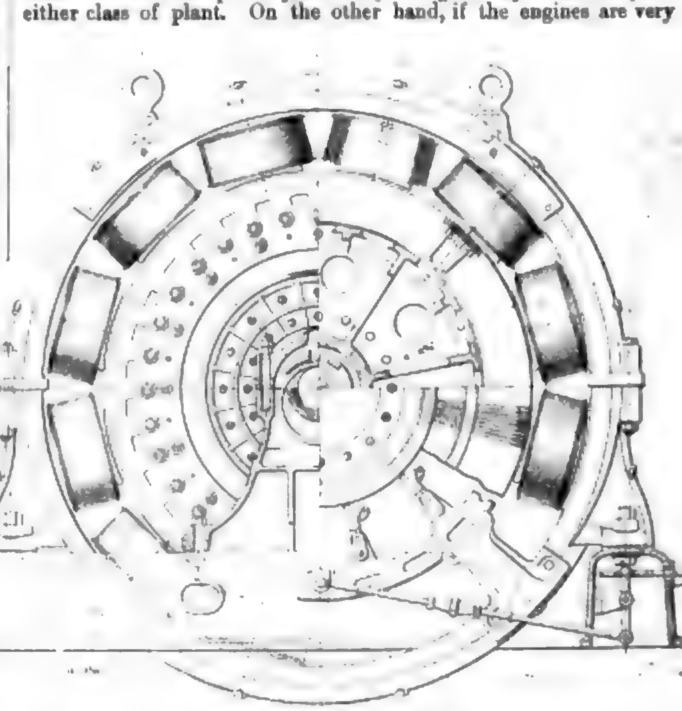


FIG. 12.—End Sectional Elevation of Continuous-Current Generator of Manchester Square Motor-Generator.

bad they should be used on the generator field poles as well, where they will have a precisely similar effect (for the case is similar), and will reduce the synchronising current between the generators practically to zero.

One result of hunting in the sub-stations is that the current in the high-pressure feeders pulsates. As a matter of fact, in accordance with what has already been said above, these pulsations occur to a certain extent even when hunting is absent, for they are due to the inherent properties of the machines. This pulsation of current in the feeders, accompanied as it is by corresponding pulsations in the pressure, becomes highly inconvenient if lighting has to be done directly from the feeders in question. The case might arise, for instance, with a transmission and distribution by three-phase currents for lighting and power, combined with a direct current distribution from sub-stations for the tramways. The remedy, first put actually into practice by Mr. Kolben in connection with the electricity supply for the town of Prague, is to insert choking coils in the high-pressure sub-station feeders, these being of the three-phase type with common core for three-phase working. The output of the choking coil in circuit with each feeder should be about 3 per cent. of the maximum power absorbed by the synchronous machinery connected to it. Thus in Prague, for instance, in one case a 900kw. sub-station (with 450kw. in reserve) is connected by a three-core cable to the power-house 3¼ miles away, a three-phase choking coil of 25kw., having an air-gap adjustable (by packing pieces) to about 0·375in., being in series with it. The principal dimensions of this coil are given in Figs. 13 and 14. The fluctuation in the pressure at the sub-station end of the feeder when working under the worst

conditions (no load) is about 3 per cent. with the coils cut out, and nothing that can be detected when they are in circuit. When the coils are in use, the synchronising current between the two synchronous motors of 650 H.P. is 8 to 10 amperes with an input of 60 amperes, and 5 to 10 amperes at full load (100 amperes), but when they are cut out the motor synchronising currents are more than double.

At another sub-station 2½ miles from the power station, having a smaller equipment—namely, two 180 kw. synchronous motor generators (one as reserve), there is no synchronising current at all between the 260 H.P. motors as long as the choking coils are in circuit. The current in this feeder when the sets are well loaded is as steady as it would be if asynchronous motors were in use.

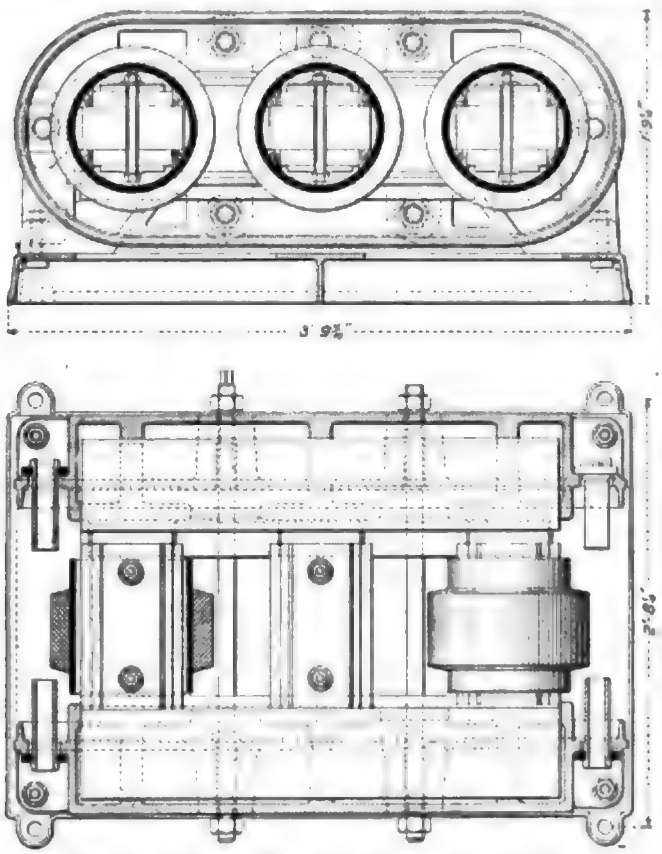


FIG. 13.—Elevation and Plan of Three-Phase Choking Coil. 25kw., 50 cycles.

The use of choking coils in the sub-station feeders has proved to be of the greatest value in Prague, because all the lighting and motor work is done from the same three-phase mains, the direct-current sub-stations serving only for the tramways. The pressure variation at the 900kw. sub-station—that is, on the terminals of the 650 B.H.P. motors—only varies between 2,900 volts and 2,980 volts, and does not change with the load, because the synchronising currents of the motors do not alter appreciably with the load; the excitations of the motors are hardly altered, being 62 amperes at no load, and 65 to 70 amperes at full load, the latter figure being attained when heavy momentary overloads are expected, such as at holiday times, when extra car services are run, &c.

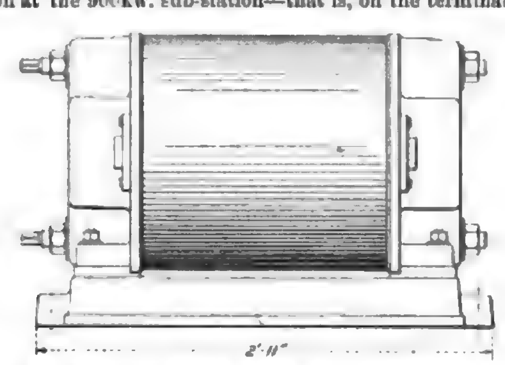


FIG. 14.—End Elevation of Three-Phase Choking Coil.

The town of Prague (250,000 inhabitants) has one of the best combined services in Europe. The whole of the very extended lighting, power, and tramway service is carried out from a single power-station of 15,000 H.P. ultimate capacity, 5,000 H.P. being now at work. There are about 26,000 8 c.p. lamps at present connected directly to the three-phase mains, as well as 400kw. of public lighting and many induction motors, including several of 100 B.H.P.; about 160 American type cars are supplied from the sub-stations at 550 volts, the average output for traction being about 1,300kw. at the present time. Every consumer having more than 16 8 c.p. lamps connected up has the three conductors taken to his premises; three-phase transformers in street boxes are used in all cases. The declared pressure is 120 volts at 50 cycles, and the minimum and maximum pressures any consumer gets at any time of the day are 118·5 volts and 123 volts respectively. The electric lighting, power, and traction services in Prague form a combined municipal undertaking of assured financial success, although but recently set to work. The transmission and distribution is carried out with three-phase currents throughout, with perfect success, balancing troubles (so much feared in this country by those unacquainted with the practical working of three-phase systems) being entirely unknown.

Great care has been taken by Mr. Kolben with regard to the design of the power-station engines at Prague, as the successful operation of such a combined system depends first of all upon their good qualities. With regard to governing, they are practically faultless, while the speed variation in one revolution—that is to say, the total variation, above and below the mean speed)—does not exceed 1 in 250; the engines are of the triple-expansion horizontal two-crank type, rated at 1,000 B.H.P. at 90 revs. per min, the flywheel effect* being 17,000 foot²-tons, in order to attain this.

The use of choking coils in the sub-station feeders may perhaps be thought objectionable, on account of the increased losses and pressure drop brought about by their use, but a little reflection will make it evident that this disadvantage is but trifling, and far more than counterbalanced by the advantage of doing away with all pulsations in the pressure. The full-load loss in a large choking coil is not more than about 3 per cent., and the inductive drop under usual working conditions, say 4 per cent. With the above-mentioned 25kw. choking coils, the full load loss is only 800 watts, and the pressure drop 60 volts (assuming the motors to be working at minimum excitation), and consequently their influence in impairing the efficiency or regulation of the system is insignificant. Naturally, it is far better to place the required reactance outside the generators than to design the latter with large reaction and consequent drop.

From what has been said above, it will be readily seen that if rotary converter or synchronous motor generator sub-stations have to be supplied from a steam-driven power station, very great care must be taken to prevent oscillations in the relative motions of the generators running in parallel, with the consequent interchange of synchronising currents. These oscillations can be started by the natural variations in the turning moment during the revolution, or by the after-effects of a bad parallel, or short circuit, &c., and are assisted by field distortion, by insufficient armature impedance, by quick-acting governors, by very heavy magnet wheels, and, of course, by faulty design, such as short connecting-rods, defective steam distribution, want of balance, &c. Given well-designed engines, it will generally be found that the trouble, when it is present, is due entirely to the governors, assisted by the momentum of the magnet wheels and by the attempts of the generators themselves to attain their proper phase relations; the cure for it consists in adjusting the governors in such a manner that they are absolutely unresponsive to very quick variations in the speed.

The reason is probably as follows:—If the governors are extremely sensitive they will endeavour to compensate for the unavoidable momentary speed variations due, for instance, to the steam impulses; as the speed increases during the impulses the cut-off will be earlier, while as the speed falls between the impulses the cut-off will be later. But the governor will overdo this, as is well known; it admits, for instance, more steam than is wanted to bring up the speed, causing the engine to accelerate, and vice versa—and in this matter it is helped by the momentum of the magnet wheels. What appears to happen is that a small relative oscillation of the revolving magnet wheels is started from unavoidable causes—that is, it is brought about by variations in the turning moment—which would, under ordinary circumstances, be completely taken care of by the momentum of the magnet wheels. Owing, however, to the sensitive governors of the engines in parallel the oscillation is not only kept going, but is actually increased by the lag of the governors in conjunction with the action of the periodic puffs of steam admitted to the engine cylinders by them. Of course, these oscillations of the moving parts of the generators cause phase displacements between the respective E.M.F. waves, which may be sufficiently large to cause the machines to become unstable. In any case, large synchronising currents will pass between the machines, and the oscillations re-appear in the sub-stations, starting hunting of the motors or rotaries, as above described.

It is found in practice that the amount of the relative motions of the generators can be reduced to practically nothing if the governors

* By "flywheel effect" is to be understood the true flywheel effect (not the kinetic energy of the rotating magnet wheel), namely, $W \times D^2$, where W = the weight of the wheel in tons, and D = mean diameter of the flying masses in feet.

can be prevented from responding to slight quick changes in the speed, and this, of course, is a matter of suitable governor dash-pots. Each engine governor should be fitted with a dash-pot of such a nature that no alteration will be made in the engine cut-off, unless the force acting on the governor is continued. Obviously the worst dash-pot to use is an air dash-pot, and the best a modified form of grease dash-pot; on the other hand, if very thick grease is used, in order to prevent the governor taking notice of short, sudden speed variations, the governor may be rendered so very sluggish that it becomes insensitive to speed variations of a permanent nature, causing objectionable variations in the frequency. It would certainly appear that something more than an ordinary dash-pot is required, and that these necessary fittings for the governors of large slow-speed engines might be profitably designed in accordance with the requirements for perfect parallel running of the generators. It is a point that does not appear to be as well recognised as it should be.

The fitting of special dash-pots to the engine governors reduces the swings of the generator magnet wheels to zero, or practically so, by preventing the admission of steam by the expansion valves during the periods of swing. It might happen, however, that the remedy in a particular case could not be applied for special reasons, and in this case the only remaining way of decreasing the amplitude of the oscillations would be to use damping-coils between the field-poles of the generators. The oscillations causing the phase differences between the E.M.F. waves of the various machines are accompanied by field distortion, just as described in connection with the sub-station machinery, and consequently they can be damped out in

The whole question turns upon the frequency employed—at a given speed a far better engine is required for high frequency generators than for those of low-frequency, as is well known now. With a given type and speed of engine, the lower the frequency the better the parallel running, because a low frequency implies a smaller number of field-poles, and consequently the speed variation in the revolution causes a smaller phase displacement between the E.M.F. waves of the different machines in parallel, meaning smaller synchronising currents and greater stability of running.

The amount of "cyclic irregularity" permissible depends, then, upon the permissible phase displacement, and this depends, to a certain extent, upon the nature of the work. Thus, for feeding rotary converters, which may be considered as being the most unfavourable case in practice, the phase displacement at any load should not exceed 2deg.—that is to say, a point on the rotating magnet wheel may not differ more than $2/p$ from the position it would have if the rotation was perfectly uniform, $p$ being the number of pole pairs. Thus, consider the case of a standard power generator of 2,000kw. at 25 cycles and 83 revs. per min.; the number of pole pairs ($p$) would be 18; the permissible "cyclic irregularity" must not exceed $\frac{1}{9}$th—that is to say, a point on the rotating magnet wheel of the generator must not be more than 0·11 of a degree in advance of, or behind, the point corresponding to absolute uniformity at the same speed. Thus the total "cyclic irregularity" or angular variation in this case would be 0·22deg.; had the frequency been 50 it would have been 0·11deg. for the same phase displacement of the E.M.F. waves, necessitating a much greater flywheel effect in this case.

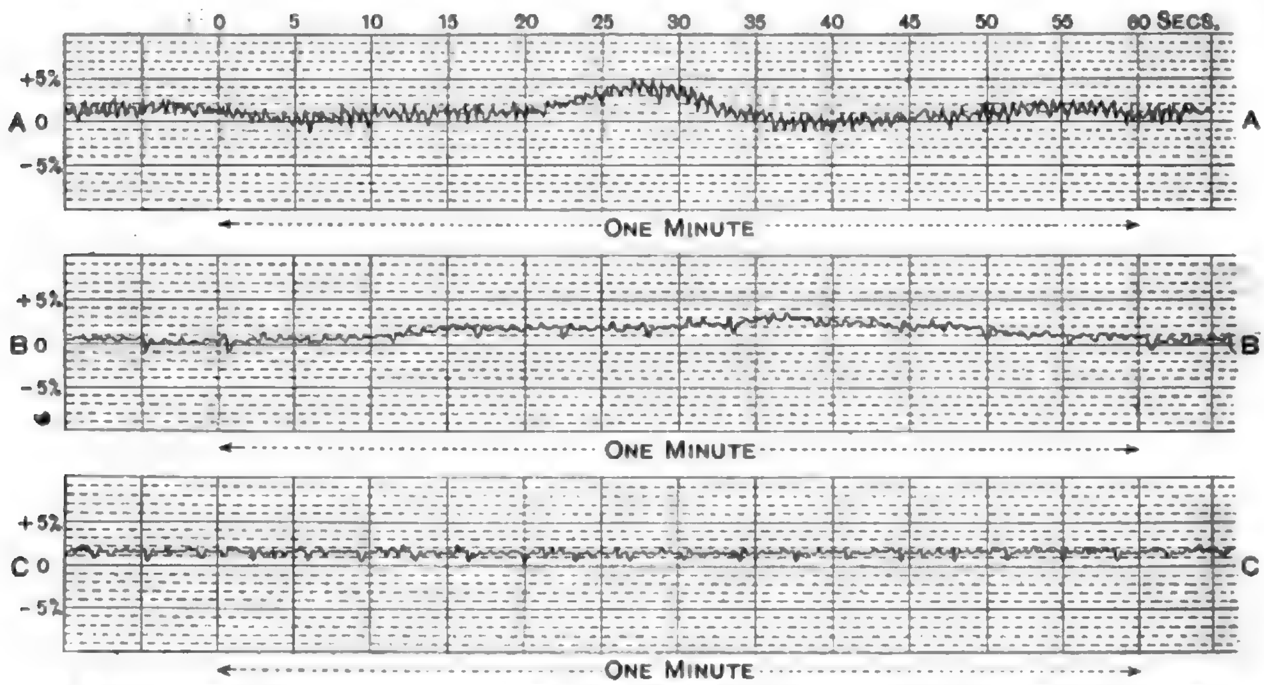


FIG. 15.—Tachograms of 1,000 B.H.P. Horizontal Engine. Triple expansion; two cranks at 90 degrees; 90 revolutions per minute.

their early stages by the same means. On very large slow-speed generating sets it is quite certain that it will pay to use such damping coils on the generators; they should be applied as shown in Fig. 7, or in a similar way.

On account of the bending of the shafts it is of importance, with machines of very large size, to arrange the generators in such a manner that they are unaffected thereby. Experience with such machines shows that, no matter what size the shaft is made, the arrangement of the generators outside the engines is not so good from the point of view of parallel running as that of putting the generators between the cranks, arranging the cylinders (if necessary) tandem fashion in order to allow of this being done. With a given cyclic irregularity the two cranks should preferably be set at an angle of 180deg. to one another.

With regard to the governing of the engines driving the power station generators, in order to be able to distribute the load properly this should not be too close. It is in general quite sufficient if the speed does not rise more than 2 per cent. when the load is decreased suddenly from full-load to half-load, or from half-load to no-load, and vice-versa. Of course, this change of speed must not be accompanied by the slightest hunting or irregularity, and the governors must control the engines perfectly when the latter are running at no-load with stop-valves full open. The question of the permissible speed variation in one revolution or "cyclic irregularity" is an important one, for to a certain extent it determines the amount of metal that must be put in the rim of the generator magnet wheels.

Of course if the generators have a larger armature reaction than is usual, the permissible phase displacement can be greater for the same synchronising current. It must always be borne in mind that with generators running in parallel one may be ahead and another behind by the amount of the maximum "cyclic irregularity," so that the amount by which the two E.M.F. waves are out of phase depends upon twice this—that is, it depends upon the total amount of variation in this case; the synchronising current will be proportional naturally to the sine of this total angle of phase displacement—in the case taken above, to sine 4deg.

In accordance with what has been said before, the variation in angular velocity during a revolution should be kept within the permissible limits with the minimum weight of magnet wheel; that is to say, the desired result should be attained rather by careful design of the engines than by very large flywheel effects. If this point be attended to, if the governor dash-pots are suitably designed, and if the pressure regulation of the generators is not too close, there will be no trouble from hunting either in the power station or in the distant sub-stations.

These remarks regarding the governing, speed variation, &c., of engines for power work can be concluded with the illustrations given in Fig. 15. The "tachograms" $a$, $b$ and $c$, are as nearly as possible exact reproductions of the records obtained by means of a Horn tachograph from one of the 1,000 H.P. engines previously referred to. The variations in the angular velocity during the revolution are quite clear—the three records represent three different adjustments

of the engine governor after the engine and generators had been erected. It will be seen that after the governor had been properly adjusted, the total variation (up and down) in the speed does not exceed 0·3 of 1 per cent., or the "cyclic irregularity" of the engine does not exceed 0·15 of 1 per cent. up or down. The Horn tachograph does not appear to be so well known in this country as it should be. It is an accurate and extremely useful instrument, whose indications represent with sufficient accuracy what the engine is doing during the revolution. This is exactly what the electrical engineer wants to know in connection with the commercial problems of parallel running.

*(To be continued.)*

## MUNICIPAL, FOREIGN & GENERAL NOTES.

### APPOINTMENTS VACANT AND FILLED.

Salford Electrical committee require an electrical engineer to superintend the laying of cables, &c., and also the erection of the overhead equipment of the electrical tramway system for the borough. Applications to town clerk (Mr. L. C. Evans, by 19th inst. See advertisement.

Willesden Guardians require a consulting electrical engineer to prepare plans, &c., for an electric lighting installation at their new infirmary in Acton-lane. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. J. Hutton Haylor), 329, High-road, Kilburn, London, N.W., by 23rd inst.

Charing Cross and Strand Electricity Supply Corporation require two assistants in the distributing engineer's department. Applications to "Mains," 15, Maiden-lane, Covent Garden, London, W.C. See advertisement.

An electro-chemist is required to superintend the manufacture of electrolytic meters. See advertisement.

Burnley Corporation have confirmed the appointment of Mr. Henry Mozley as manager of the Corporation tramways at £350 per annum for the first three years and £400 per annum after.

Mr. T. A. Rose, late managing director of Rose and Bird (Ltd.), and subsequently works manager of the Crystal Electric Lamp and Rose and Bird (Ltd.), has been appointed general manager of the Berrenberg Electric Lamp Syndicate (Ltd).

Mr. W. W. Vyle has been appointed superintending engineer of the South Wales district postal telegraphs, in succession to Mr. G. N. Partridge, retired.

**Aberdeen.**—The Council have received sanction to borrow a further £81,000 for electric lighting. The salary of the chief assistant engineer (Mr. C. A. Henderson) has been increased from £143 to £170 per annum.

**Alleged Theft of Wire.**—At the Northern Police Court, Glasgow, on Tuesday, Bailie Brechin remitted James Roberts to the Sheriff for trial on a charge of having, during the past three weeks, stolen about 18cwt. of copper wire and 10cwt. of lead. James Paterson was also remitted on a charge of having resetted 25cwt. of copper wire and 17cwt. of lead, the property of the electrical department of the Corporation and the National Conduit Co. The property is valued at about £100.

**Barnsley.**—The salary of the borough electrical engineer (Mr. S. E. Bastow) has been increased to £300, rising by annual increments of £50 to £400 per annum. The salaries of the assistants have been increased to £130 and £104 respectively. At the meeting of the Council last week, the chairman of the Lighting committee (Mr. Brady) said the output of the works during the first year had been 200,112 units, or 50 per cent. in excess of what was expected at the end of three years' working. They had met all charges, including two years' sinking fund of £685 a year, only one of which was really chargeable to the past year, and had a balance of £8. 0s. 11d. to carry forward. They had not had to draw anything from the rates, and were able to reduce the charge for current for lighting. Hitherto the charge had been 7d. per unit the first hour and 3d. after. They proposed to adopt alternative systems of charging—viz., a uniform rate of 4½d. per unit, or 7d. per unit the first hour and 2d. after.

**Belfast.**—The Gas and Electric committee are considering a request for a supply of electric current to the extensive works of Messrs. Harland and Wolff. The minimum quantity of current required would be 2,100,000 units per annum.

**Blackpool.**—The gross receipts of the electric tramway department for the year ended March 31 amounted to £30,658, compared with £22,590 in 1900. The Tramways committee are hopeful of being able to hand over £8,000 or £9,000 to the relief of rates.

**Bournemouth.**—The electric tramway between Bournemouth and Poole is practically ready for opening, but the proposal to run a Sunday service is meeting with much opposition, and the Poole Council have decided by eight votes to six to request the company not to commence running until 2 p.m. on Sundays.

**Brighton.**—It has been decided to light electrically the whole of the Pavilion proper at a cost of £455. 10s. In the vestibule of the King's apartment an electric stove is to be fitted, costing £6. 10s. with a guaranteed consumption of about one unit of current per hour.

**Carnarvon.**—Mr. Peterson's application for a provisional order has been refused by the Board of Trade.

**Cheltenham.**—At an inquiry last week into the application of the Council to borrow £6,150 for electric lighting extensions it was stated that up to the present sanction had been obtained to raise £122,000 and £110,000 had actually been spent. The present loan is to provide additional plant, including two traction generators for the supply of energy to the light railway company, and for mains extensions. The borough electrical engineer (Mr. H. Kilgour) stated that in 1896, when the works were opened, the number of customers was 101, now the number was 490, and the units sold to private consumers had increased from 47,000 to about 300,000. Commencing with two arc lamps, the number now was 260, and it was intended to bring this total up to 440. The working profits of the undertaking (exclusive of interest and sinking fund), showed a deficit of £620 on the first year, the next year a small profit, the following year a profit of £1,250, in the succeeding year a profit of £2,150, and in the next a profit of approximately £3,300. There was no opposition.

**Colchester.**—Additional property for the extension of the electricity station has been acquired by the Council.

**Crewe.**—The electricity department has received 139 applications for electric current, and 94 have been connected to the mains. Extensions of the mains have been authorised.

**Derby.**—The charge for electric current for power has been fixed at 1¼d. per unit where consumers use the maximum quantity of electricity for an average of over 50 hours per week.

**Doncaster.**—The Corporation have decided to supply electric current to the district of Balby at the same price as that charged in Doncaster.

**Dudley.**—The total capital expenditure to date on the electricity undertaking has reached £29,000. For the March quarter 147,833 units of current were generated, an increase of 108,000 units over the corresponding quarter of 1900. Even without any increased demand by the electric tramway company, a revenue exceeding £4,000 per annum is assured. The station's plant capacity is 12,000 8 c.p. lamps, and already about 3,000 lamps are connected. Generation expenses for the year to March 31 amounted to £2,910, and the receipts were £4,091, showing a gross profit of £1,181. The Council have received an offer from the local tramway company for the purchase of the tramway powers of the Corporation, but the latter body has decided to retain these.

**Edinburgh.**—The record number of applications for a supply of electric current was made during the period from March 14 to April 4 inst., when an equivalent of 9,252 8 c.p. lamps was demanded by new consumers—7,078 for lighting and 2,174 for power. The average number of applications for any similar period was about 4,000 8-c.p.

**Electric Driving.**—Mr. R. S. Blackburn, of Hebden Bridge, has recently fully equipped the extensive range of factory premises belonging to Messrs. Broadbent Bros. and Blackburn, at Hebble End Mill, Hebden Bridge. The building, originally a cotton mill, is five storeys high, and all the machinery installed is now driven electrically, including hoist, crane, and pump. The proprietors, unable to obtain a supply of current from established works in the district, decided to put down their own plant, and the work was entrusted to Mr. Blackburn. On one floor (the third) 80 sewing machines are driven by electric power. In addition to the electric driving, the whole of the lighting of the establishment is by electricity.

Mr. R. S. Blackburn has also secured a contract for the complete equipment of the large bakery belonging to the Hebden Bridge Co-operative Society for running the whole of the machinery by electricity and for lighting the extensive premises electrically.

**Electric Traction in the Potteries.**—The Kinver electric tramway was opened for traffic on Friday last.

**Great Yarmouth.**—Permission has been given by the Council to the National Telephone Co. to erect a line of telephone poles to the Golf House, on the understanding that the poles are to be hollow to provide for their use as sewer ventilation shafts.

**Hackney (London).**—Electric current will be available, it is expected, by the end of September, and an agreement has been entered into for wiring premises at a rate not exceeding 2s. per lamp installed per annum.

**Halifax.**—From April 1 the charge for current for lighting has been fixed at 4d. per unit to all consumers taking under 7,500 units per arter, and 3d. for all above. The charge for power is 2d. per unit.

**Hammersmith (London).** The Electricity and Lighting committee of the Borough Council recommend that approval be given to the plans of the borough surveyor for a new system of condensing plant for the electricity works, involving an estimated expenditure of £10,000. Application has been made to the Thames Conservancy for sanction to the proposed scheme so far as the inlet and outlet pipes connected with the new plant come under the jurisdiction of that body. The scheme contemplates the substitution of the ejector type of condensing apparatus for the evaporative type now in use, the future requirements of the generating station necessitating the erection of plant on a much more extensive scale than at present. Mr. A. H. Preece, the consulting engineer to the Council, has reported favourably upon the scheme, by which it is estimated a large annual saving will be effected.

**Hampstead** —The new borough Council have fixed the salary of the chief electrical engineer (Mr. G. H. Cottam) at £700 per annum.

**Hastings.**—Last week the Council had under discussion the accounts of the electricity department for 1900. The total annual expenditure was £7,987. 1s. 6d., and the borough electrical engineer (Mr. L. Andrews) estimated that the generation expenses had been increased by £827. 10s. by the abnormal consumption of coal, consequent upon the conditions under which the engines and boilers were working during alterations to buildings. The income from the sale of current for private lighting was £8,752. 7s. 4d., and for public lighting £2,650, out of a total income of £11,968. Interest amounted to £3,330. 18s. 4d., bad debts £85. 2s. 5d., balance carried down £818. 0s. 8d. The sum transferred to loans and sinking funds amounted to £2,306. 4s. 1d. On the credit side, the balance on Dec. 31 was £253. 2s. 10d., and to this had been transferred the balance of revenue account, £3,980. 18s. 7d. The capital expenditure to Dec. 31, 1900, was £102,255. 17s. 5d. The accounts were approved.

**Keighley.**—The electricity works were formally opened on 2nd inst.

**King's Lynn.**—On Wednesday, the Mayor (Councillor J.T Savage) formally started the new plant at the electricity generating station. The extensions comprise two multipolar dynamos with a capacity of 120 and 200kw. respectively, each designed for a maximum pressure of 500 volts, and coupled direct to vertical high-speed engines of 175 and 280 H.P. The dynamos were supplied by Messrs. Laurence, Scott and Co., the engines by Messrs. Belliss and Morcom, the boiler, economiser, &c., by Messrs. Yates and Thom, the whole extension being carried out under the superintendence of the corporation's electrical engineer, Mr. J. Pilling.

**Kinning Park.**—An arrangement has been made with the Glasgow Corporation for the supply of electric current on the same terms as those prevailing in Glasgow.

**Ladysmith (South Africa).**—In their amended estimate, which is now before the Municipal Council, Messrs. Siemens Bros. & Co. offer to put down plant for the electric lighting of the town for £5,124. The plant, which comprises two belt-driven dynamos, one engine, two boilers, and a storage battery, will have a capacity of 1,200 8 c.p. lamps. For public lighting, 50 16 c.p. or 32 c.p. incandescents will be included.

**Leith.**—The accounts of the electricity department for 1900 give the capital expenditure at £44,012. 4s. 10d., an increase of £7,208. 15s. 9d. during the year. The revenue from the sale of current for private lighting (at 5d. per unit), and for motor power (at 1½d.) was £4,208. 18s. 2d., and from public lighting (£20 per arc lamp per annum) £2,160. 7s. 9d. The expenditure was £4,743. 19s. 1d., leaving a gross profit of £1,641. 4s. 7d., and after paying interest and sinking fund instalment, and taking into account the balance at credit of account from 1899, there was a deficiency of £378. 10s. 10d. During the year 576,329 units were generated. 298,119 units were supplied to private consumers, 213,646 for public lighting, and 13,500 were consumed on the works. The maximum supply demanded equalled 356kw. There are 110 public arc lamps.

**Linlithgow.**—An offer by Messrs. Crompton & Co. to apply for a provisional order and to erect electricity works is under consideration by a committee.

**Longton.**—A deputation has been appointed to wait upon Mr. Menzies, agent of the Duke of Sutherland, to discuss his proposal to supplying electricity in bulk to the Corporation.

**Malvern.**—A special meeting of the Council was held last week to further discuss electric lighting questions. The Malvern provisional order was granted in 1890, and the Electric Light committee, recognising the futility of obtaining a further extension of time to comply with its provisions, recommended the Council to approve an electric lighting and refuse destructor scheme prepared by the surveyor. Dr. Dixey said the order would expire in a few days, and it was useless to expect further grace. Private enterprise should not be allowed to compete with the Council's gas undertaking. The electric lighting scheme would cost £14,000 and the refuse destructor £3,000. The two schemes would go well together, and it was believed the lighting would be a paying concern from the start. Mr. Foster moved that the opinion of the ratepayers should to taken, and this amendment was carried.

**Manchester.**—The special committee on overhead wires recommend the Corporation to request the National Telephone Co. to remove at the earliest possible date all overhead wires over the three tramway routes shortly to be opened for electric traction, and to place the wires underground. It has also been decided to make a similar request with regard to wires over the other existing and the projected tramway routes, the request to apply to wires within the areas in which the company has already powers to place its wires underground. The Paving and Highways committee has been asked to frame special by-laws with regard to private telephone wires, and the Postmaster-General is to be communicated with on the subject of overhead telegraph wires.

**Marylebone (London).**—The applications of the Borough Council and of the Marylebone Electric Supply Co. for provisional orders have been granted by the Board of Trade.

**Merthyr.**—The local electric tramways were opened on Saturday.

**Middlesbrough** —In the estimates of the probable revenue and expenditure for the year ending March 31, 1902, the borough electrical engineer (Mr. H. W. Clayden) puts the income at £3,600, the expenditure at £1,750, and the gross profit at £1,850. After providing for interest and sinking fund a deficit of £850 is anticipated. During the past month 75 additional applications for current had been received, representing an equivalent of 4,688 8 c.p. lamps.

**Montreal.**—According to the *Morning Post*, the Montreal Heat, Light and Power Co. is organising a trust for monopolising all the electric power and gas undertakings in and about Montreal. The capital of the trust is $25,000,000. The promoters claim they can generate electric current cheaper in Montreal than in any other part of the world. Immense new dams are being built at Chambly, and there will be an increase of from 8,000 H.P. to 30,000 H.P. in the plant at the power houses within two months.

**Motherwell.**—Considerable extensions of electric public lighting are to be carried out. Arc lamps are to be used in the principal streets, and 16 c.p. incandescents in the remaining thoroughfares. The charge for current to consumers of 20,000 to 50,000 units per quarter has been reduced from 2½d. to 1½d. per unit for power.

**Municipal Telephony.**—At the meeting of the Glasgow Corporation on Thursday last week, the convener of the Telephone committee (Mr. James Alexander) said that, after a fight, commenced in 1893, with the Post Office authorities and others, the Corporation had at length succeeded in surmounting all difficulties, and on the previous day (Wednesday) began the experimental trial of the Corporation telephone exchange. A few subscribers had been connected, and others would follow from day to day as expeditiously as possible. The prospects of the exchange were very promising. The twin-wire underground system was a vast improvement on the overhead single-wire system which they had been accustomed to. Glasgow was the pioneer of municipal telephone enterprise.

**Nelson.**—Sixty-two applications were received for the position of borough electrical engineer, and the following four have been selected from whom the appointment will be made:—Messrs. W. A. Fraser (Lancaster), C. A. L. Prusman (Doncaster), W. E. Heenan (Northampton), and O. G. Hansom (Fleetwood).

**North Berwick.**—A committee has been commissioned to report upon a proposal by Messrs. Crompton & Co. to obtain a provisional order and to erect electricity works.

**Norway.**—Messrs. Siemens and Halske, Berlin, and Schuckert & Co., Nuremburg, are equipping an extensive electricity station at Drontheim, northern Norway. The generating plant will be turbine-driven, the waters of the Lerfossen, situate about 5 miles from the town, being utilised. Messrs. Siemens are supplying the mains, cables and transformers, and Messrs. Schuckert the generating machinery. The plant will at first comprise two 1,000 H.P. generators, but the station is being built with a view of being ultimately equipped for 12,000 H.P. Electric tramways are to be established in the district, Messrs. Siemens and Halske having secured the contract for this work.

**Obituary.**—The death is announced of Mr. Robert Holliday, chairman of Read Holliday & Sons (Ltd.), electrical engineers and chemical manufacturers.

**Poplar (London).**—The proposals of the Electricity committee for the electric lighting of the Isle of Dogs have been endorsed by the Council, and 100 arc lamps are to be erected, at an estimated cost of £3,277.

**Presentations.**—On Wednesday last at Plymouth, Mr. J. H. Rider was presented by the staff of the electricity works and the corporate officers with a silver tea and coffee service on the occasion of his leaving to take up the appointment of resident electric tramway engineer to the London County Council. The presentation was made by the town clerk (Mr. J. H. Ellis), and in acknowledging the gift Mr. Rider, after referring to the cordiality which had prevailed between himself and all the members of the department, congratu-

lated the Corporation on the adoption of electric traction, but wished he could go further and compliment them on having electrically equipped all their tramways. The advantages of electric traction were very great. Not only had they greater safety and comfort with electric cars, but the quicker transit was an important consideration to business men. He also strongly recommended the adoption of penny fares.

Mr. R. M. Renwick, superintendent of the Eastern Telegraph Co. at Glasgow, was entertained by the Glasgow staff to a banquet to celebrate his 25th year of service with the company. Mr. Renwick was also the recipient of a handsome service of silver plate. Mr. Crombie, senior member of the staff, presided, and, in making the presentation, dwelt upon the cordial relations that existed between the superintendent and the members working under him. Mr. Crombie also briefly referred to the progress of telegraphy during the past quarter of a century, and the qualities which this development required from gentlemen in Mr. Renwick's position.

**Radcliffe.**—An expenditure of £81,000 for electric lighting and tramways has been decided upon.

**Railway Station Lighting.**—The Glasgow and South Western Railway Co. will take current from the Corporation mains for the electric lighting of the St. Enoch station, head offices and hotel.

**Seaford.**—The Council, which has decided to take over the provisional electric lighting order from a local syndicate, has received an offer from Mr. F. J. Warden-Stevens to form a company to establish and maintain electricity works in the district.

**Shanklin (I.W.)**—The works of the Isle of Wight Electric Light and Power Co. were opened on 3rd inst.

**Sheffield.**—Ald. Styring stated, at the Council meeting on Wednesday, that during the last six months there had been 29 cases in which the supply of electric current had been cut off or had become defective, the general cause being that water had gained access to the street boxes. The Electric Light committee was substituting overground for underground chambers.

The Darnall electric tramway route was opened yesterday (Thursday).

**South Africa.**—The Seapoint (Cape Colony) Town Council are considering the question of erecting electricity works.

**Southend.**—An inquiry was recently held into the application of the Council to borrow £40,030 for electricity works for supplying current for lighting and traction. There was no opposition.

**Stalybridge.**—Friction has arisen between the promoters of the Stalybridge, Mossley, Dukinfield and Hyde Electric Lighting and Traction Bill. Originally it was proposed to erect one of the generating stations at Stalybridge, but the Joint Electricity Board now wish to erect it at Dukinfield, and to amend the bill accordingly. The Stalybridge Council are opposed to the change, and want the matter referred to arbitration. The bill has already been read a second time.

**Stepney (London).**—Application has been made by the Borough Council to the London County Council for a loan of £34,070, balance of £105,170, for electric lighting.

**Swindon.**—The Council have accepted the scheme prepared by Messrs. Lacey, Clirehugh and Sillar for the electricity generating station buildings, and the firm are preparing detailed plans, specifications, &c., for submission to the Local Government Board prior to tenders being sought for the erection of the buildings and their equipment. An inspection of the proposed electric tramway route in the town has been made by Col. Yorke on behalf of the Board of Trade.

**Telephony in Hungary.**—The telephone was first introduced into Budapest and the adjoining township of New Pest in 1880, when a system of licensing was established. In 1887 the licence system was replaced by a lease, but in 1897 the whole of the telephone business was taken over and worked by the State, after Parliament had declared by resolution that telephonic communication, both urban and rural, could only be effectively established and worked by the State, the resolution authorising the acquisition by the Government of all the then existing lines. At this date (1897) the inter-urban telephone system consisted of 42 exchanges and the extra-urban of 255 exchanges, and there were 162 central and public exchanges. The total number of subscribers was 10,575, and the total length of lines 24,000 kilometres.

**Telephone Trunk Line Extension.**—Whitby is now connected with the trunk telephone system of the country.

**Tynemouth.**—The borough electricity works were formally opened on 3rd inst.

**Warrington.**—The Council have conditionally decided to support the scheme for the construction of a light electric railway between Warrington and Northwich.

**West London Tramways.**—As announced in our last issue, the electric tramcars of the London United Tramways on the route between Hammersmith, Kew Bridge and Acton, commenced running on Thursday last week, the objections of the Kew Observatory authorities having been removed. The 52 electric cars placed upon the route have been well patronised and on the first day's running carried about 100,000 passengers. The new service will act as an additional feeder to the Central London Railway at Shepherds Bush. It is anticipated that by July 1 considerable extensions of the electric lines will be open.

**Wigan.**—The Council have voted £100 to the gas engineer (Mr. Timmins) for services rendered in connection with the electricity undertaking.

## NEW BOOKS AND EDITIONS.

*The following New Books and Editions can be obtained of the Booksellers or direct from the Publishing Offices, 1, 2 and 3, Salisbury-court, Fleet street, London :—*

"Motive Power and Gearing for Electrical Machinery."—By E. Tremlett Carter, C.E., M.I.E.E. Price 12s. 6d., post free. In this comprehensive work an account is given of the scientific principles and modern practice in the use of engines for dynamo driving, not only for isolated power plants, but also for public electric lighting and power stations. The various forms of gearing in the power station and for electric motors are also dealt with; and the book contains, in addition, numerous tables giving exact data of the equipment and working of electric power stations.

"The Students' Guide to Submarine Cable Testing."—A new edition of this book, by Messrs. H. K. C. Fisher and J. C. H. Darby, is now ready, price 6s. net; abroad, 6s. 3d. This work is intended to serve as a guide to operators already in the telegraph service, and to those who desire to enter that service. The great cable companies now insist that their operators and probationers shall pass certain examinations in electrical subjects. The book is very fully illustrated.

"Submarine Cable-Laying and Repairing."—By H. D. Wilkinson M.I.E.E., &c., fully illustrated; price 12s. 6d. This work gives a detailed technical summary of modern practice in manufacturing, laying, testing, and repairing submarine telegraph cables.

"Practical Notes for Electrical Students."—By Messrs. A. E. Kennelly and H. D. Wilkinson. Price 6s. 6d., post free. The authors give in a clear and concise manner a good summary of the general principles of electrical science.

"Armature Winding of Electric Machines."—By H. F. Parshal and H. M. Hobart. This work has been compiled from notes made by Mr. Parshall in his capacity as Chief Designing Engineer of the Edison and General Electric Companies of America, and is intended to serve as a working treatise on dynamo design. Large 4to, 370 pages, 140 full-page illustrations and 65 full-page tables, 30s. post free.

"Temperature Coefficients of 'Conductivity' Copper." Compiled by Messrs. Clark, Forde and Taylor, consulting engineers. Strongly bound in cloth, 2s. 6d. net. Also a Sheet Table of Log. Reciprocals of Coefficients for Copper Resistances at different temperatures from 32°F. to 81·9°F. Printed on strong cardboard, 6d. net.

"Localisation of Faults in Electric Light Mains."—By F. C. Raphael. Price 5s., post free. The book deals with the important subject of localising faults in electric light and power cables; and the various methods of insulation testing are here collected and discussed.

"Electromagnetic Theory."—By Oliver Heaviside. *Vol. I.*, 12s. 6d. *Vol. II.*, 12s. 6d.

# TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

## TENDERS INVITED.

*Tonbridge* District Council invite tenders for the supply and erection of boiler and engine-house plant, condensing apparatus and pipe work, overhead travelling crane, switchboard and instruments, accumulators, mains, public arc lighting, house meters, and public incandescent lighting. Further particulars are given in an advertisement. Specifications of the consulting engineer (Mr. Robert Hammond), 64, Victoria-street, Westminster, London, S.W., after 25th inst. Tenders to the clerk (Mr. A. H. Neve, jun.), the Castle, Tonbridge, by 4 p.m. May 30.

*Kircaldy* Corporation invite tenders for the supply, delivery, and erection of engines and dynamos, storage battery and overhead travelling crane. An advertisement contains further particulars, and tenders have to be sent in to the town clerk (Mr. Wm. L. Macindoe) by 10 a.m. April 15.

*Aberdeen* Electric Light committee require six water-tube boilers and accessories. An advertisement contains further information, and tenders addressed to city electrical engineer (Mr. J. Alex. Bell), Cotton-street, Aberdeen, must be delivered by noon 27th inst.

*Cardiff* Corporation invite tenders for overhead line materials for the electrical tramways department. Some particulars are set out in an advertisement. Specifications from the engineer and manager (Mr. Arthur Ellis), Old Post Office Building, Cardiff. Tenders by April 30.

*Sunderland* Corporation invite tenders for the supply and erection of main, steam, feed, suction and exhaust pipes, &c., and additional panels to traction switchboard. An advertisement contains further

particulars. Specifications from the borough electrical engineer (Mr. J. F. C. Snell). Tenders, addressed Chairman of Lighting committee, to offices of town clerk (Mr. Fras. M. Bowey), Town Hall, Sunderland, by noon 26th inst.

The Burgh of *Partick* requires tenders for the construction, supply and erection of—(*a*) main switchboard and instruments, (*b*) batteries of accumulators and accessories. Specifications, &c., can be obtained at the office of Mr. Jas. Donaldson, town clerk, 97, West Regent-street, Glasgow, and may be inspected (but not obtained) at the offices of the engineers, Messrs. Kincaid, Waller and Manville, 29, Great George-street, Westminster, London. An advertisement contains further particulars, and tenders must be sent in to Mr. Donaldson by noon of April 29.

*Manchester* Electricity committee invite tenders for the supply, delivery, and erection at the Stuart-street generating station of water-tube boilers, steam engines, with condensing and auxiliary plant, three-phase generators and motor transformers. Specifications from the secretary of the electricity department (Mr. F. E. Hughes), Town Hall, Manchester, and specifications and drawings may also be inspected but not obtained at the office of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders (addressed to Chairman, Town Hall, Manchester) by May 7. An advertisement contains further particulars.

*Portsmouth* Corporation invite tenders for supplying and laying telephone conduits, and cables, copper wire, iron and steel stay wire, insulated wires, lighting and high-tension guards, arm bolts, nuts and washers, miscellaneous ironwork, insulators, switchboards, batteries, telephone instruments, fixing subscribers' instruments, creosoted poles, oak arms, erecting poles, arms, stays, insulators, wires, &c., and silicium bronze wire. Specifications from the telephone engineer (Mr. A. R. Bennett), 65, Renfield-street, Glasgow, and tenders to the office of the town clerk (Mr. Alex. Hellard), Town Hall, Portsmouth, by 13th inst. Further particulars are set out in an advertisement.

*Portsmouth* Corporation also require additional boilers, feed pumps, mechanical stokers, economiser, steam, feed, and other pipes, chequer plating, and sundry ironwork. Tenders by 4 p.m. April 16.

*Southend* Corporation invite tenders for the advertising spaces on their street electric tramcars. Particulars and forms of tender can be obtained from the electrical engineer (Mr. D. F. Adamson, M.I.E.E.), and tenders must be delivered to the town clerk (Mr. Wm. H. Snow) by 24th inst. An advertisement contains additional particulars.

*Alloa* Electric Lighting committee invite tenders for insulated cables, joint boxes, public arc lamps, lamp pillars, &c., and sub-station equipment and sundry connections. Specifications from the consulting engineers (Messrs. Buchan and Hogarth), 36, Hanover-street, Edinburgh, and tenders to the town clerk (Mr. F. G. Ewing), by April 30. Additional particulars are given in an advertisement.

*Norwich Mutual Telephone Co.*, who are about to establish a telephone exchange, invite tenders for various telephone cables, instruments, &c., particulars of which are set out in an advertisement. Specifications, &c., from the engineer to the company, and tenders to the secretary (Mr. Campbell Steward) by April 30.

*Battersea* (London) Borough Council invite schemes for wiring consumers' premises. Further particulars are given in an advertisement, and tenders must be lodged with the town clerk (Mr. W. Marcus Wilkins), Municipal Buildings, Lavender-hill, London, S.W., by May 14.

*Battersea* Borough Council also invite tenders for electric pumps, pipe work, &c., for condensing water, and pipes and pits for condensing water supply. Tenders to Mr. W. Marcus Wilkins, Municipal Buildings, Lavender-hill, London, S.W., noon of April 30.

*Plymouth, Stonehouse and Devonport Tramways Co.* invite tenders for the reconstruction of the existing tramway lines in Plymouth, Stonehouse and Devonport, and reducing the gauge from the standard to 3ft. 6in., also for bonding the rails. Tenders to Mr. John Glenn, 11, Queen Victoria-street, London, E.C.

*Southwark* (London) Works and Depot committee invite tenders for incandescent lamp brackets, switches and fittings to 168 gas lamp poles. Tenders to town clerk (Mr. J. A. Johnson), Walworth-road, London, S.E., by noon April 19.

*Wakefield* Electric Light committee invite tenders for arc lamps, transformers, switches, &c. Tenders to city electrical engineer (Mr. Robert Blackmore) by April 16.

*Middlesbrough* Electric Lighting committee require boiler and engine-house plant and condensing apparatus. Tenders to town clerk by April 30.

*Dublin* Lighting committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, &c. Tenders by 4 p.m. April 22.

*Poplar* (London) Guardians invite tenders for steam exhaust, heat and cold water pipes, valves, water meters, &c. Tenders to the clerk (Mr. G. H. Lough), Upper North-street, Poplar, E., by 6 p.m. May 1.

*Edinburgh* Corporation require arc lamp carbons and cast-iron pipes, pavement and road box frames and covers for one year from May 15. Tenders by April 20.

*Metropolitan Asylums Board* invite tenders for supply and erection, at Tooting Bec hospital, of electric generating and heating plant. Tenders to Board, Embankment, London, E.C., by 10 a.m. April 24.

*Aylesbury* District Council invite tenders for the construction and maintenance for a term of years of electricity supply works. Tenders to clerk by 4 p.m. April 22.

*Barrow-in-Furness* Corporation require tenders for cables, joint boxes, pipes, conduits, &c., and balancing transformer and switchboards. Tenders by April 24.

*Croydon* Corporation require tenders for excavation and making foundations for an engine and generator at the electricity works. Tenders by April 18.

*Motherwell* Electric Light committee require steam dynamo and switches, steam, feed, and exhaust pipes, &c. Tenders by April 29.

*Tavistock* District Council invite tenders for lighting the town from one to three years. Particulars from the surveyor.

*Newcastle-upon-Tyne* new Tramways committee require cast-iron pipes. Tenders by 23rd inst.

*Prussian State Railway Authorities*, Münster, invite tenders until May 1 for a steam dynamo. Tenders to General Direction der Konig. Eisenbahnen.

Tenders are invited by the municipality of *Lopera* (Jaen, Spain), for the electric lighting of the town. Tenders by April 28.

Tenders are invited by the Spanish Post and Telegraph authorities for the concession for erecting a telephone exchange at *Denia*. Tenders by May 10.

The Spanish Government also require tenders for the concession for working electric tramways in *Barcelona*, the concession already granted having been annulled. Tenders by June 3.

## TENDERS RECEIVED AND ACCEPTED.

Amsterdam Corporation have received the tenders set out below for the supply of complete motor and electrical plant for the municipal electricity works. The amount of the various tenders is given in sterling, the florin being taken as equal to 1s. 8d. :—

| | | | |
|---|---|---|---|
| Union Elektr. Ges. (Berlin) (*accepted*) | £64,300 | 0 | 0 |
| Ditto | 54,475 | 0 | 0 |
| Soc. anon. des Applications de l'Electricité (Herstal) | 93,611 | 3 | 4 |
| Ditto ditto | 71,448 | 16 | 8 |
| Braunschweigische Maschinenbau Anstalt (Brunswick) | 83,605 | 2 | 0 |
| Soc. anon. Electricité et Hydraulique (Charleroi, Belgium) | 80,021 | 15 | 0 |
| Maatschappij de Lavalstoomturbine (Amsterdam) | 75,566 | 13 | 4 |
| P. Biles (Limoges) | 72,450 | 0 | 0 |
| Helios Co. (Cologne) | 71,583 | 6 | 8 |
| Ditto | 70,750 | 0 | 0 |
| Cie Générale Electrique (Nancy) | 70,565 | 8 | 4 |
| Akt.-Ges. Elektricitätswerke vorm. Kummer & Co. (Dresden) | 68,333 | 6 | 8 |
| Westinghouse Elektr. Akt.-Ges. (Berlin) | 66,113 | 1 | 8 |
| Electr. Maatschappij Maarssen (Maarssen) | 64,598 | 16 | 8 |
| Kolben & Co. (Prague) | 64,598 | 16 | 9 |
| Elektr. Akt.-Ges. vorm. W. Lahmeyer & Co. (Frankfort) | 64,583 | 6 | 4 |
| Ditto ditto | 61,166 | 13 | 4 |
| *Cie Internationale d'Electricité (Liège) | 63,889 | 8 | 8 |
| Brown, Boveri & Co. (Baden, Switzerland) | 63,333 | 6 | 4 |
| Ditto ditto | 56,416 | 13 | 4 |
| Maschinenfabrik Oerlikon (Zurich) | 60,204 | 3 | 2 |
| Siemens & Halske (Berlin) | 56,372 | 9 | 8 |
| Allgemeine Elektricitäts Gesellschaft (Berlin) | 54,653 | 6 | 8 |
| Ditto ditto | 51,175 | 16 | 8 |
| Elektr. Akt.-Ges. vorm. Schuckert & Co. | (no figures) | | |

* Four other tenders (from £62,943. 8s. 4d. to £66,929. 5s.), were sent in by this firm.

Hastings Town Council have accepted the following tenders for their electricity department :—

Babcock & Wilcox (two 300 H.P. boilers, economiser, steam pipes, &c.), £3,100.

Wheeler Condenser Co. (circulating pump and pipes, feed pump, hot-well, &c.), £546. 8s. 6d.

British Westinghouse Co. (12 months' supply of electricity meters) :— Westinghouse wattmeter—£4. 9s. 8d. per 5 ampere, £5. 4s. per 10 ampere, £6 per 20 ampere and £7 per 40 ampere meter ; Shallenberger wattmeter—£5. 4s. per 10 ampere, £6 per 20 ampere, and £6. 8s. per 40 ampere meter.

The following tenders have been accepted by the Wigan Corporation :—

| | |
|---|---|
| Johnson and Phillips (paper insulated lead-covered cables) | £2,451 |
| John Spencer (Ltd.) (steel poles) | 284 |
| Ditto (castings) | 63 |
| Back and Manson (trolley line) | 175 |

Wolverhampton Corporation have received the following tenders for the overhead equipment of about 5 miles of tramway route, feeders, conduits and switch pillars for same :—

| | | | |
|---|---|---|---|
| Callender's Co. (*accepted*) | £6,710 | 1 | 3 |
| Siemens Bros. & Co. | 6,706 | 7 | 4 |
| St. Helens Cable Co. | £6,603 | 17 | 1 |
| W. T. Glover & Co. | 6,461 | 0 | 0 |
| Brit. Insulated Wire Co. | 6,074 | 3 | 3 |

The following tender has been accepted by the electrical tramways department of Cardiff Corporation for the provision and erection in position at the electrical power station of steam, exhaust and other piping, together with engine-house floor, switchboard gallery, and central service gangway and staircase complete :—Sir Hiram S. Maxim Electrical and Engineering Co. £6,868.

Ayr Town Council have accepted the following tenders :—

| | |
|---|---|
| Stirling Boiler Co. (boilers) | £2,471 |
| Cowans, Ltd. (switchboards) | 1,600 |
| Electrical Power Storage Co. (accumulators) | 1,527 |
| Alley and Maclellan (condensing plant) | 1,220 |
| General Electric Co. (balancers and boosters) | 525 |

Shoreditch (London) Borough Council have accepted tenders for the annual contracts for cables and sundries from the following firms :—St. Helens Cable Co., Siemens Bros. & Co., G. Braulik, London Electric Wire Co., General Electric Co., Johnson and Phillips, Williamson and Joseph, Veritys Limited, Hands Limited, and A. Vandam & Co.

The Shoreditch Council have also accepted the tender of Charles Gothard & Co. for the supply of best Welsh steam coal (Bwllya) during the next three months at 23s. 10d., and for Tredegar nuts at 23s. 6d. per ton. These prices show a reduction of 6s. per ton on last contracts.

Durban Municipal Council have accepted the tender of Messrs. Dick, Kerr & Co. for condensing plant for their electric lighting and tramway scheme at £3,545, and that of Messrs. Babcock & Wilcox for a steel chimney at £1,025.

Sunderland Corporation have accepted the tender of the Callender Co. for the supply, for three years, of bitumen-covered cables on the basis of their quotation and sliding schedule, by which the price would be regulated according to the rise and fall of the copper market.

Walthamstow District Council have accepted the tender of Messrs. D. Firth & Son for wiring and supplying fittings for the electric lighting of the town hall, public baths, public library and technical institute.

We are informed that the Westinghouse Electric Co. (U.S.A.) has been awarded the contract for the complete motor and control equipment of all the elevated lines of the Brooklyn Rapid Transit Co. of New York, comprising over 30 miles of double track railway.

Rotherham Town Council have accepted the tender of Messrs. J. Lomax Kendal & Co. for wiring the free library at £51. 8s. 6d.

Watford School Board has accepted the tender of Mr. Downer for wiring the Watford Field School at £161.

## BUSINESS NOTICES.

The Blackman Ventilating Co. (Ltd.) announce that, having acquired from Mr. James Keith, C.E., his business of heating engineer, carried on for some years past at 27, Farringdon-avenue, London, E.C., with foundries and engineering works at Arbroath, N.B., the firm has been newly named James Keith and Blackman & Co. (Ltd.), with works at Holloway-road, London, and Arbroath, and head office at 27, Farringdon-avenue, E.C. The new firm undertakes all classes of gas, hydraulic, electric heating and ventilating engineering work.

Messrs. Shippey Bros. (Ltd.) notify us that they have been appointed sole British agents for the Canadian Electrical Vehicle Co., and have received the first shipment of the new type of vehicles manufactured by that company, particulars of which are given in a well got-up pamphlet which can be obtained from Messrs. Shippey Bros. on application. We are informed that arrangements have now been completed to construct and equip these vehicles in England.

Messrs. Bergtheil and Young, Camomile-street, London, have admitted into partnership Mr. R. O. Ritchie, of Leeds, who takes over the Manchester branch of the firm.

Messrs. Nalder Bros. and Thompson (Ltd.) have removed their branch office from 2 to 6, Holborn-place, E.C., where Mr. E. R. Roberts represents them. The principal offices of the firm, to which all correspondence should be addressed, remain at 34, Queen-street, London, E.C.

## PETITIONS, BANKRUPTCIES, LIQUIDATIONS, &c.

A petition for the winding-up of the British Electrozone Corporation (Ltd.) will be heard in the High Court on 17th inst.

A petition, presented by Mr. A. Scott, a contributory, for the winding-up of the National Company for the Distribution of Electricity by Secondary Generators (Ltd.), will be heard at the Royal Courts of Justice, London, on 17th inst.

A receiving order has been made against George W. De Tunzelmann, engineer, 6, Penywern-road, Earl's Court, S.W., and 1, Bush-lane, Cannon-street, E.C., London.

James Brown, "hosier and electrical engineer," 23, Silksworth-row, Sunderland, has been adjudicated bankrupt.

A meeting of the creditors of Albert Isaac Greenberg, electrical engineer, 30, Arthur-road, Erdington, and carrying on business as the Midland Electrical Co., at 20, Caroline-street, Birmingham, was held last week. Debtor, whose statement of accounts showed liabilities £839 and deficiency £734, attributed his failure to bad trade and law charges. The bankrupt was a traveller until 1895, when he commenced business in partnership at Liverpool as a Continental agent. The business was unsuccessful. In 1819 debtor introduced £150 and joined a Mr. F. Pendergast, his partner's share consisting of stock and book debts. Last March the partnership was dissolved, and debtor continued the business under the style of the Midland Electrical Co. The assistant official receiver said that there was very little prospect of a dividend, for besides a few book debts, there was only about £30 to meet the deficiency.

---

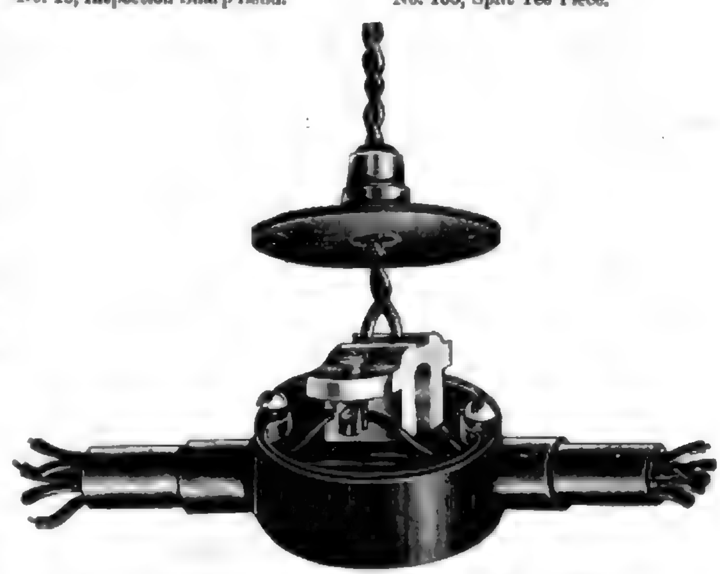
**For Sale.**—Salford Electricity committee offer for sale about 4,000 incandescent lamps for 100 and 200 volt circuits. Quotations to borough electrical engineer, Strawberry-road, Salford, by 26th inst. See advertisement.

**Partnership.**—An old-established firm of electrical engineers desire a partner qualified to design and direct the manufacture of continuous-current dynamos and motors. See advertisement.

**"Simplex" Steel Conduit.**—A very useful price list of the manufactures of the Simplex Steel Conduit Co., of Coventry-street, Birmingham, 20, Bucklersbury, London, and 1, Peel-street, Manchester, is now available, containing over 100 8vo pages. The list is well got up, and contains a quantity of information of service to installation contractors and supplies dealers. The extensive use of

Simplex Conduit System.
No. 19, Inspection Sharp Bend.

Simplex Conduit System.
No. 105, Split Tee Piece.



Simplex Conduit System.—No. 118, Improved Pendant Fitting.

this company's goods is shown by a representative list of some of the more important installations erected on the Simplex system during 1899-1900. The list gives evidence of the endeavour of the company to keep pace with the rapid development in conduit wiring which is a feature of installation work at this time. We show herewith several of the newest fittings used in this system.

**B.T.H. Plant.**—Pamphlet No. 91 of the British Thomson-Houston Co. deals with magnetic blow-out controllers for electric cranes, hoists, haulage in mines, electric launches and automobiles. A number of excellent illustrations of this apparatus are given. Pamphlet No. 92 treats of form CD automatic circuit breakers, of which several examples are shown.

**G. E. Co.'s List K.**—The 8th edition of the General Electric Co.'s telephone catalogue (K) contains a number of useful and interesting novelties. A feature of the list is the "Handcom" telephone

in which automatic switch circuits or cradles are dispensed with, the functions of the instrument being performed in the handle of the hand combination. This type of instrument is also developed into an intercommunication system, as the instrument lends itself to fixture in any position. The General Electric Co.'s "reply and call" system does away with the plug board for sub-station intercommunication and substitutes a line selector instrument, whilst the telephone proper has a two-way switch for reply and call. The "Municipal" is the name given to a new type of instrument constructed on Continental lines. These instruments have been supplied to Glasgow, Tunbridge Wells, and Guernsey. Another novelty is the "Traction" telephone system, comprising telephones both fixed and portable for communicating from feeder pillars with the power station, and other points on the route. One set is illustrated in the list of which considerable numbers have been supplied to electric power station engineers for use on electric tramway routes. Mining, engine house, military, police, and other telephones complete the list. The special instruments for police use are being supplied to Walthamstow and Tottenham.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) on April 3 and 4, with the ports of destination:—

*Africa*—Cape Town, £31; Durban, £105; East London, £24; Port Elizabeth, £963. *Australasia*—Adelaide, £171 (including £129 telegraph wire); Lyttleton, £60; Melbourne, £576 (telegraph material); Perth, £86; Sydney, £1,265 including £1,170 telegraph wire). *Burma*—Rangoon, £11. *Canada*, £181. *Ceylon*—Colombo, £190. *China*—Shanghai, £322. *France*—Rouen, £55. *Germany*—Hamburg, £25. *Gibraltar*, £143. *India*—Calcutta, £53; Karachi, £499,000 (telegraph cable); *Japan*—Tokyo, £32; Yokohama, £156. *Malta*, £147 (including £131 telegraph material). *Straits Settlement*—Singapore, £222. *Sweden*—Stockholm, £247 (telegraph wire). Total, £504,063 (for two days) against £34,454 for the week last year (April 4 to 10).

**Imports of Electrical Goods into the United Kingdom**.—The value of the electrical goods imported into this country during March was £130,076, against £97,296 in the preceding month, and £73,085 in March last year. The total for the three months ended March 31 was £321,689, against £197,018 for the corresponding period last year.

# PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

## APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

December 27, 1900.

23,617. G. J. MOSCHOS. Liverpool. Improvements in or connected with overhead electric tram or railway cars or locomotives.

23,647. H. C. HARRISON and J. DAY. Weston-super-Mare. Improvements in the electrolytic deposition of metals.

23,649. S. KRAUS. London. An improved electric bell.*

23,675. O. BRITZKE. London. Improved process and apparatus for obtaining electric current.

23,688. A. PACINOTTI. London. Direct electromagnetic traction with electromagnetic railway car. (Date applied for under Patents, &c., Act 1883, sec. 103, July 10, 1900, being date of application in Italy.)

December 28, 1900.

23,700. J. B. LANGFORD. London. Improvements in electrical couplings.

23,726. E. MILLER. London. Improvements in and relating to automatic switches for telephones.

23,729. B. H. F. D'ARNOULT. London. Improvements relating to secondary batteries. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 22, 1900, being date of application in France.)

23,733. L. G. WOOLLEY. London. Improvements in indicators for fire-alarm telegraphs.*

23,735. W. P. THOMPSON. Liverpool. Improvements in electro-mechanical apparatus for preventing collisions of railway trains. (Matteo Aliberti and G. Boni, Italy.)

23,743. E. TIQUET. London. Improvements in battery cells.*

23,748. E. ARNOLD, O. S. BRAGSTAD and J. L. LA COUR. London. Improvements in windings for use in polycyclic electric current systems.

23,749. E. ARNOLD, O. S. BRAGSTAD and J. L. LA COUR. London. Improvements in means for the distribution of dependent polycyclic currents.

December 29, 1900.

23,773. J. H. COWELL. Devon. Improvements in switches for starting and controlling electric motors.

23,774. W. JOHNSON and J. MAKIN. Sheffield. Improvements in apparatus for producing interchangeable numerals, letters, words and the like by means of electric lamps.

23,790. H. C. LEAKE. London. Improvements in and relating to means for the avoidance of hunting of synchronous alternate-current machinery running in parallel.

23,803. J. E. JASSET and A. E. CINQUALBRE. London. An improved process for depositing nickel and other metals upon metallic surfaces.

December 31 1900.

23,852. G. DIETZE. London. Improvements in devices for indicating and measuring pulsatory or varying magnetic fields.*

23,860. E. M. HEWLETT. London. Improvements in electric distribution systems. (Date applied for under Patents, &c., Act, 1883, sec. 103, July 28, 1900, being date of application in United States.)*

23,875. J. LAWRENCE and J. E. SPAGNOLETTI. London. Improvements in dynamos, motors, and motor generators.

23,877. C. W. ATKINSON. London. Improvements in and relating to insulators for electrical purposes.

23,878. L. I. BLAKE and L. N. MORSCHER. London. Improvements in process of and mechanism for separation of conductors from non-conductors.*

23,880. A. W. PRUST and A. APEL. London. Improvements in or relating to insulating and protective coatings, especially applicable to electric conductors.*

23,892. F. STRUM. Liverpool. An improved magneto-electric device for igniting explosive mixtures.*

23,896. LA SOCIÉTÉ D'ETUDES "VOITURES ELECTRIQUES DE PARIS." London. Regulating device for electric motors. (Date applied for under Patents, &c., Act, 1883. sec. 103, June 25, 1900, being date of application in France.)

23,903. A. VOELKER. London. An electric glass furnace.*

January 1, 1901.

5. H. A. KENT. London. Electric refrigerators or apparatus for cooling air, vapour or liquids by means of electric currents.

17. G. H. SMITH. Cardiff. Improvements in electric glow lamps.

18. G. W. HOLT. Birmingham. Improvements in electric switches.

31. A. WATSON. Birmingham. Improvements in switches for electrical purposes.

34. G. SPEARYS and W. H. WOOD. Birmingham. Improvements in electrical wall plugs, plug connections, and the like for electrical purposes.

42. R. H. DUNN. Somerset. Means for the generation of electrical energy by the liquid oxidation (or other non-ignition decomposition) of coal or carbon, and for the utilisation of the electricity and chemical and other combination produced thereby.

56. H. C. HARRISON. London. Improvements in the electrolytic deposition of metals.

62. C. J. BAYARD and A. E. LAMKIN. London. An improved coin-freed apparatus for telephones and other purposes.

65. P. L. R. FRASER. London. A safety appliance for overhead electric wires.

74. A. P. LUNDBERG and G. C. LUNDBERG. London. Improvements in switches for controlling electrical circuits.

90. M. MONTHIERS. London. Device for regulating electric motors.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1899.

22,260. LAKE (Millet). Electrically-operated governors, chiefly designed for regulating the speed of dynamos or motors.

22,634. VICARINO. Apparatus for electrically lighting railway carriages and for other vehicles.

22,830. ROBINSON (Robinson). Primary batteries.

24,718. KINGSBURY (Western Electric Co.). Telephone systems and apparatus.

24,879. ISHERWOOD. Electrical conductors.

25,186. MARCONI and MARCONI'S WIRELESS TELEGRAPH Co. (LTD.). Apparatus employed in wireless telegraphy.

25,216. HEYL-DIA. Electrical cable conduits.

25,281. LANE. Electrical traction on the closed-conduit system.

25,407. PHIBBS. Holders for electric incandescent lamps.

25,422. STILLWELL. Systems of electrical distribution and circuit-breakers for use therein. (Date applied for under International Convention, May 24, 1899.)

25,423. DULAIT and GARBE. Electrical resistances.

25,621. LUNDBERG and LUNDBERG. Electric light switches.

25,641. SCHLOMANN and DE CASTRO. Electro-mechanical accumulators.

1900.

16,146. EDISON. Process of making metallic duplicate phonograph records.

16,700. BRITISH THOMSON-HOUSTON Co. (LTD.) (Steinmetz). Systems of electrical distribution.

16,701. BRITISH THOMSON-HOUSTON Co. (LTD.) (Hewlett). Electrically operated pumps.

16,703. BRITISH THOMSON-HOUSTON Co. (LTD.) (Day). Controlling electric motors.

16,916. WETTER (Elektrizitäts-Aktiengesellschaft vormals Schuckert & Co.). Electro-magnets.

17,174. SIEMENS BROS. & Co. (LTD.) (Siemens and Halske Actiengesellschaft). Carbon brush-holders for dynamos.

17,467. CEDERGREN and KAHR. Telephone switchboards.

18,144. SCHALLER. Polyphase alternating-current transformers.
18,175. ROYER. Advertising clock, either combined or not with an electric alarm or call.
18,347. FERNT (Allgemeine Elektricitäts-Gesellschaft). Switch apparatus for electrically propelled vehicles.
18,451. McCALLUM. Circuit controller for electric street-railway cars and other uses
18,615. BRITISH THOMSON-HOUSTON CO. (LTD.) (Hewlett). Electro-magnetic blow-outs for electric cutouts.
18,616. BRITISH THOMSON-HOUSTON CO. (LTD.) (Case). Electric controllers.
18,718. SECK. Magneto-electric ignition devices for explosion engines.
18,914. EDISON. Electric meters.
19,497. BRITISH THOMSON-HOUSTON CO. (LTD.) (Hewlett). Automatic circuit breakers for electric circuits.
19,500. BRITISH THOMSON-HOUSTON CO. (LTD.) (Hewlett). Electric switches.
19,934. WOITTEQUAND. Mounting of electric bells.
20,507. HALL. Sparking plug for electrically-fired internal combustion engines.
20,522. BRITISH THOMSON-HOUSTON CO. (LTD.) (Hewlett). High-potential line switches for electric currents.
20,535. WILLCOX (Riker). Power transmitting devices.
21,292. BRITISH THOMSON-HOUSTON CO. (LTD.) (Union Electricitäts-Gesellschaft.) Means for obtaining magnetic adhesion of locomotives or motor-cars in electric railways.
21,293. BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz). Insulated electric conductor and method of making the same.
21,448. BRITISH THOMSON-HOUSTON CO. (LTD.) (Steinmetz). Systems of electrical distribution.
21,449. BRITISH THOMSON-HOUSTON CO. (LTD.) (Rice). Interrupting devices for electric circuits.
21,459. SACHS. Lightning arresters for safety cutouts for electric circuits.
21,538. BOULT (Jackson). Plates for electric batteries or the like.
21,642. WARD. Electric fuses.

# COMPANIES' MEETINGS AND REPORTS.

## Willans and Robinson (Ltd.)

The half-yearly ordinary general meeting of this company was held on Wednesday last week, Mr. MARK ROBINSON, M.Inst.C.E., presiding.

The SECRETARY (Mr. C. S. Essex) having read the notice convening the meeting,

The CHAIRMAN said: I am pleased to be able to congratulate you upon a prosperous half-year, from the profits of which we are able to pay not only a dividend at the rate of 12 per cent. for this half year, but also 2 per cent. with respect to the previous half-year, and yet to increase our carry forward. Such success encourages us to hope for great things in the future, when, if ever, we succeed in overtaking our still growing business. With regard to the points raised at the last meeting by Mr. Anderson and Mr. Peache, these have given rise to the long series of "Cases" and "Opinions" lately distributed to the shareholders. The main question raised was, What is profit and what is capital? We made no secret of our belief that share premiums are profit and not capital, as some of our friends contended, and that view is entirely and unanimously confirmed by the auditors and by the three eminent counsel whom, in the end, we consulted. The expense incurred over the Paris Exhibition has, equally with all the other items similarly charged against these premiums, been pronounced by counsel to be an entirely proper charge, and we have written off this charge against the premiums account. We proposed to carry the balance of share premiums to reserve, to which Mr. Anderson objected, on the ground that the reserve was liable to be used "to equalise dividends"—in other words, might possibly be distributed among the shareholders. Counsel give no support to Mr. Anderson's views, on the ground that share premiums are profit. But there is a peculiar phrase in one of our articles, which says that in our case dividends are only to be paid out of "profits arising from the business of the company," and two of the counsel think that share premiums do not arise "out of the business of the company," and all agree in the statement that "it is open to question" whether share premiums may, in view of this peculiar article, be distributed as dividends. Mr. Anderson's objection to carrying any sum from premiums account to reserve while the latter is in its present form is, therefore, justified. A reserve fund which cannot be used in time of emergency would be of little use, and it is fortunate that counsel are clear that, though premiums may not be distributed (in this company) as dividends, yet the right to charge special expenses against them is certain. We should be justified, therefore, in charging any serious loss to reserve, even if reserve were made up entirely of share premiums. It was said at our last meeting that the original directors had received more than they were entitled to under their agreements and under the articles of association. Counsel have been asked their opinion, and have given it in a form which we think makes it unnecessary for more to be said upon that point. But I may say that the majority of the counsel consulted have given the opinion that the original directors might put in a claim with fair prospect of success to their proportion—that is, three-tenths—of the share premiums we have been talking about, to say nothing of the premiums which we may obtain in future. The original directors intend to make no such claim. Two years ago the original directors voluntarily gave up the further automatic increase of their salaries, which was secured to them by the articles of association in respect of further increases of capital. They felt that a direct personal interest in increasing the capital might expose them to misconstruction. They have the same feeling now, and do not wish it to be possible for anyone to say that the increase of capital they now recommend brings a direct personal gain to them, and they therefore renounce altogether the claim.

Good progress has been made with the boiler works at Queensferry. There has been some temptation to hasten the development of this work by beginning to make boilers with incomplete appliances, and without waiting for the materials of our own manufacture, which we intend to use. The recent discussion about water-tube boilers in the Navy, and the emphatic condemnation by the Admiralty Boiler committee of the boilers hitherto chiefly fitted, have offered inducements to push forward the manufacture, in the hope of securing a large share of the Navy orders which are probably soon to be placed. We are certain that this policy would be a mistake. The Navy has played almost no part in our forecasts. Some of you may remember that the Willans engine was once the approved, if not the only recognised, engine for dynamo driving in the Navy. For 10 years or thereabouts we have never had a Navy order, but we have done pretty well without. We believe this boiler branch of our business is going to be of great value to us. Water-tube boilers are not a passing fashion. Their supremacy is assured, whatever some would-be guides of public opinion may assume; but the ruling type has still to be selected. No great sum has yet been sunk in the boiler works—up to the present about £51,000. But the liabilities upon the buildings and the plant nearing completion, and others which it will be necessary to enter into, are beyond the power of our present capital. In speaking of what we have in view, I do not wish to be misunderstood as suggesting any development of the business not already approved by the shareholders. It is only a question of how far the extension should go and how perfect it should be. As an instance, and referring to the Rugby not the Queensferry works, we first intended to build extensions of certain shops. But as these arose and took shape, we saw clearly that many subsidiary departments ought to be increased if due proportion were to be observed throughout the scheme. The larger engines we were called upon to build seemed at first to be sufficiently provided for by the extensions already under construction. But with means for doing more actual work on engines came previously unnoticed opportunities for saving in other directions. A completer system of works railways, and more powerful and more numerous cranes were seen to offer ready means for further cheapening the work. Extension of electrical working was seen to promise economies, and a new power station, already planned, though not ordered, is the result. Like considerations have applied in the new Queensferry works, and the result is the recommendation made in the report. We propose to issue £150,000, half preference and half ordinary shares. The issue price should be the same as last time—£6 for preference and £8 for ordinary. I now move the adoption of the report and accounts.

Mr. HOLLAND seconded the resolution.

Mr. BRYAN DONKIN: I think we ought to be very well satisfied with the action of the directors during the past year, and particularly with the chairman's very full statement to-day, and the distinct desire which we can see on the part of the directors to do what is right and just in obtaining this volume of business. With regard to the premium on the issue of new shares, it will, I take it, go to reserve?

The CHAIRMAN: The bulk will go to reserve, unless there should be any strong wish that it should go to writing off goodwill.

Mr. DONKIN: In the volume of "Opinions" we have received there is reference to the claims of the staff. It seems an excellent plan that the heads of departments should be so interested in the prosperity of the concern, and I have known it work well in other cases. Very little is told us in the report as to Thames Ditton. Do those works still go on?

Mr. PEACHE: I should like to express my gratification at the very clear statement given us to-day by the chairman respecting the questions raised at the last meeting, which conclusively proves that the course the directors had taken in the past was perfectly correct.

Mr. ANDERSON: I also have to thank the directors for the courteous way they went into the question I raised at the last meeting. The lawyers seem anxious for us to go to further expense, but I understand that the matter has now been settled without having further reference to law.

The CHAIRMAN: I would first say, as to Thames Ditton, that we never hear of it. I have not seen Thames Ditton for two years. The work there is in charge of a foreman, and the work goes on automatically and most satisfactorily, and a great deal of our small work is done there. I may say that our relations with our workmen were never happier. With regard to the new boiler works, I was asked if any boiler work was going on there. No; and we do not intend that it shall until the whole thing starts complete. We have had enough of boiler making in the past with imperfect appliances. As to share premiums, Mr. Stewart asked whether the directors make a like claim to their proportion of share premiums in the future. I have already said we have renounced that claim altogether.

The resolution was then carried unanimously.

The CHAIRMAN (in reply to a shareholder) said: Messrs. Humphreys and Tennant have fitted one ship in the Navy with Niclausse boilers and after considerable trials she has been proved a success. The manufacture we have chiefly in view at Chester is that for land service, which will involve certain differences from the marine type.

The dividends and bonus set out in the report were then formally proposed by the chairman and approved unanimously.

Resolutions approving the re-election of the retiring directors, Capt. M. H. P. Riall Sankey, R.E. (ret.) and Mr. Thomas O. Lazenby, and for the re-appointment of the retiring auditors, Messrs. Cooper Bros. & Co., were then carried unanimously.

The DEPUTY CHAIRMAN (Sir Gilbert A. Clayton East, Bart.) then moved a resolution that the capital of the company be increased to £750,000 by the creation of 50,000 additional £5 shares, 25,000 to be 6 per cent. cumulative preference shares and 25,000 ordinary shares (ranking with the existing preference and ordinary shares).

The resolution was duly seconded, and in the discussion which followed reference was again made to the Niclausse boiler.

Mr. DONKIN asked the chairman if he would give the shareholders some particulars of what was being done with this boiler in the French Navy.

The CHAIRMAN said at the time the English Admiralty took up the Belleville boiler there was one large French cruiser fitted with the Niclausse boiler, and that vessel has just gone successfully through her trials. Some small vessels were also fitted with these boilers, and they have proved very successful. The "Friant," the cruiser referred to, has been in almost constant employ since that time, and she went out with other French cruisers to China last autumn. The "Friant" sailed from France last but arrived first. This led to a great many other French vessels being fitted with the Niclausse boiler, but the "Friant" is the only large ship fitted with the Niclausse boiler which has done any active service. The French Government thinks so well of these boilers that they have ordered more Niclausse than Belleville boilers for the French Navy. Another large cruiser, the "Gambetta," is to be fitted with this boiler. Two Spanish war vessels are fitted with the Niclausse boiler. One of them, the "Cristobel," was the only vessel that distinguished herself in the late war. The Russians have also ordered several vessels to be fitted with Niclausse boilers. In the English Navy the "Suffolk," of 22,000 H.P., is fitted with Niclausse boilers, as is also a sloop of between 1,400 H.P. and 1,500 H.P. The "Seagull," also fitted with this boiler, has been through every imaginable kind of severe trial, such as, I believe, no other boiler but the Niclausse could possibly have gone through. The excellent little boats that ply on the Seine, in Paris, and which I wish we could copy here, are all fitted with Niclausse boilers; all the newer boats, about 35 of them, are fitted with Niclausse boilers, for the repairs of which very simple and expeditious arrangements can be made.

After some further discussion the resolution was carried unanimously.

A hearty vote of thanks to the chairman and directors was passed, and the proceedings terminated.

## Dover Electricity Supply Co. (Ltd.)

The seventh annual meeting of this company was held at Dover on April 3, Sir W. CRUNDALL presiding.

The CHAIRMAN said 12 months ago he foreshadowed that in all probability they would pay a 5 per cent. dividend this year, but in that unfortunate forecast he had left out the important factor of the price of coal. This enhanced cost had brought down their dividend to 3½ per cent., an increase of ½ per cent. over the previous year. The difference in the cost of coal represented as nearly as possible a 1½ per cent. dividend. He believed that next year they would pay probably 6 per cent., or even more, in dividend. They might have increased their dividend by following the lead of their rivals, the Dover Gas Co., in increasing the price of electric current, but they thought that would be bad policy. The prospects for 1901 looked very rosy. They had a large contract for supplying current to the contractors for the new Admiralty harbour works and for lighting the Admiralty Pier and the Prince of Wales's Pier, including the lighthouse. They were also in negotiation with the Harbour Board for supplying current for power for several electric cranes on the Admiralty Pier. They had also a largely-increased number of applications from the general public for private lighting. During the past year they had expended nearly £10,000 on capital account, the greater portion of which was for the plant and mains for the harbour works contract. Such additional capital as might be required in the next few years would probably be for mains only, as they had now about sufficient machinery at their station to enable them to supply double the quantity of current for lighting and power as was now supplied. They were assured by their engineers that the machinery and plant at the station was in thorough working order, practically as good as the day it was put down. This was conclusively proved by the report of the expert brought in by the Corporation in connection with their proposed purchase of the undertaking. With regard to this proposed purchase, he hoped the shareholders would not sell the business, because he was sure that, with a little patience, they would find that they had a good 10 to 12½ per cent. investment, and he failed to see why those who had worked hard for the last six or seven years should be robbed of what they considered their future prize. For something like five years the shareholders had practically no return for this hard work, but he could see that in the next year or two their earnings would increase by leaps and bounds. He then moved the adoption of the report and accounts, and the payment of the dividend therein recommended.

The motion was carried unanimously, and the proceedings terminated.

**BLACKHEATH AND GREENWICH DISTRICT ELECTRIC LIGHT CO. (LTD.)**—The directors' report for the year to Dec. 31 states that supply commenced from the company's own generating station on Feb. 14, 1900. Delay in delivery of machinery involved a serious loss of revenue, and part of this loss (£1,200) has been recovered from the contractors as compensation. The business is steadily increasing. The number of lamps connected on Feb. 14, 1900, was equivalent to 5,967 8 c.p., and on Dec. 31 last was 14,473. The number of consumers had increased from 132 to 342. On March 31 the connections amounted to an equivalent of 16,520 8 c.p. lamps and applications for 4,907 further have been received, making 21,427 connected and applied for. The issue of £100,000 4½ per cent. debenture stock was fully subscribed.

**BROMLEY (KENT) ELECTRIC LIGHT AND POWER CO. (LTD.)**—At the meeting last week the chairman (Mr. F. E. Gripper) said there had been an increase of over 6,000 8 c.p. lamps during the year, which meant that they had nearly doubled the output, and they had nearly 5,000 lamps which they were supplying in Chislehurst besides, many awaiting connection. This (March) quarter they had sold 89,000 units against 54,000 for the corresponding period last year, an increase of 50 per cent. Last year they had spent about £13,000, largely in increasing their mains. The principal expenditure in a district like Bromley was for mains, because they covered a large district. He believed that a great deal of the success of the company had been due to their liberal expenditure on mains at an early stage in their existence. During last year they laid 7¾ miles of new mains and their station buildings were now large enough to hold plant which would last them eight to ten years, with 50,000 to 60,000 lamps lighted. On wiring the profit of £195 was inconsiderable, but they did not try to get any monopoly in wiring in Bromley. The average price for current worked out at 4⅔d., or 4·7d. per unit, whereas a year ago it was 4·85d. They had written off the whole of the preliminary expenses, and that left them with £835. 6s. 3d. available for division. The directors recommended that a 4 per cent. dividend be paid, that £400 be placed to reserve for renewal of plant, &c., and that £135 be carried forward. The report and accounts were adopted.

**BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS CO. (LTD.)**—The directors' report states that the total receipts for the past year were £127,097 and the expenditure £89,137, leaving £37,960. After providing for debenture interest and placing £3,000 to renewal fund, there remains £16,911. An interim dividend of 3 per cent. on the "A" preference shares was paid in October, absorbing £6,000, and the directors now recommend additional dividends on the "A" preference of 3 per cent. (making 6 per cent. for the year), and on the "B" preference of 2½ per cent., absorbing £9,437, and leaving £1,474 to be carried forward. The arrears of the cumulative dividend on the "B" preference shares is now 14s. 6d. per share. Horse traction on the lines was not entirely superseded by electric traction until Sept. 10 last.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 26$\frac{1}{16}$d. per oz. (April 11). Consols (2¾ per cent.) 95½—95⅝ for money, 95¾—95⅞ for account; 2½ per cent. 96—96½ (April 11). Consols Pay Day, May 3; Stocks and Shares Continuation Days, April 24 and May 13. Ticket Day, April 25; Pay Days, April 12 and 26; Mining Share Carry-over Days, April 23 and May 11.

**CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)**—An issue of £250,000 4 per cent. debenture stock in this corporation has been made this week.

**CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)**—Mr. George Herring has been elected chairman of this company in succession to Sir David L. Salomons, Bart., resigned. At an extraordinary general meeting on Wednesday the resolutions passed on 21st ult. were confirmed.

**COMPAGNIE FRANCAISE DES TRAMWAYS ELECTRIQUES ET OMNIBUS DE BORDEAUX.**—The general meeting will be held in Paris on April 23.

**ORIENTAL TELEPHONE AND ELECTRIC CO (LTD.)**—Subject to final audit, the payment of a further dividend of 8·40d. per share (tax free), making 6 per cent. for the year ended Dec. 31, is declared.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc. or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | ... | ... | ... | ... | ... | ... |
| *Birmingham Tramways. | April 6 | 4,210 | - 71 | 13 | 52,630 | + 548 |
| *Blackburn Corporation.. | „ 5 | 533 | + 116 | 14 | 5,622 | + 609 |
| Blackpool Corporation... | „ 4† | 150 | ... | 1 | 150 | ... |
| Blackpool and Fleetwood | „ 6 | 384 | + 178 | 14 | 2,268 | - 11 |
| Bolton Corporation ...... | „ 7 | 1,699 | + 682 | 1 | 1,699 | + 682 |
| Bradford Corporation... | „ 7 | 877 | + 491 | ‡1 | 1,113 | + 571 |
| Brisbane Trams ........ | Feb. 20 | 1,904 | + 107 | 7 | 14,567 | + 2,004 |
| *Bristol Trams & Carriage | April 5 | 4,027 | + 1,289 | 14 | 50,891 | + 14,576 |
| *Buenos Ayres & Belgrano | ... | ... | ... | ... | ... | ... |
| Carlisle Trams. Co. ...... | „ 7 | 170 | ... | 14 | 1,629 | ... |
| Central London Railway | „ 6 | 5,654 | ... | 14 | 84,889 | ... |
| City & South London Ry. | „ 7 | 1,793 | + 413 | 14 | 28,144 | + 10,825 |
| Cork Elec. Trams ........ | „ 4 | 381 | + 59 | 13 | 4,622 | + 494 |
| Dover Corporation ...... | „ 6 | 231 | + 51 | 1 | 221 | + 61 |
| Dublin & Lucan Rly. ... | „ 6 | 96 | - 20 | 14 | 1,019 | + 140 |
| Dublin United ........... | „ 5 | 3,206 | - 1,884 | 14 | 33,504 | + 857 |
| Dublin Southern Dist.... | „ 5 | 715 | 1,039 | 14 | 9,760 | |
| *Dundee Corporation ... | „ 3 | 532 | + 163 | ... | ... | ... |
| *Glasgow Corporation ... | „ 6 | 8,547 | - 433 | 14 | 116,829 | + 1,587 |
| Halifax Corporation .... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | ... | ... | ... | ... | ... | ... |
| Hull Corporation ......... | „ 6 | 1,724 | + 971 | 40 | 58,184 | + 31,619 |
| *Liverpool Corporation... | Mar. 30 | 8,079 | + 906 | 13 | 101,733 | + 14,450 |
| Liverpool Overhead Rly. | April 7 | 1,607 | + 290 | 14 | 20,813 | + 1,359 |
| Portsmouth Corporation | „ 6 | 575 | - 62 | ... | ... | ... |
| *Sheffield Tramways ...... | „ 7 | 3,317 | + 1,395 | 14 | 39,809 | + 14,283 |
| Southampton Corporat'n | „ 4 | 580 | + 279 | ... | ... | ... |

* Partly electrical. † 4 days only. ‡ Plus two days.

**DUDLEY, STOURBRIDGE AND DISTRICT ELECTRIC TRACTION CO. (LTD.)**—The directors' report states that the total revenue for the year to Dec. 31 was £18,712, and the expenditure £11,812; profit £6,900. After deducting preference dividend (£703) there is, including £2,314 brought forward from last account, £8,511 available for distribution. A dividend at the rate of 4 per cent. per annum is recommended.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed 17th inst. as a special settling day in the provisional scrip certificates, fully paid, for £698,201 4 per cent. debenture stock of the *Central London Railway Co.*, and has ordered the same to be quoted in the official list. Application has also been made to the committee to appoint a special settling day in, and to grant a quotation to, the further issue of 10,000 ordinary £10 fully paid shares (Nos. 60,001 to 70,000) of the *City and South London Railway Co.*, and to allow the further issue of 10,000 ordinary £5 fully paid shares (Nos. 80,001 to 90,000) of *Willans and Robinson (Ltd.)* to be quoted in the official list.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 2. | | Price Wednesday, Apr. 10. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During 8 Days Ending Apr. 10 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| 100,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | ¾ | 1 | ¾ | 1 | ... | ... | ... | ... |
| £100,000 | Stock | 33/2 | Do. 4½ 1st Deb. Stock Prv. Certs. (red. & con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | ... | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,661 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7½ | 8½ | 7½ | 8½ | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 8¾ | 8½ | 8¾ | 4 0 0 | March and September | ... | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 30,000 | 5 | 4/3 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | ... | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 5¾ | 5 | 5½ | 4 1 10 | " " | ... | ... |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 6½ | 6¾ | 6½ | 6¾ | 4 8 0 | March | 6⅛ | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 7 | 8 | 7 | 8 | 5 0 0 | February and August | 7⅞ | 7⅝ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12½ | 13½ | 12 | 13 | 4 12 4 | January and July | 14⅛ | 12⅞ |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 121 | 146 | 121 | 126 | 4 0 4 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½%, 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | 10⅛ | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary | 9 | 9 | 8½ | 9½ | 5 6 4 | ... | 8⅞ | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 11½ | 12½ | 11½ | 12½ | 4 16 0 | March and September | 11⅞ | 12 |
| £300,000 | Stock | 4½% | Do. 4½% Deb. Stock (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | ... | ... |
| 10,300 | 5 | ... | Folkestone Electricity Supply Co. Ordinary | 5½ | 5¾ | 5½ | 5¾ | ... | ... | ... | ... |
| 11,000 | 5 | ... | Hove Electric Lighting Ordinary | 7½ | 8½ | 7½ | 8½ | ... | ... | ... | ... |
| 15,000 | 5 | 10% | Kensington and Knightsbridge Ordinary | 11 | 12 | 11 | 12 | 4 7 6 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. ... (Deb. Stk. (red.) | 6½ | 7 | 6½ | 7 | 4 3 7 | January and July | ... | ... |
| £73,000 | Stock | 4% | Kensgtn. & Knghtg. Co & Notting Hill Co (Jt. Stck.) 4% | 101 | 103 | 101 | 103 | 3 17 8 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 1¾ | 1½ | 1¾ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 3½ | 4½ | 3½ | 4½ | 6 13 4 | ... | ... | ... |
| £350,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 98 | 101 | 98 | 101 | 3 19 3 | Mar., June, Sept., Dec. | ... | ... |
| 85,000 | 10 | 6/0 | Metropolitan Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | April and October | 12½ | 11⅞ |
| 13,769 | 10 | 9d. | Do. (£7 10s. paid) | 9 | 10 | 9 | 10 | ... | ... | ... | ... |
| £320,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 8 | June and December | ... | ... |
| £280,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 5 | ... | ... | ... |
| 6,452 | 10 | 8/0 | Notting Hill Electric Ordinary | 13½ | 14½ | 13½ | 14½ | 4 13 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 5½ | 6½ | 5½ | 6½ | 3 16 11 | " | ... | ... |
| 200,000 | 1 | 1/6 | Rand Electric | ¾ | 1 | ¾ | 1 | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 200 | 220 | 200 | 220 | 3 12 9 | April and October | ... | ... |
| £115,500 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 2 | " " | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 13½ | 14½ | 13½ | 14½ | 5 0 0 | February and August | ... | ... |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 98 | 101 | 98 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £50,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 3½ | 3¾ | 3½ | 3¾ | ... | ... | ... | ... |
| 103,518 | 5 | 5/0 | Westminster Electric Supply Ordinary | 11½ | 12½ | 11½ | 12½ | 4 4 0 | March and September | 12⅛ | ... |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 200,037 | 5 | 2/0 | Anglo-Argentine Shares (1 to 200,037) | 3½ | 4½ | 3½ | 4½ | 4 17 0 | April and October | ... | ... |
| £250,000 | Stock | 6% | Do. Permanent 6% Deb. Stock | 123 | 128 | 123 | 128 | 4 14 10 | ... | ... | ... |
| 10,000 | 10 | 9/0 | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 6 0 8 | ... | ... | ... |
| 75,000 | 5 | ... | Brisbane Electric Trams. Investment Ord. | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 75,000 | 5 | ... | Do. 5% Cum. Pref. | 4½ | 4¾ | 4½ | 4¾ | ... | ... | ... | ... |
| £400,000 | Stock | ... | Do. 4½% Deb. Prov. Certs. | 99 | 101 | 99 | 101 | ... | ... | 97⅞ | ... |
| 50,000 | 10 | 8½% | Bristol Tramways and Carriage Ordinary | 23½ | 23¾ | 23½ | 23¾ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 6% | Do. Cumulative Preference (fully pd) | 10½ | 10¾ | 10½ | 10¾ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 | 116 | 114 | 116 | 3 8 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 12,600 | 10 | 5/0 | Do. 5% Preference | 10 | 10½ | 10 | 10½ | 4 15 3 | May and November | ... | ... |
| £250,000 | 40 | ... | Do. 4½% 1st Mort. Debs. | 100% | 102% | 100% | 102% | ... | ... | ... | ... |
| 60,000 | 10 | 6/0 | British Elec. Trac. Ord. | 15 | 16 | 15 | 16 | 5 6 3 | ... | ... | ... |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | February and August | 12⅛ | 12⅛ |
| £360,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 119 | 122 | 119 | 122 | 4 2 0 | ... | 120½ | 120½ |
| 40,000 | 5 | 3/0 | Buenos Ayres & Belgrano 6% "A" Cum. Pref. | 5 | 5½ | 5 | 5½ | 5 14 3 | ... | ... | ... |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5 | ... | ... | ... | ... |
| £220,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | ... | ... |
| £120,000 | Stock | 5% | Do. 5% 2nd Deb. St'k Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 8 | ... | ... | ... |
| 34,140 | 10 | 2/0 | Calcutta Trams. (Nos. 1 to 100,000) | 10½ | 11½ | 10½ | 11½ | ... | ... | 10⅞ | ... |
| £250,000 | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 101 | 104 | 101 | 104 | ... | ... | ... | ... |
| 400,000 | 1 | ... | Cape Electric Trams. Shares | 1½ | 1¾ | 1½ | 1¾ | ... | ... | ... | ... |
| 296,297 | 10 | 2/6 | Central London Ordinary | 8½ | 9½ | 9 | 9½ | 2 18 0 | June and December | 9⅛ | 9 |
| 60,000 | 5 | 2/6 | City of Birmingham Trams. Co. 5% Cum. Pref. | 5½ | 5¾ | 5½ | 5¾ | 4 6 11 | ... | 5⅛ | ... |
| £300,000 | 100 | 4% | Do. 4% 1st Mort. Debs. | 103 | 105 | 103 | 106 | 3 16 9 | ... | ... | ... |
| £654,000 | Stock | 1½% | City and South London Railway Con. Ordinary | 41 | 50 | 46 | 50 | 2 10 0 | February and August | 47 | ... |
| 37,500 | 10 | 2½% | Do. Ordinary (Nos. 22,501 to 60,000) | 4 | 5 | 4 | 5 | ... | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £200,000 | Stock | 5% | Do. (1896) | 122 | 127 | 122 | 127 | 3 18 9 | ... | ... | ... |
| £344,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 112 | 117 | 112 | 117 | 3 8 5 | May and November | ... | ... |
| 60,000 | 10 | 6/0 | Dublin United Trams. (1896) Ltd., Ordinary | 13 | 14 | 13 | 14 | 4 5 9 | ... | ... | ... |
| 59,987 | 10 | 6/0 | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 16 0 | ... | ... | ... |
| £300,000 | 100 | 3½ | Do. 3½ per Cent. Mort. Debs. (red.) | 98 | 103 | 98 | 103 | ... | ... | ... | ... |
| 20,000 | 5 | 5% | Dudley, Stourbridge & District Elec. Tracti'n. Pref | ... | | 5½ | | ... | ... | ... | ... |
| 20,000 | 5 | ... | Electric Lgt. & Traction of Australia 6% Cum. Pref. | 4½ | 5½ | 4½ | 5½ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | †Imperial Tramways Ordinary | 21½ | 22½ | 21½ | 22½ | 3 12 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | † Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 18 8 | " " | ... | ... |
| £300,000 | Stock | 4½% | † Do. 4½ per Cent. Debenture | 112 | 114 | 112 | 114 | 3 18 11 | January and July | ... | ... |
| 30,000 | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 5% Pref. | ... | | ... | | ... | May and November | ... | ... |
| 37,600 | 10 | 3½% | Liverpool Overhead Railway Ordinary ... xd | 7½ | 7½ | 7½ | 8 | 4 1 7 | February and August | ... | ... |
| 10,000 | 10 | 5% | Do. 5 per Cent. Preference ... xd | 13 | 13½ | 13 | 13½ | 3 15 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debenture | 102 | 104 | 102 | 104 | 3 17 2 | January and July | ... | ... |
| $350,000 | $1,000 | 5% | London Street R'y. (Ont.) 1st Mrt. 5% Dbs. (red.). | 100 | 102 | 100 | 102 | 4 18 0 | ... | ... | ... |
| £3...144 | Stock | 3/4 | Lond. Utd. Trams 4% 1st Mt. Db. Stk. Prv Crts (fllypd) | 101 | 104 | 102 | 104 | ... | ... | ... | ... |
| £200,000 | 100 | 5% | Montreal Str't R'lw'y St'rl'g 5% Mor. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £140,000 | 100 | 4½% | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 3 | 3½ | 2½ | 3½ | 3 5 8 | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5½ | 5 14 3 | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | | ... | | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | | ... | | ... | " " | ... | ... |
| 13,334 | 10 | ... | Potteries Electric Traction Ordinary | 11 | 12 | 11 | 12 | ... | ... | ... | ... |
| 20,000 | 10 | 5/0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 4 10 11 | February and August | ... | ... |
| £125,000 | Stock | 87/6 | Do. 4½ per Cent. Debenture Stock | 107 | 109 | 107 | 109 | 4 3 2 | ... | 108 | ... |
| £540,000 | Stock | 3% | Waterloo and City Ordinary | 94 | 97 | 94 | 97 | 3 2 2 | June and December | 94½ | ... |

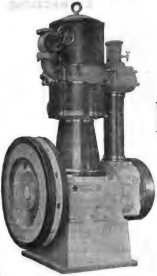
## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 2. | | Price Wednesday, Apr. 10. | | Rate per Cent. Yielded. £ s. d. | Dividend Due. | Business Done During 8 Days Ending Apr. 10 Highest | Lowest |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | | | | |
| [illegible] | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 99 | 102 | 99 | 102 | 3 16 6 | January and July | ... | ... |
| 25,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 55 | 65 | 55 | 65 | ... | ... | ... | ... |
| [illegible] | Stock | 17/6 | Anglo-American | 61 | 64 | 61 | 64 | 5 15 9 | Feb., May, Aug., Nov. | 62½ | — |
| £3,[illegible],640 | Stock | 30/0 | Do. Preferred | 95 | 97 | 95 | 97 | 6 3 6 | „ „ | 96 | 95½ |
| £3,[illegible],640 | Stock | 5/0 | Do. Deferred | 5½ | 6½ | 5½ | 6½ | 3 17 2 | „ „ | ... | ... |
| 13,333,300 | $100 | 8½ | Commercial Cable Capital Stock | 160 | 170 | 160 | 170 | 4 14 2 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,039 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 101 | 103 | 3 17 8 | „ „ | 101½ | ... |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | „ „ | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | ... | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | „ „ | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 2/0 | Direct United States Cable | 9¾ | 10¼ | 9¾ | 10¼ | 6 16 7 | Jan., Apr., July, Oct. | ... | ... |
| £106,300 | 100 | 4½% | Direct West India Cable 4½% Rg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £[illegible],000,000 | Stock | 35/0 | Eastern Ordinary (1 to 1,300) (red.) | 143 | 148 | 143 | 148 | 4 14 10 | Jan., Apr., July, Oct. | 145 | 143 |
| £1,036,466 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock | 93 | 96 | 93 | 96 | 3 14 3 | „ „ | 95 | 94 |
| £1,432,360 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 117 | 113 | 117 | 3 9 0 | May and November | ... | ... |
| 260,000 | 10 | 2/6 | Eastern Extension | 14½ | 14¾ | 14½ | 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14⅝ | ... |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £3 pd., is'd at £3 pm, all pd | 13½ | 14½ | 13½ | 14½ | ... | ... | ... | ... |
| £[illegible]0,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 116 | 3 9 3 | February and August | ... | ... |
| £[illegible]0,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1909 | 99 | 102 | 99 | 102 | 3 18 3 | February and August | ... | ... |
| £[illegible]0,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 17 8 | May and November | ... | ... |
| 1[illegible]0,237 | 10 | 1/9 | Globe Telegraph and Trust | 9½ | 10½ | 9½ | 10½ | 5 2 5 | Jan., Apr., July, Oct. | 10½ | 9½ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14½ | 15½ | 14½ | 15½ | 3 19 8 | „ „ | 15½ | ... |
| 190,000 | 10 | 3/0 | Great Northern of Copenhagen | 33 | 34 | 33 | 34 | 3 13 6 | January and July | ... | ... |
| £[illegible]2,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (wthn Nos | 99 | 102 | 99 | 102 | 4 2 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European (1 to 1,200) (red. | 47 | 51 | 48 | 50 | 5 0 0 | May and November | ... | ... |
| £[illegible]00,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £[illegible]00,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 102 | 99 | 102 | 3 15 6 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | ... | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust | 124 | 129 | 124 | 129 | 4 14 0 | „ „ | ... | ... |
| 15,609 | 10/0 | ... | West African Telegraph | 3½ | 3¾ | 3½ | 3¾ | 4 9 8 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 | 100 | 97 | 100 | 5 0 0 | March and September | ... | ... |
| 30,008 | 2½ | ... | West Coast of America | ½ | 1 | ½ | 1 | ... | ... | ... | ... |
| £180,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ½ | 1 | ½ | 1 | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 8 11 6 | „ „ | 6½ | ... |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 8 11 6 | „ „ | ... | ... |
| £[illegible]90,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 14 4 | January and July | ... | ... |
| 307,980 | 10 | 2/0 | Western Telegraph (late Brazilian Submarine) | 13¾ | 14¼ | 13¾ | 14¼ | 4 15 3 | Mar., June, Oct., Dec. | 14¼ | 14 |
| £676,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | ... | ... |
| £[illegible]48,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | ... | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | ... | ... |
| 231,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/3 | 2/9 | 2/3 | 2/9 | 10 18 2 | April and October | ... | ... |
| 72,690 | 1 | 2½% | Monte Video Telephone Ordinary | ½ | ¾ | ½ | ¾ | 5 0 0 | November | ... | ... |
| 96,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ¾ | 1 | ¾ | 1 | 5 0 0 | „ | ... | ... |
| 600,000 | 5 | 2/6 | National | 3½ | 3¾ | 3½ | 3¾ | 7 17 2 | February and August | 3 5/16 | — |
| [illegible]5,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 13 | 11 | 13 | 4 12 4 | „ „ | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 | 12 | 10 | 12 | 5 0 0 | „ „ | ... | ... |
| 250,000 | 5 | 2/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 4½ | 4¾ | 4½ | 4¾ | 5 11 1 | „ „ | 4½ | 4½ |
| £3,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 90 | 93 | 90 | 93 | 3 15 11 | June and December | ... | ... |
| £[illegible] | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 96 | 99 | 96 | 99 | 4 1 8 | ... | ... | ... |
| 1[illegible],504 | 1 | 0/8 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | ... | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | ... |
| [illegible] | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | ... |
| £1[illegible],947 | Stock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 14 9 | June and December | ... | ... |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| 70,000 | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ½ | 1 | ½ | 1 | 5 14 3 | ... | ... | ... |
| 145,000 | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 17 3 | March and September | ... | ... |
| 85,000 | 1 | ... | British Electric Works Co. Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| 80,000 | 1 | ... | Do. 5 per Cent. Cumulative Preference | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £[illegible]0,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 | 90 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 8 16 4 | July and February | ... | ... |
| 70,000 | 5 | 5/0 | Do. 6 per Cent. Preference | 6½ | 6¾ | 6½ | 6¾ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4½ | 5 | 4½ | 5 | 6 0 0 | ... | ... | ... |
| 90,060 | 2 | 1/2½ | Brush Electrical Engineering | 1½ | 1¾ | 1½ | 1¾ | 3 8 7 | September | 1¾ | 1½ |
| 15,781 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. | 2½ | 2¾ | 2 | 2½ | 5 6 8 | „ | [illegible] | ... |
| 15,781 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £1[illegible],000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 5 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 | 16 | 15 | 16 | 4 13 9 | „ „ | 15 | — |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | „ „ | 5¾ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 10 | November and May | 112 | 111 |
| 450,000 | 1 | 0/9¾ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1¼ | ¾ | 1¼ | 7 2 3 | ... | ... | — |
| £150,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 | 98 | 95 | 98 | 4 12 0 | ... | ... | ... |
| 60,000 | 1 | 0/7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0/7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9¾ | Crompton and Co. (Nos. 1 to 54,000) | 3½ | 4 | 3½ | 4 | 5 12 7 | January and July | ... | — |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 6 | „ „ | ... | — |
| 60,000 | 1 | 0/7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | — |
| 99,361 | 5 | 1/6 | Edison & Swan United ("A" Shares) (£3 paid) | 1¾ | 2 | 1¾ | 2 | 9 0 0 | February and August | ... | ... |
| 17,189 | 5 | 2/6 | Do. (£5 paid) | 3 | 4 | 3 | 4 | 6 12 3 | „ „ | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 | 89 | 87 | 89 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Standing Prv. Cts (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | ... | ... | ... |
| 25,500 | 5 | 2/6 | Edmundson's Electricity Corporation Ord. | 4½ | 5½ | 4½ | 5½ | 5 1 10 | Half-yearly | 5 | ... |
| [illegible] | 5 | ... | Do. Cumulative Preference | ... | | 5½ | 6 | ... | ... | ... | ... |
| £75,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | ... | ... |
| 112,160 | 2 | 1/2½ | Electric Construction Limited | 1¾ | 2¼ | 1¾ | 2¼ | 5 6 8 | January and July | 1¾ | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2¾ | 3 | 2¾ | 3 | 4 13 4 | July | ... | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | ... | ... |
| [illegible] | 1 | ... | Giffre Electro Chemical and Power Co. Ord. | ¾ | | ¾ | | ... | ... | ... | ... |
| [illegible] | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15 | 16 | 15 | 16 | 5 5 0 | February and August | 15 | ... |
| [illegible] | 5 | 2/3 | Do. 4½ per Cent. Preference | 5½ | 6 | 5½ | 6 | 3 15 0 | „ „ | 5¾ | 5½ |
| £[illegible],000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | „ „ | — | ... |
| [illegible],000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 | [illegible] | 21 | 22 | 6 10 11 | „ „ | ... | ... |
| £[illegible],000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 [illegible] | March and September | ... | ... |
| 37,350 | 12 | [illegible] | Telegraph Construction and Maintenance | [illegible] | 41 | [illegible] | 41 | 5 2 6 | March and July | 39½ | 39½ |
| £[illegible],000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1908 | 101 | 104 | 101 | 104 | 3 17 [illegible] | January and July | ... | ... |
| [illegible] | 5 | 4/0 | Do. Manufacturing Ordinary | 11 | 12 | 11 | 12 | 3 5 1 | ... | ... | ... |
| 20,000 | 5 | 2/6 | Do. 6 per Cent. Cumulative Preference | 5½ | 6 | 5½ | 6 | 4 3 4 | ... | ... | ... |
| 30,000 | 5 | 5/0 | Willans and Robinson Ordinary | 11¾ | 12½ | 11¾ | 12½ | 4 16 3 | April and October | 12¼ | ... |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference | 6¾ | 7¾ | 6¾ | 7¾ | 4 2 3 | „ „ | ... | ... |
| £100,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 [illegible] | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

† The London Stock Exchange Committee refuses to quote these.

**Universal Engines**



Manufactured by
THE BRUSH ELECTRICAL
ENGINEERING COMPANY, Ltd.,
49, Queen Victoria Street, London, E.C.

---

**Ebonite.**

Telegrams:
INSTANTLY LONDON.

*Large Stock kept*
of
Sheets, Rods,
Tubes,
Accumulator
Boxes, &c.

THE HARBURG INDIA-RUBBER C. CO.
London Warehouse: F. WINTER, 8, Redcross St., E.C.

**Vulcanite.**

---

**TEMPERATURE COEFFICIENTS OF "CONDUCTIVITY" COPPER.**

To the Telegraph Engineer it is a matter of great importance to know with accuracy the temperature coefficient of a wire with which he is dealing, since the inferences to be drawn as to the perfection of the insulation of a cable laid in deep water depend largely upon a knowledge of the temperature of the sea bottom. In the absence of soundings with suitable thermometers, these temperatures can only be calculated from the resistance of the conductor.

The compilers of TEMPERATURE COEFFICIENTS OF "CONDUCTIVITY COPPER" (Messrs. Clark, Forde and Taylor, the well-known consulting engineers) have recently made fresh investigations of the temperature coefficient over the range of temperatures to which cables are usually exposed, and the results of their investigations are now published.

**Table I.** gives the resist. at different temperatures when the Res. at 32°F.=1
**Table II.** gives the resist. ditto ditto when the Res. at 60°F.=1.
**Table III.** gives the resist. ditto ditto when the Res. at 75°F.=1.
And
**Table IV.** gives the log. reciprocals of coefficients in Table III.

*These Tables are strongly bound in cloth, price* **2s. 6d.** net.

**SHEET TABLE showing**
**LOG. RECIPROCALS of COEFFICIENTS for COPPER RESISTANCES**

At different temperatures from 32°F. to 84·9°F.

*Printed on strong cardboard, price* **6d.** *net.*

"The Electrician" Printing & Publishing Co., Ld., Salisbury-court, Fleet-st., E.C

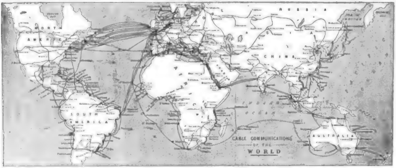
---

HAMBLET'S
BLUE BRICKS
FOR
MANHOLES & ENTRANCES
FOR
ELECTRIC
INSTALLATIONS ETC.
UNEQUALLED BY ANY
OTHER MATERIAL
FOR SUCH PURPOSES.

CONDUITS MADE
TO ANY SECTION.

For Catalogue of Various Manufactures
address,
HAMBLET'S LTD.,
West Bromwich.

## THE EASTERN TELEGRAPH COMPANY'S SYSTEM AND ITS GENERAL CONNECTIONS.



THE

# EASTERN TELEGRAPH COMPANY

(LIMITED).

IN CONNECTION WITH THE

**EASTERN EXTENSION, WESTERN, EASTERN AND SOUTH AFRICAN, EUROPE AND AZORES, WEST AFRICAN, PACIFIC AND EUROPEAN, AND AFRICAN DIRECT TELEGRAPH COMPANIES, AND THE DEUTSCHE SEE-TELEGRAPHEN GESELLSCHAFT.**

By **DIRECT TRIPLICATE CABLES** to Spain, Portugal, Gibraltar, Malta, Egypt, Aden, and India.

By **DIRECT DUPLICATE CABLE ROUTES** to Madeira, St. Vincent, Brazil, Argentine Republic, Uruguay, also to Peru, Chili, and other parts of South America; and to Suakin, Perim, Penang, Malacca, Singapore, Labuan, Java, Australia, New Zealand, Tasmania, New Caledonia, Bangkok, Cambodia, Saigon, Tonquin, Hainan, China.

By **ALTERNATIVE CABLES** to Zanzibar, Mombasa, Mozambique (duplicate), Lourenço Marques (Delagoa Bay), Durban and Capetown; Bathurst, Sierra Leone, Accra, Lagos, Bonny, Bolama, Bissao, Cameroons, St. Thome, Principe, Loanda, Benguella, Mossamedes, Conakry, Grand Bassam, and Gaboon.

By **SINGLE CABLE** to the Azores, Tangier, Tripoli, Cyprus, Seychelles, Mauritius, and Manila.

Telegrams should be sent from the Company's Stations—

**LONDON**—11, OLD BROAD STREET, E.C.; 8, LEADENHALL STREET; 3, GREAT TOWER STREET; 42, PARLIAMENT STREET, S.W.; 208a, WINCHESTER HOUSE, E.C.; 37, HOLBORN VIADUCT, E.C.; FOREIGN AUCTION HALL, COVENT GARDEN MARKET, W.C., and 449, STRAND, W.C.

**MANCHESTER**—20, Brown Street. **LIVERPOOL**—K13, Exchange Buildings.

**GLASGOW**—5, ROYAL BANK PLACE.

### COMPANY'S LEVANT SYSTEM:

Odessa, Constantinople, Dardanelles, Tenedos, Salonica, Smyrna, Chio, Syra, Candia, Rettimo, Canea, Sitia Rhodes, Trieste, Corfu, Zante, Patras, Corinth, Athens, Cephalonia, Santa Maura, Tinos, Andros, Zea, and all the Greek Islands.

This Company's Cables are worked by Muirhead's System of Duxplex and Automatic Curb Transmission upon all its Main Sections.

In sending Telegrams from Postal Stations care should be taken to mark them— "VIA EASTERN" these words being signalled gratuitously by the Postal Authorities

Books of Forms and Tariffs forwarded post free on application at the Company's Chief Offices as above, or at

37, RUE CAUMARTIN, PARIS; and HOTEL DES POSTES ET TELEGRAPHES, MARSEILLES.

Winchester House, 50, Old Broad Street, E.C. By Order GEORGE DRAPER, *Secretary.*

# THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

## ELECTRICAL ENGINEERING, INDUSTRY, AND SCIENCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

No. 1,196. [No. 26. Vol. XLVI.] FRIDAY, APRIL 19, 1901. PRICE SIXPENCE (by post, 6½d.) Abroad, 8d., or 16 cents, or 80c., or 70pf.

### CONTENTS OF THE CURRENT NUMBER.

## NOTES.

CONTRARY to expectation, the list of nominations for the President, Vice-Presidents, and Members of Council for the forthcoming session of the Institution of Electrical Engineers was not announced at the meeting last night.

THE special report by the Board of Trade (under Sec. 1 of the Electric Lighting Act, 1888), which we reprint on another page, sets forth in chronological order the electric lighting history of St. Marylebone, the purpose of this historical fragment being to justify the decision of the Board for a second time to dispense with the consent of the local authority in the matter of an application for a provisional order by the Marylebone Electric Supply Co. Parliament itself accordingly will have to decide whether this district is or is not to be subject to competition in electrical supply; and if so, whether the new rival is to be the local authority or the company which that authority has treated so unfairly. On the previous occasion when the consent of the same local authority—then known as the Marylebone Vestry—was withheld from the same company, the pretext of the Vestry was that it contemtemplated doing the work itself. After having ousted the new company on this plea, however, the Vestry decided not to do any actual work itself, the matter thus lapsing for a time. History is repeating itself in a measure: substantially the same issue is to go before Parliament. It remains to be seen whether the once discarded and now revived pretext—that the local authority seriously means to supply electricity, will be accepted as bonâ fide by our legislators.

IN our issue for January 4th, reference was made to the unsettled condition of the carbide industry, due to the over-speculation and over-production which had characterised the period 1898-1900. During 1900 the price of carbide had fallen from £20 to £10 per ton at Hamburg, and at the latter price many of the works had ceased to yield a profit. Dr. ROSE, the British Consul at Stuttgart—who has sent home many valuable reports upon the progress of the carbide and acetylene industries in Germany—has given further details of this financial crisis in the carbide industry in the March issue of the *Journal of Acetylene Gas Lighting*. In 1900 the carbide companies which have agreed to place their output and sales in the hands of a Frankfort company (the Gold- & Silberscheide Anstalt) produced 50,000 tons of carbide, while the consumption in Germany only amounted to 15,000 tons. The companies who have entered into the above agreement, it may be explained, own works in Germany, Switzerland, Austria, Sweden, and Norway, but the French and Italian makers of carbide are outside the association, and in these two countries the capacity of the carbide works is also greatly in excess of the demand. At the commencement of 1901, therefore, the dealers in carbide in Europe carried a stock of 85,000 tons, with the prospect of further additions during the early months of the year. In these circumstances, hopes of a decided recovery in price are held by Dr. ROSE to be somewhat visionary, and the suspension of manufacture by many of the works is likely to become permanent. At Thusis, in Switzerland, aluminium is to be manufactured in place of carbide, while the power at the Ruhr carbide works is to be devoted to the manufacture of wood-pulp. At Lauterbach, in Switzerland, and at Milan, the carbide works have been closed for an indefinite period, and in the latter case the company who owned the plant and machinery is stated to have lost heavily.

THE above facts and figures can hardly prove pleasant reading for those who have invested largely in this new industry. Abroad, the big electrical engineering companies will be most heavily hit by the collapse, as these, in many cases, have provided the plant and machinery for the carbide works on the basis of payment in shares—instead of in cash. In this country, speculation in the manufacture of carbide has been on a much more limited scale, and the chief losses that have occurred have been in connection with acetylene generator patents, of little value save for company flotation purposes.

The professional company promoter has, in fact, been the bane of each of these new industries since their birth, and it may take years of solid work and effort by a different class of men to place either industry in Europe upon a basis of sound finance. Acetylene illumination has a future, that we are perfectly ready to admit. It is, however, not only foolish, but also financially unsound, to talk and act as though acetylene would displace every other illuminant now in the field,—and this has been the mistake of the past. Acetylene will be used only when its cost is below that of other illuminants for the particular locality concerned. With electricity, coal gas, and oil as rival illuminants, its field of utilisation can never be a very extensive one. When those responsible for the finance of the carbide and acetylene industries recognise this truth a repetition of the errors of the past will become impossible.

Ignorant people sometimes scoff at the idea of utilising direct solar heat for raising steam. There are other people, not less ignorant of what can really be achieved, who go to the opposite extreme and advocate the wholesale use of this "cheap" source of power. The fact, however, is that while the production of mechanical power from direct solar radiation has long been *un fait accompli*, there are but few localities where it offers any advantage over other methods. In our contemporary *Nature* for the 11th inst. there is an illustration of a large sun motor, which has been erected in California for pumping. The reflector which serves to focus the radiation upon a small boiler consists of no less than 1,800 little mirrors, arranged like a mosaic on a parabolic annulus 36ft. 6in. at its major diameter, and 15ft. diameter at the lower truncated extremity. By an arrangement of clockwork actuating an equatorial mounting the sun is kept in focus. Doubtless there are not a few places in "the ends of the earth" where such a plant would usefully provide energy to be stored for artificial lighting after dark.

**City and Guilds of London Institute.**—His Majesty the King has graciously consented to become patron of the City and Guilds of London Institute, of which, as Prince of Wales, he has been president since 1881.

**Obituary.**—Lady Siemens, widow of Sir William Siemens, F.R.S., died on Friday, last week, at Sherwood, Tunbridge Wells. She was the youngest daughter of the late Mr. Joseph Gordon, Writer to the Signet, Edinburgh, and was married to Sir William Siemens in 1859.

**Dublin Section of the Institution of Electrical Engineers.**—At a meeting of this section at the Royal Dublin Society yesterday the following two Papers were read:—(1) "Sources of Electromagnetic Vibrations," by Dr. F. T. Trouton, F.R.S. (2) "Notes on a Humming Telephone," by F. Gill.

**The Telegraphone.**—Those who are interested in Mr. Poulsen's ingenious invention, the telegraphone, may be glad to avail themselves of an opportunity to inspect it. The instrument will be on view throughout next week from 11 a.m. to 4 p.m. daily, at 2, Angel-court, Throgmorton street, E.C.

**Society of Arts.**—His Majesty the King who, as Prince of Wales, has been president of the Society of Arts since 1863, has graciously acceded to the request of the Society and consented to become its patron. His Majesty has also permitted the society to continue the use of his profile on the medals of the society.

**Personal.**—The King has been pleased, on the recommendation of the Secretary for Scotland, to approve of the appointment of Prof. T. Hudson Beare, now Professor of Mechanical Engineering at University College, London, to the Chair of Engineering in the University of Edinburgh in succession to the late Prof. Armstrong.

**Cable Interruptions and Repairs:—**

| | Date of Interruption. | Date of Repair. |
|---|---|---|
| Latakia—Cyprus | June 21, 1899 | — |
| Pará—Maranham | Mar. 2, 1900 | — |
| Perim—Obock | Mar. 22, 1901 | April 15, 1901 |
| Sierra Leone—Conakry | April 2, 1901 | April 16, 1901 |
| Bali—Macassar | April 14, 1901 | — |

**Kew Magnetic Observatory and the West London Tramways.**—With regard to the arrangements which have been arrived at between the authorities of Kew Observatory and the London United Tramways Co., we learn that although it has been decided to remove the instruments to some place where they will be free from disturbance by electric traction, the precise nature of the arrangements have not yet been decided upon by the Laboratory committee.

**Motor Car Experimental Run.**—A long-distance run with a light electric motor car was carried out last week by M. Garcin between Paris and Mantes and back, when a distance of 85 miles on one charge of the battery was covered in 6 hours 32 min. 55 sec. The vehicle weighed complete 14 cwt. 38lb., and was fitted with a battery of accumulators of the Buquet-Garcin Schiore type of 120 ampere-hours' capacity and weighing only 6½ cwt. The run is claimed to be a record for a car of such light weight.

**Combination Conduit for Chicago.**—The *Western Electrician* of Chicago for March 16th, describes a scheme, proposed by the Chicago city electrician, Mr. E. B. Ellicott, to construct a combination conduit with sufficient ducts for all the corporations using electric wires, and an ordinance has been prepared requiring that hereafter all streets, to be newly paved, shall be provided with sufficient ducts for present and future requirements. The scheme provides for separate manholes for each company, the cost of construction of the system being divided in proportion to the ducts required.

**Sheffield Municipal Electricity Works.**—With regard to the statement in our last issue (see page 955) as to the extinction of light at Sheffield, we are asked to state that the information was not accurate and is liable to give a wrong impression. The supply of electrical energy in Sheffield, it appears, has only once been cut off during the last six months, this being due to a large 1,100kw. alternator suddenly breaking down. The minor extinctions to which Ald. Styring referred really only affected a very few customers through the blowing of a fuse in a local transformer, and in some of the cases cited only one consumer was affected.

**Paris Exhibition Literature.**—The fifth number issued of MM. Hospitalier and Montpellier's "L'Electricité à l'Exposition de 1900" (Paris: Vve Ch. Dunod) contains descriptions of measuring instruments, and is written by MM. Montpellier and Aliamet. A large number of old and well-known instruments are described in it, but as the majority of newer patterns exhibited at the Exhibition are dealt with in considerable detail as well, the publication will be found useful to both instrument makers and instrument users in this country. Ammeters and voltmeters are included, and, in fact, are responsible for a large portion of the number, but integrating meters are presumably reserved to be dealt with separately.

**The Andrew Carnegie Research Scholarship.**—The Iron and Steel Institute notifies that candidates must apply to the secretary before the end of April in connection with the Research Scholarship founded by Mr. Andrew Carnegie. The object of the scholarship is to enable students to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. The scholarship is for one year, but the Council may renew for a further period. The results of the research are to be communicated to the Iron and Steel Institute in the form of a Paper, and if of sufficient merit the Andrew Carnegie gold

medal will be awarded. The gift consisted of 32 $1,000 Pittsburg, Bessemer and Lake Erie Railway Co. 5 per cent. debenture bonds.

Power Transmission in Utah.—The *Electrical World* of New York for March 30th in a Paper on the lessons from the operation of the power transmission system of the Utah Light and Power Co., after describing the installation, which was started in 1897, mentions that one peculiarity of the company's system, as at present operated, is the absence of fuses, save on the street transformers and secondary distribution. Oil-insulated transformers have shown themselves much more reliable than the dry, two or three dry transformers burning out usually after each thunderstorm. It is found that over mountainous country No. 4 is the smallest copper wire that should be used. A 6-mile line of No. 2 aluminium wires has been tried with success, the wire being made especially soft, and not stretched very tight. In the case of the Ogden line, where are six No. 1 wires with 50 poles to the mile, the cost of the copper was $1,000 a mile out of a total of about $2,500. The maximum load from the power station has now increased to 5,500 H.P.

Lightning Research Committee.—It is announced in *Nature* this week, that a committee, to be known as the Lightning Research Committee, has been organised by the Royal Institute of British Architects and the Surveyors' Institution, with the object of collecting and tabulating information from all parts of the country as to damage resulting to buildings from lightning. The committee includes Mr. John Slater (chairman), Major-Gen. E. R. Festing, C.B., F.R.S.; Dr. Oliver Lodge, F.R.S.; Messrs. J. Gavey, W. P. Goulding, W. N. Shaw, F.R.S., H. H. Statham, A. R. Stenning, Arthur Vernon, Killingworth Hedges, C.E. (hon. secretary). In pursuance of their inquiry the committee seek the co-operation of competent observers in all parts of the country, with a view to obtaining accurate details, noted on the spot, of the effect of lightning-strokes on buildings, whether fitted with conductors or not. Persons willing to assist by their observations are invited to communicate with the secretary at the offices of the Royal Institute of British Architects, 9, Conduit-street, London, W.

Wireless Telegraphy and the United States Weather Bureau.—The work of the United States Weather Bureau in its experiments with wireless telegraphy is being pushed with business-like energy. At present, says the *Western Electrician*, the experiments are being confined to stations along the coasts of Virginia and North Carolina. Mr. Willis L. Moore, chief of the bureau, finds from his experiments up to this time that the greatest efficiency in long-distance transmission is obtained from wire cylinders. Each of the new coast stations is being equipped with cylinders of 16 wires, each wire being 140ft. in length. At present stations are in operation at Hatteras and Roanoke Island, in Pamlico Sound, North Carolina. When the third station now building at Cape Henry is completed, the distance between the most widely separately stations will be a little more than 125 miles. The two completed stations and the one building are now connected by an ordinary telegraph line, which will be abandoned on the completion of the third station.

National Standardising Bureau for the United States.—The bill establishing a National Standardisation Bureau has passed both Houses of Congress. The functions of the bureau will consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce and educational institutions with the standards adopted or recognised by the Government; the construction, when necessary, of standards, their multiples and sub-divisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere. The following sums of money have been appropriated: For the payment of salaries, $27,149; for the erection of a suitable laboratory, of fireproof construction, $100,000; for equipment, $10,000; for site, $25,000; miscellaneous expenses and contingencies, $5,000.

Testing Electric Light Networks.—A pamphlet on this subject, written by M. Paul Charpentier, has been sent us by the publisher (Ch. Béranger, Paris). It suggests a method of testing and localising faults in electric lighting networks, which is a development of the Agthe and Kallmann test-wire system, combined with the loop system, as applied to this class of networks. The author proposes to add between the two external layers of insulation of the cable a wire spiral with a short pitch. If the cable is damaged, this spiral wire will be earthed, as there is only a thin layer of insulation between it and the lead, and a continual test of it will reveal any faults. These wires are to be connected up among themselves in the same way as the working conductor of the cable, and an additional telephone wire is to be laid alongside to form an insulated return for the loop test and to facilitate communication with the station while testing outside. We do not think that M. Charpentier's system will work as well as he anticipates. As a means of insulation testing it has the disadvantage of leaving out of account the consumer's wiring, and there would be various sources of difficulty and error in applying it for fault localisation. These might perhaps be overcome, but we think that the system will hardly receive general application.

The Manufacture of Carbons for Electrical Purposes.—In the issue of the *Zeits. für Elektrochemie* for March 28th Zellner gives a detailed account of the development of the electric light carbon industry. The first English patent for the manufacture of such carbons was granted to Staite and Edwards in 1846. Their method consisted in mixing pulverised charcoal with sugar solution, moulding under pressure, and heating the moulds in chambers from which the air was excluded. The resultant rods were again soaked in sugar solution and submitted to a second heating. The method was, therefore, in principle similar to that now used, but many improvements had to be made before the manufacture reached its present high standard of excellence. Limit of space forbids any reference to the numerous patents which have been granted for improvements in the process of manufacture since 1846, but these are fully dealt with in the original article. Zellner states that great improvements were made after the Paris and Vienna exhibitions of 1881 and 1883, greater attention being paid to the purification of the raw materials used in the manufacture. Reference is made to the fact that although the first patents in connection with this industry had been granted to English inventors, and although the first text book upon the subject was published by "The Electrician" Printing and Publishing Co. ("The Manufacture of Electric Light Carbons." O. Pritchard. 1890), yet the manufacture was allowed to slip into foreign hands, and England, in that year, was meeting her requirements of electric light carbons chiefly by importation from the Continent. The article closes with a reference to the new branch of manufacture of carbons for electrolytic purposes, and with a list of the firms in Europe now engaged in the industry. Germany stands first with 14, France and England follow with 5 each, and the remaining six are distributed over the rest of Europe. The value of the recent text book "The Manufacture of Carbons for all Electrical Purposes" by Jehl—the successive chapters of which were published originally in our columns—is acknowledged, and the thick fog of ignorance that for many years hung over the industry is admitted to have been dispelled.

Poleforcia.—We have received a pamphlet describing the most amazing invention of the last century,—the invention of no less than "a new method whereby power may be produced and utilised, and it destroys the modern accepted theory of energy so far as regards its universal application." Naturally a new power must have a new name, and the incomprehensible "Poleforcia" has been selected for the purpose. The invention consists in the use of several fly-wheels, each fly-wheel being provided with its own driving motor, and these alternately give rotation to a shaft. Though truly an astounding discovery, unfortunately it is not new; we believe it dates back like many other discoveries to the ancient Egyptians. The complicated gearing by which the fly-wheels are thrown in and out of action probably is new; but really the scheme is not immense enough. There should have been a very small

engine and a gigantic fly-wheel, say half the size of Europe, then we should work away at the fly-wheel, say, for a century or two, till the wheel got up a prodigious velocity; and after that what could not be done with the public? But now-a-days we want our returns so quickly. Then there is the name Poleforcia, a name that might refer to one of the old heathen goddesses. The name should certainly be a catch, and though it is only claimed as a new word for momentum—"no kintic (*sic*) energy business"—it is after all what prosaic people familiarly know as kinetic energy.

**The Financial Position of the Accumulator Industry in Austria-Hungary.**—In our issue of March 28th we referred to the report of the German firm of accumulator manufacturers, Boese & Co., of Berlin. The issue of the *Centralblatt für Accumulatoren und Elementenkunde* for April 1st contains some remarks upon the position of the accumulator industry in Austria, which show that it is not prospering as in the neighbouring country of Germany. The ease with which capital has been found for exploiting new inventions relating to the design and manufacture of accumulators for traction purposes, is held to have been one of the chief causes of the present unsatisfactory position. Such accumulators have been placed upon the market without sufficient preliminary trials, and both the users and the financiers have lost heavily by this premature exploitation of new accumulators. Time and knowledge are required to thoroughly test a new design or type of accumulator plate. The demands of the users have been gradually raised until a stationary accumulator battery plate is expected to have a life of 2,000 chargings and dischargings, and an automobile accumulator battery plate a life one-quarter to one-third of this limit. The financier is ignorant of these facts, and has been willing to invest his money in promotion schemes foredoomed to failure. It is pointed out that in recent years no less than five firms in Austria-Hungary have ceased to manufacture accumulators, owing to the unsatisfactory financial position of the industry. These facts are taken from an article appearing in the *Zeitschrift für Elektrotechnik* of Vienna, and the comment of the writer in the German paper is, that they have apparently been published in the interests of the surviving firms, who naturally would like to check any further developments in this industry within the confines of the dual-monarchy.

**"Standing Order No. 22."**—The official circular of the Tramways and Light Railways Association contains the following announcement:—

One of the most important points of interest to the members of the Tramways and Light Railways Association which has arisen during the last month is the proposed amendment to Standing Order No. 22, referring to the necessity of tramway promoters obtaining the consents of the local authorities of the districts to be affected by the proposed scheme. The following is a copy of the existing standing order, and the proposed alterations are enclosed in brackets:—In cases of bills to authorise the laying down of a tramway [proof shall be given before the committee on the bill that the promoters have either obtained] the consent of the local authority of the district or districts through which it is proposed to construct such tramway, and where in any district there is a road authority distinct from the local authority, the consent [also] of such authority in any case where power is sought to break up any road subject to the jurisdiction of such road authority [or that the consent of such local or road authority has been withheld, and if in the opinion of the committee such consent has been unreasonably withheld and ought to be dispensed with, the committee shall report accordingly with the reasons and facts upon which their opinion is founded]. We understand that the Earl of Morley (the chairman of committees of the House of Lords) first intended to bring forward the above amendment some four weeks ago, but that since then private pressure has been brought to bear in opposition to the proposals, and the amendment is at present indefinitely postponed. We would specially recommend all the members of the Tramways and Light Railways Association to most seriously consider the question whether local authorities have not at present altogether an excessive power of veto with regard to the introduction of tramway systems promoted by independent parties. If they consider this question should be answered in the affirmative they should most certainly seize the present opportunity of using their influence, both privately and publicly, in favour of the proposed amendments. There is no doubt that on occasions local authorities have acted unreasonably in withholding their consent to proposed tramway schemes, and, in any case, it appears only wise and fair to give the promoters the opportunity of referring to an independent opinion where there is any question of the power of veto being used without sufficient justification.

**A New Accumulator Factory.**—The Pfluger accumulator factory at Oberschoneweide, described in a recent number of the *Centralblatt fur Accumulatoren und Elementenkunde*, was completed in April, 1900, and covers 54,000 sq. yards. In the foundry 2 tons of lead are used per day for casting purposes. Chemically pure lead is employed. The cleaning and trimming of the rough cast lead plates is effected partly by machine and partly by hand. The coating of the plates with paste is carried out in a separate department, in which special precautions are taken to prevent lead poisoning. The air in this part of the factory is kept moist by the evaporation of water from the channels with which the cement floor is provided, while during working hours the walls of the rooms are frequently sprinkled with water. After drying and hardening the pasted plates are taken to the "forming" room and are subjected to repeated charging and discharging tests. In this department also special attention has been paid to the comfort and health of the workpeople, and the ventilation of the rooms is effected by a fan driven by a 2 H.P. electric motor. Trolley lines run into all departments of the factory, and facilitate the transfer of the finished and partly finished plates. The electrical energy required for charging the finished cells is derived from a transformer installation, where a 6,000 volt three-phase current is transformed into continuous current of the desired voltage by three motor generators. That the accumulator industry in Germany is profitable is proved by the financial report, given in this journal, of the Accumulatoren und Elektricitats Werke A. Gesellschaft vorm. W. A. Boese & Co. This company shows a net profit of £37,530 on the past year's operations, and declares a dividend of 11 per cent., carrying at the same time large sums forward and to reserve.

## MEETINGS OF SCIENTIFIC AND ENGINEERING SOCIETIES, &c.

**TO-DAY (FRIDAY), April 19th.**

INSTITUTION OF MECHANICAL ENGINEERS.

*8 p.m.* Ordinary General Meeting, when the President's Address will be delivered.

ROYAL INSTITUTION.

*9 p.m.* Evening Discourse by Prof. J. J. Thomson, F.R.S. Subject: "The Existence of Bodies Smaller than Atoms."

**MONDAY, April 22nd.**

SOCIETY OF ARTS.

*8 p.m.* Cantor Lecture I. "Alloys," by Sir W. C. Roberts-Austen, F.R.S.

**TUESDAY, April 23rd.**

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER SECTION.

*7.30 p.m.* Annual general meeting at Owens College for the election of officers for the ensuing session.

**WEDNESDAY, April 24th.**

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

*7.30 p.m.* Meeting at 28, Victoria-street, S.W. Paper to be read: "Distribution of Energy in Coal Mines," by F. E. Pring.

SOCIETY OF ARTS.

*8 p.m.* Ordinary Meeting. Paper to be read: "Patent Law Reform," by Alexander Siemens.

**THURSDAY, April 25th.**

INSTITUTION OF CIVIL ENGINEERS.

*8 p.m.* "James Forrest" Lecture. Subject: "On Chemistry in its Relations to Engineering," by Prof. Frank Clowes.

INSTITUTION OF JUNIOR ENGINEERS.

*8 p.m.* Lecture VI. "On Works Management," by A. H. Barker, at the Westminster Palace Hotel.

**FRIDAY, April 26th.**

PHYSICAL SOCIETY.

*5 p.m.* Meeting in the rooms of the Chemical Society, Burlington House. Agenda: (1) "On the Thermodynamical Correction of the Gas Thermometer," by Prof. Callendar, F.R.S. (2) "On the Production of a Bright-line Spectrum by Anomalous Dispersion, and its Application to the Flash-Spectrum," by Prof. R. W. Wood.

SOCIETY OF ARTS.

*8 p.m.* Howard Lecture I. "Polyphase Electric Working." By A. C. Eborall.

**SATURDAY, April 27th.**

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS' SECTION.

Visit to the works of Messrs. Easton, Anderson and Goolden, Erith, Kent.

## CONTEMPORARY ELECTRICAL SCIENCE.

[Compiled by E. E. FOURNIER D'ALBE.]

*Sine Currents.*—A Hertzian oscillator gives frequencies which are variable within very wide limits. But the period of actual oscillation is very small in comparison with the time of quiescence. Kohlrausch's sine inductor gives very pure sine currents, but their frequency does not exceed 150. Induction-coil currents have frequencies of 1,000 and more, but they are not even approximately sinusoidal. Hummel's continuous-alternate-current transformer gives frequencies of 400 to 500, but even those are not sufficient for demonstrating resonance phenomena. M. Wien has therefore devised a method of producing sinusoidal alternate currents with frequencies as high as 8,500 ~ per second. In these currents none of the higher components have an amplitude exceeding 1 per cent. of the main amplitude. The latter is 0·2 ampere with a resistance of 100 ohms, and that suffices for most measurements. For experiments in which the currents need not be very purely sinusoidal, double the frequency may be produced with the same apparatus—viz., 17,000 ~ per second. The principle of the apparatus is the following :—A disc of wood or brass carries a number of pieces of transformer sheet-iron round its rim, and the latter moves between the poles of an electromagnet. The alternations thus generated are reinforced by what the author terms "electric resonance," which consists in bringing the proper period of the electric system into unison with the frequency by inserting a suitable capacity and regulating the inductance. By this device the amplitude of the main current is greatly augmented, while the overtones remain small as before.

[M. WIEN, *Ann. der Physik*, No. 3, 1901.]

*Manometric Study of the Telephone.*—Since Morritt has shown the possibility of photographically registering the variations of manometric flames, the sphere of usefulness of this very sensitive reagent has been very greatly increased. L. W. Austin has applied this method with considerable success to the study of the motion of telephone membranes. A jet was inserted through a rubber cork cemented into the opening of a telephone cap, and another hole was drilled in the cap through which the gas was introduced, thus making a manometric capsule of the telephone itself. The apparatus was tried with a number of different alternators and the curves from all of these showed their own peculiarities of form, though a certain distortion seemed to be present. The reason for this has not been with certainty determined, but it seems probable that it is due at least in part to the flame itself and its tendency to flare. In any case, the lower line of the luminous part of the flame follows quite accurately the motion of the diaphragm, and the device is very useful for showing the current-curve of an alternator. In connection with a second manometric flame actuated by a tuning fork of known period it becomes a frequency teller. It may also be employed for studying the distortion of sounds inherent in telephone transmission, and it offers a convenient method of comparing small alternating E.M.F.s. For photographing the flames acetylene gas must be employed, coal gas not being of sufficient actinic power.

[L. W. AUSTIN, *Phys. Review*, February, 1901.]

*Velocity of Flame Ions.*—The new method suggested by J. J. Thomson for determining the velocity of ions in a gas not having hitherto been carried out, C. D. Child has applied it to the determination of the velocity of ions produced by a flame. The method consists in measuring the potential and the flow of current in a space through which only ions charged with one kind of electricity were passing. The main difficulty encountered in carrying the method into practice is that of accurately determining the potential at two points. A wire probe will not serve the purpose, as a positive charge will not leak off from it while a negative charge will. The author therefore employed the water dropper for this purpose. A gas flame was burnt between two metallic plates kept at a constant difference of potential by means of a water battery, and the water dropper was introduced between the flame and one of the plates. The results show that the velocity of the positive ions drawn from a Bunsen burner is approximately 2·2cm. per second for a potential gradient of 1 volt per centimetre, and that for negative ions 2·6cm. In the case of an unlimited supply of ions, if the discharge takes place between two regular surfaces the velocity may be determined by simply measuring the current per unit area and the difference of potential between these surfaces, and if the surfaces are not at all regular, the relative velocities of the positive and negative ions may be determined by comparing the positive and negative currents.

[C. D. CHILD, *Phys. Review*, February, 1901.]

*Allotropic Forms of Silver.*—The electroplating process with silver is subject to certain irregularities which have been to a great extent cleared up by Berthelot's discovery of the four allotropic states of silver—viz., silver modified by the action of oxygen at 550deg., silver precipitated by copper and not heated, the same heated afterwards, and crystallised silver. Whenever one of these varieties is opposed to another in an electrolytic cell containing a 10 per cent. solution of silver nitrate a current is generated, amorphous sheet silver being positive with respect to the other varieties. Since the amorphous variety has the greatest heat of oxidation, its electro-chemical behaviour is just what one might expect. The author has not succeeded in determining the E.M.F. developed between two allotropic forms, as the current never lasts more than 5 min. At the end of that time the surfaces of the two electrodes are equalised by the deposition upon the cathode of the particular allotropic variety of silver of which the anode consists. It is difficult also to obtain any one of the forms in a pure state, as most of the processes tried give rise to a mixture of two or more forms.

[BERTHELOT, *Comptes Rendus*, March 25, 1901.]

*Blaze Currents as a Sign of Life.*—An electrical method for estimating the vitality of seeds has been based by A. D. Waller upon the "blaze currents" discovered by him and first described in connection with a frog's eyeball. A "blaze current" is a galvanometrical token of an explosive change locally excited in living matter. It may be a current in the same direction as the stimulating current, or in the opposite direction. In the latter case it is equivocal, as it cannot be distinguished from a counter-current due to polarisation. It is, therefore, the direct current that the author relies upon as a criterion of life. The proof that the criterion is a true one is furnished by the author's experiments on beans of various ages. Beans not more than a year old all show blaze currents, and all germinate vigorously in the incubator. Seeds grown in 1860 show no perceptible blaze currents, and do not germinate. New seeds show only half the E.M.F. of blaze current (*i.e.*, about 0·02 volts) after three days soaking in water, and none after four weeks' soaking. Anæsthetics and cold also influence the blaze currents and the germination in a parallel manner. It is evident that the author has discovered a test which enables us to satisfactorily distinguish between living and dead matter.

[A. D. WALLER, *Proc. Roy. Soc.*, March 25, 1901.]

*Loud-speaking Radiophone.*—T. Tommasina has constructed an electric radiophone which can be heard throughout a large hall. It is not so sensitive as previous patterns, but still responds to exciter sparks of only 1mm. length. No relay is used, and the receiver is simply in circuit with a battery and a telephone. While in the ordinary coherers the particles must be free to move, they are embedded in a pasty mass in the new coherer. The author employs silver filings mixed with lycopodium, sulphur, or glass powder, and embedded in glycerine. The electrodes are platinum coils wound on glass. Electric waves impinging upon this coherer produce an increase of resistance which, however, only lasts as long as the impact lasts. The coherer is, therefore, self-righting, and to such an extent that the author declares it to be an interrupter controlled by electric waves. Its efficiency, as such, is directly proportional to the strength of the current traversing it. At a certain critical current strength the galvanometer needle becomes nearly stationary, while the telephone responds vigorously. This shows that the interruptions are practically instantaneous.

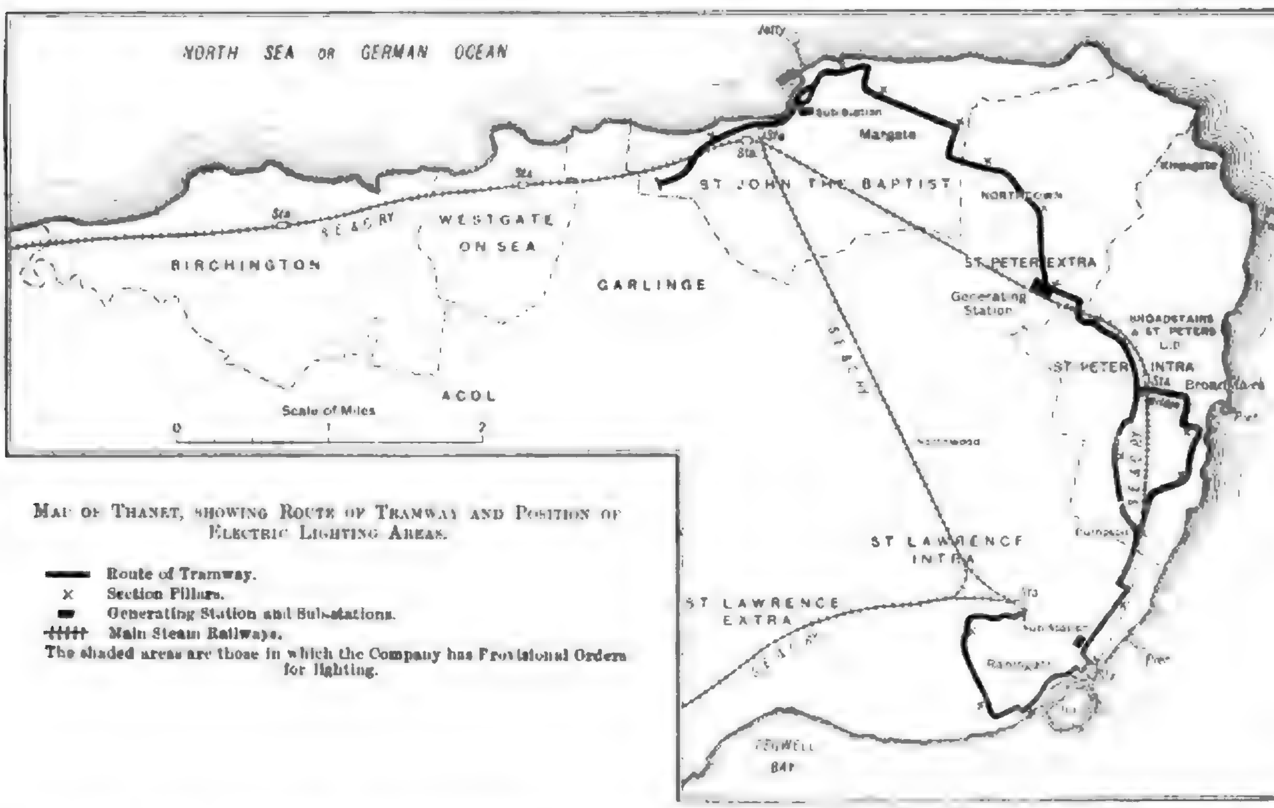
[T. TOMMASINA, *Comptes Rendus*, March 11, 1901.]

# THE ISLE OF THANET TRAMWAYS.

In this article it is intended to describe the Isle of Thanet Tramways, which started running with great success on Thursday, April 4, the day before the commencement of the Easter holidays. A most interesting fact in connection with these tramways is that they are a light railway "within the meaning of the act," but to examine critically the precise distinction intended by this act would be outside the scope of the present article. At all events, we welcome the fact that the Light Railway Commissioners are ready to pass an inter-urban tramway as a light railway, even though there be no intention on the part of the promoters to avail themselves of provisions in the act for the conveyance of farmers' produce, cattle, pigs and poultry; and we should be the last to object if Mr. Gerald Balfour's bill now before Parliament left a loop-hole for purely urban electric tramways to come in, and thus evade the iniquitous 21 years' purchase clause of the Tramways Act of 1870.

The Isle of Thanet Tramways include at present about (about 3 miles) of absolutely new roads the company has been compelled to build, besides widening 1½ miles of the existing roads, coupled with a three months' suspension of the work in the towns of Margate, Broadstairs, and Ramsgate both in 1899 and 1900, which the local authorities were able to enforce during the "season."

Originally it was intended to run the tramway from Margate to Westgate, and on through Birchington to Birchington Bay, but opposition on the part of the residents and landowners at Westgate caused this part of the scheme to be thrown out. In addition to the provisional orders already mentioned, the areas corresponding to which are shaded in the map, the company naturally wished to acquire powers for electric lighting in Ramsgate. Here, however, the Corporation opposed the company, and obtained a provisional order itself, but as no further use has been made of this order up to the present, we should not be surprised to hear soon that a transfer has eventually been negotiated.



MAP OF THANET, SHOWING ROUTE OF TRAMWAY AND POSITION OF ELECTRIC LIGHTING AREAS.

Route of Tramway.
× Section Pillars.
Generating Station and Sub-stations.
Main Steam Railways.
The shaded areas are those in which the Company has Provisional Orders for lighting.

11 miles of track, but electric lighting provisional orders have also been obtained for Margate, Broadstairs, Westgate, Birchington and St. Peter's—the Margate provisional order having been transferred from the Corporation and the others obtained directly by the Isle of Thanet Tramways Co.—and all these districts will be supplied from the large power-station situated at St. Peter's. The map which we publish on this page shows the route of the tramways, the disposition of the areas, and the position of the generating works. The whole scheme has initiated with Mr. W. M. Murphy, whose name is well known in connection with the Dublin tramways, and with characteristic energy he has brought it into effect in spite of stubborn opposition from several quarters locally and delays on all sides. So long ago as December, 1896, he deposited his application with the Light Railway Commissioners. In May, 1897, the Commissioners sat in Ramsgate to hear objections, and the light railway order was finally confirmed by the Board of Trade in August, 1898. On April 18, 1899, the work was started, and the fact that the line then took two years to complete is largely accounted for by the great length

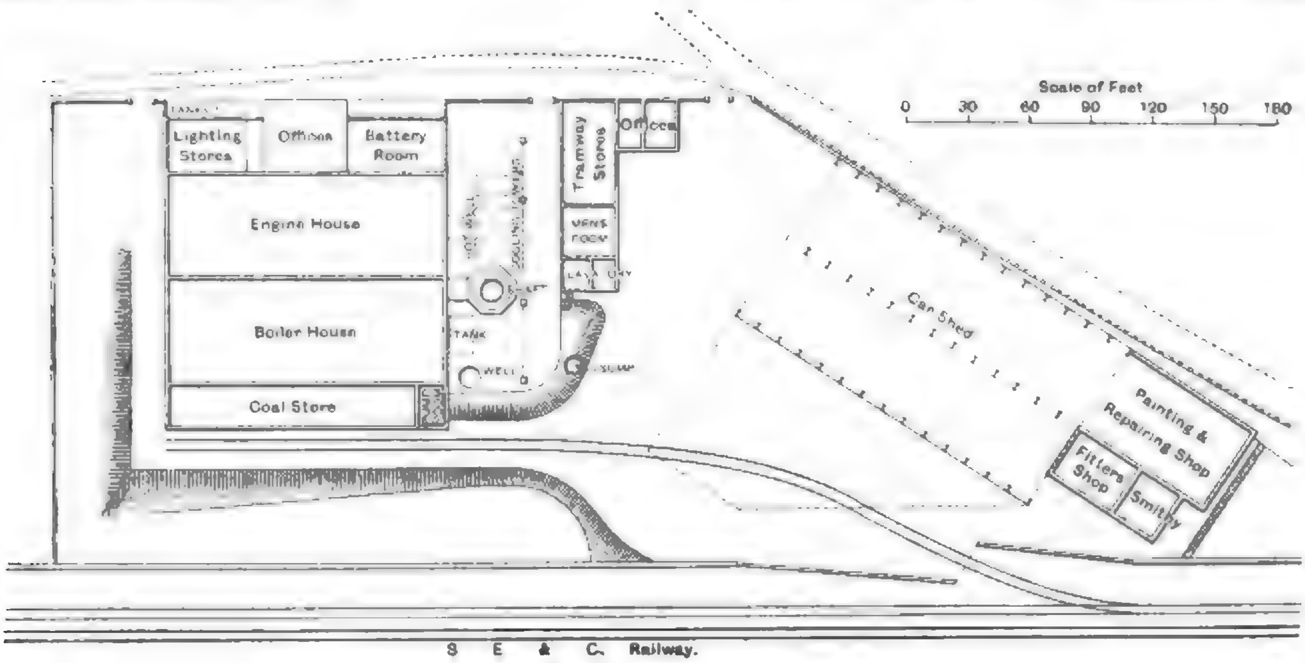
The work has been carried out under the direction of Mr. Arthur J. Salter, engineer to Mr. Murphy, Messrs. Kincaid, Waller and Manville being the consulting engineers, and Mr. H. F. Parshall advising also as to the electrical equipment. Mr. Beverley Griffin is supervising on the spot for Mr. Murphy, Mr. T. E. Etlinger on behalf of Messrs. Kincaid, Waller, and Manville, and Mr. Streatfield for the British Thomson-Houston Co., the chief contractors. Mr. Arthur A. Tyler is general manager, and Mr. Richard Humphries resident engineer. Following is a list of the contractors and sub-contractors :—

| | |
|---|---|
| British Thomson-Houston Co. ..... | Electrical equipment of station, sub-stations, line and cars. |
| R. W. Blackwell & Co. .................... | Allis engines and steam pipes. |
| Bellis and Morcom ....................... | Engines for three-phase generators. |
| Babcock and Wilcox .................... | Boilers. |
| Wheeler Condenser & Engineering Co. | Condensers and cooling tower. |
| Blake and Knowles Steam Pump Works .................................. | Feed-pumps. |
| Railton and Campbell .................. | Oil separators. |
| Desrumaux Automatic Water-Softener and Purifier ............... | Water-softener. |

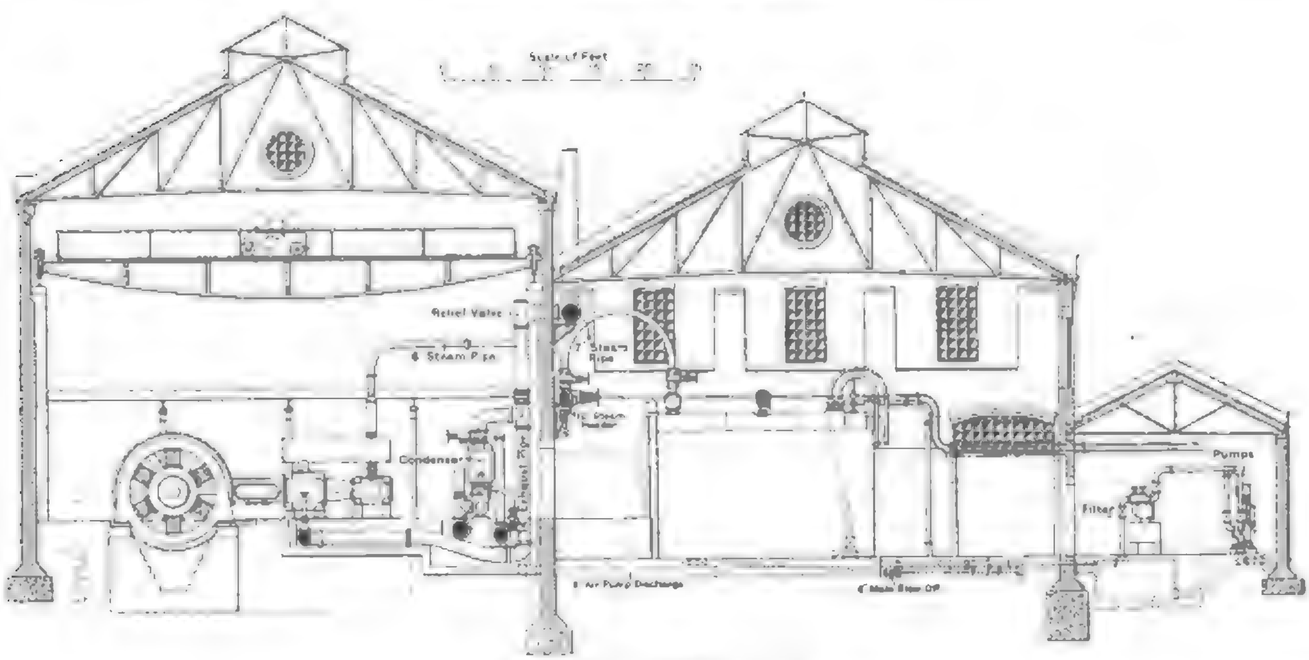
| | |
|---|---|
| Worthington Pumping Engine Co. | Pumps to reservoir. |
| Clay Cross Co. | Economiser. |
| Tudor Accumulator Co. | Batteries in station and sub-station. |
| Stothert and Pitt | Traveller. |
| A. Haacke & Co. | Lagging. |
| National Electric Wiring Co. | Station wiring. |
| British Insulated Wire Co. | Cables. |
| National Tube Co. | Poles. |
| McGloughlin & Co. | Pole brackets. |
| Ross and Walpole | Pole bases. |
| Lorain Steel Co. | Rails. |
| Askham Bros. and Wilson | Points and crossings. |
| Felten and Guilleaume (W. F. Dennis & Co.) | Bonds. |
| St. Louis Car Co. | Cars. |

other photographs illustrating this article, was taken for us by Messrs. Swaine & Co., of Broadstairs.

Four Babcock and Wilcox boilers are erected at present, in pairs according to the usual custom. They are hand-fired, and each has a heating surface of 3,140 sq. ft., and is constructed for a working pressure of 160lb. per square inch. Each is composed of 14 sections of tubes, 10 tubes high. The tubes are 4in. in diameter and 18ft. long, connected at the end by the firm's well-known staggered headers. The several sections are connected at each end to a steam and water drum 42in. in diameter and at one end with a mud-drum, by means of 4in. tubes. To allow for free expansion and con-



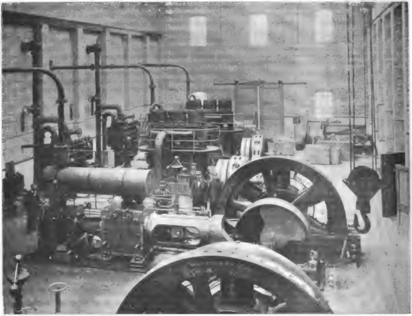
GROUND PLAN OF POWER-HOUSE BUILDINGS.



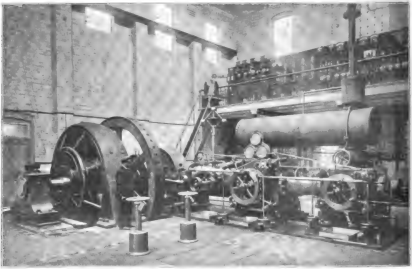
CROSS SECTION OF POWER-HOUSE.

The power-house is most conveniently situated, lying as it does almost at the centre of gravity of the line, and on the railway. A siding carries the coal straight alongside the coal bunkers, into which the fuel can thus be dumped directly without the assistance of conveying plant. This arrangement is seen in the ground plan of the works above, and in the general view of the buildings on p. 971, which, as well as the traction, the boilers are suspended from girders resting on wrought-iron columns entirely independent of the brickwork. The steam range is single.

Water is obtained from a well 130ft. deep with adits 800ft. long. This is employed both for feed and condensing purposes, the feed-water being passed through a lime water-softener built as an iron tower, upon the top of which is a

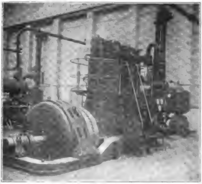


General View of Engine Room from Switchboard Gallery.



Allis-B.T.H. Traction Generator, and Switchboard Gallery.

reservoir. The Broadstairs water main serves as a stand-by. The two feed-pumps are vertical, with 8in. steam cylinders, 6in. pump cylinders, and 12in. stroke. Each can deliver about 5,000 gallons per hour, at 50 strokes per minute. They have an adjustable form of valve motion which can be regulated so as to secure the full length of the stroke under all conditions of work. The Desrumaux water-softener is in three parts—the saturating chamber, the reagent tank, and the settling chamber. In the latter, the surfaces on which the precipitate deposits itself are in the form of a conical spiral of plates, which rest on cast-iron supports within the tower and are easily removable. They can be cleaned by flushing with water.


Belliss B.T.H. Three-Phase Set.


Car Shed, Showing the two Types of Vestibule Car.

The economiser is fitted in the main flue near the chimney base. It consists of 240 tubes in sections 10 pipes wide, the tubes being 9ft. long by $4\frac{3}{16}$in. diameter, affording a total heating surface of 2,400 sq. ft. Each tube is fitted with a set of triple scrapers with bevelled cutting edges and overlapping joints, driven by belt-gearing from a small high-speed horizontal engine $4\frac{1}{2}$in. cylinder diameter and 8in. stroke. There is no preliminary feed-heater.


General View of the Power-House and Car Sheds.

The engine room is a fine building, well-lighted by a glass roof and end windows, and a switchboard gallery is situated at one end. At present two 200kw. continuous-current traction sets are installed and two 2,500 volt three-phase generators. The former only are running at present, and supplying power at 500 volts to the overhead line through an underground cable, with distributing pillars placed at half-mile sections in the usual way. By the time the load has increased sufficiently, the three-phase plant will be running and supplying current

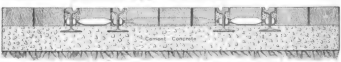
to sub-stations in Margate and Ramsgate, whence the line will be fed through rotatory converters. The two horizontal Allis engines, driving the continuous-current sets, are of the firm's usual tandem pattern with Reynolds-Corliss valve gear; the gear shows up very clearly in the illustration. Above the cylinders the receiver is situated, heated with live steam. The cylinder diameters are 14in. and 28in. by 30in. stroke, and the speed is 185 revs. per min. The engines are each fitted with a 14ft. flywheel weighing 10 tons 14 cwt.

Descent into Ramsgate.

The generators directly-coupled to these are of the standard B. T. H. 6-pole pattern wound to 500 volts at no-load, and over-compounded to 550 volts at full load. They are guaranteed to stand a momentary 50 per cent. overload without sparking at the brushes.

The most interesting feature of the three-phase sets is their small size. Driven by fast-speed engines, they offer a remarkable contrast to the large three-phase fly-wheel pattern alternators one is used to seeing, and also to the two continuous current sets standing next to them. Although the capacities of the latter are 200kw., as against the 800kw. of the Belliss–B.T.H. three-phase machines, their overall dimensions are 27ft. 9in. by 14ft. 6in. by 8ft. 10in. (height from floor level to the top of flywheel), while those of the alternators are 19ft. by 9ft. by 11ft. above the floor in spite of their 50 per cent. greater output. The Belliss engines are three-crank compound, having a complete engine on each crank, and indicating 520 I.H.P. at 300 revs. per min. and condensing.

Construction with Macadam



Cross Section of Interlacing Lines

Road Construction.

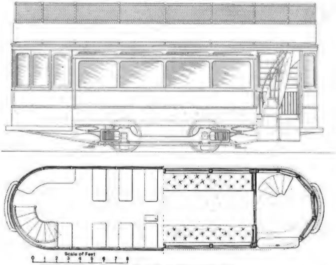
They are guaranteed to withstand a 25 per cent. overload for short periods. The governors are driven directly from the crank shaft and act on the throttle valve; they are guaranteed to control the speed of the engines within 3 per cent. when the maximum load is suddenly thrown on or off.

The three-phase alternators, whose frequency is 50 ∿ per sec., have revolving magnets consisting of 20 poles. These are built up of sheet-iron punchings and bolted together, the coils being wound on the sheet-iron spools with wooden flanges supported by the extended metal pole-pieces. As the size of the box girder casting supporting the armature is comparatively small, it is made up in one section only. The construction of the armature and the machine generally follows the standard B.T.H. practice; an exception, however, is in the collector rings which are of cast iron and not copper, this, we are informed, being the B.T.H. Co.'s latest practice for high-voltage machines. They are separated from the supporting rings by mica insulation. The collector brushes are of carbon.

Three Wheeler condensers of the Admiralty type are placed in the engine room behind the engines, as seen in our view from the switchboard gallery, one serving for the two Allis engines, and the Belliss engines having one each. Each has a cooling surface of 1,570 sq. ft., and is mounted on a combined pump, having one 12in. steam cylinder, a 14in. air cylinder and a 14in. water cylinder, with 12in. stroke. The Barnard-Wheeler cooling tower, erected in the position seen

in the ground plan, is similar to that described in our article on the Sunderland tramways (Vol. XLV., p. 661). It is in two sections, each capable of dealing with the circulating water required for 17,500lb. of exhaust steam per hour. On the basis of 35lb. of water per 1lb. of steam, this is equal to 122,000 gallons per hour, and the water is cooled from about 125deg. to 80deg. The condensed water is passed through two oil separators of the porous partition pattern.

The Sea-Front at Margate.



Plan and Elevation of Single-Truck Car.

The additional machines at present in the engine room are a motor-driven 21kw. booster for charging the cells to be used for lighting in St. Peter's and Broadstairs and for exciting the three-phase machines, and a 10kw. balancing transformer for the three-wire 250-volt lighting circuits. No traction booster is required, as the sub-stations feed into the line at the two ends. All these machines are four-pole. The booster motor is rated at 35 h.p., and is on the 500 volt mains, and

running at 975 revs. per min., the booster raising the pressure by 45 to 175 volts. The balancer runs at 1,300 revs. per min.

As the switchboard has to fulfil three purposes, it is of rather large size, but it should be easy to manipulate, and complexity is avoided. On the extreme right are the three-phase high-pressure panels, forming the connecting link between the three-phase alternators and the feeders to the sub-stations. These are fitted with Parshall high-pressure switches, similar to those described recently in connection with the Central London Railway (Vol. XLV., pp. 554-557).

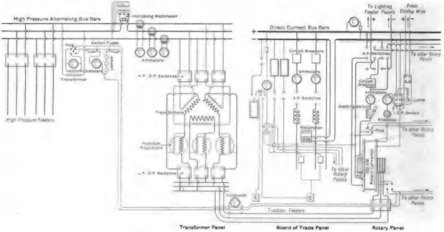


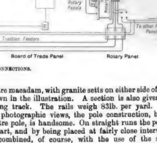
Diagram of Sub-Station Switchboard Connections.

The left-hand panels of the switchboard are of the B.T.H. standard traction pattern, with feeder, generator, and Board of Trade panel, and in the centre are the lighting feeder, battery, booster and balancer panels. The "equalising" switches are on the generator panels.

The traveller spanning the engine-room is designed for a working load of 15 tons, and has single and double purchase gear. It is carried on fish-bellied steel girders. The end carriages are of steel, and there are plate and angle side-frames to the crab. Two speeds are provided for the hoisting gear, and the load is lifted on wire rope. The span is 49ft., centre to centre of rails, and the crane is arranged for the motions to be worked from platforms provided along the girders.

A view of the car-shed which adjoins the generating works is given on p. 971. It contains eight tracks with continuous inspection pits under all the tracks, and can hold about 40 cars. The cars themselves are partly on single trucks and partly on bogies, and all double-decked. Both types are seen in our view of the car-shed, and in addition we give an elevation and plan of one of the former. These are both of the vestibule platform type. The single-truck cars measure 17ft. 11in. in the body with 6ft. platforms and 6ft. wheel base. The wheel-base of the bogies is 4ft. 2½in., with 8ft. 1½in. between centres of bogies, the car bodies being 21ft. 11in. long with 6ft. platforms. They seat 50 and 62 passengers respectively. The controllers are of the B 18 type of the B.T.H. Co., with four notches series, four parallel and six brake notches, and there is the usual reversing switch interlocking with the controller handle. Each car is fitted with two 35 H.P. motors. In spite of heavy gradients, amounting in one place (from the sea-front to the fort at Margate) to 1 in 13 or 14, there is only the ordinary chain brake in addition to the electric brake, but no trouble has been experienced on the down or up grades. There are also some extremely sharp curves, the sharpest being 38ft. radius, but the swivel trolley-heads have given very little trouble going round them. Extra long trolley poles are used, 18ft. 6in. for the bogie cars and 16ft. 6in. for the single-truck cars.

The gauge is 3ft. 6in., and the line is chiefly double track. To a large extent this is interlacing, and in a few places, where the streets were not even wide enough to allow for this, single track has been employed. In the towns the paving is mostly wood, in other places alternate wood and setts, and the inter-urban parts are macadam, with granite setts on either side of the rails, as shown in the illustration. A section is also given of the interlacing track. The rails weigh 83lb. per yard. As seen in our photographic views, the pole construction, both side and centre pole, is handsome. On straight runs the poles are 120ft. apart, and by being placed at fairly close intervals on curves (combined, of course, with the use of the side trolley) much ugly pull-over wire construction is avoided.



Section of Three-core High Pressure Cable (Full Size).

The sub-stations at Ramsgate and Margate, which were not completed at the time of our visit, will contain two and four 8-pole 1,000kw. rotatory converters respectively, between each of which and the feeders three independent transformers are employed. In addition to the converters a small battery is added at Margate to provide for the lighting. The Margate

connections are shown in our diagram, only one transformer and one converter panel being given to avoid overcrowding, although there are four of each on the actual board. Wires lead from these to the battery and booster panels and the lighting feeder panels, which are not shown as they have no unusual features.

The three-core high-tension feeders from the works to the sub-stations are of the B.I.W. clover-leaf type, shown in section on the opposite page. The 500 volt cable feeding the trolley wire at the section pillars are 61/16 and 61/20 low-tension single, the pilot cable to the end of the track is 7/22 low-tension single, and 1/16 twin air-space telephone cable is used for telephone purposes. All the cables are lead-covered and laid on the solid system in wooden troughing with specially refined pitch filling.

## ELECTRICAL POWER IN BRITISH WORKS.*

BY W. GEIPEL, M.I.E.E.

(*Concluded from page 899.*)

### Other Advantages of Electric Driving.

I have already stated that there are cases where it does not pay to adopt electricity on the score of the saving in fuel and in losses in transmission, and that every case must be judged upon the governing conditions. But in making the consideration there are one or two further points to be taken into account. Perhaps the most important is

*Increased Output.*—It is found in all three classes, more especially in old works, that when the load is thrown on there is a tendency for the speed to fall. In Class 1 the engine itself may be well governed, but slipping of belts may take place through overwork or slackness. It is a common thing to find in works, more especially with main driving belts, that the belts are overloaded; they have probably been put up for a given number of machines, and more machines have been thrown on subsequently. Again, in such a works it is frequently necessary to stop owing to accident or breakage in one place or another, which involves the shutting down of the main engine, and consequently the stoppage of the whole of the machinery; this with electric motors is not necessary. In the case of the scattered engines the governing is generally defective and the engines are frequently overloaded, so that throwing on machines may seriously reduce the speed of the rest. On the other hand, the speed of the electric motors is arranged to be correct at full load, and when the whole of the load is switched off the motor the speed should not rise more than 2 or 3 per cent., so that with such a constant speed the tools may be driven at a higher average speed than in cases where a greater variation takes place. That there is an increased output is invariably ascertained by those who have adopted electric driving. Messrs. Richardson estimate that the increased speed and output of their machinery average 20 per cent. This figure also represents the increase which is usually found in printing establishments after introducing electric power.

*Facilities of Working.*—The electric motor is a comparatively portable article, and the cables by which it is connected to the generator are flexible; consequently, in cases where the work is heavy the tools may be carried to the work, and thus save the loss of time and labour in moving heavy weights. It has been stated, indeed, that the floor of a modern erecting shop should be one large face plate on which the heavy work is permanently fixed, the tools being brought to the work. The ordinary shop shafting must be laid out so that it is in direct line with the engine, consequently the machines must be placed more with a view to suit the shafting than to handling the work to the best advantage. In the case of new shops, driven electrically, the overhead line shafting may be altogether dispensed with, thus allowing of good light, which is so important; the cranes have free access to the whole of the shops, while the dust, which is set up by overhead belting, is to a large extent avoided. In a rail rolling mill in the United States, where every advantage was taken of the disposal of the machinery when electric driving was adopted, it is stated that the work hitherto done when using separate engines, with 6,000 workmen, is now accomplished with electric power by 4,000 hands.

*Facility of Extending.*—As further machinery is added on the old system, the makeshift policy of altering the slide valve of the engine to give a later cut-off is frequently adopted regardless of the ensuing loss of steam, or, to avoid extending the shafting, a new machine may be crowded into an unsuitable position. Electric power is vastly more flexible. An extra motor is easily added when further machinery is put down, so that the machine may be placed in the most favourable position without crowding or overloading, and little or no provision need be made in the power of the motor, which may be put down to suit the work immediately in view.

*Repairs.*—It is difficult to obtain reliable data as to the cost of repairing shafts and belts; certainly the cost of repairs to small separate engines is known to be a considerable item. Generally speaking there should be a saving on this item, more particularly if the motors are well adapted to their work.

It is impossible to cover the whole of the case for and against electric power in the space at my disposal, but in the foregoing I have endeavoured to put before you the more prominent considerations in such a manner as to facilitate your own considerations of each individual case as it may come before you. I will now make a few brief remarks on the subject of

### Electric Systems Available.

In the first place, it is necessary to know whether electric power can be obtained from outside; and if so, at what cost. It is probable that in the majority of cases such a supply is already available, while electricity supply works are being rapidly extended throughout all manufacturing districts. In small works, it will always be cheaper to purchase the supply in this way. It may be interesting to you to know that this method is already being largely adopted. I give you the following examples:—

| Town. | No. of Motors. | H.P. of Motors. |
|---|---|---|
| Bradford | 411 | 1,636 |
| Edinburgh | 385 | — |
| Liverpool | 237 | 770 |
| Manchester | 464 | 1,691 |
| Nottingham | 125 | 460 |
| Birmingham | 186 | 475 |

The point at which it pays to incur the trouble and expense of having a special generating plant in the works depends upon the amount of power required, and the price for which it can be produced, as compared with that for which it can be purchased. The price charged by the local authorities varies generally between 1d. and 2d. per Board of Trade unit. At Manchester it is 1½d., Edinburgh 1½d., Bradford 1d. The cost per indicated horse-power-hour with a large economical engine should not exceed a quarter of a penny, which is equal to, say, 0·375d. per Board of Trade unit, at the terminals of the generator; this price, however, would be increased according to the price and quality of coal, and as the engines become smaller. Where it is found cheaper to have an independent plant, I am of opinion that the engines should be of the enclosed type, either triple expansion or compound condensing, and direct coupled to the electric generator. This type of engine is self-oiling, the working parts are mostly lubricated by the splashing of the oil, and there are comparatively few bright parts to be kept clean. With the horizontal, or even vertical, slow speed engine greater attention is required, much more room is occupied, and heavier foundations are necessary. The generating plant should be divided up into not more than three units, one being a stand-by. Where condensing water is not available, it will generally pay to adopt some artificial method of cooling the water, such as a cooling tower or spraying nozzles.

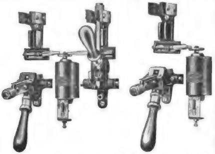
I now come to the question of the generators, which involves the consideration of the relative methods of the continuous and alternating current. I do not think it possible to lay down a hard-and-fast rule as to the selection beyond stating that the two most suitable for a works are the two-wire continuous-current system and the three-phase system, using star winding so that lamps may be connected between the neutral wire and the phase wires. There is little or nothing to choose between the two systems on the score of efficiency so far as concerns the percentage of power lost in the transmission. The continuous current is probably more suitable for small works, where the number of motors is few and the commutators of less importance. For larger works there are advantages in the use of the three-phase system which should certainly be carefully considered. In the first place the generator itself is more mechanical, the current passes direct from the winding of the armature through bound terminals to the conducting cables. There is no commutator required beyond that on the exciter, which has to deal with less than 5 per cent. of the total current. The heavy armature bars and connections are stationary, and there is not, therefore, the same difficulty in effectually insulating them as is found in the case of continuous-current generators. The regulation of continuous-current generators is generally done by compound winding. Three-phase generators have also been so arranged, but for the latter I prefer to make use of an automatic regulator. That known as the Chapman regulator acts admirably, and is in use, amongst other places, at the Bristol Waggon Works. It consists of a series of contacts, over which a slider is moved by means of a solenoid excited by current taken from the exciter. This solenoid is controlled by a relay placed in the main circuit, which actuates the solenoid according as the voltage is above or below normal. I should mention that the solenoid is designed specially to annul all sparking at the relay contacts. There appears to be no difficulty with this device in automatically maintaining the voltage within 1 per cent. up or down. Some point has recently been made of the fact that provision should be made in alternating generators for the extra current due to the power-factor of the motors. This, however, is always duly provided for by makers of three-phase machinery. There is no difficulty whatever in doing it, and it does

* Abstract of a Paper read before the Gloucestershire Engineering Society February 19.

not add to the expense where the power-factor is a normal one. Usually the generators are wound for a factor of 0·8.

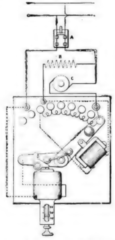
As to the conducting cables for power circuits, there is no difference between the continuous current and the three-phase current as to the quantity of copper, with this exception: the voltage is generally settled in order that the lighting of the works may be done from the same plant, which necessitates that the voltage between the lighting wires shall not exceed about 200. In the case of the three-phase, this would be the voltage between the neutral and the phase wires; consequently, the voltage across the phase wires would be 350. By virtue of this, for the same percentage of loss the quantity of copper in the case of three-phase motors would be less than half that on the continuous system. On the other hand, it is possible to effect an economy in this respect in the case of the continuous current by using three wires and 400 volts. This, however, involves the use of two generators, or, at any rate, two commutators and armature windings on one generator; otherwise, as is now more general, an external balancing dynamo motor—complications which in the case of the three-phase are not necessary. I may mention here that in the Bristol Waggon Works, where my firm fixed up a three-phase installation, I found that by making the worst condition of balance—viz., by switching in all the lamps on one phase, and none on the other two, that the difference in the lighting effect could not be observed; it was only between 2 and 3 per cent.

It is sometimes urged as an objection to the three-phase system that, instead of having two conductors to run, there are three. I have not found this any disadvantage whatever, while for the larger motors it is really an advantage to be able to run three small instead of two heavy cables.



As to the motors, it appears to be generally admitted that the three-phase induction motor is of a stronger mechanical design, more particularly in the revolving parts. The current in the revolving part has no electrical connection with the circuit. It may have a very low tension, thus rendering the insulation of the winding more permanent. In the case of the continuous-current motor, there is not only the commutator difficulty, but the rotating armature must be wound with a large number of small windings, and must be insulated to stand the full pressure of the supply. The only part of the three-phase motor which is in connection with the supply, and therefore has the full pressure, is the stationary winding; this, like the generator, is connected to the circuit through bound and insulated terminals; there is no point, therefore, in the circuit, either at the generator or motors, which is exposed to the touch of workmen. Either system can be used for working at constant speed or at variable speed. In the case of variable speed, where large torque is required at low speeds, the continuous-current series-wound motor is, perhaps, more suitable; if it is not a desideratum that the torque should be largely increased, then the three-phase motor is equally suitable, and it has the additional advantage that the speed controlling apparatus has no connection with the main circuit, while, in the case of the continuous current, the controller must be carefully designed and operated on account of its being in the main circuit, and subjected to the full pressure thereof. I may mention in this connection that my firm have supplied to the Patent Shaft and Axletree Co. a dozen motors of 20 H.P. each for operating their various heavy cranes, the motors being used at variable speeds with the controlling apparatus in the rotor circuit. There is a further advantage which may be claimed for the three-phase motor, and that is that temporary overloading has no deleterious effect, and where the load is unduly increased, such as it may be by hot bearing or breakdown of a machine, the motor breaks out of step and the safety fuses blow, no damage being done. Overloading in the case of continuous-current machines may damage the commutator and cause much trouble. It is stated that 90 per cent. of the repairs required by continuous-current machinery are due to the commutators.

There is little to choose between the switching apparatus required by either system. For continuous current only two switches and fuses per feeder circuit are necessary, while for the three-phase three switches and fuses are required, but as these are for smaller currents there is little difference in the cost, if any. I have found it better to use the automatic circuit-breaker, now commonly used in the United States, in place of the usual switch and safety fuse.



When an abnormal load opens the circuit through the blowing of the ordinary safety fuse there is a delay caused in replacing the fuse; moreover, there is a tendency for workmen to replace with a fuse which is too large to be safe; this, of course, robs the circuit of its protection and frequently results in damage. An excellent circuit-breaker at a reasonable price is made by the Ward Leonard Co., combining a hand-operated switch with an automatic device for opening the circuit which can be set to open at any pre-arranged current. Here are some samples of these circuit-breakers; they are also shown in the illustration both single and double pole. After acting the switch is always ready to be re-closed, and should it happen that the fault in the motor or its circuit remains the switch instantly re-opens. Only those who have had to replace large fuses appreciate fully the advantage of such a device. These circuit-breakers are generally fixed on the main switchboard. At or near each motor it is customary to place the starting switch. For the three-phase motor, with the exception of the larger sizes, nothing

more is necessary than an ordinary switch and fuse, or a circuit-breaker of the type above mentioned may be used. For the continuous-current motor it is necessary to provide a starting resistance in addition. This resistance should be switched in gradually, otherwise damage may be done to the commutator by too rapid starting. Ward Leonard, who has given special attention to this subject, has designed what he terms a "fool-proof" motor switch. There is a sample "fool-proof" switch on the table, and I give an illustration showing the connections and outside appearance. It prevents the attendant from operating the resistance switch too rapidly, it opens the circuit if the current becomes excessive or if the voltage fails, even during the period of starting-up the motor, while in no case can the motor be re-started without first inserting the resistance. This is a desideratum, as the attendant is apt to forget to re-insert the resistance before re-starting and damage results.

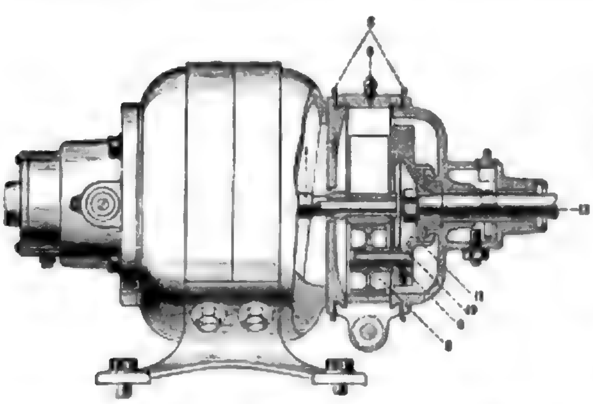
It has been urged against three-phase motors that they run at a high speed. I have not, however, found their speed to be greatly different to the continuous-current motors which I have installed; in some cases it is slower, in other cases faster. Of course, it is possible by extra expense to greatly reduce the speed of either form of motor, but the cost is prohibitive, so that it is usual to resort to some method of reducing the speed of the motor either by belting or gearing.

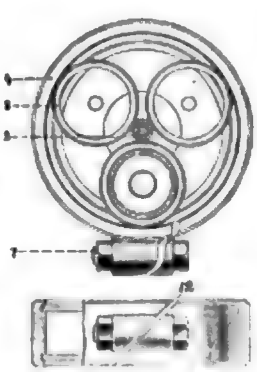
I have recently used a very neat and compact speed reducing gear which does away with belting and toothed gear. It is known as the "Centrator" gear, and has been for many years largely used for driving laundry and dairy machines. Referring to the diagram, 2 is a central roller on the motor shaft between which and the outer adjustable ring 12 the flexible steel rings 3 are pressed so that they become slightly oval. Inside of the rings are easy fitting rollers, 8, these are pivoted to the disc 9, which is keyed to the slow-driven shaft. As the motor turns the roller 2 the steel rings rotate and carry with them the disc at the desired reduction in speed. Another very ingenious method of reducing the speed of motors, and at the same time of increasing the torque, has been invented by Ward Leonard. This system is more particularly suited to cases where the motor is required to work through very large ranges of speed, such as in printing, where, in setting the machine, it is usual to run it round at something like 1 per cent. of its full speed. To explain this system fully is beyond the scope of my Paper; but I give an illustration showing one of his methods. The regulation is done without any resistance whatever in series with the motor, and the only resistance used is a small field rheostat, which, at the most extreme range, absorbs but 2 per cent. of the energy absorbed by the series resistance, while generally it absorbs much less. Further, it is provided with a large number of small contacts, so that in passing from one to the other there is not that jump in the speed which is so objectionable when using the ordinary resistance. + and − are the supply mains; ABC is a motor generator, of which A is the small motor, B the generator armature, and C the generator field; D is a field rheostat for the generator; E is the armature of the driving motor, and F is the field thereof. The motor generator is one-half of the rated power of the driving motor. Each of the fields is excited directly from the mains independently of its armature. In series with the field C of the generator there is inserted the rheostat D, which can be arranged for reversing, as shown in the figure. The motor generator runs at constant speed, but the voltage of the generator armature is varied according to the strength of its field, C, so that it can give any voltage from nothing up to its maximum, which, in the particular arrangement shown in the figure, is the same as that between the mains. This armature is connected in series with the armature of the driving motor E, so that the current used for driving the motor E always passes through the generator B. It will be seen that by operating the switch of the rheostat D, the generator B can be made either to assist or to oppose the voltage between the mains + and −; when it is fully excited, and opposing the main voltage, there is no difference of potential across the motor armature E, and this is the condition when starting. As the rheostat is gradually switched into circuit, the opposing voltage of generator B falls, and the armature of the driving motor E rotates at first very slowly, but the current passing may be the same as the maximum-load current, so that the torque at the starting may be a minimum.

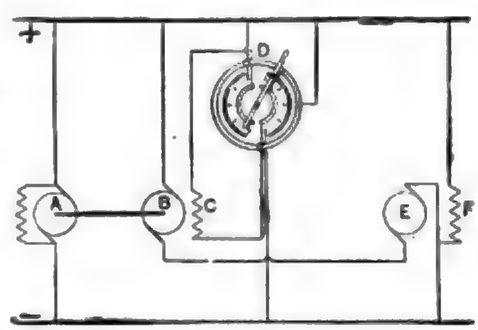
The maximum torque, then, is obtained without a resistance in series with the motor armature, for the armature B of the generator has merely a back E.M.F. action, which absorbs no energy. As the rheostat is still further switched out of circuit, the opposing E.M.F. of the generator B becomes less and less until it is zero, and the motor E is driven at half speed, having across its terminals the full voltage of the mains. Further, as the field rheostat is reversed and gradually switched out of circuit, the generator B begins to assist the voltage of the mains; and when the rheostat is finally switched out of circuit the generator B doubles the voltage of the mains, and the motor E works at full speed. It will thus be seen that the armature of the motor E may always operate with its maximum current, while the voltage supplied thereto varies directly as the speed at which it is desired the motor shall be driven without the use of any resistance or energy-wasting device in circuit. In addition to driving printing machinery, this system is used for large cranes, fast and heavy lifts, for naval purposes, such as training guns, haulage machinery, and various other purposes.

In conclusion, I will sum up the advantages of electricity apart from the efficiency of transmission, and the saving in power which in most machinery establishments would pay for the additional cost of the electric plant in from two to five years; they are:—

1. Absence of overhead shafting, which requires special construction of shops, and causes vibration, dust and dirt.
2. Absence of belts, dust arising therefrom, repairs necessary thereto and shadows.







3. Clear head room for the use of electric cranes and hoists.
4. Better light and cleanliness.
5. Regularity of speed of machinery, and saving of wear and tear thereof.
6. Placement of machinery to facilitate handling of work.
7. Easy application of motors for special tools, such as key seating, cylinder boarding, air compressing.
8. Facility of running one or two machines without the rest for working overtime.
9. Special suitability for working cranes and lifting apparatus.
10. Ease of extension.
11. Utility for electric lighting and other purposes.
12. General flexibility of the system.
13. Increased output.

## BOOKS RECEIVED.

*Copies of any of the undermentioned works can be had from The Electrician Office post free, on receipt of published price.*

"Science Abstracts" for March, 1901. Edited by W. R. Cooper. (London: E. and F. N. Spon.) 2s.

"Important European Electrical and Engineering Developments at the Close of the Nineteenth Century." By W. J. Hammer. Reprint from Vol. XVIII. of the *Transactions* of the American Institute of Electrical Engineers. (New York: The Author.)

"The Inspector and the Trouble Man." By A. E. Dobbs. A Reprint from the *Telephone Magazine*. (Chicago: The Electrical Engineering Publishing Co.)

"Recenti Progressi nelle applicazioni dell' Elettrica." By R. Ferrini. 3rd edition. (Milan: U. Hoepli.)

"L'Année Electrique Electrothérapique et Radiographique, 1900." By Dr. F. de Courmelles. (Paris: Ch. Béranger.) 3fr. 50c.

"Elaboration des Métaux Dérivés du Fer." By L. Gages. Two Vols. (Paris: Gauthier-Villars.) 3f. each.

## ELECTRICITY WORKS ACCOUNTS.

### County of London and Brush Provincial Electric Lighting Co. (Ltd.).

Our two tables this week are summaries of the accounts for 1900 of the Clerkenwell and Wandsworth stations. Before referring respectively to these analyses it may be useful to give a few particulars respecting the above company's operations as a whole.

Their capital expenditure during the year, on account of the London districts, was £174,481, making the total expenditure in respect of those districts £892,677. Of this total £408,821 was the amount spent in the Northern Districts supplied from the City-road station. These districts comprise St. Luke and Clerkenwell, Eastern and Western Holborn and St. Giles. In the Southern Districts, supplied from the Wandsworth station, and including Wandsworth, Putney, Tooting Graveney, Streatham, Clapham, Camberwell and Southwark, the expenditure to Dec. 31 last was £181,856.

In the following table we give the more important particulars from the general accounts of the company.

Confining our attention to the London operations only, it will be seen that the gross profit from the two stations, before providing for depreciation, sinking fund or interest charges, was £29,048. The extraneous sources of revenue, however, have now dwindled, so that last year they formed an inconsiderable proportion compared with the London earnings, therefore it would appear only fair to debit to those earnings nearly the whole, if not all, of the head office expenses (£7,555 last year) usually payable out of revenue. This would reduce the above gross profit to about £21,493, out of which have also to come the capital charges on account of the two London concerns. Another point of interest in these general accounts is the depreciation fund. This fund, now with a balance of £16,100, has been charged with the repairs and renewals of 1899 and 1900—charges totalling £7,400. The account has only received £6 500 from ordinary revenue, the remainder, or £17,000, being made up of premiums on stock issues. Thus, while there has been no depreciation allocation out of revenue, £900 of repairs and renewals at the station and of distribution plant has been paid by premiums. The balance carried forward from last year's accounts is £3,639, as compared with £12,594 from 1899.

| Items. | 1899. | 1900. |
|---|---|---|
| CAPITAL. | | |
| Authorised capital | £800,000 | £800,000 |
| Share capital received | 600,000 | 600,000 |
| Loans received | 254,957 | 397,515 |
| Depreciation and repairs and renewals fund | 11,916 | 16,100 |
| Capital appropriated to Northern Districts Orders | 337,822 | 408,321 |
| Capital appropriated to Southern Districts Orders | 380,373 | 484,356 |
| Capital expended in lands, buildings, &c. | 10,534 | ... |
| Capital invested in and advanced to the Bournemouth and Poole, Dover, and Scottish House-to-House Companies | 99,101 | 107,501 |
| REVENUE. | | |
| Gross Revenue | 55,462 | 38,516 |
| Miscellaneous sources of revenue | 36,619 | 5,653 |
| Revenue from Northern Districts department | 6,718 | 15,476 |
| Revenue from Southern Districts department | 9,542 | 13,572 |
| Repairs and renewals paid out of depreciation fund, Northern Districts | 1,988 | 1,763 |
| Repairs and renewals paid out of depreciation fund, Southern Districts | 1,595 | 2,052 |
| EXPENDITURE OUT OF REVENUE. | | |
| Total | 9,120 | 7,555 |
| Directors' fees, rents, rates, taxes, insurance, wages, and proportions of salaries | 6,758 | 5,480 |
| Miscellaneous charges | 2,363 | 2,075 |
| FINANCIAL RESULTS. | | |
| Balance from revenue account | 47 341 | 30.961 |
| Balance from last account | 5,776 | 12,694 |
| Interest charges | 6,957 | 13,200 |
| Set aside for depreciation, repairs and renewals | 10,500 | 8,000 |
| Premiums | 4.000 | 8,000 |
| Sum available for distribution | 39,661 | 30,355 |
| Dividend on preference shares | 6 per cent. | 6 per cent. |
| Dividend on ordinary shares | 4 per cent. | 4 per cent. |

NORTHERN DISTRICTS.

The output figures in our first table indicate that the number of units sold last year was no less than 115 per cent. higher than in 1899. In character as well as in magnitude there was a great improvement, the load-factor having risen from 8·14 per cent. to 12·85 per cent. It is highly gratifying to find from the revenue account that these improved conditions have been taken advantage of in securing lower costs.

A glance at our table will show that there has been effected a general and substantial reduction in the expenditure per unit. It is, of course, not to be expected that the fuel item should be reduced. Unfortunately, for the purposes of comparison there are items of costs included, as explained above, in the general accounts which probably should be shared between the costs sheets of the two stations. This fact renders it useless to discuss too closely the various items of cost, the greater number of which, as they appear in our tables, are decidedly below the 1899 averages in company stations under similar conditions of load.

The total applications for connection up to December 31st, including customers for power, represented the equivalent of 143,195 8 c.p. lamps, of which 119,076, or nearly 95 per cent. above those at the end of 1899, were connected. The customers for power were 165, with motors aggregating 1,171 H.P. Additional plant for both power and lighting is being installed for next winter.

SOUTHERN DISTRICTS.

The output of the Wandsworth station for 1900 was barely 20 per cent. above that of 1899, while the load-factor shows a decline from 12·4 per cent. to 7·96 per cent. It is hardly surprising, therefore, to find that the costs have gone up. The increase per unit sold is, however, but little in excess of the rise in the fuel item. Unfortunately, the distributing costs have risen from 0·254d. to 0·374d. per unit.

As the result of securing the connection of the equivalent of 35,825 8 c.p. lamps the total lamp connection has risen by no less than 65·6 per cent. during the year.

---

The following is a list of electric supply works the accounts of which have been analysed, together with the dates on which statements and analyses of accounts have appeared:—

| | | | |
|---|---|---|---|
| Aberdeen (Municipal) | Oct. 12, 1900 | Kingston-on-Thames (Mun.) | July 20, 1900 |
| Ayr (Municipal) | Nov. 2, 1900 | Lancaster (Municipal) | Feb. 15, 1901 |
| Bath (Municipal) | April 20, 1900 | Leeds (Municipal) | Dec. 7, 1900 |
| Bedford (Municipal) | Aug. 3, 1900 | Leicester (Municipal) | Jan. 26, 1900 |
| Belfast (Municipal) | July 6, 1900 | Leyton (Municipal) | Jan. 18, 1901 |
| Birmingham (Company) | Sept. 15, 1899 | Liverpool (Municipal) | Mar. 22, 1901 |
| Blackburn (Municipal) | Jan. 19, 1900 | London (Company) | June 8, 1900 |
| Blackpool (Municipal) | Oct. 5, 1900 | Londonderry (Municipal) | Feb. 16, 1900 |
| Bournemouth (Company) | Sept. 7, 1900 | Manchester (Municipal) | Sept. 14, 1900 |
| Bolton (Municipal) | Nov. 30, 1900 | Newcastle and District (Co.) | Oct. 6, 1899 |
| Bradford (Municipal) | June 22, 1900 | Newcastle-upon-Tyne (Co.) | Dec. 14, 1900 |
| Brighton (Municipal) | May 4, 1900 | Newport (Mon.) (Municipal) | Jan. 11, 1901 |
| Bristol (Municipal) | Aug. 24, 1900 | Northampton (Company) | Oct. 20, 1899 |
| Bromley (Kent) (Co.) | June 15, 1900 | Norwich (Company) | Dec. 29, 1899 |
| Brompton & Kensington (Co.) | Mar. 15, 1901 | Notting Hill (Company) | Mar. 29, 1901 |
| Burnley (Municipal) | Nov. 30, 1900 | Nottingham (Municipal) | Sept. 21, 1900 |
| Burton-upon-Trent (Mun.) | April 21, 1899 | Oldham (Municipal) | Feb. 1, 1901 |
| Bury (Municipal) | Sept. 28, 1900 | Oxford (Company) | April 12, 1901 |
| Cambridge (Company) | April 12, 1901 | Pontypool (Company) | Sept. 28, 1900 |
| Canterbury (Municipal) | Oct. 26, 1900 | Portsmouth (Municipal) | Aug. 24, 1900 |
| Cardiff (Municipal) | Jan. 11, 1901 | Prescot (Company) | Dec. 8, 1899 |
| Charing Cross (Company) | Mar. 15, 1901 | Preston (Company) | Dec. 14, 1900 |
| Chelsea (London) (Co.) | Mar. 22, 1901 | Reading (Company) | Dec. 21, 1900 |
| Cheltenham (Municipal) | Nov. 10, 1899 | Richmond (Company) | June 29, 1900 |
| Chester (Municipal) | Aug. 3, 1900 | Salford (Municipal) | Feb. 23, 1900 |
| City of London (Company) | June 15, 1900 | Scarborough (Company) | July 13, 1900 |
| Clerkenwell (Company) | May 18, 1900 | St. Helens (Municipal) | Jan. 25, 1901 |
| Coventry (Municipal) | Feb. 23, 1900 | St. James' & Pall Mall (Co.) | Mar. 8, 1901 |
| Croydon (Municipal) | July 20, 1900 | St. Pancras (Vestry) | June 8, 1900 |
| Derby (Municipal) | Jan. 26, 1900 | Sheffield (Municipal) | Feb. 1, 1901 |
| Dewsbury (Municipal) | Feb. 15, 1901 | Shoreditch (Vestry) | Nov. 23, 1900 |
| Dover (Company) | April 27, 1900 | Smithfield Markets, Lond. (Co.) | Mar. 8, 1901 |
| Dundee (Municipal) | Nov. 2, 1900 | Southampton (Municipal) | Feb. 8, 1901 |
| Eastbourne (Company) | May 4, 1900 | Southport (Municipal) | July 7, 1899 |
| Edinburgh (Municipal) | Dec. 7, 1900 | South Shields (Municipal) | Nov. 9, 1900 |
| Exeter (Municipal) | Aug. 6, 1899 | Stafford (Municipal) | Aug. 17, 1900 |
| Folkestone (Company) | April 27, 1900 | Sunderland (Municipal) | Nov. 9, 1900 |
| Glasgow (Municipal) | Sept. 14, 1900 | Taunton (Municipal) | June 16, 1899 |
| Guildford (Company) | Oct. 19, 1900 | Tunbridge Wells (Mun.) | Jan 18, 1901 |
| Halifax (Municipal) | Sept. 21, 1900 | Wakefield (Municipal) | Dec. 1, 1899 |
| Hammersmith (Vestry) | June 29, 1900 | Walsall (Municipal) | June 23, 1899 |
| Hampstead (Vestry) | Oct. 19, 1900 | Wandsworth (Company) | May 11, 1900 |
| Hanley (Municipal) | July 27, 1900 | Westminster (Company) | Mar. 22, 1901 |
| Harrogate (Municipal) | Jan. 25, 1901 | Whitehaven (Municipal) | Feb. 8, 1901 |
| Harrow (Company) | Dec. 21, 1900 | Winchester (Company) | Oct. 26, 1900 |
| Hast'gs & St. Leonards (Mun.) | Sept. 7, 1900 | Windsor (Company) | Dec. 22, 1899 |
| Hove (Company) | July 6, 1900 | Woking (Company) | Dec. 22, 1899 |
| Huddersfield (Municipal) | Aug. 17, 1900 | Wolverhampton (Municipal) | July 27, 1900 |
| Islington (Vestry) | Nov. 23, 1900 | Woolwich (Company) | Jan. 12, 1899 |
| Kensi'gton & Knightsbr' (Co.) | Mar. 16, 1900 | Worcester (Municipal) | April 20, 1900 |
| Kingston-upon-Hull (Mun.) | July 13, 1900 | Great Yarmouth (Mun.) | Dec. 28, 1900 |

| | CLERKENWELL or Northern Districts. | | | | WANDSWORTH or Southern Districts. | | | |
|---|---|---|---|---|---|---|---|---|
| *Undertaking Worked by* | County of London & Brush Provincial Electric [Lighting Co. (Ltd.). | | | | County of London & Brush Provincial Electric [Lighting Co. (Ltd.). | | | |
| *Date of Commencement of Supply* | September, 1897.[a] | | | | January, 1897. | | | |
| *System of Supply* | Alt.-cur. from trans. sub-stations for light and [con.-cur. at 500v. for power. | | | | High & extra H.P. feeders, alt.-cur. trans. sub-stations [understreets suppl'g L.P. 2-w. netw'k. | | | |
| *Chief Engineer* | C. P. Sparks. | | | | C. P. Sparks. | | | |
| **YEAR ENDED** | DEC. 31, **1899.** | | DEC. 31, **1900.** | | DEC. 31, **1899.** | | DEC. 31, **1900.** | |
| **QUANTITIES—** | | | | | | | | |
| Units generated | 1,199,094 | | 2,549,205 | | 1,068,230 | | 1,403,929 | |
| " SOLD (TOTAL) | 920,094 | | 1,976,651 | | 846,421 | | 1,013,487 | |
| " sold to consumers | 920,094 | | 1,976,651 | | 846,421 | | 1,013,487 | |
| " sold for public lighting, &c. | — | | nil | | — | | nil | |
| " used on works | 29,584 | | 90,335 | | 26,301 | | 26,964 | |
| UNITS SOLD PER 8 C.P. LAMP CAPACITY | 9·93 | | 21·8 | | 30·1 | | 19·1 | |
| Maximum supply demanded | 1,290 kilowatts | | 1,826 kilowatts | | 781 kilowatts | | 1,453 kilowatts | |
| Number of public lamps | — | | nil | | — | | nil | |
| Number of consumers | — | | 1,027 | | — | | 1,361 | |
| Connections to mains in 8-c.p. lamps | 61,183 | | 119,076 | | 54,647 | | 90,472 | |
| CAPACITY OF PLANT IN 8-C.P. LAMPS | 92,200 | | 90,700 | | 28,100 | | 53,100 | |
| CAPACITY OF PLANT IN KILOWATTS | 2,950 | | 2,900 | | 900 | | 1,700 | |
| **CAPITAL—** | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. | Total. | Per kilowatt capacity. |
| AUTHORISED (TOTAL) | —[b] | — | —[b] | — | —[a] | — | —[a] | — |
| Share | —[b] | — | —[b] | — | —[a] | — | —[a] | — |
| Loan (including Debenture charges) | —[b] | — | —[b] | — | —[a] | — | —[a] | — |
| RECEIVED (TOTAL) | £337,822[c] | £115 | £408,321[c] | £141 | £380,373 | £422 | £484,356 | £285 |
| Share | | | | | | | | |
| Loan (including Debenture charges) | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| AUTHORISED BUT NOT YET RECEIVED (TOTAL) | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| Share (unissued) | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| Share (uncalled) | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| Loan (including Debentures) | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| REPAID (TOTAL) | —[b] | — | —[b] | — | — | — | — | — |
| RESERVE OR SINKING FUND | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| DEPRECIATION FUND | —[b] | — | —[b] | — | —[b] | — | — | — |
| EXPENDED (TOTAL) | 337,822 | 115 | 408,321 | 141 | 380,373 | 422 | 484,356 | 285 |
| Lands and buildings | 73,674 | 25·0 | 74,728 | 25·8 | 66,445 | 73·8 | 71,972 | 42·3 |
| Plant | 135,248 | 45·8 | 170,204 | 58·7 | 84,066 | 93·4 | 131,462 | 77·3 |
| Mains | 121,204 | 41·1 | 153,869 | 53·1 | 227,382 | 253 | 278,366 | 164 |
| Miscellaneous | 7,697 | 2·61 | 9,519 | 3·28 | 2,480 | 2·76 | 2,556 | 1·50 |
| BALANCE OF CAPITAL ACCOUNT | — | — | — | — | — | — | — | — |
| **REVENUE—** | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. | Total. | Per unit sold. |
| TOTAL | £19,050 | 4·972d. | £33,647 | 4·085d. | £18,712 | 5·310d. | £25,532 | 6·053d. |
| Revenue from supply | 18,054 | 4·710d. | 32,667 | 3·969d. | 17,996 | 5·108d. | 24,369 | 5·780d. |
| " meters, &c. | 626 | 0·163d. | 979 | 0·119d. | 667 | 0·189d. | 1,158 | 0·275d. |
| " public lighting | — | — | — | — | — | — | — | — |
| " sale of lamps, &c. | — | — | — | — | — | — | — | — |
| " miscellaneous sources | 370 | 0·100d. | 1 | — | 49 | 0·014d. | 5 | 0·001d. |
| **EXPENDITURE OUT OF REVENUE—** | | | | | | | | |
| TOTAL COSTS | £12,332 | 3·218d. | £18,170 | 2·206d. | £9,170 | 2·600d. | £11,960 | 2·835d. |
| WORKS COSTS | 9,324 | 2·432d. | 15,381 | 1·866d. | 8,077 | 2·290d. | 10,660 | 2·527d. |
| *Generation of electricity* | [illegible][d] | [illegible] | *14,159*[h] | *1·719d.* | *7,181*[c] | *2·037d.* | *9,083*[c] | [illegible] |
| Fuel (including cartage, &c.) | 4,105 | 1·071d. | 9,177 | 1·114d. | 3,239 | 0·922d. | 4,640 | 1·100d. |
| Oil, waste, water, stores | 708 | 0·185d. | 692 | 0·084d. | 716 | 0·203d. | 610 | 0·145d. |
| Wages at station | 1,812[e] | 0·473d. | 2,374[e] | 0·288d. | 1,580[d] | 0·448d. | 2,023 | 0·480d. |
| Repairs and maintenance at station | 1,961 | 0·512d. | 1,609 | 0·195d. | 1,523 | 0·432d. | 1,696 | 0·402d. |
| *Distribution of electricity* | *550* | *0·144d.* | *1,222* | *0·148d.* | *895* | *0·254d.* | *1,577* | *0·374d.* |
| Wages, &c. | 522[e] | 0·136d. | 1,068[e] | 0·130d. | 823[d] | 0·233d. | 1,221 | 0·289d. |
| Repairs, renewals of mains, &c. | 28 | 0·007d. | 154 | 0·019d. | 73 | 0·021d. | 356 | 0·084d. |
| *Public lighting* | — | — | — | — | — | — | — | — |
| Attendance | — | — | — | — | — | — | — | — |
| Renewals | — | — | — | — | — | — | — | — |
| MANAGEMENT AND PROPERTY CHARGES | 3,008 | 0·786d. | 2,789 | 0·339d. | 1,092 | 0·310d. | 1,300 | 0·308d. |
| *Royalties* | — | — | — | — | — | — | — | — |
| *Rent, rates, taxes* | *2,418* | *0·631d.* | *2,129* | *0·258d.* | *475* | *0·135d.* | *685* | *0·162d.* |
| *Management* | *590* | *0·154d.* | *660* | *0·080d.* | *617* | *0·175d.* | *615* | *0·146d.* |
| Salaries | —[e] | — | —[e] | — | —[d] | — | —[d] | — |
| Stationery, &c. | 184 | 0·048d. | 252 | 0·031d. | 154 | 0·044d. | 228 | 0·054d. |
| Establishment charges | 254 | 0·066d. | 153 | 0·019d. | 225 | 0·064d. | 164 | 0·039d. |
| Law charges, &c. | 152[f] | 0·040d. | 255[i] | 0·031d. | 238[e] | 0·068d. | 223[h] | 0·053d. |
| **FINANCIAL RESULTS—** | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded | Total. | % to mean cap. exp'nded |
| WORKING PROFIT FOR YEAR | £6,718 | 2·20% | £15,476 | 4·15% | £9,542 | 3·06% | £13,572 | 3·14% |
| Sum carried to Depreciation Fund | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| Sum carried to Reserve or Sinking Fund | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| Net interest on loans (incl. Debenture charges) | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| BALANCE FROM LAST ACCOUNT | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| BALANCE AVAILABLE FOR DISTRIBUTION, &c. | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| *Deficit* | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| ORDINARY DIVIDEND PAID | —[b] | — | —[b] | — | —[b] | — | —[b] | — |
| PERCENTAGE OF TOTAL COSTS TO GROSS REVENUE | 64·7% | | 54% | | 49% | | 46·9% | |
| Expenditure per kilowatt capacity | £4. 3s. 7d. | | £6. 5s. 5d. | | £10. 3s. 10d. | | £7. 0s. 10d. | |
| REVENUE PER KILOWATT CAPACITY | £6. 9s. 2d. | | £11. 12s. 0d. | | £20. 16s. 0d. | | £15. 0s. 2d. | |
| Expenditure per 8-c.p. lamp capacity | 2s. 8d. | | 3s. 7½d. | | 6s. 6½d. | | 4s. 6d. | |
| REVENUE PER 8-C.P. LAMP CAPACITY | 4s. 1½d. | | 7s. 5d. | | 13s. 3½d. | | 9s. 7½d. | |
| REVENUE PER 8-C.P. LAMP CONNECTED | 6s. 2½d. | | 5s. 7½d. | | 6s. 10½d. | | 5s. 7½d. | |
| Price charged for lighting, per unit | 7d. (1½hr.) to 3d.[g] | | 7d. (1½hr.) to 3d.[g] | | 7d. to 3d.[f] | | 7d. (1½hr.) to 3d.[i] | |
| Price charged for power, per unit | 4d. (1hr.) to 2d.[g] | | 2½d. | | 6d. to 3d.[g] | | 6d. (1hr.) to 3d.[i] | |
| Price charged for public lighting | — | | — | | — | | — | |

CLERKENWELL.—REMARKS—*a* Date of commencement of generation of electricity. *b* The *total* authorised capital of the *Company* is £800,000. The net revenue and capital accounts are not separately rendered from the totals referring to the whole of the Company's operations. *c* Being the capital appropriated to the County of London (North) Electric Lighting Order, 1892, the Northern Extensions Order, 1897 and Holborn and St. Giles Order, 1898. *d* Includes £225 stores and works expenses. *e* The engineers' salaries are included under "Wages at station" and "Distribution of electricity." *f* Inclusive of £87 to insurance and £60 to auditing. *g* On max. demand system. *h* Inclusive of £307 stores and works expenses. *i* Includes insurance £167, auditing £65, and law £21.

WANDSWORTH.—REMARKS—*a* The *total* authorised capital of the Company is £800,000. *b* The net revenue and capital accounts are not separately rendered from the total respecting the whole of the Company's operations. *c* Inclusive of £114 to stores and works expenses. *d* The engineers' salaries are included under generation and distribution charges. *e* Includes £51 to insurance and £60 to auditing. *f* On max. demand system 1½ hour scale. *g* On max. demand system, 1 hour scale. *h* Includes auditing £70, law £13, and insurance £140. *i* On max. demand system.

# The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878).

Published every Friday, Price Sixpence; Post Free, Sixpence-Halfpenny
Editorial, Publishing and Printing Offices,

1, 2 & 3 SALISBURY COURT, FLEET ST., LONDON.
*Telephone:* 949 Holborn. *Telegrams:* ELECTRICIAN NEWSPAPER LONDON

*All Letters relating to Subscriptions, Advertisements, and other business matters should be addressed to the Publisher* "THE ELECTRICIAN," *Salisbury-court, Fleet-street, London, E.C. Cheques and Money Orders should be made payable to* "THE ELECTRICIAN" *Printing and Publishing Company, Limited, and be crossed "Coutts and Co."*

*All Editorial letters to be addressed to* THE EDITOR.

*All letters for insertion in* "THE ELECTRICIAN," *or containing questions, must be accompanied by the name and address of the writer as evidence of good faith. No notice whatever is taken of anonymous communications.*

"THE ELECTRICIAN" *is published every Friday morning, in time for the morning mails. It is on sale at the railway bookstalls throughout the Kingdom on Friday morning, and can be obtained of all Booksellers and Newsvendors; or direct from the Publishing Offices, as above*

**Subscription Rates.**—The Rates for Subscriptions to "THE ELECTRICIAN" are as under:—

| | YEAR | HALF-YEAR | QUARTER | |
|---|---|---|---|---|
| United Kingdom | 26s. 0d. | 13s. 6d. | 7s. 0d. | Post free, payable in advance. |
| Postal Union | 30s. 0d. | 16s. 0d. | 8s. 0d. | |

*New Volumes of* "THE ELECTRICIAN" *commence in April and October.*

## SPECIAL NOTICE.

The present number of "THE ELECTRICIAN" completes Vol. XLVI. With next week's number will be issued (Gratis) the Index to the Volume.

**READY NEXT WEEK.**—Vol. XLVI. of "THE ELECTRICIAN." Price 17s. 6d. The volume will consist of 1,000 pages. Postage 1s. extra.

Cases for binding Vol. XLVI. are now ready, price 2s.; post free, 2s. 3d

## POLYPHASE SUB-STATION MACHINERY.

Mr. EBORALL'S Paper upon "Polyphase Sub-station Machinery," and its discussion, our report of which we conclude in this issue, must seem to some of our Continental and American friends to bring a somewhat strange subject at this date before the principal association of electrical engineers of this country. British engineers enjoyed for so long the first place in engineering work, that it might be expected that they should be familar with the matter of the Paper, which, as the author frankly states, does not bring forward anything new. Polyphase synchronous and asynchronous motors have been employed largely for many years both on the Continent and in America, while rotatory converters are also well known. In this country, however, various reasons, among which prejudice and ignorance have certainly had a part—a critical and impartial examination of the true causes would be most instructive and interesting—have caused this class of machine to be almost entirely neglected; and now that polyphase systems are practically unavoidable, we find our manufacturers without sufficient experience, and our engineers, speaking generally, in a state of ignorance as to their practical working. In these circumstances the Paper no doubt served a useful purpose, and many engineers will be grateful to the author for having written it. Such a state of affairs is entirely wrong, and this Paper makes evident again the great difference between the Old Engineering and the New. The old rule-of-thumb man will find himself entirely at a loss to understand much of what has been said. The necessity for efficient technical training of such a character as will enable our young engineers to keep abreast of and take a part in the development of modern electrical plant of all classes is being more and more emphasised every day. A short time back a "trained engineer" was one who had served his time in the shops. In America the term is only applied to a man who has received a technical training in addition to his shop experience. In such a training the fundamental phenomena of alternating currents, including the principles of practical design, the calculation and effect of reactions and reactance, under all sorts of conditions such as occur in practice,

must be made as familiar to the student as OHM's law and the common phenomena of continuous-current working, and the whole instruction must be directed solely with a view to its use in practical work. This is being done abroad, and until we take the problem up as seriously as is done there, we cannot hope to make up the ground which this Paper and its discussion again show that we have lost.

It seems to be commonly believed that the working of rotatory converters introduces considerably more complication, —especially where not compounded—than that of synchronous motor generators. We think this view is probably exaggerated in relation to the large systems under consideration, and that it arises from want of experience. In a small system, where cheap labour must be employed, the matter is different; but in the cases considered skilful superintendence is essential in any case. In the interests of economy we have much increased the complexity of our systems of supply already; and should not hesitate to go further as long as we have sufficient assurance that a suitable economy will be effected, and that the plant will be reliable. In particular, the voltage regulation of rotary converters has been referred to as presenting difficulties. For traction work with compound machines the simplicity of the regulation was emphasised in the opening of the discussion; while for lighting work, where the induction regulator has been commonly recommended, the added complication is in practice very little, and the regulator can occupy space which would not otherwise be utilised. In connection with the problems of regulation, it does not appear to be generally recognised how much may be obtained under suitable conditions by the field rheostat alone. There is working at the present time, in this country, a rotatory converter which is used as a booster for accumulator charging, and which gives a range of voltage of over two to one by manipulation of the field rheostat alone. In this case, as in that of Glasgow, the necessary reactance is provided in the transformer itself. This is three-phase and symmetrical, but with the primary and secondary of any one phase wound upon different parts of the same leg, so as to allow for considerable magnetic leakage taking place. It is probably not advisable to rely upon this method of regulation alone in lighting work, though it would often be possible to do so.

The effect of compounded rotatories upon each other, upon the feeding system, and upon the generators, is not usually fully understood. When the whole system is lightly loaded the current supplied by the generators will be lagging and will keep down their voltage. As the load increases the current increases, but at the same time changes phase, so that at full load the increased current does not necessarily cause any alteration in the generator volts. The effect on the generator, in fact, is equivalent to compounding. Further, any single rotatory may change load independently of others in other sub-stations, and with little effect on the voltage either of feeders or of generators. This method of regulation thus possesses some well-marked advantages, and it is clear that in some cases the alteration of phase of the current is of advantage in its relation to the rest of the plant. The effect can, of course, be obtained with motor generators, the generator current being led round the fields of the alternator so that the strength of these may be dependent upon the load.

Considerable attention has been devoted to the troubles which are sometimes experienced in the parallel running of synchronous machinery, and the impression is common that rotatory converters are specially bad in this respect. In practice, however, it is found necessary to adopt similar precautions for all classes of such machines. At the present time, difficulty in the parallel running of alternators in the same station is not uncommon, while it is known that if the attempt is made to couple machines in different stations to the same network, disturbance is very likely to be experienced. In the first transmission plant installed in this country for tramway purposes, synchronous motor generators were used in two sub-stations, and supplied with current by alternators belt-driven from Willans engines. Parallel running was at first very difficult, and even after the plant was well understood there were conditions of load under which certain combinations of the running plant were more or less awkward to work. Even under the best conditions the ammeter needles were perpetually in a state of oscillation. In spite of this, however, the plant ran, after the first difficulties were disposed of, in the most reliable way, and the oscillations did not increase to any dangerous limit, or affect the direct-current supply. At a later date the motor generators were replaced by rotatory converters of larger capacity in one sub station, and on the whole, apparently, with better results. A generator was installed in the power-station, direct-driven, and running at a lower speed than the earlier Willans-driven machines. It was found that when the supply was changed over from belt-driven to direct-driven sets, the frequency of such disturbance as could be detected on the instruments changed at the same time, thus indicating again the fact that hunting disturbances all start with irregularities in the generating plant. This is merely given as an illustration at home of the fact explicitly stated by American engineers from similar experiences, that synchronous motor-generators require similar precautions to those necessary with rotatory converters. To run a single machine or a single sub-station close to the generators is not difficult. The disturbances, however, showed themselves as soon as several sub-stations were required to run in parallel; and just as with generating stations inter-connected, the greater the distance the greater the possibility of unsteadiness. It is a point of the utmost importance that the resistance of the feeding cables between the different sub-stations should be limited, and in all modern systems it will be found that the losses allowed in the feeders are usually smaller than with other methods of supply.

Just as a good technical training is fully valued abroad, so the importance of experimenting with and fully testing all classes of electrical plant has been appreciated there, and carried into practice to an extent little found here. When multiphase transmission to several sub-stations containing converting machinery began to be developed on the present lines in America, hunting troubles soon appeared, and an immense amount of experimenting was at once entered into to discover the cause. The influence of speed variation and of the governor, of resistance between sub-stations, and the good effect of copper damping plates, were soon appreciated, and rules laid down by which satisfactory working could be assured. There still remained, however, variations in the working of different machines which were very contradictory; and it would be of great service at the present day if a working explanation of the causes were given by which the influence of different features of design could be estimated. We should probably be saved from taking too great precautions in some directions and too little in others, with resulting advantages as regards first cost and good operation. In the meantime we again draw attention to the fact that such matter as is treated of in this Paper should be as familiar to the engineer entrusted with the design of a system as his A B C. The "one system man" is out of date, and the modern engineer must be fully acquainted with all and unbiassed in favour of any. His decision must be finally made by placing a monetary value upon the various advantages and

disadvantages of different classes of plant so as to reduce the whole to a common basis—that of expense in working and maintenance, including interest on capital outlay. It is lamentably obvious how often fashion, one-sided experience, or want of sufficient detailed examination upon this common basis, have had influence in the past.

## ST. MARYLEBONE ELECTRIC LIGHTING (No. 2) ORDER, 1901.*

In 1889 the Metropolitan Electric Supply Co. (Ltd.) obtained an order giving them electric lighting powers in the parish of St. Marylebone.

In the same year, after an exhaustive inquiry by the late Sir Francis Marindin into the question of the electric lighting of the metropolis, and having in view the provisions of the Electric Lighting Act, 1888 (sec. 1), that "the grant of authority to any undertakers to supply electricity within any area, whether granted by licence or by means of a provisional order, shall not in any way hinder or restrict the granting of a licence or provisional order to the local authority, or to any other company or person within the same area," the Board of Trade adopted the policy, as regards the metropolis, of granting powers to two bodies in respect of the same area, and this policy has been confirmed by Parliament in respect of several parts of the metropolis.

In 1898 applications for provisional orders in respect of the parish were made to the Board of Trade by the Vestry and by two companies, and the Board, in accordance with their usual practice of giving preference to the local authority, granted an order to the Vestry, and refused the applications of the two companies.

The Metropolitan Company opposed the confirmation of the order on the ground that competition by the Vestry would be rate-aided, and consequently unfair, and the House of Commons (the first House) refused to confirm the order, after hearing by a Select Committee.

During 1899 numerous complaints were received by the Board of Trade from consumers in the parish as to interruptions in the supply given by the Metropolitan Company, and the necessity was then urged for a competitive supply.

In 1900 the Marylebone Electric Supply Co. (Ltd.), one of the companies who applied in 1898, applied again for an order, but the application was opposed by the Vestry (as the local authority under the Electric Lighting Acts) who stated that they had resolved to apply again for an order.

The Board of Trade held an inquiry in the matter, and having regard to all the circumstances, they decided to dispense with the consent of the Vestry and granted the order, but the bill to confirm the order was rejected on second reading in the House of Commons (the first House).

In the course of the debate representations were made that the Vestry were in negotiation for the purchase of the Metropolitan Company's undertaking in the parish.

The Vestry subsequently decided not to proceed with the negotiations.

This session the Borough Council of St. Marylebone (who have succeeded the Vestry) and the Marylebone Company have both applied for orders in respect of the parish (now the borough).

The Borough Council (as local authority under the Electric Lighting Acts) have refused their consent to the company's application, but the Board of Trade have decided to dispense with the Council's consent, and have granted the order (and also the order applied for by the Borough Council) with the view of giving Parliament the opportunity of deciding on the question as a whole whether any—and, if so, what—supply of electricity in St. Marylebone should be authorised in competition with the supply given by the Metropolitan Company.

## SOME NOTES ON POLYPHASE SUB-STATION MACHINERY.†

BY A. C. EBORALL.

(*Concluded from page 953.*)

### III.—Relative Comparison of the Different Types of Sub-station Converters.

From what has already been said about the three classes of sub-station equipment, a good general idea can be formed of their relative advantages and disadvantages. From the point of view of simplicity and ease of operation asynchronous converters are far ahead of the two types of synchronous machines. But this advantage is gained at the expense of plant efficiency, and consequently, simply on account of the lagging currents incidental to their use, this type of converter is unsuitable for work of any magnitude. It will continue to find its chief use in connection with schemes for the conversion of power for lighting and tramways, where the total amount of power to be transmitted and distributed is relatively small, and where the sub-station converters do not exceed 150kw. in size.

Synchronous motor generators, on the other hand, are ideal machines for the work in many respects. High power-factors over the whole of the system are assured; there are no complications in working, and no parallel-running troubles need be feared, provided a fair amount of care has been taken with the design of the plant in the first instance. Moreover, these machines possess (in common with the asynchronous converters) two very great advantages, the first being that they can be operated equally well from circuits of any reasonable frequency, there being no difference in the performance of the motors for frequencies between 25 and 60 cycles. The second great advantage is that the regulation of the direct-current pressure can be performed in well-known ways with the greatest ease, and not only this, but the direct-current pressure is independent of the pressure fluctuations at the ends of the long, high-pressure feeders. Both asynchronous and synchronous motor generators are efficient types, the efficiency of the asynchronous motor being generally about 1 per cent. less than the synchronous machine, while the efficiency of the latter will be about the same as that of the direct-current generator of equal size driven by it. Both classes of machine require simple switch-gear, and very little of it, the advantage being with the asynchronous machine, on account of the simple starting arrangements.

Rotary converters are on the same footing with regard to starting and power-factor as synchronous motor generators, and have two great advantages over either form of motor generator—they are 4 to 5 per cent. more efficient at all loads, and possess a greater overload capacity. They are, on the other hand, extremely sensitive with regard to parallel running; with regard to fluctuations in the feeder pressure, moreover, their manner of operation is by no means simple, and the arrangements for regulating and running are in general somewhat complicated; this is on account of the special regulating arrangements and extra switch gear required for the step-down transformers and auxiliary devices.

With regard to the important points of floor space required, and first cost, there is very little to choose between the different types of machines. Comparing the machines alone, there is, of course, a considerable advantage in favour of the rotary converter, but the additions to the latter equipment in the shape of transformers, air-blast outfits (when used), special regulators, and extra switch-gear, bring up the cost of a rotary converter equipment to very nearly the same figure as that for the synchronous motor generator equipment; the asynchronous converter equipment is somewhat dearer than the latter as a rule.

The table given on the following page serves to illustrate the above-mentioned points in a practical way. Examples given are taken from practice, and the machines (built in the same works) are compared upon *exactly* the same basis with regard to conditions of operation, such as speed, frequency, voltage, &c. The case selected to illustrate what has been said is an actual combined lighting and power scheme, current for lighting purposes being taken from the high-pressure feeders en route to the sub stations, as well as from the latter—hence the frequency. The case is somewhat unfavourable to the motor generators, as these machines were arranged with a generator at each end of the motor shaft, having half its output; consequently the floor space required is greater, and the cost more, than would have been the case had each motor driven a single generator of equal output. It will be seen that with the larger machines the only substantial advantages of the rotary converter compared with the synchronous motor generator are those of greater efficiency and overload capacity. These are, of course, of very great importance, but for many purposes the greatly superior performance of the synchronous motor generator from the points of view of simplicity, parallel running, and pressure regulation must be carefully balanced against them.

Before concluding a word or two must be said with regard to the performance of rotary converters of large size at different frequencies. It is not too much to say that the limit of successful operation of these machines is reached at 40 cycles; above this frequency there is no doubt whatever in the author's mind that in all cases the best type of converter to employ in the sub-stations is the synchronous motor generator, whatever the nature of the work. Above the frequency of 40 cycles there are two great difficulties in the way of successful working—good parallel running of the rotaries becomes extremely difficult, the machines hunting at the slightest provocation, and the question of commutation becomes a very difficult one to solve in a satisfactory manner. As already pointed out in connection with the generators, the lower the frequency the better the parallel running, for with a given angular displacement the phase difference between the E.M.F. waves of the various machines is smaller. The same argument applies equally to the case of the rotary converter, for in order to put the high-frequency machine on the same basis as the low-frequency machine in this respect, it would be necessary to have the same number of poles in each machine, meaning that a machine operating at 50 cycles would have to run at double the speed of a machine of the same

* Special report by the Board of Trade under sec. 1, Electric Lighting Act, 1888.

† Paper read before the Institution of Electrical Engineers, March 14.

*Comparison of Sub-station Machinery.*

Transmission : Three-phase at 5,500 volts between lines and 40 cycles.
Distribution : Three-wire at 510 volts between outers, neutral conductor earthed.

| Type of equipment. | Asynchronous motor generator. | | Synchronous motor generator. | | Rotary converters and step-down transformers. | |
|---|---|---|---|---|---|---|
| Output of sub-station converter ...... | 150kw. | 500kw. | 150kw. | 500kw. | 150kw. | 500kw. |
| Speed of converter ...... | 480 | 300 | 480 | 300 | 480 | 300 |
| No. of field-poles (generator)........ | 6 | 10 | 6 | 10 | 10 | 16 |
| Peripheral speed of commutator ..... | 1,760 | 1,880 | 1,760 | 1,880 | 2,970 | 3,100 |
| No. of commutator bars ... | 162 | 270 | 162 | 270 | 400 | 560 |
| Temperature rise, any part after 24hr. at full load.. | 35°C. | 35°C. | 35°C. | 35°C. | 35°C. | 35°C. |
| Rise of pressure when full load switched off, sub-station 'bus bar pressure constant | 15% | 12% | 14·5% | 11·5% | 9·5% | 8% |
| Efficiency Full load | 83·5% | 86% | 84% | 87% | 90% | 92% |
| Efficiency Half „ | 75·5% | 80% | 76% | 79% | 85% | 87·5% |
| Overload capacity for one hour with fixed brushes | 25% | 25% | 25% | 25% | 50% | 75% |
| Power factor. Full load | 90% | 91% | 100-95% (leading) | 100-96% (leading) | 100-95% (leading) | 100-96% (leading) |
| Power factor. Half „ | 87% | 88% | | | | |
| Starting cur. from A.C. side in terms of full load cur. | 80% (Rotor resist.) | 50% (Rotor resist.) | 100% (Starting motor.) | 100% (Starting motor.) | 80% (Starting motor.) | 60% (Starting motor.) |
| Full load drop of speed...... | 3·5% | 3% | None | None | None | None |
| Relative cost pr kw. inc. regulating gear... | 20kw. | 15·6 | 19·1 | 13·2 | 12·4* | 13·0* |
| Floor space required per kw. (sq. ft.).. | 0·8 | 0·5 | 0·75 | 0·5 | 0·55 | 0·45 |

output operated at 25 cycles. This is of course impossible, on account of mechanical considerations, the principal difficulty being the commutator. If, on the one hand, the peripheral speed of the commutator is too great, the use of carbon brushes is rendered very difficult, and also the segments may buckle, while on the other hand, as the number of segments required is practically fixed (by the permissible voltage per bar), these would become too thin if the diameter of the commutator is less than a certain amount. The higher the direct-current pressure, the greater the difficulties in this respect. The net result is that with high frequency the number of field poles on the rotary has to be increased, the diameter of the armature has to be increased (which means increased momentum), and also the armature reaction of the machine has to be made larger, in order to get a proper division of the current in the various branches of the armature. All these features, common more or less to the high-frequency rotary, namely, crowded poles, high peripheral speeds, high armature reaction, thin commutator segments, high voltage per bar, short distance between brush holders, &c., are wholly unfavourable to successful parallel running and good commutation, to say nothing of the increased wear and tear due to abnormally high speed. It is for this reason that a frequency of 25 cyles has been standardised for rotary converter work, and at this frequency the machines are undoubtedly satisfactory. Between 30 and 40 cycles their performance is still good under favourable conditions (that is, proportionately better engines, high speeds and low voltages), while above 40 cycles the use of the rotary converter, in units of large size, would be practically out of the question.

Low frequency of operation, such as 25 cycles, while satisfactory, if the whole output of the power station is to be absorbed by the converter sub-stations, is undesirable if other work has to be done in addition. Generators, motors, and transformers become unduly heavy and expensive, and lighting work from the alternating current mains is out of the question. But, on the other hand, all parallel running is better, and all inductive effects in generator, line, transformers, and motors diminish with low frequency, resulting in improved regulation over the whole system. Taking all these things into account, modern practice has shown that a frequency of 40 to 50 cycles is the best that can be employed for the work in question ; a departure from this in order to suit the requirements of the rotary converters in the sub-stations constitutes in itself a disadvantage which is not present when motor generators are used for the same work.

* Including middle-wire booster.

### Concluding Remarks.

Given that it is required to convert polyphase current into direct current by means of converting sub-stations, it is possible, based upon the considerations noted in the Paper, to draw the following general conclusions :—

1. For power work, and for those cases where the amount of lighting to be done is relatively small, rotary converter sub-stations operated at 20 to 30 cycles are preferable.

2. For lighting work, the use of motor generators, operated at 40 to 50 cycles in the sub-stations, will give the best results. This is also the case when the lighting load on the sub-station forms a considerable proportion of the total output of the latter.

3. Of the two classes of motor generator sub-station that equipped with asynchronous machinery is, on the whole, unsuitable for work of any magnitude.

The above conclusions may, perhaps, form a basis for discussion, but they must not be considered as being perfectly definite, on account of the widely different conditions that are met with in modern practice. Finally, the author would like to suggest in this connection that the discussion might profitably include the broad question of the transformation and distribution of large amounts of polyphase current for supply over large areas, for it is one of the most important questions of modern electrical engineering. Although in many cases direct-current sub-stations are undoubtedly advisable, still in many cases the direct distribution of polyphase current from simple transformer sub-stations will undoubtedly be the best solution, not only from the technical, but also from the commercial point of view.

## DISCUSSION.

*Thursday, March 14.*

Mr. M. B. FIELD thought that American engineers had now come to the conclusion that rotary converters were the right machines, provided the frequency was sufficiently low, say 25 cycles. Above 50 cycles troubles are likely to ensue with rotary converters, although the Westinghouse Company did not hesitate to build them up to 60 cycles. The full-load efficiency of a fair-sized rotary was 95 per cent., and, including its transformers, 93 per cent., which was much higher than with any other rotating converter, whether synchronous motor-generator or non-synchronous motor-generator. A rotary converter would run with 2½ times its full load without the least instability, and could be started up from the three-phase side with only about 30 per cent. above full-load current. Some 60,000 H.P. was transformed by means of rotary converters in the Metropolitan Railway Co.'s system in New York, and no difficulties whatever were being experienced. In Glasgow some 24 500kw. rotary converters would be installed in the various sub-stations, each rotary being direct-connected to a negative series booster. The rotaries were compound-wound, and the sole regulating device for varying the tension on the continuous-current side was the magnet winding. The transformers were specially designed with large self-induction ; in fact, they would give a 12 per cent. drop with full-load current, the load being a pure self-induction. The effect of varying the excitation was to vary the amount of lag or lead of the currents received from the transformers, with the effect that the self-induction of the latter increased or decreased the transformation ratio to the desired amount. In such sub-stations, where the frequency could not be conveniently kept down to 25, he thought that a very workable combination would be that of synchronous motor generators together with non-synchronous motor generators. The synchronous motor generators would be so designed that they could be sufficiently over-excited to make up for the lagging current taken from the line by the non-synchronous motor generators. With such a system the efficiency would be high ; there would be no difficulties whatever in starting, since, to start up a sub-station in the first instance, a non-synchronous unit would be run up to speed, and then a synchronous motor generator would be started up from the continuous-current side. Further, the sub-station as a whole would be receiving currents from the line, which would be exactly in phase with the E.M.F. He did not agree with Mr. Eborall that the proper place for damping copper pieces was only between the pole tips, and that they were useless elsewhere. Many makers surrounded the pole with a massive ring, which was thickened up at the pole tips, the poles being often chamfered off at the tips, and the copper rings were arranged to enclose the tips, so that part of the polar surface was, as it were, made of copper. Normally the whole pole flux passed through the ring, and in order for it to be blown out into the intervening space between the pole-tips it would have to cut across the ring. The induced currents in the latter would, of course, prevent this to any serious extent. The case sometimes arose where it was required to run a rotary reversed—that is, to supply it with continuous current and take a three-phase current from it—some regulating device was here essential to prevent the rotary from racing. For instance, if a lagging current were taken from the rotary it

would tend to demagnetise the field magnets and the rotary would speed up. Cases had been known where rotaries had flown to pieces owing to this cause. In any case the frequency was very variable, which is naturally objectionable. In Dublin, where on occasions a rotary was run reversed, the following ingenious device had been resorted to. Connected to the main rotary was an auxiliary one with no winding on its field poles. It was supplied on the three-phase side with alternating currents by means of series transformers inserted in the main three-phase line. The continuous-current brushes supplied merely current to the compound winding of the main rotary. The field magnet system of the auxiliary rotary was rotatable, and its position was so adjusted that when the main current was in phase with the E.M.F. the auxiliary rotary back E.M.F. was at an angle of 90 degrees to the current it received from the series transformers. It therefore received no power, and could give out none, that is, no current circulated in the compound winding of the main rotary. If the current lagged or led the auxiliary rotary received from the series transformers a correspondingly lagging or leading current which magnetised the field magnets of the auxiliary rotary in the one direction or the other, so that its continuous current brushes supplied to the compound winding of the main rotary a current which compounded or decompounded the machine according as it gave out a lagging or a leading current. The device was absolutely automatic and the speed variation was never more than one or two revolutions. The auxiliary rotary must have an output of about 1 or 1½ per cent. of the main rotary.

Prof. SILVANUS P. THOMPSON thought that thanks were due to Mr. Eborall for having pointed out certain advantages of the mesh connection over the star connection. Although some of these were certainly known before, he did not remember them having been published. With respect to the use of damping coils between the pole pieces, he agreed with Mr. Field that there was some advantage in putting a thick copper coil round the pole, but he did not stop there, because this did not secure the whole advantage. There might be a reaction due to a lagging or leading current which tended to distort the magnetism to one side of the poles producing an unequal distribution which would be sufficient to admit of hunting. He considered the real remedy was the original one which he had emphasised some 12 years ago, viz., to use an *amortisseur* on the plan adopted by Leblanc, and have a number of closed copper circuits so that there were circuits through the pole faces as well as round them and between them. The large 3,000kw. machines exhibited by the Allgemeine Elektricitats Gesellschaft at the Paris Exhibition had the pole-pieces pierced with five holes of different sizes from front to back and copper rods inserted in each hole. The ends were all short-circuited together, making practically a squirrel cage embedded in each pole, and he ventured to think this a far more effectual method. Another matter mentioned in the Paper was the use of three-phase choking coils. It had interested both Mr. Mordey and himself, and he had, in 1895, specially pointed out the advantage in a three-phase distribution—where there was, of course, capacity between the three lines—of putting in three-phase choking coils at intervals along the lines. Dealing with the question of the variation of speed of engines, he said he had discussed this with Prof. Dalby who, in his lectures, had given some data about the amount of variation of speed of engines of different types, but he did not remember having seen published any exact data about the variation of the angular speed of engines of different types under different conditions. He put this point to those interested in the engine question as one upon which it was most important that full information should be available. What kind of specification for an engine could be drawn up so as to ensure that the cyclic irregularity should not exceed a permissible minimum and what means were there, besides the Horn tachograph, of measuring or recording on any given engine set, the amount of cyclic variation under different conditions? About two years ago he read a Paper before the Institution on the rotatory converters, but certainly Mr. Eborall had made out a good case for the employment of motor generators under the conditions of supplying large quantities of electrical energy by a three phase system at a high voltage with substations for the purpose of converting to continuous current. But, after all, did it not remain to be proved that whether they used rotatory converters or these combined motor generators they were only making the best of what was a very imperfect job? They were putting down into sub-stations large quantities of revolving machinery which required constant attention, and he looked forward to the time when it would be possible to do without them. One way of simplifying matters would be by not using continuous current, but three-phase current throughout.

Mr. S. Z. de FERRANTI thought the Paper did a great deal of good in emphasising the extreme complication of the system which was required to convert alternating current into continuous current. He agreed with Dr. Thompson that all this was not going to be permanent. The principle case for systems of this class was electric traction. With regard to the question of the prevention of hunting, he certainly agreed with Dr. Thompson that the true solution was the original one invented by Leblanc, who had gone into the matter very fully. Leblanc was a most profound mathematician, and his theoretical results had agreed very well with practice.

Mr. W. B. ESSON said he had only had experience with the last system mentioned by Mr. Eborall viz., where there were induction motors with direct current generators coupled one to each end, forming a three-wire system. This had been a case of distribution over a mixed area, the Board of Trade allowing supply by alternating currents to one part and insisting on continuous current to another. On account of the feeders being a considerable length they had had to generate an alternate two-phase current and the induction motor was found to be by far the most simple in starting, management, &c. They also had in view that an induction motor would start itself, supposing a short occurred in the line and burnt itself out. Another thing about these induction motors was that the fineness of the regulation, in a sub-station, practically precluded the use of a squirrel cage rotor. He also considered Mr. Eborall's air-gap of $\frac{1}{16}$in. for an induction motor with a rotor 3ft. 9in. diameter too small to be safe. American practice favoured the use of a much larger one than that on the Continent. With a rotor of that size the Americans would use an air-gap twice as large. Referring to the picture of the Metropolitan Company's machine in the Paper, he remarked that a very striking feature about American and Continental machines was that they seemed to be very much lighter in weight than the English. They had far less material in them, and he asked Mr. Eborall what was the drop in this particular machine. We were now making machines in this country with a drop on a non-inductive load of 2½ to 3 per cent., but it would appear that this machine had a drop of something like 8 or 9 per cent. on a non-inductive load. It was impossible if half as much material again was put into English machines to compete in price with Continental work, and the fact was that English engineers were making their machines too good. On the matter of hunting, he said he had had a great deal of trouble with horizontal engines worked by the usual Corliss trip gear, and the trouble had been found to be simply due to the fact that the trip cams were not the proper shape.

Prof. C. A. CARUS-WILSON quoted Mr. Eborall as follows:—"The momentum of the converters should be kept as low as possible, for this apparently indirectly assists hunting." In his opinion, momentum was the initial cause of hunting, and therefore assumed more importance in the whole problem than was given to it in the Paper. He confined his remarks more particularly to the use of these converters for traction work, in which the primary circuit was well regulated, and the irregularities were more particularly due to the very large variations of load on the secondary side. In this case, when an extremely heavy load was taken from a substation, a very large disproportion of torque on the two sides of the rotary took place, and the inevitable result was a very large cross flux. This could easily be shown by putting a brake on the armature of the rotary whilst it was running. Under normal conditions a rotary working without any frictional or torque loss on its own shaft would be entirely without cross flux of any kind, and the cross flux was the inevitable accompaniment of a disproportion of torque between the primary and secondary sides. Directly there was a heavy load thrown on the secondary side, as was frequently the case in traction work, there was a sudden disproportion of torque between the sides, simply due to the fact that the momentum would not allow the primary torque to follow up the sudden demand on the secondary side. The result was that the greater the momentum of the rotating part the greater was the instantaneous disproportion between the two sides, and the greater was the amount of cross flux. On this account it was quite clear that Mr. Eborall was correct when he said that a very heavy flywheel action in a rotary was very detrimental from the point of view of hunting. But he disagreed with Mr. Eborall's conclusion, which was that, on this account, the amount of momentum of the rotary should be reduced as low as possible. It was quite impossible to get rid of momentum altogether, and the actual mechanical momentum of the rotating part of the converter was not the only thing that produced this effect. There were two other things which had exactly the same effect. One was the ohmic resistance in the rotary, and the greater this was the greater would be the disproportion in torque. High ohmic resistance had the same effect as large momentum. But, besides this, the question of the strength of the magnetic field had also a very important bearing upon it, because the stronger the magnetic field the less would be the disproportion of torque between the two sides. Thus a strong magnetic field counterbalanced the effect of large momentum, and the effect produced by this strong field increased as the square of the strength of the field. This was borne out by Mr. Eborall when he said that over-excitation of the rotaries was a condition favourable to good operation, thus implying that it was not because a strong field was more stiff, but because a strong field counteracted the effect of the mechanical momentum. In order to reduce the effect of a sudden overload, the essential requirements were low ohmic resistance, low mechanical momentum and as strong a field as possible. Referring to the disadvantage of considerable momentum, he said that some time ago when traction schemes were first beginning to be talked about, a great deal had been said as to having subsidiary motor generators stationed along the line in order to give relief when very sudden overloads were experienced, and also to prevent excessive drop in the trolleys and feeders, the motors acting as generators when the pressure had eased. It seemed to him that the motor generator was exactly the thing that at one time so many people were aiming at, and it seemed still a thing to be aimed at that the momentum of the rotary or motor generator should be made to act as a buffer to prevent excessive overloads in the secondary being reproduced in the primary. For this reason he urged the consideration of the question as to whether damping effect in some shape or form could be carried out to such perfection as to act as a complete offset to hunting, and whether it would not be advisable to increase the momentum of the rotating parts in such a way that the sudden overloads on the secondaries would not be reproduced in the primaries. Following out this idea, and accepting Mr. Eborall's suggestions at the end of his Paper, it would appear to him that that type of sub-station for traction service would be most desirable where the greatest amount of momentum could be placed in the rotating part of the converter or motor generator.

Mr. E. G. CRUISE remarked that, as far as he could see, polyphase transformers would be considerably more economical than three single transformers; they took up far less space and would be cheaper. Another point was that there would be no difficulty in the regulation whatever in asynchronous and synchronous motor generators. But this assumed the line pressure was absolutely constant, and, as far as he could see, in power schemes one of the difficulties would be to keep the line-pressure constant, especially if they were feeding, say, half-a-dozen sub-stations from one trunk line. He did not see how it was possible to take a separate feeder to each sub-station. Again, how far did Mr. Eborall think the pressure

might vary so as not to interfere with the working of the synchronous motor, because theoretically the torque ought to vary something like the ratio of the square of the impressed volts, and if this were varied very much there would be a very difficult state of affairs to deal with, quite apart from the regulation of the line pressure.

Mr. W. H. PATCHELL, referring to the equipment of the sub station of the Charing Cross and City undertaking, said that from what Dr. Thompson and Mr. Ferranti had said it would be seen what he had had to suffer before making up his mind what system to adopt. Everyone had advised him to use a different method; eventually, however, he had decided to do without statics. His 10,000 volt generating plant was large enough for generating this voltage directly, without sacrificing either efficiency or prime cost, but when he came to the sub-station he had decided upon fairly small units, because, on account of the very varying load in certain districts, they had to run sometimes at very different pressures. 300kw. for the motor generator was the figure. Then, as to the question between the induction motors and synchronous motors. He required small machines for balancing, and he used a 300kw. induction motor to drive two 150kw. direct-current generators. For the larger plant he had put down a synchronous motor driving a 300kw. direct-current generator. Thus he got the benefit of induction motors, which start quickly, and of synchronous motors, which gave a good power-factor, and these would be started from the direct-current side. It might be interesting to state, in view of the Institution's visit to Germany, that Messrs. Lahmeyer were making the plant at Frankfort, and it would probably be there at the time of their visit.

Mr. C. P. SPARKS thought engineers in England were in agreement with the writer of the Paper as regards conclusion number two, viz., that the simplicity derived from the use of motor-generators was more desirable than the extra efficiency offered with rotaries. With a scattered area, such as an agricultural one with factories here and there, a polyphase system might do, but there appeared to him to be little advantage in carrying the polyphase network into populous districts, owing to the greater expense in laying this than was the case with an ordinary three-wire continuous-current network. The only reason in favour of polyphase networks in such districts was the question of electrolysis, but this had been largely met by the introduction of triple concentric cables where the neutral conductor was earthed. Another point in favour of continuous current was that at present, although polyphase motors were lighter and, they were told, less expensive to build, the fact remained that no polyphase motor could to-day be bought with its accessories to compete in price with a direct-current motor at the same speed. This was a very difficult fact to get over, and the company prepared to supply polyphase energy was directly handicapped in the first case.

Mr. A. C. EBORALL, in reply, said that, with the exception of Dr. Thompson and Mr. Ferranti, the whole question of the transformation and distribution of polyphase current had more or less been left out of the discussion. He was also sorry that more had not been heard about suitable engines for large work, which was one of the toughest problems at the present time. Nowadays, we had not to think of small units. The machine of to-day and to-morrow was, in his opinion, a 2,000kw. or 3,000kw. slow-speed machine, and it was for these big units that the question of suitable engines became of very great importance. Therefore, when writing the Paper, he had touched upon the leading points in the hope that somebody would pick them out and criticize him, but they had not done so. He did not think Mr. Field's remarks required much comment. As Mr. Field pointed out, American engineers preferred rotary converters as against motor generators, and in order to employ them they reduced the frequency to the neighbourhood of 25 ∽ per sec. But he had pointed out in the Paper how very disadvantageous was the use of these very low frequencies. The best was from 40 ∽ to 50 ∽ per sec. For very low frequencies the generators were heavier, the transformers were heavier, lighting became impossible, and the whole plant became more costly. Therefore it was a great point in favour of motor generators that a frequency of between 40 ∽ and 50 ∽ could be used with success. Reference to damping coils had been made by Mr. Field, Dr. Thompson, and Mr. Ferranti. He himself had been most interested in the matter, and what he had in his mind was this: the early application of damping coils was that the magnets were built-up poles of sheet iron, and the pole-pieces themselves were perforated. Through these holes copper rods were passed, and these were all short-circuited. Now his (the author's) point was that the copper was wanted principally at the pole-horns, parallel to the armature, and that putting copper anywhere else was an unnecessary expense, especially for machines with solid pole-shoes. Mr. Field had made the suggestion of both asynchronous and synchronous motors in the sub-station, and Mr. Patchell had told them that this was precisely what he was doing in connection with the City lighting. Probably in this case the synchronous motors would be over-excited, in order to get rid of the idle current of the induction motors. The objection to asynchronous motors was that they caused reactions right through, which demagnetise the generating plant. This was why synchronous motors having a power-factor in the neighbourhood of unity were preferable in nearly every class of sub-station work. His own idea was that if the work was small and machines of only, say, 100kw. to 50kw. were required, then very likely it would pay to use asynchronous machines in the sub-stations on account of their greater simplicity, but for big work he was quite sure synchronous machines would give the best results. Mr. Field had also referred to the inverted rotatory, viz., a machine taking in direct current but generating three-phase current, and had further pointed out that the weakening of the field was a serious danger which caused the speed of the rotary to increase unless it were guarded against. Steinmetz's arrangement for getting over this had also been described. But it was a question whether such arrangements were really of any commercial good. It seemed to be making complications in the power house out of all proportion to the result attained. Then Mr. Field had come to the balancing effect of rotary converters fed by three transformers, star connected, and had stated, as an objection, that the transformers had to be built somewhat large in order to carry the balancing current. This was absolutely correct. Balancing could be done in two ways. Either put the machines on a three-wire system with balancers across, which cost a certain amount of money, or suppress the use of balancers and take the middle wire back to the middlepoint of the transformer. It was all a question of cost, and although the particular arrangement of Mr. Field's was very nice, he was inclined to think it better to put the extra money in the stationary transformers. Dr. Thompson's questions as to the mesh connection and damping coil he would refer to in the pages of the *Journal*. Dr. Thompson's reference to the use of choking coils was, if he understood aright, more particularly to using them in order to annul the capacity of the line. In the present case the choking coils were put in series with the feeders, and their effect was not to annul the capacity, but to get rid of the pulsations in the pressure which were encountered when using synchronous machinery at the end of long feeders. The results of using such choking coils were given in the Paper. The synchronising currents at Prague were hardly noticeable with the choking coils in, but when the choking coils were out the synchronising currents were quite 10 per cent. of the full load current of the motor, and these currents caused a very objectionable flickering of the lights unless the coils were in, perhaps 2 per cent. up and down. He thought he had been slightly misunderstood on the question of using polyphase currents throughout. In his conclusions, he said: "*Given* that it was required to convert polyphase current into direct current"; it was a commercial question. He considered, on the whole, that it was a mistake to use converting sub-stations except for traction work, and for this, at the present time, he did not think there was a good enough three-phase traction motor on the market. They were being employed on the Swiss mountain railways, but to put similar motors on street tramcars on a big system would be quite unworkable. There were the two overhead conductors, the heavy lagging currents, the small clearances in the motors, the difficulties of economical speed control, and the unbalancing effect of the return current through the rails, which in the case of traction made sub-stations a necessity, but for combined lighting and power work he did not think they were necessary. In many towns the three-phase system was used throughout for lighting directly, and given well designed plant, balancing troubles existed only in the imagination. Mr. Eason had spoken of some of his own work from which it was apparent that he preferred asynchronous motor generators as a rule. But he would like to know the magnitude of the work referred to by Mr. Eason. If it was Greenwich, it was a very small installation, and hardly came within the scope of the Paper. His Paper spoke of converting work where the converters ran into 1,000kw. each. He totally disagreed with Mr. Eason on the question of the drop in Continental machines and their weight. Mr. Eason's remark that English machines were too good was a serious reflection on the common sense of the British engineers who did not buy them. If the machines in question were good, they would be bought. They were not bought, and therefore could not be good. American and Continental machines were better at present, and this was a justification for going abroad for such machinery. The drop in the Metropolitan machine which Mr. Eason had assumed at 9 per cent. was only 5 per cent.; this was purely from considerations of design. A good deal of the trouble met with in this country with parallel working with slow speed sets was simply because the armature reactance was too small. On the Continent it was possible to give consumers at the far end of a town a drop in pressure which did not exceed Board of Trade limits; it was not asked for, but it was obtained. The Metropolitan machine in question was certainly light, but that was because it was very well designed. He could quite believe that if the trip gear of an engine was not well designed trouble would follow, but this did not happen often. Most of the trouble in this matter was traceable to the governors. He was not quite sure whether Prof. Carus-Wilson agreed with the Paper or not. If he did not, his only answer was that the statements given therein were based upon actual experience. He had found that the momentum of synchronous machinery used in this connection should be kept as low as possible. It was probably due to the reason that the controlling devices had a better chance of getting to work. If hunting were set up it was easier to stop it. Mr Cruise had spoken of polyphase *versus* three single transformers. In the Paper he had made the remark that it was preferable to use three-phase transformers wherever possible. As to their cost and weight, he thought most manufacturers would agree that such transformers above 100kw. cost more and were heavier than three single transformers. The limit of working with polyphase transformers was about 100kw. The question of handling in connection with big units was also important. Mr. Cruise had also raised the question of regulation in a plant of synchronous motor generators in sub-stations. A good synchronous motor would stand an overload of three times the full load before pulling out of step, although Mr. Cruise was right in saying that the torque depended on the square. It was not possible to go beyond certain limits. In practice it was found that with the ordinary variations of drop on such systems (a maximum variation of 10 per cent.) left the direct current absolutely unaffected with motor generators. With rotary transformers, of course, the volts were all over the place. Regarding Mr. Sparks' remarks, that it was cheaper to lay a direct-current system than a three-phase one, he said he had not been carefully into this matter. However, the cost seemed about the same. In one case there was a three-core cable, and in the other two separate cables, and the cost of laying was about the same. In a polyphase system a saving of about 20 per cent. in copper was effected. With regard to the V curves in the Paper, he said similar curves relating to small single-phase machines were first shown to the Institution many years ago by Mr Mordey, and on the Continent the curve had always been known as Mr. Mordey's V curve.

A hearty vote of thanks was accorded to Mr. Eborall at the conclusion of the discussion.

## SOME NOTES ON THE ELECTRICAL TRANSMISSION OF POWER IN COAL MINES.*

BY H. RAVENSHAW.

The object of this Paper is to discuss the special features met with in electric power plants in coal mines, and to give a record of difficulties and mishaps which have come directly before the notice of the author during the last 10 years. A great many of these plants are now in use, and are doing good work all over the country, lighting, pumping, haulage, and coal cutting being the principal uses to which electricity has been put.

*Lighting.*—It is usual to employ a separate plant for lighting, as the lamps are required in the pit night and day. A pressure of 220 volts is usually employed for the lighting circuits, and from 300 to 800 volts for the power. Underground engine-rooms which are at a considerable distance from the generating station are often lighted from the power mains with several lamps in series. The light is generally very much appreciated, especially at the shaft bottom, and at landings where there is often a good deal of shunting carried on. Where the mine is dry, Simplex steel tubing can be used to great advantage in places where there is not likely to be a fall of roof. There is an immense amount of primitive wiring in use, it being quite usual to run the wires on insulators and for the workmen to bare the two wires and hang a lamp across wherever they want it. This is, of course, only done in the parts of the mine which are not fiery. Enclosed arc lamps are very suitable for screens and pit heads, as well as for the pit bottom.

*Generating Plant.*—Very low steam pressures are usually employed at collieries, and, coal being comparatively cheap, the steam engines are often of a primitive pattern. Condensing plants are seldom used. Old winding engines are very often employed, and have the advantage of being extremely reliable; as a rule, however, they do not govern at all well. For power the units are usually from 100 I.H.P. to 200 I.H.P. and for lighting 50 I.H.P. In the best plants Corliss and vertical engines, with flywheel governors, are employed. These drive the dynamos with ropes or belts. Some of the best mines, however, are employing higher steam pressures and vertical high-speed direct-coupled sets. The most important requirement is absolute reliability, as spare plant is seldom put down and the machinery often works for at least 16 hours a day.

*Generators.*—Owing to the fact that non-condensing steam engines are used, there is always a great deal of steam about the surface works of a colliery, and this, combined with the immense amount of fine coal dust, covers everything with a film, which is by no means a good insulator. For this reason it is not advisable to employ dynamos which have internal ventilating spaces, and in any case all insulating materials have to be of the very best quality. The greatest care has to be taken with spare machines and armatures, as these are liable to get very damp. The author has known armatures which were not suitably insulated to break down one after the other, and this is generally found to occur on damp days in January or February. Exactly similar machines which were working underground where everything was very dry, gave no trouble whatever.

The load on the generators is likely to be extremely variable, there being, as a rule, only two or three motors on the circuit, which may all be stopped at the same time. It is quite usual with haulage for the load to vary from 25 per cent. over-load to open circuit in a very short space of time. It is, therefore, most important that the generators shall run without requiring any attention to the brushes. One man as a rule looks after a fan engine and all the electric light and power engines and dynamos, and if the machinery is suitable he has a very easy time.

*Switchboard.*—Owing to the atmosphere being charged with damp coal dust, the switchboard must be thoroughly insulated and must be fireproof. In a switchboard largely adopted by the author the slate slabs are thick and rest on a low wall of glazed bricks, the top being supported from the wall of the building by iron brackets. The only woodwork is a strip of teak along the top of the slates, fastening together panels of the same potential. The slates have the edges bevelled, and there is no wood or metal framework.

Owing to the fact that single-armoured cables are generally used, any sudden break sets up an enormous tension on the insulation, and it is best to employ massive slow-break switches of the simplest character. A most important instrument for the switchboard is a megohmmeter, arranged to read direct the insulation resistance between either pole and the earth. A log is kept of the insulation, and any leak put right as soon as possible. Where men's lives depend to a great extent on an absence of leakage, it is of the greatest importance that everything should be kept in first-rate order.

*Cables.*—For shaft work there does not seem to be anything better than Callender's armoured vulcanised bitumen cables, and when these are protected from falling objects and are kept well coated with Stockholm tar, they will last a very long time. The cables are almost always carried down the down-cast shaft, as the fumes and steam in the up-cast shaft are very injurious to the armouring. The cables should be so fixed that they will not be struck by any corves or other trifles which have a habit of falling down the shaft. Underground cables are generally suspended from the props which support the roof; they are hung fairly slack and should be suspended by loops of yarn or leather, and not nailed up with cleats. If thus supported, in case of a fall of roof, the cables fall to the ground, and are not so likely to be cut through. Ordinary rubber and lead-covered cables are often used, but a good armoured cable is greatly to be preferred.

All joints should be made in proper joint boxes, as solder cannot be employed, and a single-pole switch should be fitted on each conductor wherever there is a junction. Double-pole switches should not be used, but single-pole coupled externally. These switches should be entirely lined with slate, and made so that there is no possibility of an arc being started to the case. The switches should be made so that they will break the circuit with certainty in case of a short circuit.

*Switch Gear for Motors.*—Where the cables enter the underground engine-room they should be connected to two single-pole switches, similar to those mentioned in connection with the junctions. It is most important that the shunt circuit of the motor should not be broken, as the extremely high tension at breaking causes a vicious spark and puts tremendous stress on the insulation. By far the safest plan is to connect permanently across the shunt coils a non-inductive resistance of about twice the resistance of the fields. The current used is very small, and the field circuit can be broken with impunity. The author has known the shunt coils of a motor to be left on and to be broken by switching off at the surface, thus causing an enormous stress on the insulation of the mains. All series coils should also be fitted with a similar resistance. Precautions such as this reduce the flash from the switches, or, in case of a broken cable, to a very great extent.

*Motor Starting Switches.*—If a good double pole break is arranged where the cables enter the engine-room, a single pole starting-switch can be employed. This is rather important, as the parts of opposite potential are kept well apart. The author has employed liquid switches with a good deal of success; but it must always be remembered that, where they are used for regulating, steam is given off and ventilation must be allowed, so that leakage is not caused by the condensed steam. In any case, all resistances should be made so that they will carry the full working current, as they are sure to be used some time or other for regulating. The cones of liquid switches are of either iron or lead, and should be made so that they can be easily examined and replaced. Where there is gas all switches must be entirely enclosed.

*Motor.*—There appears to be a fairly general opinion that there is a great deal of danger from the explosion of gas ignited by the sparking at the brushes, and a number of experiments have been carried out which do not seem to have proved anything one way or the other. Whether this is so or not, it is perfectly obvious that the heat from a burnt-out armature or the arc from a broken circuit would be quite sufficient to ignite gas, and where there is any chance of gas being present it is necessary that the armature and commutator at least, if not the fields, should be enclosed in strong, gas-tight cases. All the terminals should be made so that cables cannot be accidentally pulled out, and the machines should be of such construction that they will pull up at once in case of a bad leak or short circuit. It is well known that a Gramme armature will go on running for some time with a burnt-out coil, all the time doing itself a very great deal of damage and developing a great deal of heat. A drum armature, however, in which the conductors of opposite potential are close together, will stop at once if there is a short circuit in the armature, and if proper fuses are fitted the machine is at once cut out. This is a most important feature in this type of machine, and Gramme armatures should never be used for any underground mining machinery.

Totally enclosed machines are by no means in favour among colliery managers, as they are difficult to keep clean and to inspect, and the general opinion seems to be that an open machine is to be preferred, precautions being taken that the engine-room is kept free from gas. Enclosed machines are certain to be run some day with the covers loose or entirely off. It is possible to obtain motors which will not break down and which do not spark at the brushes, and with careful supervision and an organised testing of the insulation from the switchboard in the generating station, there should be no danger from fire or explosion.

*Pumping.*—The advantages of electric motors for this work are obvious, and a large number of pumps are in use. Compound motors are generally employed, as they will not run away if the pump loses its water. Owing to the damp places in which they usually work, pump motors are often entirely enclosed, and shunt-wound machines under these circumstances are apt to give trouble owing to the resistance of the fields rising as the machine gets hot. This increases the speed and the armature current. The addition of a fair amount of series winding prevents these difficulties from arising.

* Paper read before the Institution of Electrical Engineers, March 28.

*Haulage.*—The author cannot quote a single instance in which electric locomotives have been employed in coal mines. Wire rope haulage appears to be almost entirely employed. With continuous rope haulage the motor usually runs at a constant speed, the rope pulleys being started and stopped by means of clutches. With single rope, and main and tail, haulage the electric motor is shown to advantage, the smoothness of starting and complete control over the speed, as well as the ease of reversal, giving an extremely handy hauling engine.

*Coal Cutting.*—The motors employed for coal cutting are usually series wound, and are subject to extreme variations of load and to very great shocks. They are entirely enclosed, and are consequently liable to get very hot. It is, in fact, difficult to imagine a more trying load. With these motors it is, of course, imperative that they should be entirely enclosed, both for the protection of the armatures from falling coal, and to keep out the coal dust. It is most important that effective switches and cutouts should be fitted at the junction where the motor cables are carried from the main cables, so that, in case of damage to the flexible cables or of burn out in the motor, both poles are quickly cut out.

*Generally.*—The amount of bad or unsuitable work to be found in colliery installations is very surprising, and it is apparently only due to the strict supervision and high order of intelligence to be found among those in responsible positions in collieries that there are so few accidents. With good work electric power transmission is an immense boon, and there should be a very great field for extensions. As the author has not employed any multiphase motors in mining work, he is not in a position to discuss their use. Many of the points raised, however, will apply to both systems.

As one mishap gives more instruction than many years of steady running, a list is given herewith of a number of accidents and defects which have come directly before the notice of the author. For obvious reasons the actual localities are not given.

*A. Engines.*—A stud sheared which fixed a flywheel governor in place. The engine ran away.

*B. Dynamos.*—Three armatures broke down one after the other, stopping the pit for three days. The first armature broke down. The spare dynamo had not been run for several months, and on starting up burnt out. The spare armature had been kept in a damp place, and broke down at once. All these armatures were only insulated with compressed paper.

*C.* The brushes for three dynamos cost £40 in one year, and armatures constantly broke down owing to over-heating. The brush-holders were originally few in number, with large carbon blocks. These were changed for a number of holders, each carrying a small block of carbon. After this alteration the machines ran well, and a set of carbons now lasts for many months.

*D.* A number of instances of short circuits have occurred, owing to the ventilating spaces in the armature becoming filled with coal dust. The armatures often broke down after they had been standing for some time. The coal dust seems to absorb moisture.

*E. Switchboard.*—An arc was started at 600 volts between two contacts about 1½in. apart at opposite potentials on a switch connected to a megohmmeter. The base of the switch was ebonite, and the leak was due to a fine layer of damp coal dust.

*F.* In another case a voltmeter was entirely burnt out, evidently from the same cause.

*G.* While there was a heavy earth on the mains an arc was started between a switch on the engine-room switchboard and part of the metal framework supporting the slate. This was evidently due to coal dust.

*H. Cables.*—Two armoured bitumen cables were laid in a wooden trough, which was close to a leaking steam-pipe. Both cables went to earth within a few hours of each other. The trough has since been filled with bitumen, and no further trouble has occurred.

*I.* A nail fastening up a cleat had evidently been driven through an armoured cable, passing through the insulation but not touching the conductor. This finally came in contact with the conductor, and, as there was a bad leak but not a dead earth on the other pole, an arc was set up and a very serious fire only prevented by the fact that the assistant manager was close by, and telephoned to the engine-man on the surface to shut down.

*J.* A common twin cable was carried down a shaft for lighting a mine. 60 volts were lost in this cable, the volts at the surface being 110, and in the mine 45 to 50.

*K.* A runaway train of tubs cut through one of the cables. The accident happened close to a box containing a double pole branch switch. The drag on the cables broke the marble bases of the switch into several pieces, and an arc was started to the iron case.

A number of cases have occurred where runaway trains have cut the armoured cables clean through.

*L. Motor switches.*—Owing to there being no stop inside the switch, and the handle being put on the wrong way, a double pole switch was carried back too far and a short circuit effected between opposite poles.

*M.* A main regulating switch was not marked, and was arranged to switch off left-handed instead of right-handed. An accident occurred to the gear, and the attendant, instead of switching off, switched on to full speed.

*N.* A double pole enclosed switch was fitted with a fibre arm. The insulation of the fibre broke down and caused a short circuit.

*O.* A single pole enclosed switch had a cast-iron arm supporting the moving contacts. The arm broke in switching on, but the contacts remained in position. It was therefore impossible to switch off the current, as there was no double pole switch fitted.

*P.* A gas-tight cover to a liquid switch was fastened by cramps binding the porcelain jar very tightly. The jar cracked when it got hot, and caused a partial earth owing to leakage of the solution.

*Q.* Owing to insufficient room being allowed for a liquid switch gear, the steam from the solution caused an arc to be started between opposite poles on several occasions.

*R.* A double pole switch in the shunt circuit of a compound motor worked perfectly well on the surface when tested with its own motor. On being erected underground, at the end of several miles of armoured cable, the length of break was not sufficient, and an arc carried on between the contacts.

*S. Motors.*—In several cases a Gramme armature has gone on running with a short circuit in the armature, burning the armature to a cinder.

*T.* No record has been found of a drum armature running on with a short circuit. Several cases have occurred in which the armatures have pulled up at once from a short circuit, the damage to the coils being very small.

*U.* A cable was brought from the magnets of a large shunt motor to a switch in another part of the engine-room. This cable was loosely run, and was accidentally pulled out of the connection. A tremendous flash was the result, the commutator was badly damaged, and the fuses on the surface blown.

*V.* The shunt circuit of a compound motor was broken, and the motor ran away.

*W.* After some repairs the series coils of a compound motor were connected up the wrong way. The machine gave a great deal of trouble, and it was some time before the mistake was found out.

*X.* A shunt motor driving a pump was driven by a shunt dynamo through a long line. The motor was enclosed, and the fields got very hot. The field of the motor being weakened, the current increased, and it was found to be impossible to run the plant for more than two or three hours at a time.

## CORRESPONDENCE.

### ANALYSING WAVE FORMS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In analysing wave forms of alternating current and E.M.F., I have found the following method to possess some advantages over those generally used, except, of course, the Henrici Analyser. It is required to express current or E.M.F. as a periodic function of time in the form of a Fourier series.

$$E = a_1 \cos\theta + a_3 \cos 3\theta + a_5 \cos 5\theta + \ldots \\ + b_1 \sin\theta + b_3 \sin 3\theta + b_5 \sin 5\theta + \ldots$$

where $\theta = 2\pi \sim t$ in radians, and the constants $a_1, a_3 \ldots, b_1, b_3 \ldots$ &c., are to be determined. Let the base line of one complete period be 2K in. long; it represents $2\pi$ radians, or 360deg. Erect ordinates through 0deg. and 180deg., and with a planimeter measure the area enclosed between these ordinates, the curve and the base line; let it be $Q_1$ sq. in. Erect ordinates through 60deg. and 120deg., and measure the area between these, call it $Q_2$. In the same way measure the area between ordinates through 45deg. and 135deg., call it $Q_3$; the area between 90deg. and 270deg., call it $P_1$; the area between 120deg. and 240deg., call it $P_2$; the area between 135deg. and 225deg., call it $P_3$. Then the coefficients in the expansion are:—

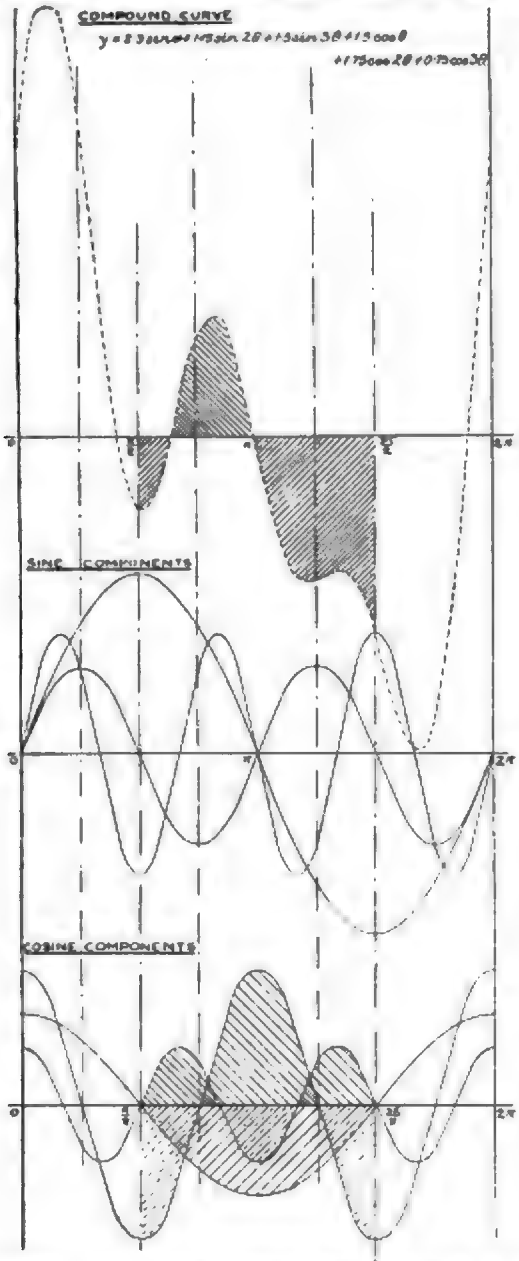
$$a_1 = \frac{-0{\cdot}785P_1 - 1{\cdot}11P_3}{K}, \qquad b_1 = \frac{0{\cdot}785Q_1 + 1{\cdot}11Q_3}{K},$$

$$a_3 = \frac{5{\cdot}44P_2 - 6{\cdot}77P_3}{K}, \qquad b_3 = \frac{1{\cdot}57Q_1 - 3{\cdot}14Q_2}{K},$$

$$a_5 = 5a_1 + 9{\cdot}07\frac{P_2}{K}, \qquad b_5 = \frac{1{\cdot}82Q_1 + 5{\cdot}25Q_2 - 5{\cdot}5Q_3}{K}.$$

These coefficients being given in inches. If E is 0 when $\theta = 0$ then $a_1 + a_3 + a_5 = 0$, if we neglect higher overtones, which are rarely of any importance.

Where the curve crosses the base line between our limits of measurement the planimeter will record the difference between the part above and that which is below the base line, so that $P_1$, $P_2$, &c., will be positive or negative, according as to whether the greater part is above or below the axis. The above equations have been obtained by integrating the general expression between limits which are distant by the period of



any overtone, and are equidistant from 90deg. or 180deg. For example, the area enclosed by the curve

$$y = a_1 \cos\theta + a_2 \cos 2\theta + a_3 \cos 3\theta + \ldots + b_1 \sin\theta + b_2 \sin 2\theta + b_3 \sin 3\theta$$

between the limits $\pi/2$ and $3\pi/2$ is

$$P_1 = \int_{\frac{\pi}{2}}^{\frac{3\pi}{2}} y \,.\, d\theta = \left(-2a_1 + \frac{2}{3}a_3 - \frac{2}{5}a_5 + \ldots\right)\frac{K}{\pi}.$$

A reference to the enclosed figure will make this clear, the curve whose equation is given is resolved into its components. The net area of the sine components between these limits is zero; all even cosine components vanish and one loop of $\cos\theta$ is measured negatively; one loop of $\cos 3\theta$ is measured positively, and so on.—Yours, &c.,

Newcastle, April 15. W. B. WOODHOUSE.

# LEGAL INTELLIGENCE.

## Maxwell v. British Thomson-Houston Co. (Ltd.).

In the Court of Appeal on Tuesday counsel applied before the Master of the Rolls and Lord Justices Vaughan Williams and Romer for leave to serve third parties (Messrs. R. W. Blackwell & Co.) with notice of defendants' appeal. He said the action was tried before Mr. Justice Kennedy at Leeds, and resulted in a verdict for plaintiff. Defendants were appealing from that verdict. The third parties were sub-contractors.

Their lordships granted the application.

In connection with the action tried at the last Leeds Assizes before Mr. Justice Kennedy and a special jury (fully reported in our issue of the 29th March) the further consideration of the matter came before his lordship on Tuesday, in London, on the question of the liability of the sub-contractors, Messrs. R. W. Blackwell & Co., who were third parties in the action. As an appeal is pending by defendants against the decision of the Leeds jury it was arranged that further consideration of the question now before the Court should stand over until after the appeal.

## J. Gibbs & Co. v. Chloride Electrical Storage Syndicate (Ltd.).

Mr. T. T. TERRELL, K.C., moved *ex parte* before the Court of Appeal (the Master of the Rolls and Lords Justice Vaughan Williams and Romer) on Wednesday, on behalf of defendants, for a stay of execution pending an appeal from the judgment of Mr. Justice Bigham on defendants bringing the amount of plaintiffs' claim (£487) into court. Counsel said the action was brought by plaintiffs to recover £487, balance of price of goods sold and delivered. The action was fully reported in *The Electrician* for April 5 (p. 910). Defendants admitted the claim, but counterclaimed for £579. 9s. 5d. Mr. Justice Bigham held that defendants had failed to prove their counterclaim, but as plaintiffs had been guilty of a breach of contract he deprived them of their costs.

The MASTER OF THE ROLLS: An admitted debt and counterclaim for damages. You failed on your counterclaim. You admit you owe the money. Then why not pay them?

Mr. TERRELL said the plaintiffs were a limited company, and if defendants paid them the money they might not be able to get it back if their appeal was successful.

The MASTER OF THE ROLLS: No, the application must be refused, with costs.

## Finchley Urban District Council v. Finchley Electric Lighting Co. (Ltd.).

On Tuesday Mr. Justice Kekewich was informed by Mr. Warrington, K.C., that the motion on the paper asking for the continuance of an interim order made by Mr. Justice Farwell would most probably not come before the Court, as he anticipated that terms would be arranged which would dispose of the motion and of the action.

## National Co. for Distribution of Electricity by Secondary Generators.

The petition of Mr. Adam Scott for the compulsory winding-up of this company was before Mr. Justice Wright on Wednesday. The grounds for the petition were said to be that there were circumstances which required such a strict examination as could only be obtained under a compulsory order. Petitioner said he represented shareholders for £68,000, and himself held £1,000. There were allegations against the directors and promoter of conspiracy to defraud in connection with the French patents and other foreign rights.

His LORDSHIP said he had read the affidavit of the petitioner, and there was sufficient ground for winding up the company, because it was, in fact, at present winding itself up. The only question was whether there were grounds for a compulsory order. The voluntary liquidation had been going on for two years, and if he dismissed the petition Mr. Scott would not be deprived of any remedy he might have against the directors for misconduct or misfeasance. At present he did not see sufficient grounds on the petition of one shareholder, who was said to have given only £5 for 1,000 shares, for making an order, and he dismissed the petition with costs.

## River Plate Electric Light and Traction Co. (Ltd.).

The petition of Messrs. Glyn, Mills, Currie & Co. for the compulsory winding-up of this company was before Mr. Justice Wright, on Wednesday.

Mr. EVE, K.C., for the River Plate Company, said the matter had been standing over for a very long time, and he understood that the petitioners were satisfied that the only chance of getting anything for the unsecured creditors was that an arrangement should be made to sell out the undertaking in Argentina, and he was content that the matter should stand over generally on the terms that if any proceedings were taken in the debenture-holders' action the petitioners should have notice.

The order was made on these terms.

## British Electrozone Corporation (Ltd.).

The petition of Messrs. Ede and Allom for the compulsory winding up of this corporation was before Mr. Justice Wright on Wednesday. On the application of counsel for the petitioners the petition was ordered to stand over.

**Dewberry v. British Westinghouse Electric and Manufacturing Co (Ltd.).**

In the Birmingham County Court, on Monday, Robert H. Dewberry, electric wireman, sued the defendant company, his employers, for compensation for a serious accident which occurred to him in October last while engaged, on defendants' behalf, at the works of the Metropolitan Carriage and Waggon Co., Saltley. The action was tried by Judge Whitehorne and a jury.

It appeared that plaintiff was working at a height of 35ft. from the ground running electric wires along the inside of the roof of a new shed. Plaintiff and another workman were working on ladders, which they preferred to scaffolding, which the foreman instructed them to erect. Plaintiff's ladder had to be placed at a dangerous angle in order to avoid a railway carriage, and the bottom of the ladder rested upon a plank. During the temporary absence of a labourer told off to hold it the ladder slipped, and plaintiff was thrown to the ground, sustaining very serious injuries. Defendants contended that plaintiff had been guilty of contributory negligence, as he did not work on a scaffold as instructed, and mounted the ladder while it was unguarded.

After hearing the evidence the jury found for defendants, and judgment was given accordingly.

An application was then lodged on plaintiff's behalf under the Workmen's Compensation Act, but its consideration was adjourned.

**Legal Fixtures.**

List of causes with an electrical interest entered for hearing at the Royal Courts of Justice during the present Easter Sittings:—

SUPREME COURT OF JUDICATURE.—COURT OF APPEAL.

CHANCERY DIVISION.—*General List.*

Isle of Thanet Electric Tramway and Lighting Co. (Ltd.) v. Abbott. (Appeal of plaintiffs from order of Mr. Justice Byrne, dated June 21, 1900.)

Chamberlain and Hookham (Ltd.) v. Corporation of Bradford. (Appeal of plaintiffs from order of Mr. Justice Farwell, dated May 25, 1900.)

Great Northern Railway Co. v. Great Northern and City Railway Co. (Appeal of defendants from order of Mr. Justice Buckley, dated Dec. 19, 1900.)

Corporation of Wolverhampton v. British Electric Traction Co. (Ltd.). (Appeal of defendants from order dated Dec. 20, 1900.)

In re Madras Electric Tramways Co. (Ltd.). Electric Construction Co. (Ltd.) v. Cooper. (Appeal of plaintiffs from order of Mr. Justice Cozens-Hardy (for Mr. Justice Wright), dated March 1, 1901.)

KING'S BENCH.—*Final Appeals.*

National Telephone Co. (Ltd.) v. Corporation of Huddersfield. (Appeal of plaintiffs from judgment of Justices Grantham and Channell, dated June 20, 1900.)

National Telephone Co. (Ltd.) v. Corporation of Tunbridge Wells. (Appeal of plaintiffs from judgment of Justices Grantham and Channell, dated June 18, 1900.) (These two actions to come into the paper together.)

British Electric Traction Co. (Ltd.) v. Commissioners of Inland Revenue (Revenue side). (Appeal of respondents from judgment of Justices Kennedy and Phillimore, dated November 27, 1900.)

Maxwell v. British Thomson-Houston Co. (Ltd.), R. W. Blackwell & Co., third parties. (Appeal of defendants from judgment of Mr. Justice Kennedy, dated March 27, 1901, with Special Jury, Leeds.)

Lane v. Elliott Bros. (Appeal of defendants from judgment of Mr. Justice Day, dated Jan. 17, 1901, without a Jury.)

*New Trial Paper.*

St. Helens Corporation v. United Alkali Co. (Ltd.). (Application of defendants from judgment, or new trial on appeal from verdict and judgment, dated December 19, 1900, at trial before Mr. Justice Bucknill and Special Jury, Liverpool.)

HIGH COURT OF JUSTICE.—CHANCERY CAUSES.

*Before Mr. Justice Wright.*—Companies (winding-up) petitions.

River Plate Electric Light and Traction Co. (Ltd.). (Petition of Glyn, Mills, Currie & Co.)

British Electrozone Corporation (Ltd.). (Petition of Ede and Allom.)

National Company for the Distribution of Electricity by Secondary Generators (Ltd.). (Petition of Adam Scott.)

*Before Mr. Justice Cozens-Hardy.*—(Causes for trial with witnesses.)

National Society for the Distribution of Electricity by Secondary Generators (Ltd.) v. Gibbs. Action and counterclaim. (Application to fix a day.)

*Before Mr. Justice Farwell.*—(Causes for trial with witnesses).

In re Arbitration between the River Plate Construction Co., Jas. Capel and Chas. Bright.

London County Council v. Metropolitan Electric Supply Co. (Ltd.) Action.

*Before Mr. Justice Buckley.*

Metropolitan Electric Supply Co. (Ltd.) v. Ginder. Action (advanced by order to be on list by April 18).

Sawyer v. Continental Water and Electrical Power Syndicate (Ltd.) (In liquidation). Action.

*Before Mr. Justice Joyce.*—(Causes of trial with witnesses).

British Motor Traction Co. (Ltd.) v. Sherrin. Action. (Pleadings to be delivered).

British Motor Co. (Ltd.) v. Ford. Action.

KING'S BENCH DIVISION.—*Special Paper.*

In re Arbitration between the Brush Electrical Engineering Co. and the Governor of Malta.

*Crown Paper (for Argument).*

National Telephone Co. v. Gulliver & Co. (Appeal by defendants from decision of Judge Lumley Smith of Westminster County Court.) Judgment or new trial.

South London Electric Supply Corporation v. Parrin. (Appeal against conviction by Metropolitan Police Magistrate under Public Health (London) Act, 1891.)

*Non-Jury Actions.*

London Motor, &c., Co. (Ltd.) v. Daimler Motor Co. (Ltd.). Contract.

National Telephone Co. (Ltd.) v. Exchange Telegraph Co. Injunction.

Corporation of Middlesbrough v. Imperial Tramways (Ltd.). Injunction.

Motor Traction Co. v. Straker. Contract.

Greenwood and Batley (Ltd.) v. Blaisdell. Goods sold.

# MUNICIPAL, FOREIGN & GENERAL NOTES.

## APPOINTMENTS VACANT AND FILLED.

Willesden Guardians require a consulting electrical engineer to prepare plans, &c., for an electric lighting installation at their new infirmary in Acton-lane. An advertisement contains further particulars, and applications must be sent to the clerk (Mr. J. Hutton Haylor), 329, High-road, Kilburn, London, N.W., by 23rd inst.

Sutton Coldfield Corporation invite applications for the position of resident electrical engineer. An advertisement contains further particulars, and applications must be in to the town clerk (Mr. Thos. V. Holbeche), by 25th inst.

Poplar (London) Borough Council require clerical assistants for the generating and distributing sub-departments of the electricity department, and also a meter reader and inspector. Applications by 22nd inst.

Mr. Joseph A. Jeckell, of South Shields, has been appointed engineer and manager of the Coventry electricity works, in succession to Mr. Gilbert S. Ram, at a salary of £350 per annum. Mr. Jeckell was appointed borough electrical engineer at South Shields in 1893, and was responsible for the drawing up of the specifications and the design of the electricity works for the Corporation. Since the completion of the works he has had entire charge, and has seen their capacity quadrupled since they were first started.

Mr. O. Dewey has resigned his position of distributing stations assistant to the Manchester Corporation in order to take up the position of assistant engineer to the Notting Hill Electric Lighting Co. While with the Manchester Corporation Mr. Dewey supervised the erection and starting of the whole of the high-tension continuous-current and three-phase sub-stations of the Manchester electricity undertaking.

Mr. J. W. Pulsford, B.A., late scholar of Sidney Sussex College, Cambridge, and second master of the Dorchester Grammar School, has been appointed junior mathematical teacher at Merchant Venturers' Technical College, Bristol.

Mr. W. B. Woodhouse, A.M.I.M.E., has been appointed chief electrical assistant at the Neptune Bank power station of the Newcastle-on-Tyne Electric Supply Co.

Mr. C. Garnett has been appointed borough electrical engineer at Darwen.

Mr. W. S. Johnson, of Sheffield, has been appointed clerk of works at the Heywood electricity works at £2 per week.

With reference to the recent demand for telegraphists for Natal we learn that the required number has now been obtained.

**Alfreton.**—An inquiry was held here on Wednesday into the Council's application for a provisional electric lighting order. It was stated that the price of gas, the present illuminant, was in 1899 raised from 3s. 9d. to 4s. 3d. per 1,000. The Council proposed to purchase the gas works, but the price demanded was deemed too high. The Council tested the feeling of the town on electric lighting, and out of 751 persons canvassed, 181 signified intention to take the light, 106 in favour of the light, 380 papers were not filled in, and 56 against. Mr. W. W. Nelson, clerk to the Council, gave statistics relating to the ratable value, borrowing powers, &c., and said that, with the exception of the gas interest, the Council were unanimously in favour of electric lighting. Mr. C. A. Baker (Messrs. Gibbings and Baker, the Council's consulting engineers) estimated the cost of the scheme at £13,734, the yearly maintenance charges at £1,498. 5s. 10d., and the probable revenue £1,500. Mr. J. S. Barnes (the Council's engineer) also explained the details of the scheme. In opposition, Mr. A. A. Campbell Swinton said he thought the expense of the scheme was under-estimated and the revenue over-estimated. There would, he estimated, be a deficit of £614.

**Ambleside.**—The Council will transfer their provisional order to the Windermere and District Electric Supply Co., the Council retaining the right of purchase at 15 years and at quinquennial periods after.

**Ashton-under-Lyne.**—The electrical engineer (Mr. Appelbee) is preparing specifications and obtaining tenders for two additional 250 H.P. units of generating plant, and the surveyor (Mr. Earnshaw) is to procure tenders for rails, &c., for the proposed electric tramway system. The first contract is advertised in another column.

**Bath.**—In the last report prepared by Mr. G. F. Metzger prior to his departure for Manchester, it is stated that during the March quarter the private connections were equivalent to 882 8 c.p. lamps, while 67 arc lights were added, equivalent to 1,675 8 c.p. lamps. The total now connected was 28,573, but the remainder of the arc lamps to complete the London-road section, which are to be lighted this month, would bring up the total connections to 29,073. The capacity of the works is 30,000 8 c.p. lamps. In his report Mr. Metzger states that he left the Corporation with the full conviction that everything was in good working order, and that a time free from breakdowns was before them. He had endeavoured to leave everything in such a condition as would leave no criticism open to his successor. It could not be expected that a net profit would be the result of last year's working when the fact was taken into consideration that nearly £20,000 of plant had been unremunerative until the erection, &c., was completed, although interest and sinking fund had been paid on the amount. The large increase of private lighting during the past six months and the doubling of the number of street arc lamps (which latter alone would bring in a revenue of £2,200) should give them the long-desired credit balance on the working of the new financial year they were now entering upon. Mr. F. Teague (Mr. Metzger's successor) endorsed all that Mr. Metzger had said concerning the condition of the works.

**Cardiff.**—An inquiry was held here last week into the application of the Corporation to borrow £277,630 for the construction and equipment of electric tramways. The town clerk (Mr. J. L. Wheatley) gave particulars of the indebtedness, ratable value, &c., of the borough, and said the tramways would be worked on the overhead trolley system. Track laying commenced on Dec. 18 last, and cable work on the 28th. Tenders for the car shed and power station had been let. Technical details were supplied by the engineer and manager (Mr. Arthur Ellis).

**Chatham.**—The directors of the Chatham, Rochester and District Electric Light Co. have offered to sell to the Council so much of their undertaking as lies within the borough for £35,000, a figure which is considered too high by the Council.

**Companies Struck off the Register.**—The following companies were struck off the register of joint-stock companies on 12th inst:—

Aluminium Plating Syndicate.
Electric Horse Promotion Synd.
Freudenberg's Automatic Telephone Syndicate.
Freudenberg's Multiple Telephone Syndicate.
Improved Telephone Patents.
Penzance, Newlyn and St. Just Light Railway Co.
Premier Electricity Meter Co.
Vice Versa Portable Electric Lamp Syndicate.
Whitstable Electric Light and Power Co.

The following are to be struck off at the expiration of three months if cause is not shown to the contrary:—

Anglo-Continental Motor Synd.
British Electro-Chemical Agency.
British Engineering Co.
Electric Hansom Cab & Carriage Co.
Electric Light and Power Co.
Electric (Ltd.).
Electric Metal Working Syndicate.
Electric Night Advertising Co.
Elieson Electrical Switch.
General Electrical Co. of Roumania.
Highland Water Power Syndicate.
High Power Electrolyte Syndicate.
Johnson Miners' Safety Lamp Co.
Maxim Auto Car Syndicate.
Maxim Carbide Process and Acetylene Gas Syndicate.
Penarth Tramways Syndicate.
Peterborough Electric Light and Power Co.
Pioneer Electric Carriage Co.
Steady Arc Lamp Co.
Telegraph Improvement Co.
Telephone Construction Co.
Traction Syndicate.
Trehearne Electrical Engineering Co.
Wenlock Electrolytic Co.
Werner Cadmium Electric Accumulator Syndicate.

**Dublin.**—The *Belfast News Letter* is responsible for the announcement that Messrs. J. & W. Stewart, over whose contract for the station buildings at the Pigeon House a great deal of discussion has taken place, have brought an action for libel against the *Irish Independent* Newspaper Co.

**Electric Railway in Barcelona.**—Messrs. Corady & Co., 1, Plaza Angel, Barcelona, have secured from the municipality a concession to build an electric railway nearly 5 miles in length round the Montjuich mountain. The cars, it is stated, are to be drawn by electric locomotives. The chief engineer to the project is the Marquis Armand de Bourbon Neilson.

**Electric Express Railway in Russia.** It is reported that a proposal is before the Russian Ministry of Railways for the construction of an electric express railway between St. Petersburg and Moscow, a distance of 610 kilometres.

**Electric Traction in St. Petersburg.**—The whole of the tramway lines in St. Petersburg have now passed into the possession of the municipal authorities, who are about to advertise for proposals to convert the whole of the lines to electric traction. It is intended to adopt the conduit system for the centre of the city, and the overhead system in the suburbs. All the present lines are single track.

**Guernsey.**—The equivalent of over 8,000 8 c.p. lamps are now connected to the company's mains. A reduction in the charge for electric current is announced.

**Hendon.**—The Board of Trade have deferred the revocation of the Council's provisional electric lighting order for 12 months from May 17.

**Holywell.**—A committee has been formed to report upon electric lighting matters.

**Horley (Surrey).**—The Council have received intimation that a local company is being formed to apply for a provisional electric lighting order.

**Islington (London).**—In December the Lighting committee were instructed by the Council to report upon the condition and working of the electricity department, and a lengthy report has now been issued, stating that the committee have not deemed it necessary to consult an electrical expert. They had visited the electricity works of St. Pancras, Shoreditch, Hampstead and Hammersmith, and without in any way depreciating them, had arrived at the conclusion that none of them would bear comparison with the works at Islington either as regards durability of the buildings or quality of the machinery. The reasons why the undertaking in Islington has hitherto failed to prove as remunerative as those of St. Pancras, Hampstead and Shoreditch were mainly the small output and relatively large expenditure in capital and wages, and that the proportion of unremunerative street lighting was greater in Islington, where, out of the total units sold in 1899, practically 50 per cent. was applied to street lighting, and in Hampstead 8 per cent., St. Pancras 14½ per cent., and Shoreditch 22 per cent. only. The relatively small output in Islington was due to the fact that until recently the object of the undertaking had been to supply the more important business centres of the borough, and that not only were those scattered and at wide intervals, but their hours of consumption were limited during the winter months to an average of four or five hours per night and in the summer to probably one or two hours. The result was that during the greater part of every 24 hours much valuable machinery and plant was lying idle. As to capital expenditure, the Islington site is declared more costly than that in any other borough except Shoreditch. The capital cost of the site was, the committee submit, justified. The buildings contain plant of a capacity of 5,500 H.P. completed or in course of erection, and there is room for a further 5,000 H.P. The machinery and plant was of the highest quality, and the mains consisted of cast-iron conduits, through which were drawn heavy double steel-armoured high-tension cables. The low-tension distributors were steel-armoured and laid in earthenware pipes. The high-tension feeders were so laid as to enable any portion of a main to be isolated in case of a fault. In working expenses, interest and sinking fund have been included, but the report states that but for the difficulty the late Vestry had in obtaining the consent of the County Council to certain small loans for machinery for extensions, those extensions would have been in working order, and the cost (£30,000) would not have involved a dead charge of approximately £1,200. The expenditure under wages was, from any standpoint, high compared with either St. Pancras, Hampstead, or Shoreditch, due to the fact that Islington pays a higher rate for labour than any other undertaking in London, and at the same time, contrary to the practice obtaining elsewhere, employs no apprentices or improvers. As regarded other working expenses Islington compared favourably with other boroughs. Since the station was opened in March, 1896, only on four or five occasions have more than an individual consumer at a time been deprived of light, and that when those exceptional interruptions have occurred they have been limited to, at most, eight or ten consumers. Further, no explosions or accidents of any kind have occurred since the installation. In conclusion, the committee view the future prospects of the undertaking with confidence, provided that for some time to come any further extensions of mains, especially for street lighting, is avoided. The report concludes as follows:—

"We would not, however, have it go forth as the view of the committee that the object of the electric light installation belonging to Islington should be mainly one of profit. We believe that the sanitary and even the moral effect of securing a brilliant, wholesome and cleanly illuminant for the streets and for the private use of residents of the borough is worthy of consideration by a public body, altogether apart from profit, and it is on these considerations we think the Council must base their justification as electric light undertakers."

A motion to receive the report having been made, Ald. Tomkins moved an amendment that the last two lines (as to the undertaking being run on anything but a profit-earning basis) be deleted, and after discussion this was carried.

**International Building Trades' Exhibition.**—This exhibition is being held at the Agricultural Hall, Islington, London, until April 27, the exhibits dealing mainly with architectural, sanitary and general building requisites. The exhibitors, however, include the Conduit and Insulation Co., who show their system of steel armoured insulated conduit; the Dowsing Radiant Heat Co., showing various styles of electric radiators; Messrs. Ruston, Proctor & Co., Crossley Bros., Meldrums, Babcock & Wilcox, and W. F. Stanley. Messrs. Fleming, Birkby & Goodall, of Halifax, and 39, Lime-street, London, have an exhibit of their "Teon" textile belting; Mr. W. Holler, of Soho-square, London, shows some interesting specimens of hammered ironwork. An interesting exhibit also is that of the British Uralite Co. who show samples of material for which good insulation properties are claimed, together with extreme lightness. The James Keith and Blackman Co., of 27, Farringdon-avenue, London, E.C., have on show several examples of Blackman combined electric fans and motors, and the United Asbestos Co.'s stand is as attractive as usual.

**Leigh (Lancs.).**—Councillor G. Shaw, Mayor of Leigh, at the annual dinner of the Leigh Burns Club on Wednesday, referred to the extensive new cable works now being erected by the Anchor Electrical Cable Co., of which he is a director, and intimated that these were but the precursors of other extensive works to be built in the district in connection with the electrical and allied industries.

**Leith.**—The charge for electric current has been reduced from 5d. to 4d. per unit. There are now about 280 consumers, representing an equivalent of 25,830 8 c.p. lamps connected.

**Lewes.**—A committee has been formed to report upon the cost of erecting electricity works.

**Light Railway.**—The Light Railway Commissioners have submitted to the Board of Trade the order for the construction of light (electric) railways in the districts of Worsbro' and Hoyland Nether, and in the parish of Tankersley, in the West Riding of Yorks. Objections by 27th inst.

**Manchester.**—In the estimates of income and expenditure of the Electricity committee for the next financial year a deficit of £5,000 is anticipated. Last year £4,000 was voted in relief of rates, but the reserve fund of £13,000 will be drawn upon to meet any deficiency on next year's working. The Gas committee also announce that they will not be able to contribute more than £11,000 in relief of rates instead of the usual £50,000. On the other hand the Tramways committee expect to have a surplus of £20,000 at the end of their first year's working. The capital account of the Tramways committee now stands at £625,000.

The Electricity committee has resolved to charge the Tramways committee for electric current 1¼d. per unit for the first few months by way of experiment.

**Midsomer Norton.**—A report on the proposal to establish electricity works has been ordered to be printed for distribution among members.

**Municipal Loans.**—*Kirkcaldy* Town Council has obtained sanction to a loan of £50,000 for erecting electricity works.

*Wolverhampton* Corporation have secured authority to borrow £59,942 for electric lighting.

*Heywood* Corporation have been authorised to borrow £15,000 for electric lighting, but the Local Government Board have refused to sanction a loan of about £2,000 for wiring premises.

**Municipal Telephony.**—The Tunbridge Wells Corporation telephone department is busy placing before potential users the advantages of the municipal system, and the special reasons why support should be given by the burghers of Tunbridge Wells to the municipal undertaking.

The Brighton Town Council yesterday (Thursday) decided to proceed with their scheme for the construction and equipment of a municipal telephone exchange. Application is to be made for a loan of £45,000 for carrying out the work.

Mr. A. R. Bennett has been instructed by the Aberdeen Corporation to report on the question of establishing a municipal telephone exchange.

**Municipal Trading.**—The Shoreditch (London) Borough Council recently informed Messrs. Aublet, Harry & Co. that the company's statements as to alleged unfair competition on the part of the Council's wiring department (see *The Electrician*, March 22) were not correct. A second letter has been forwarded by the company asking the Council again under what clause of the Municipal Lighting Acts power is taken to become contractors to consumers for supplying and fitting up electrical plant. As ratepayers the company contend they are entitled to a specific reply to their inquiry.

**Musselburgh.**—Edinburgh Council decided on Wednesday to exercise the right conferred on them by the Portobello and Musselburgh Tramways Order, 1900, and notice is to be served upon the National Electric Traction Co. requiring them to transfer to the Corporation the powers granted by the order for the construction of electric tramways.

**Northampton.**—The Corporation is to acquire the local tramways. An offer of £37,500 has been made, but the company ask £45,000.

**Obituary.**—Sir Edward Watkin, a prominent figure in the railway world from the early forties down to last year, passed away on Sunday last. Sir Edward was for many years chairman of the South-Eastern Railway and the Metropolitan Railway, and was instrumental in bringing the Great Central Railway to its London terminus at Marylebone. He only retired from active association with his numerous railway schemes a few months ago. He was associated during his busy career, either as secretary, manager or director, with most of the great lines of railway in this country, and with the Grand Trunk of Canada and the Erie of the United States. Sir Edward was born in London in 1819.

**Paisley.**—The Finance committee has reported a deficiency in the electric lighting account for the year ended Dec. 31 of £4,723. 1s., and it has been decided to provide the deficiency out of the funds of the Gas department.

**Paris Metropolitan Railway.**—It is claimed that the new underground electric railway in Paris has beaten the world's record for the number of passengers carried for a period of three months, this number being, for the period from Jan. 1 to March 31, 1901, 11,315,799. The number carried on Easter Sunday alone was 182,216.

**Peterborough.**—An inquiry was held here last week into the application of the Council to borrow £12,200 for electric lighting, to be employed as follows:—Completion of present works, £5,000; extension of plant and mains, £6,000; street lighting, £1,200. The city engineer (Mr. J. C. Gill) gave evidence in support of the application and supplied the necessary technical details.

**Ramsgate.**—A committee is to report upon the expediency of carrying out the terms of the Council's provisional electric lighting order obtained in 1890. The committee have power to engage an electrical expert.

**Richmond.**—The Council are opposed to the Richmond (Surrey) Electric Light and Power Co. undertaking the supply of electric current in Heston and Isleworth, and the town clerk has been instructed to apply for an injunction if necessary.

**Stepney (London).**—The Borough Council are making extensions of their arc lighting system. On Wednesday current was switched on to the 10 arc lamps which have been erected on the west of the Tower, Tower Hill, north of the Tower, and south of Trinity-square, and as far east as the Mint and the Minories, and in a few weeks the whole route is to be similarly illuminated in almost a direct line to Bow Church.

**Smoke Nuisance.**—The London County Council having drawn the attention of the St. Pancras Borough Council to an alleged nuisance arising from the issue of black smoke from the generating station in Longford-street, the Public Health committee has sought legal opinion whether the Borough Council could proceed legally against one of its own departments for an offence under the Public Health (London) Act, 1891. This opinion is to the effect that no such action would lie. At Wednesday's meeting Dr. W. Smith said additions were being made in the furnaces which it was hoped would effect a considerable improvement.

**Swindon.**—Following the recent visit of Col. Yorke, of the Board of Trade, a provisional order has been granted to the Corporation to construct tramways in the borough. A site for the generating station has been secured, and Messrs. Siemens Bros. & Co. have the contract for the equipment of the station. About 10 miles of rails (2¾ miles double track) will be laid. Messrs. Lacey, Clirehugh and Sillar are consulting engineers to the Swindon Corporation.

**Tenement Lighting.**—A report has been prepared by the West Ham borough electrical engineer (Mr. J. K. Bock) on the electric lighting of artisans' dwellings. Mr. Bock points out that when it was decided to install the electric light in the Bethell-avenue houses, and to make a charge of 6d. a week for current, there was no precedent regarding the cost of supplying the electric light to artisans' dwellings, and this must, therefore, be regarded as a test case. In order to gain an idea as to the actual consumption of light in these dwellings a meter and demand indicator was installed to register the total current used in each block of houses. By treating each block as one consumer it is possible to show the difference between the actual price obtained and the price which would have been obtained if the current had been sold by meter. The readings ranged from July to January, the heaviest half of the year. If current is sold by meter a deduction of 1½d. per week from the income from each dwelling is necessary to provide interest and repayment on additional capital expenditure incurred by installing meters. The annual saving in the cost of cleaning, painting, &c., must also be considered, and as the Corporation, as owner, benefited by that, Mr. Bock thinks it is justifiable to charge a portion of the cost of the electric light to

repairs and maintenance. The following are the figures for the two quarters :—

| Quarter ended Sept., 1900. | Block 1 (20 tenements) 14 weeks. | Block 2 (16 tenements) 14 weeks. | Block 3 (18 tenements) 11 weeks. |
|---|---|---|---|
| Units registered by meter | 105 at 7d. 500 at 2d. | 137 at 7d. 348 at 2d. | 150 at 7d. 232 at 2d. |
| Price by meter............... | £8 10s. 10d. | £6. 17s. 11d. | £6. 6s. 2d. |
| Average price per tenement per week by meter | 7¼d. | 7½d. | 7¼d. |
| Average price obtained ... | 6d. | 6d. | 6d. |

| Quarter ended Jan. 4, 1901. | Block 1 (20 tenements) 14 weeks. | Block 2 (16 tenements) 14 weeks. | Block 3 (18 tenements) 18 weeks. |
|---|---|---|---|
| Units registered by meter | 192 at 7d. 1,404 at 2d. | 160 at 7d. 1,186 at 2d. | 246 at 7d. 1,259 at 2d. |
| Price by meter.............. | £17. 6s. 0d. | £14. 11s. 0d. | £17. 3s. 4d. |
| Average price per tenement per week by meter | 1s. 2¾d. | 1s. 3½d. | 1s. 1d. |
| Average price obtained ... | 6d. | 6d. | 6d. |

Average price per tenement per week for half-year if sold by meter (deducting 1½d. for repayment of meters) .. .... ..... 9½d.

Average price per tenement per week received for the half-year (deducting 1½d. cost of lamp renewals, &c.)........................ 4½d.

In order to place the artisans' dwellings on the same basis as ordinary consumers, it is therefore necessary either to increase the charge per week, to instal ordinary meters and demand indicators, or to instal prepayment or penny-in-the-slot meters. If the prepayment meter is adopted it will be necessary to arrange a fixed price per unit at which the light will be supplied. The present charges for electricity are 7d. per unit for an average of one hour per day, and 2d. for all units after. Accordingly, if the light is used for an average of one hour per day the average cost would be 7d. per unit, two hours 4½d., three hours 3⅔d. The whole question of the cost depends on the probable period during which the maximum number of lights are used.

In conclusion Mr. Bock makes the following suggestions :—

(1) That prepayment meters be installed in all the artisans' dwellings.

(2) That any consumer may have a prepayment meter installed for a private dwelling if the installation does not exceed 3 amperes (five 16 c.p. lamps at 100 volts, or ten 16 c.p. lamps at 200 volts).

(3) That the charge per unit, if prepayment meters are used, should be 4½d. per unit (at this rate one 8 c.p. lamp would cost 1d. for seven hours).

(4) The prepayment meters should only be installed at this rate in private dwellings. By adopting this course all dwelling houses are offered the same terms as the artisans' dwellings.

**The Telegraph Service in the South African Campaign.**—In the course of Lord Roberts's report on the services of the various units of the forces acting in the South African military operations, a meed of praise is awarded to the telegraph service established under the supervision of Lieut.-Col. R. Hippisley, R.E. After stating that "no portion of the army has had more work or greater responsibility than this branch," Lord Roberts proceeds :—

With a personnel of 25 officers and 1,221 operators, linesmen, &c. (of whom four officers and 153 N.C.O.'s and men have died or been invalided), nearly 2½ millions of messages have been dealt with during the past 13 months, some of them containing as many as 4,000 words. The telegraph systems taken over, repaired, and maintained exceed 3,300 miles in length, with over 9,000 miles of wire. In addition, 959 miles of air line have been erected and 1,145 miles of cable laid. Great credit is also due for the quick way repairs to the lines, so frequently interrupted by the Boers, have been carried out. This is a most dangerous service, as there is always a chance that the enemy may be lying in wait near the break, but there has been throughout the most unhesitating promptitude in its performance. The young officers in charge of cable carts have also often had perilous work to perform when winding back their wire, alone or with a very small escort.

**Walsall.**—An inquiry was held here on Tuesday into the application to borrow £3,000 for electric lighting extensions in the centre of the town, where it is proposed to erect a new transformer sub-station. Technical details were supplied by the engineer, Mr. Alex. Wyllie. There was no opposition.

**West Hartlepool.**—The Electric Light committee have fixed the charge for arc lamps at £20 per lamp per annum for all-night lamps and £13. 10s. if current is switched off at midnight. In the estimates for the coming year the committee anticipate a deficiency of £470. At the Council meeting last week the chairman (Ald. Wilson) in referring to the demand for electric current, said the North Eastern Railway Co. would probably take current for 30 arc lamps as an experiment, and if the arrangement proved satisfactory would probably take current for from 80 to 100 lamps.

**Wigan.**—The Electric Light and Tramways committee has discarded the maximum demand system of charging for electric current, and in future the following scale will be in force :—(1) Offices, warehouses, churches, public offices, municipal buildings, factories, banks, &c., 5d. per unit ; (2) shops, baths, libraries, police offices, assembly rooms, 4d. per unit ; (3) public-houses, off-licence houses, G.P.O., offices (open all night), railway stations, theatres, 3d. per unit. The charge for power is to be 1d. per unit.

**Wolverhampton.**—The electric lighting mains are to be extended at a cost of £600.

**Workhouse Lighting.**—Barnsley Guardians have applied for sanction to a loan of £4,000 for the electric lighting of the workhouse.

## TRADE NOTES AND NOTICES.

[*Notices for insertion under the above heading must reach the Office not later than first post Thursday morning. New Catalogues, Price Lists and similar matter should be sent early in the week.*]

### TENDERS INVITED.

*Portsmouth* Corporation invite tenders for supplying and laying telephone conduits, and cables, copper wire, iron and steel stay wire, insulated wires, lighting and high-tension guards, arm bolts, nuts and washers, miscellaneous ironwork, insulators, switchboards, batteries, telephone instruments, fixing subscribers' instruments, creosoted poles, oak arms, erecting poles, arms, stays, insulators, wires, &c., and silicum bronze wire. Tenders to office of town clerk (Mr. Alex. Hellard) by 30th inst.

*Manchester* Electricity committee invite tenders for the supply, delivery, and erection at the Stuart-street generating station of water-tube boilers, steam engines, with condensing and auxiliary plant, three-phase generators and motor transformers. Specifications from the secretary of the electricity department (Mr. F. E. Hughes), Town Hall, Manchester, and specifications and drawings may also be inspected but not obtained at the office of the consulting engineers (Messrs. Kennedy and Jenkin), 17, Victoria-street, Westminster, S.W. Tenders (addressed to Chairman, Town Hall, Manchester) by May 7. An advertisement contains further particulars.

*Manchester* Electricity committee also require tenders for two electric cranes, steam, exhaust, &c., pipes for the Bloom street generating station. Tenders by 25th inst.

The directors of the *Great Eastern Railway Co.* invite tenders for the supply of stores and materials, including telegraph materials, galvanised iron, lead, tin, &c., bolts, screws, and rivets, tools, hardware, cast-iron pipes, &c. Further particulars are given in an advertisement, and forms of tender may be obtained at the secretary's office, Liverpool-street terminus, London, E.C., on and after 30th inst. Patterns can be seen at the company's stores, Stratford, and tenders must be forwarded to the secretary (Mr. W. H. Peppercorne), by 10 a.m. May 14.

*Ashton-under-Lyne* Electricity committee invite tenders for two continuous-current generating units, each of 250 H.P. to 300 H.P., with double-acting enclosed engines. An advertisement contains further particulars, and specifications may be obtained from the borough electrical engineer, Mr. Neville Appelbee. Tenders to Town Clerk by noon, April 29.

An advertisement elsewhere notifies that the *Dundee* Town Council require tenders for the supply of copper bonds. Specification, &c., may be obtained from the city electrical engineer (Mr. Walter H Tittensor), Dudhope-crescent-road. Tenders to the town clerk (Sir Thomas Thornton, LL.D.), City Chambers, Dundee, by May 1.

*Middleton* Corporation invite tenders for the erection of a refuse destructor to work in conjunction with their electricity works. Some particulars are given in an advertisement, and all further information may be obtained from the town clerk (Mr. Frederick Entwistle), Town Hall, Middleton. Tenders to chairman of Destructor committee by 27th inst.

*Motherwell* Electric Light committee invite tenders for cast-iron lamp columns, arc lamps, switches, fittings, &c. An advertisement contains further particulars, and tenders must be sent into the town clerk (Mr. James Burns) by May 18.

*Cardiff* Corporation invite tenders for overhead line materials for the electrical tramways department. Some particulars are set out in an advertisement. Specifications from the engineer and manager (Mr. Arthur Ellis), Old Post Office Building, Cardiff. Tenders by April 30.

*Tonbridge* District Council invite tenders for boiler and engine-house plant, condensing apparatus and pipe work, travelling crane, switchboard and instruments, accumulators, mains, meters, public arc and public incandescent lighting. An advertisement contains further particulars and tenders must be sent to the clerk (Mr. A. H. Neve, jun.) by 4 p.m. May 30.

*Alloa* Electric Lighting committee invite tenders for insulated cables, joint boxes, public arc lamps, lamp pillars, &c., and sub-station equipment and sundry connections. Tenders to town clerk by April 30.

*Sunderland* Corporation invite tenders for main, steam, feed, suction and exhaust pipes, &c., and additional panels to traction switchboard. Tenders to Chairman of Lighting committee by noon 26th inst.

The Burgh of *Partick* requires tenders for main switchboard and instruments and batteries of accumulators and accessories. Tenders to Mr. Jas. Donaldson, 97, West Regent-street, Glasgow, by noon of April 29.

*Aberdeen* Electric Light committee require six water-tube boilers and accessories. Tenders to city electrical engineer (Mr. J. Alex. Bell) by noon 27th inst.

*Norwich Mutual Telephone Co.*, who are about to establish a telephone exchange, invite tenders for various telephone cables, instruments, &c. Tenders to secretary (Mr. Campbell Steward) by April 30.

*Battersea* (London) Borough Council invite schemes for wiring consumers' premises. Tenders to Mr. W. Marcus Wilkins, Municipal Buildings, Lavender-hill, S.W., by May 14.

*Battersea* Borough Council also invite tenders for electric pumps, pipe work, &c., for condensing water, and pipes and pits for condensing water supply. Tenders by noon of April 30.

*Middlesbrough* Electric Lighting committee require boiler and engine-house plant and condensing apparatus. Tenders to town clerk by April 30.

*Dublin* Lighting committee invite tenders for condensing plant, pipework, feed pumps, superheaters, mechanical coaling apparatus, &c. Tenders by 4 p.m. April 22.

*Metropolitan Asylums Board* invite tenders for supply and erection at Tooting Bec hospital, of electric generating and heating plant. Tenders to Board, Embankment, London, E.C., by 10 a.m. April 24.

*Aylesbury* District Council invite tenders for the construction and maintenance for a term of years of electricity supply works. Tenders to clerk by 4 p.m. April 22.

*Barrow* Corporation require cables, joint boxes, pipes, conduits, &c., and balancing transformer and switchboards. Tenders by April 24.

Tenders are invited for an electric lift for the *Dearnley* workhouse infirmary. Particulars from Messrs. Butterworth and Duncan, architects, South Parade, Rochdale.

*Motherwell* Electric Light committee require steam dynamo and switches, steam, feed, and exhaust pipes, &c. Tenders by April 29.

*Southend* Corporation invite tenders for the advertising spaces on their street electric tramcars. Tenders to town clerk by 24th inst.

*Ludlow* Corporation invite tenders for electricity generating plant. Tenders to town clerk by May 20.

*Ludlow* Corporation also invite tenders for erecting electricity station buildings. Tenders by May 9.

*Wrexham* Town Council require tenders for supplying and fixing electric calls for the fire brigade. Tenders by 24th inst.

*East Ham* District Council invite tenders for advertising rights on their electric tramcars. Tenders by 22nd inst.

### TENDERS RECEIVED AND ACCEPTED.

Bournemouth Corporation have received the following tenders in connection with their electric tramway scheme:—

*Contract No. 1 (38 Electric Cars).*

| | | | |
|---|---|---|---|
| British Westinghouse Co. (*accepted*) | £28,020 0 | Hungarian Railway Carriage & Machine Co. | £30,030 0 |
| Bramigk & Co. | 35,025 0 | Hurst, Nelson & Co. | 29,472 4 |
| Siemens Bros. & Co | 30,970 0 | B. T. H. Co. | 29,364 2 |
| R. W. Blackwell & Co. | 30,374 0 | Brush Co. | 28,381 0 |

One informal tender was also received.

*Contract No. 2 (Four Steam Dynamos).*

| | | | |
|---|---|---|---|
| B. T. H. Co. (*accepted*) | £14,733 | Anchor Electric Co. | £15,100 |
| Ditto | 13,993 | Johnson - Lundell Elec. Trac. Co. | 16,135 |
| Ditto | 12,321 | Ditto ditto | 14,283 |
| Brush Co. | 18,930 | Lanc. Dynamo & Motor Co. | 15,406 |
| Ditto | 17,250 | Ditto ditto | 14,844 |
| British Westinghouse Co. | 17,857 | Ditto ditto | 11,982 |
| Ditto ditto | 16,234 | Siemens Bros. & Co. | 14,890 |
| Ditto ditto | 11,932 | Ditto ditto | 12,199 |
| British Schuckert Co. | 17,453 | Bow, McLachlan & Co. | 14,030 |
| Ditto ditto | 16,145 | C. A. Parsons & Co. | 13,418 |
| Ditto ditto | 15,485 | Ditto ditto | 12,531 |
| Anchor Electric Co. | 15,900 | Ditto ditto | 12,239 |
| Ditto ditto | 15,200 | | |

Five informal tenders were also received.

The Electrical Co., 122-124, Charing Cross-road, London, have obtained through their Manchester branch the order for an 800kw. slow-speed direct-current generator for the Openshaw works of Sir W. G. Armstrong, Whitworth & Co. There was considerable competition for the order, both home and foreign.

Wolverhampton Corporation have accepted the tender of the Callender Company for feeders, switch pillars, &c., in connection with the electrical equipment of the Tettenhall-Bilston-road tramway at £6,710.

Colne Town Council have accepted the tender of Mr. J. Hawley for masonry work (at £2,364), and that of Messrs. Horfield & Jackson for carpentry and joinery (at £351) for the electricity station building.

Farnworth (Lancs.) District Council have accepted the tender of Messrs. R. W. Blackwell & Co. for copper tramway bonds.

Leith Electric Lighting committee recommend the acceptance of the tender of the Indiarubber Co. for the supply and erection of an additional steam dynamo at £3,398.

## BUSINESS NOTICES.

Mr. Ernest Kilburn Scott, M.I.E.E., A.M.Inst.C.E., has been appointed engineer and manager for the United Kingdom, Colonies, and Egypt to the International Electric Co., of Liège, and London offices have been taken at Clun House, Surrey-street, Strand, W.C. Mr. Scott has for many years been closely associated with the electrical industry in this country, and will give special attention to the application of continuous and multiphase motors to machine driving in works and factories, and for mining and general power transmission, electric traction, &c. Already in this country the International Electric Co., of Liège, have supplied large quantities of machinery, and among others to a number of important firms in the Middlesbrough and Hartlepool districts, and in Dumbarton, Glasgow, Belfast, and South Wales. The company is the leading electrical manufacturing undertaking in Belgium, and was founded in 1899 by Mr. H. Pieper, who is now general director. Mr. G. J. Melms, the manager of the International Company, is well known in the United States and on the Continent, and, as manager for Messrs. Brown, Boveri & Co., personally supervised the construction and operation of the extensive municipal electric station at Frankfort-on-Main.

Owing to increase of business Callender's Cable and Construction Co. have removed to larger offices at Hamilton House, Victoria Embankment, London, E.C.

The London office of the Sun Fan Co. has been changed to 6A, Billiter-buildings, Leadenhall-street, E.C., and the company has opened a new office at 82 and 83, Deansgate-arcade, Manchester. Mr. G. C. Fuller, lately with the Blackman Ventilating Co., has joined the staff of the Sun company.

The Atlas Engineering Co. have appointed Mr. H. E. Montgomery, 113, Cannon-street, E.C., to be their representative in London and district, and Mr. T. L. Davidson, 49, Jamaica-street, Glasgow, to represent them in Scotland.

An Italian firm having offices in Rome, and a good connection, desires to represent British manufacturers of automotors, electrical machinery, &c. See advertisement.

## BANKRUPTCIES, LIQUIDATIONS, &c.

It has been resolved to wind-up voluntarily the New British Incandescent Electric Lamp Co. (Ltd.), and to appoint Mr. E. C. Moore, 3, Crosby-square, London, E.C., as liquidator.

The Electric Street Car Manufacturing Syndicate (Ltd.) is to be wound-up voluntarily, and Mr. M. Fletcher has been appointed liquidator.

Claims against the Electrical Vehicle Syndicate (Ltd.) must be sent in by May 31 to the liquidator, Mr. A. Holmes, Portland-road, Newcastle-on-Tyne.

A meeting of the contributories of the Perfect Arc Lamp and Accessories Co. (Ltd.) (in liquidation) was held yesterday at the offices of the liquidators, Messrs. C. J. Lee & Sons, 85, Gracechurch-street, London, E.C. It was stated that no further sum would be available for distribution beyond the 2s in the £ already distributed, the sale of the property by order of the Court having realised only a small sum.

A meeting of the creditors of the Crowdus Accumulator Co. (Ltd.) (in liquidation) was held at the office of Mr. Claud Scott, 32, Victoria-street, London, S.W., on Monday last, when we learn that a statement was made that by the order of the Court the sale of the company's property had been made and had realised £650, the whole of which goes to the debenture-holders, whose claims figure in the liabilities for £6,000. We understand there is no likelihood of any dividend for the ordinary creditors.

In the bankruptcy of James Brown, electrical engineer, &c., 28, Silksworth-row, Sunderland, the first meeting of creditors will take place on 19th inst. at 25, John-street, Sunderland, and the public examination on 18th inst., at the Court House, Sunderland.

A statement has been issued on the occasion of the payment of the second and final dividend in the bankruptcy of Messrs. E. J. Paterson and C. F. Cooper, who failed in 1896 when trading as Paterson and Cooper, with works at Dalston (London) and offices at Westminster and Glasgow. Items are set out in the statement showing that £2,400 has been actually realised for the goodwill of the business. The plant, stock-in-trade, &c., estimated by the debtors to realise £14,000, actually realised £8,200. The total receipts from the estate were estimated to produce £17,517, and actually realised £12,687. The Board of Trade and court fees and law costs have swallowed up £508, the trustee's remuneration has cost £1,238, the total amount paid to preferential creditors was £600, and £9,229 has been distributed amongst the unsecured creditors, the total dividend having reached 9s. 0½d. in the pound. The estate now shows a small balance of £22. 15s. The first dividend was paid in March, 1898, and since that date endeavours have been made to realise the interests of the firm in the Hermite patents, but these endeavours have proved fruitless, as when offered for sale by auction not a single bid was made. Mr. E. C. Moore, 3, Crosby-square, London, E.C., is the trustee of the estate.

**Partnership.**—An old-established firm of electrical engineers desire a partner qualified to design and direct the manufacture of continuous-current dynamos and motors. See advertisement.

**Agents Wanted.**—Messrs. Johnson and Phillips, Old Charlton, Kent, are prepared to appoint agents for the sale of their electrical goods in various districts. Particulars are set out in an advertisement.

**New Works.**—Messrs. Vickers, Sons and Maxim recently contemplated the erection of works on Walney Island, opposite their shipyard at Barrow, for the manufacture of the material required in the carriage-lighting system of the Consolidated Railway Electric Lighting and Equipment Co., the sole rights for which the Vickers Company have acquired for Europe, but they have, it is stated, met with so much opposition that they have determined to put down their new works at Birmingham.

**Water Power.**—An advertisement offers for sale by private treaty a freehold estate on the banks of the Thames, close to the line of the London and South-Western Railway, where unlimited water power is available.

**Fire.**—An outbreak of fire occurred in the packing department of the works of the London Electrical Fittings Co. on Friday last. No damage was done to the plant or stock, and no delay is likely to occur in the execution of orders.

**Scottish Electrical Contractors' Association.**—A pamphlet, setting out the constitution and rules of this association with regulations for workmen, is now ready. The objects of the association are "to discuss questions affecting the general interests of the trade and to promote uniformity of action or practice regarding these." Membership is open to (1) firms whose sole or chief business is that of electrical contractors, and (2) firms who are bonâ fide employers of not less than three skilled electrical engineers regularly engaged upon electrical contracting work in Scotland. The rules under notice were finally confirmed on Feb. 28 last. The rules for workmen set out the working hours, rates of wages and overtime, allowances, rules for apprentices and improvers, &c. General agreement is given by the association to the standard clauses agreed upon between the Electrical Engineering Plant Manufacturers and the Municipal Electrical Association in February, 1898.

**Electrical Co.'s Lists.**—The Electrical Co., 122-124, Charing Cross-road, London, W.C., have ready several new lists of dynamos and motors, switches, insulation testing sets, and alternating-current induction instruments. Copies of these lists can be obtained on application. The detector set illustrated is for measuring insulation resistances, for testing joints and connections, and similar purposes, and for quick tests is claimed to be equally useful for workshop and laboratory uses. Insulation resistances can be tested ranging from 500 to 2,000,000 ohms with sufficient accuracy for all practical purposes.

E.C. Insulation Testing Set.

**Electricity Meters.**—The Schattner Electricity Meter Co. have prepared and issued a comprehensive catalogue of the current-measuring devices manufactured by the company under the Long-Schattner patents. The pamphlet is in convenient size, the several types of meters are illustrated, and all necessary information is given relating to the construction and use of these instruments. There is, in addition, the report of Dr. S. P. Thompson, and testimonials from a number of users. The opinions of the technical press are also set out. The company have recently removed to more extensive premises at Tyndale Works, Upper-street, Islington, London, N., and report that largely increased orders are being received for these meters.

**"Hart" Accumulators.**—The Hart Accumulator Co., Marshgate-lane, Stratford, London, E., have prepared a useful pocket edition of their price list of storage batteries, and copies can be obtained by electrical engineers and contractors on application. The various types of "Hart" cells are illustrated.

**Brush Electric Traction Plant and Machinery.**—A well illustrated and comprehensive catalogue of electric traction plant and rolling stock manufactured by the Brush Electrical Engineering Co. is now available, and gives at a glance a good idea of the facilities which this company now possesses for supplying this class of plant. In the preface it is claimed that from the first introduction of electric traction in the United Kingdom the Brush Company has consistently added to its facilities for supplying the necessary rolling stock and electrical equipment for electric railways and tramways. The manufacture of plant for complete installations of electric tramway systems is now undertaken by the company (with the exception of the items comprised in overhead construction and feeders). The plant illustrated includes steam alternator sets, motors, controllers, rheostats, trucks, and double and single-deck cars of several designs, including an example of the cars used on the Central London Railway.

**Instrument List.**—Sig. C. Olivetti, of Ivrea, Italy, has just published a well illustrated list of electrical and scientific instruments. The list (in Italian) can be obtained on application.

**Import Duties on Electrical Plant in Sweden.**—The Swedish Government is considering a proposal to increase the import duty on electrical plant from 10 per cent. ad val. to 20 per cent.

**Exports of Electrical Apparatus and Material.**—The following list gives official particulars of the exports of British manufactured electrical apparatus and material (including telegraph and telephone wire and material, but not including electrical instruments or machines, which are not separately specified) from April 5 to 16, with the ports of destination :—

*Africa*—Alexandria, £136 ; Cape Town, £878 ; Durban, £3,010 ; Port Elizabeth, £645 ; Zanzibar, £11. *Argentina*—Buenos Ayres, £2,810 (including £1,402 telegraph material). *Australasia*—Brisbane, £2,570 (including £617 telegraph cable) ; Hobart, £248 (telegraph cable) ; Otago, £693 ; Sydney, £2,294 (including £57 telegraph material) ; Wellington, £216. *British Guiana*—Demerara, £27. *Caribbee Islands*—Dominica, £37. *Ceylon*—Colombo, £165. *China*—Shanghai, £98. *France*—Paris, £126. *Germany*—Hamburg, £980 (including £200 telegraph material). *Gibraltar*, £65. *Holland*—Amsterdam, £132. *Hong Kong*—£87. *India*—Bombay, £120 ; Calcutta, £3,989. *Japan*—Nagasaki, £107 ; Yokohama, £2,285. *Malta*, £56. *Spain*—Vigo, £11. *United States*—New Orleans, £64. Total, £21,890 (for 12 days), against £42,090 for two days last year (April 11 and 12).

## PATENT RECORD.

*The following list of Applications for Patents and Specifications published has been compiled for this journal by* MESSRS. J. C. CHAPMAN & Co., *Chartered Patent Agents, of 70, Chancery-lane, W.C., from whom any available information in connection with Patents, Designs, and Trade Marks may be obtained.*

### APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications are not open to public inspection until after the acceptance of the complete Specification. The names within parentheses are those of communicators of inventions. When complete specification accompanies application, an asterisk is affixed.*

January 2, 1901.

131. A. P. LUNDBERG and G. C. LUNDBERG. London. Improvements in electric light switches.*
134. J. J. STOCKALL, senr. London. Improvements in gearing for electric clocks, checking instruments, and for indicators and the like.
157. D. PERRETT. London. An improved electric motor.
165. G. K. B. ELPHINSTONE. London. Improvements in electric telegraph transmitting apparatus.

January 3, 1901.

180. A. DAVIDSON. Sheffield. Improvements in telephone index boards.
187. R. E. MIDDLETON. London. Improvements in electrically-propelled vehicles.
202. A. W. BEUTTELL. London. Improvements in or relating to fittings for incandescent electric lamps for illuminating shop windows or for other analogous purposes.
217. H. W. C. COX. London. Improvements in or relating to electrolytic current interrupters for X ray work.
234. H. HIRST and G. H. IDE. London. Improvements in suspensory devices for carrying incandescence electric lamps by flexible conductors.

January 4, 1901.

257. J. H. GORDON and W. ROSS, junr. Glasgow. Electrically-played banjo or like stringed instruments.
266. J. MATTHEWS and W. DAVIES. Birmingham. Improvements in brushes for dynamos and the like.
275. C. W. S. CRAWLEY and W. L. MADGEN. London. Improvements in electric switches.
294. M. M. BAIR. London. Improvements relating to galvanic cells or batteries.

January 5, 1901.

310. A. E. RICHARDSON. Manchester. Improvements in electrical switches.
316. J. MUNDY and W. RUSSELL. Glasgow. Improvements in switches for overhead bar railways.
333. P. M. LE HÉGARAT. London. Improvements relating to electric motors.
340. L. KUSNICK. London. Improvements in electromagnetic apparatus for winding clocks or time-pieces.

January 7, 1901.

365. T. J. LITTLER. Liverpool. An improved electric car trolley-head.
367. A. P. LUNDBERG and G. C. LUNDBERG. London. Improvements in multiple wall connections for electric lighting, heating, and the like.*
393. P. A. NEWTON. London. Improvements in electrolysis and apparatus therefor. (The National Electrolytic Co., United States.)*
409. G. MARCONI and MARCONI'S WIRELESS TELEGRAPH CO. (LTD.). London. Improvements in apparatus for wireless telegraphy.
410. G. MARCONI and MARCONI'S WIRELESS TELEGRAPH CO. (LTD.). London. Improvements in apparatus for wireless telegraphy.
411. G. MARCONI and MARCONI'S WIRELESS TELEGRAPH CO. (LTD.). London. Improvements in apparatus for wireless telegraphy.

January 8, 1901.

431. O. LAUCKNER. London. Improvements in the electrolytic bleaching of cotton and other textile materials, and in apparatus therefor. (A. Vogelsang, Germany.)
439. E. G. PULFORD. Liverpool. Improvements relating to electrical organs.
467. D. LAING and G. M. TERRY. London. Improvements in attachments for telephones.*
469. O. BEHREND. London. Improvements in or connected with electrical storage batteries or accumulators.
47. THE BRITISH THOMSON-HOUSTON CO. (LTD.). London. Improvements in electric motors. (E. D. Priest, United States.)*
484. H. H. LAKE. London. Improvements relating to secondary electric batteries. (Globe Electric Co., United States.)*
485. H. H. LAKE. London. Improvements relating to electric switches. (Globe Manufacturing Co., United States.)*
492. R. ARNO. London. Improvements relating to apparatus for measuring the power and the phase difference in three-phase electric systems. (Date applied for under Patents, &c., Act, 1883, sec. 103, June 8, 1900, being date of application in Italy.)
500. T. HENWOOD and THE REASON MANUFACTURING CO. (LTD.). London. Improvements in or connected with joint fittings for electric cables.
501. F. M. LEWIS. London. Improvements in or connected with electo motors.
503. A. DE CASTRO and H. W. SCHLOMANN. London. Improvements in electric driving mechanism.*
507. W. ELY. Liverpool. Improvements in electric switches.*

January 9, 1901.

543. J. PARSONS and P. F. OTTO. Liverpool. Current collectors and safety devices applicable to electric railways and tramways.
560. H. S. JACQUES. Birmingham. A device for drawing the trolley-arm of an electric locomotive or other vehicle propelled by electricity to a safe position should the trolley become disconnected with the supply wire or bar.
569. A. CAMPBELL. London. Improvements in electrical regulating, measuring, and indicating apparatus.
585. F. H. HEADLEY. London. Improvements in and relating to electric switches and the like.
594. J. T. ARMSTRONG and A. ORLING. London. Improvements in and connected with means and apparatus for the production of light by electricity.
595. J. TARBOTTON ARMSTRONG and A. ORLING. London. Improvements in and connected with means and apparatus for the production of light and certain other rays by electricity.
596. J. T. ARMSTRONG and A. ORLING. London. Improvements in and connected with means and apparatus for the production of light by electricity.

January 10, 1901.

612. R. KENNEDY. Leeds. Improvements in the manufacture of sulphate of ammonia from furnace gases and the like by electrolysis.
624. M. SUTHERLAND and E. MARCUSON. London. Improvements in or relating to electric storage batteries.
681. J. M. HEWITT, W. G. RHODES and J. M. NEWTON. Manchester. Improvements in electric monorail railways and vehicles therefor, applicable also for other traction.
688. F. TREMAIN. London. Improvements in the construction of telephone cables.*
690. J. Y. JOHNSON. London. Improvements in electric controllers. (The Electric Controller and Supply Company, United States.)
691. J. Y. JOHNSON. London. Improvements in resistance coils. (The Electric Controller and Supply Company, United States.)
692. J. Y. JOHNSON. London. Improvements in arc rupturing devices for brush holders and the like. (The Electric Controller and Supply Company, United States.)
700. R. D. SANDERS. London. Improvements in the manufacture of wire strips and the like by electro-deposition, and in apparatus therefor.
702. C. M. JOSEPH (*dit* CLAUDIUS) LIMB. London. Improved system of electric traction. (Date applied for under Patents, &c., Act, 1883, sec. 103, July 5, 1900, being date of application in France.)
706. E. L. BENJAMIN. London. An automatic indicator and recorder of and signal aboard approaching or passing cars or trains and of the routes taken, likewise a herald thereof to passengers' waiting points, as all such independent of fog &c., also applicable to electric bell annunciators for minimising wires, movements, &c., and to other purposes.

## SPECIFICATIONS PUBLISHED.

NOTE.—All Specifications can now be obtained at the uniform price of 8d. each.

1900.

610. KRONHEIMER. Electric order telegraphs for use on shipboard and elsewhere.
1,089. EDMUNDS. Electrical conductors or cables.
1,168. KINGSBURY (Western Electric Co.). Registering apparatus and circuits for telephone measured service.
1,813. LAKE (Arno). Filaments for electric incandescence lamps.
1,825. LAMME. Dynamo-electric machines. (Date applied for under International Convention, June 30, 1899.)
1,937. URQUHART and GOODWIN. Overhead collectors for electrically-propelled railway vehicles.
2,050. TYLER. Controlling electrically-propelled vehicles.
2,159. MORRISON. Apparatus for electro-plating pins and other small objects.
2,?22. WRIGHT AND REASON MANUFACTURING Co. (LTD.). Electricity meters.
2,543. E. H. MAQUAY (administratrix of the late S. W. Maquay). Primary batteries.
2,670. HUTCHINSON and PACKARD. Production of electric incandescent lamps.
2,897. CHAPMAN. Electric railways on a surface contact system.
3,143. BROWN. Electric relays.
3,144. BROWN. Telephones.
3,192. DE CASTRO and SCHLOMANN. Electric batteries.
3,258. SPOONER (Neveur). Electric switches.
3,561. CROSSLEY and ATKINSON. Electric ignition for internal combustion motors.
3,762. DE MARE and FRÉMY. Application of steatite to electrical purposes as an insulating material.
3,913. WRIGHT and REASON MANUFACTURING Co. (LTD.). Metering of electricity.
3,968. MUIRHEAD and EDGAR. Recording instruments for electric telegraphs.
4,046. HEMINGWAY and COLBY. Fusible cutouts for electric installations.
4,105. MILLS (Bonnet, Paufique and Linière). Crossings and the like on electric tramways.
4,672. WALKER. Electrical terminals.
6,662. HUNTER. Telephone transmitters.
7,561. BRITISH THOMSON-HOUSTON Co. (LTD.) (Westendrap). Maximum indicating devices applicable for measuring electric currents and for other purposes.
8,475. BRITISH THOMSON-HOUSTON Co. (LTD.) (Steinmetz). Alternating electric current motive apparatus.
9,511. CUTTLER. Construction of swivel heads of electric car trollies.
11,003. LAKE (McElroy-Grunow Electric Railways System). Electric railways on the third-rail or surface-contact systems.
11,562. HEWITT. Electric lamps.
12,702. RIASSE and SENGEISEN. Electrical accumulators.
12,846. GLASMACHERS and MULLER. Portable electrical safety lamps.
13,134. WALTON. Electric arc lamps. (Date applied for under International Convention, Dec. 21, 1899.)
13,970. BRITISH THOMSON-HOUSTON Co. (LTD.) (Steinmetz). Armatures for dynamo-electric machines.
13,974. BRITISH THOMSON-HOUSTON Co. (LTD.) (Lovejoy). Bonds for electric railway rails and other conductors.

## COMPANIES' MEETINGS AND REPORTS.

### Dudley, Stourbridge and District Electric Traction Co. (Ltd.).

The nineteenth ordinary general meeting of this Company was held on Wednesday, Mr. C. SHIRREFF B. HILTON presiding.

The SECRETARY (Mr. W. F. Herring) read the notice calling the meeting, and the report and accounts were taken as read.

The CHAIRMAN said: Gentlemen, our share capital is now fully issued. At this time last year it was only £61,870, but since then we have issued 8,211 shares to the British Electric Traction Co. in part payment to them as contractors, and 19,370 shares were issued under the prospectus published in June last, making our total capital £200,000. The balance payable to the British Electric Traction Co. is now only small, £5,000 odd, as compared with £71,173 last year, and shows that, to that extent, the work has been gone on with. The depreciation fund has been increased by £1,000, which was placed to it last year; and we next come to the profit and loss account, which is appreciably better than it was last year. We brought forward from last year £2,313, and the profit for 1900 amounts to £6,900, making together £9,214, and that, after paying the preference dividend to December 31 last, leaves £8,511. On the other side of the balance-sheet we have the capital outlay on the old lines now reconstructed, amounting to £59,136, which is rather more than it was last year. On reconstruction of old lines and on light railways, the amount is now £159,348. Of that there has been expended during the past year £76,039. On the debit side of the profit and loss account, we find that the running expenses have been increased to £8,874, against £4,493 in the previous year. This increase is, of course, accounted for to a great extent by the opening of the new lines, but it has also been increased by the rise in price of fuel, and, therefore, I hope we may look for rather better results in that direction during the present year because coal has already gone down in price. Maintenance and repairs stand at a slightly lower figure. That does not mean that less has really been spent on maintenance than in the preceding year, but I think we have had fewer accidents owing to rather better management. Administration and general expenses have gone up a little, which was necessary owing to increased business. On the other side, the traffic receipts have increased to £18,290, against £11,000 in 1899, and that is due, of course, mainly to the opening of the new lines. The Netherton and Cradley Heath line was opened in October, and the Kingswinford and Wordsley line in December last. The Board have every reason to be satisfied with the result so far obtained, and we are expecting during the current year not only to keep up those results but to improve upon them. Of course, it has affected the traffic on the old line as well, because, as is always the case when you open new lines, they help as feeders to the old ones. Of the balance at our disposal we propose to place £2,000 to sinking fund and £1,500 to depreciation, bringing this up to £7,579. We suggest the payment of a dividend at the rate of 4 per cent. per annum and to carry forward £1,906. The Directors have decided to go on with the extension of the line running to the Lye, and when this is done we hope the end of our capital expenditure will be reached for a time. To provide for this additional outlay the Directors propose to issue a further £60,000 of debentures. In every direction, therefore, I think that the outlook is favourable for the coming year. I have only one other matter to refer to, and that is the retirement of Mr. Garcke and Mr. Raworth from the Board. It was with great regret that we accepted their resignations, but, as many of you are doubtless aware, Mr. Garcke and Mr. Raworth have so many engagements of a pressing nature that they are quite unable to keep up with them all. I now move the adoption of the report and accounts.

The motion was carried unanimously, as were resolutions approving of the company joining the British Electrical Superannuation Fund.

The retiring directors, Messrs. C. A. Edge, H. F. Woodward and J. A. Lycett, having been re-elected, and the auditors re-appointed, a vote of thanks brought the proceedings to a close.

### Blackheath and Greenwich District Electric Light Co. (Ltd.).

At the meeting, held on Wednesday, Sir JOHN A. WILLOX, M.P., presided.

The SECRETARY (Mr. Sidney H. Webster) having read the notice calling the meeting,

The CHAIRMAN referred to the delay which had occurred in the completion of the company's works; £1,200 had been recovered from the contractors as a consequence. This sum was, however, a poor equivalent for the loss of business. Since the company had begun to supply current from their own station, in February, 1900, the supply had given reasonable satisfaction to consumers. When they commenced their consumers numbered 132 with the equivalent of 5,957 lamps connected. At the close of the past year the number had risen to 342, and the lamps connected to 14,473. This progress still continues, as on April 1 the number of lamps connected had further increased to 16,520, and there were new applicants to the equivalent of 4,907 lamps. The company, therefore, in its first year, had no less than 21,500 lamps connected or applied for. These figures related almost exclusively to the supply of current for illumination; but there was a hopeful prospect in the supply of energy for power. In the Greenwich district there were many industrial concerns which would find it convenient and economical to take current from the company's station. Some large contracts of this description had been negotiated, and there was every reason to anticipate that the company would soon have a good day load for power as well as a good night load for light. This would augment the revenue without entailing any material increase in the working charges. The area served by the company was very extensive, and building operations were in rapid progress. The company's mains passed through good residential districts and busy centres of trade. The adoption of the "free" wiring system had proved advantageous in attracting consumers, and the board's experience was that once the light was introduced the lamps were soon extended beyond the original grant of six free lights. As to the financial results of the company's brief experience, he thought that they could not be deemed unsatisfactory. It was no small achievement to come out of the first year's working of an electric light company on an even keel. The accounts showed a profit of £144. This result had been obtained under very adverse conditions, and he thought they might safely reckon that the current year would yield a more substantial margin of profit. He moved the adoption of the report and accounts.

Mr. HENRY W. BOWDEN (managing director) seconded, and, after the chairman had replied to a number of questions, the report was adopted.

### Eastern Extension, Australasia, and China Telegraph Co. (Ltd.).

The report of the directors for the half-year to Dec. 31 last states that the gross receipts amounted to £360,889. 3s. 2d., against £339,450. 4s. 10d. for the corresponding half-year of 1899. The working expenses, including £23,586. 11s. 3d. for maintenance of cables, absorbed £104,640. 3s. 1d., against £116,935. 6s. 8d., leaving £256,249. 0s. 1d. Deducting £5,795 for income tax, £6,400 for debenture interest, £525 for donations to Indian Famine and Foochow Flood Relief Funds, and £1,500 for a testimonial to the late chairman (the Marquis of Tweeddale, K.T.), as recommended by the shareholders, leaving the net profit for the half-year £242,029. 0s. 1d. Adding £16,832. 16s. 2d. brought forward, there is an available balance of £258,861. 16s. 3d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute a like

amount on the 25th inst., making, with interim dividends for the first half-year, a total of 5 per cent. It is also proposed to pay a bonus of 4s. per share (or 2 per cent.), making the distribution for the year 1900 7 per cent., and leaving a balance of £146,361. 16s. 3d. After deducting £4,880 to provide the agreed dividend on the new issue of shares, there remains £141,481. 16s. 3d., which has been transferred to general reserve, which fund has also been credited with the premium of £150,000 received on the new issue of shares, and debited with £125,137. 1s. 10d., the amount of expenditure to date on the Cape-Australian cable.

During the half-year the company, in conjunction with the Great Northern Telegraph Co., has constructed land lines between Taku, Tientsin and Peking, in connection with the international cables recently established by them to the north of Shanghai. These land lines have been opened to the public without any additional charge for telegrams exchanged between Europe and China.

The "standard revenue" fixed by the Cape-Australian cable agreement for regulating Australasian tariffs having been maintained during 1900, further reductions of rates were brought into force on Jan. 1 for telegrams exchanged with South Australia, Western Australia, and Tasmania. These rates are 3s. 6d. per word for ordinary telegrams and 2s. 6d. per word for Government telegrams. The Government of New South Wales has since accepted the agreement, and the reduced rates were applied to telegrams exchanged with that State as from Feb. 1 last.

The s.s. "Anglia," with the first section of the Cape-Australian cable (Durban-Mauritius), left the Thames for Natal on 29th ult.

A contract has been entered into with the Netherlands Indian Government for supplying and laying, on account of that Government, a cable between Java and Borneo. The cable is now being manufactured, and is expected to be laid during the current half-year.

## Indo-European Telegraph Co. (Ltd.).

The report for 1900 states that the directors are still in negotiation with the Imperial German Government for an extension of the company's concession. The company has assented to bear its share of a reduction in the rate to India, which it is expected will be introduced before long. The lines of the company continue to work most efficiently, and both the Wheatstone and duplex systems continue to give satisfaction.

The revenue from all sources for the year amounted to £151,643. 11s. 4d., compared with £142,343. 4s. 2d. for 1899, an increase of £9,300. 7s. 2d. The expenses were:—On commercial and general account £39,531. 19s. 5d., on maintenance account (expenses and charges) £38,827. 6s. 6d., total £78,359. 5s. 11d., against £74,657. 7s. 7d. for 1899, an increase of £3,701. 18s. 4d. Deducting the expenses from the total revenue a balance remains of £73,284. 5s. 5d., and after deducting income tax (£3,560. 2s. 5d.) and taking into account amount from 1899 (£7,692. 12s. 8d.), and also a repayment by the Persian Government of £17,237. 19s., the balance remaining is £94,654. 14s. 8d. From this £25,000 has been placed to reserve, and deducting this sum, together with interim dividend (£10,625) and a provision for depreciation of securities of £15,000, a balance remains of £44,029. 14s. 8d. The directors propose a dividend for the six months ending Dec. 31 of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both tax free, making in all 10 per cent. for the year, carrying forward £12,154. 14s. 8d.

**BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO.**—At the meeting on Wednesday (Mr. J. J. Clark, J.P., presiding) the directors, in their report, regretted the disappointing result of the year's working, mainly due to the fact that in July last it was necessary to close the line for repairs for five weeks. The loss involved during this profitable period amounted to fully £500. In consequence of this suspension and the large amount expended in repairs, the result of last year's working showed a loss of £287. 7s. 5d. In August the Corporation served a notice on the company requiring the removal of the line within three months to a point varying from 125ft. to 250ft. further out to sea in order that certain groynes might be extended. The company's engineer reported that this was impossible, and representations to this effect were made to the Corporation, but without avail; and on Feb. 19 the contractors to the Corporation removed a portion of the rails, without taking any steps to reinstate the line, thus destroying all communication with the Brighton terminus. Whether in so doing the Corporation had exceeded their power was a question which was having the serious consideration of the company's legal advisers. Mr. Clark said they had hoped that, after going to considerable expense in transferring their custom for power to the Corporation mains, the saving then made would have enabled them to, at any rate, show a small dividend for the preference shareholders, besides paying debenture interest. The works of the Corporation had undermined the foundations of their line, and the company discovered that the line was not sufficiently safe to continue running without considerable repairs, which not only cost them £260 to £300, but involved the closing of the line for five weeks. He maintained that, although the Act of Parliament gave the Corporation the right to give the company notice to remove their rails to a farther distance if the Council required to lengthen their groynes, that power should have been exercised reasonably, and it was unreasonable to ask the company to do something impossible. More than that, he maintained that the Corporation had no right to stop their line and to take up their rails without removing them to the point where the civic body would wish to place them. They had no right simply to destroy the line, and, having done the work which they asked the company to do, to charge the company with the cost. That was, of course, an important matter, and involved the very existence of the company. Consequently the directors had thought it right to consult their legal advisers. The Corporation had, however, authorised Mr. Volk to extend his line to the Brighton boundary, and, so far, he (the chairman) acknowledged the Corporation had done something to minimise the damage which the shareholders had sustained, because in any case they would be able to continue running the car from the boundary of Brighton. He did not know what they would do without without Mr. Volk, who, he was bound to say, gave a great deal of time and energy to the railway and did his best to assist the company.

**ELMORE'S GERMAN AND AUSTRO-HUNGARIAN METAL CO. (LTD.)**—The directors' report states that in view of the fact that copper stores and book debts show an increase of M.312,388.83 (£15,619), compared with the previous year, and as the weekly output averages nearly 22 tons per week, more capital is required, and it is proposed to increase the debenture stock to £100,000. Of the 5,000 preference shares offered to the shareholders last year, 3,605 were taken up, and the balance (1,394) will be again offered. The Metall Gesellschaft directors have declared a dividend equal to M160,000 (£7,604), from which has to be deducted the amount of the balance of charges of the Austrian Company for the year, amounting to £4,504. From the balance the directors recommend a dividend of 5 per cent. (2s. per share less tax) on the preference shares, carrying forward £208, and a dividend of 1¼ per cent. (3d. per share) to the ordinary shareholders.

**GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)**—At the recent annual meeting the directors reported that the net revenue showed a deficit, caused mainly by the price of coal and by the coal consumption and the wages at the company's works being abnormally high owing to the want of a sufficient battery of accumulators. A new battery has now been provided. The increase in the gross income during 1900 was about 38 per cent. over the previous year. The Chairman (Dr. F. R. Russell) said the old battery of storage cells was sufficient to keep up the supply during the night when it was first put in, but was quite inadequate for the heavy load which came on two years ago. During last year the coal bill amounted to very nearly 4d. per unit, but during the first quarter of the present year that had been reduced to 2d. They had 32 new customers last year, and already this year had 14 more. Mr. J. Honey Kent said want of capital had prevented the board providing the plant which he advised should be obtained more than a year ago. If they deducted the cost of coal from the total cost of production, the figure would work out at 1·83 per unit for all other expenses, which was lower than that of most private companies.

**ORIENTAL TELEPHONE AND ELECTRIC CO. (LTD.)**—The report of the directors for the year to Dec. 31 states that the revenue account shows a credit balance of £13,456. 4s. 5d., including £1,507. 16s. 10d. forward. After deducting £4,237. 12s. interim dividend there remains £10,676. 9s. 3d. The directors recommend a final dividend of 3½ per cent. (tax free), making, with the interim, 6 per cent. for the year; £2,000 is put to reserve, and £2,673. 16s. 6d. carried forward. The electric lighting branch of the company's business shows an increased surplus over that obtained in 1899, and the current year has opened with a fair amount of business on hand. The dividends declared by the Indian subsidiary companies have again been 6 per cent. for the year, and substantial sums have been carried forward. The Telephone Co. of Egypt (Ltd.) has declared a dividend of 7½ per cent. on its preferred shares, against 6 per cent. in former years, and has transferred a considerable sum to reserve for further developing the business. The China and Japan Telephone Co. has paid its debenture interest and makes fair progress, but the accounts for the past year have not yet been presented. A small exchange has been opened at Johore, which is in direct communication with the company's system in Singapore. The company has also been granted a licence by the Government of India to open an exchange at Mandalay.

## NEW COMPANIES, STATUTORY RETURNS, &c.

**ELECTRIC RAILWAY OMNIBUS (LTD.)**—Registered April 11, with a capital of £5,000 in £1 shares, to acquire the business of the Electric Railway Omnibus Co., and to carry on the business of omnibus, cab and vehicle proprietors, &c., and to deal in electrical and other vehicles.

**GEORGE LEEK & SONS (LTD.)**—Registered April 4, with a capital of £3,000 in £10 shares, to carry on at Salford the business of mechanical and electrical engineers, metal workers, boiler makers, &c.

**LA COMPANIA DE ALUMBRADO Y FUERZA ELECTRICA "HISPANIA."**—This company has been formed at Carthagena (Spain) to establish a large power station and to supply electric energy to the mining undertakings in the La Union and Carthagena districts.

**MAUND AND ROBSON (LTD.)**—Registered April 6, with a capital of £10,000 in £5 shares, to carry on business as electrical and mechanical engineers, contractors, manufacturers of and dealers in railway, tramway, electric and other apparatus, generators and accumulators, and users and suppliers of electricity, &c. The subscribers are A. Maund (electrical engineer), W. H. Robson (electrician), Mrs. L. B. Robson, Mrs. K. P. Maund, J. Graham, J. B. Robb (electrician), and T. Gould

**PEARSON FIRE ALARM SYNDICATE (RAILWAYS, DOCKS AND SHIPPING), LTD.**—Registered April 11, with a capital of £10,000 in £1 shares, to acquire and turn to account patents, licences, inventions, rights, &c.

**VANCOUVER ENGINEERING WORKS (LTD.)**—Registered April 4, with a capital of £40,000 in £1 shares, to acquire the engineering works and business at Vancouver city of Armstrong, Morrison & Co., and to carry on the business of marine, hydraulic, electrical, and general engineers, boiler makers, &c.

**WILLIAM WILSON & CO. (LTD.)**—Registered April 1, capital £30,000 in £1 shares, to carry on business of ironmongers, electricians, and engineers at Manchester and Middleton.

**CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION (LTD.)**—The annual return to March 15 gives the capital as £800,000, in £5 shares 80,000 preference), of which 50,000 preference and 50,000 ordinary have been taken up. No mortgages or charges to date of return, but the company has just made an issue of £250,000 4 per cent. debenture stock.

**CHELSEA ELECTRICITY SUPPLY CO. (LTD.)**—The annual return to March 20 has been filed. The capital is £400,500, in 74,000 ordinary and 6,000 preference shares of £5 each and 500 founders' shares of £1 each, of which 44,436 ordinary, 6,000 preference and 500 founders' shares have been taken up. £5 per share has been called up on 28,143 ordinary and 6,000 preference, and £2 per share on 9,627 ordinary shares. £189,969 has been received: 6,666 ordinary and 500 founders' shares are considered as fully paid. Mortgages and charges: £150,000 debenture stock and £88,000 buildings.

**CRYSTAL PALACE DISTRICT ELECTRIC SUPPLY CO. (LTD.)**—The annual return to March 28 gives the capital as £75,000 in £1 shares, 47,859 taken up. £1 per share has been called up and paid on 2,859. 45,000 shares are considered as fully paid. Mortgages and charges £50,000.

**W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)**—According to the annual return to March 14, the capital is £400,000 in 40,000 preference and 40,000 ordinary shares of £5 each, of which 35,000 preference and 35,000 ordinary have been taken up. £5 per share has been called up on 35,000 preference and 29,000 ordinary. £30,000 is considered as paid on 6,000 ordinary shares. Mortgages and charges £50,000, less £950 transferred to trustees.

**NATIONAL TELEPHONE CO. (LTD.)**—The annual return to March 7 gives the capital as £6,000,000 in 15,000 first and 15,000 second preference shares of £10 each, and 250,000 third preference and 890,000 ordinary shares of £5 each. All the first, second, and third preference and 590,000 ordinary shares have been taken up. £10 per share has been called up on the first and second preference and £5 per share on 221,716 third preference and 545,587 ordinary shares. £363,485 is considered as paid on 44,413 ordinary and 28,284 third preference shares. Mortgages and charges, £2,500,000.

**WESTMINSTER ELECTRIC SUPPLY CORPORATION (LTD.)**—According to the annual return to March 13 the capital is £550,000 in £5 shares, 109,520 of which have been taken up. Mortgages and charges, £250,000.

**YORKSHIRE ELECTRIC POWER SYNDICATE (LTD.)**—In the annual return to March 7 the capital is given as £10,000 in £100 shares, all taken up. £35 has been called up on each share, and £3,506 has been received. No mortgages or charges.

## CITY NOTES.

**MEMORANDA.**—Bank rate 4 per cent. (since Feb. 21, 1901). Price of silver 27$\frac{3}{4}$d. per oz. (April 18). Consols (2$\frac{3}{4}$ per cent.) 95$\frac{1}{16}$—95$\frac{3}{16}$ for money, 95$\frac{1}{4}$—95$\frac{1}{2}$ for account; 2$\frac{1}{2}$ per cent. 95$\frac{1}{2}$—96 (April 18). Consols Pay Day, May 3; Stocks and Shares Continuation Days, April 24 and May 13. Ticket Days, April 25 and May 14; Pay Days, April 26 and May 15; Mining Share Carry-over Days, April 23 and May 11.

**AFRICAN DIRECT TELEGRAPH CO. (LTD.)**—The tenth drawing of this company's 4 per cent. mortgage debentures (146 in number) will take place on May 1 at noon at the offices of the company, Winchester House, Old Broad street, London, E.C.

**CALCUTTA TRAMWAYS CO. (LTD.)**—The directors' report for 1900 states that for the first half of the year the work of reconstruction continued to prejudicially affect the receipts, but during the second half, when reconstruction was complete on most of the lines, the traffic began to show a very satisfactory expansion, which is well maintained. The electrical equipment of the system is proceeding rapidly, and much of the plant is already on the spot. The directors will shortly issue the remaining £100,000 4$\frac{1}{2}$ per cent. debenture stock.

**DEUTSCH-ATLANTISCHE TELEGRAPHEN GESELLSCHAFT.**—The operations of this company during 1900 resulted in receipts of £15,351 from interest and £29,379 from cable traffic, making a total of £52,130, including the balance from the previous year. After meeting expenses and providing for depreciation and renewal funds, there remains a net profit of £28,089, of which it is proposed to distribute a dividend at the rate of 2 per cent. per annum (absorbing £20,916), the balance being placed to reserve and the next account. There have been two interruptions on the company's lines during the present year.

**GREAT NORTHERN TELEGRAPH CO. (LTD.)**—With a balance forward from 1899 of £64,319. 10s. 1d., the total receipts for the year 1900 of this company were £616,364. 8s. 1d. The total expenses were £97,097. 3s. 1d. An interim dividend of 10s. per share has already been paid, and it is now proposed to declare a final dividend of £1 per share (making 15 per cent. for the year). £166,666. 13s. 4d. is placed to reserve and renewal funds, £55,555. 11s. 1d. to renewal fund for cable steamers, £5,555. 11s. 1d. to staff pension fund, and the balance forward is £64,989. 9s. 6d.

**GENERAL ELECTRIC CO. (U.S.A.)**—The statement of affairs for the year ended Jan. 31 shows that the profits (including $419,000 from sale of securities), after deducting all patent and miscellaneous expenses and allowances for depreciation and losses, were $6,244,000, an increase of $765,000 over the previous year:—

| Expenses. | | Earnings. | |
|---|---|---|---|
| Cost of goods sold, including expenses, taxes, &c. | $23,586,000 | Balance, Jan. 31, 1900.. | $2,353,000 |
| Debenture interest...... | 240,000 | Sales.. | 28,783,000 |
| Dividends on common and preferred stocks. | 1,728,000 | Royalties and sundry profits | 298,000 |
| Balance, Jan. 31, 1901.. | 6,628,000 | Interest and dividends received on bonds and stock owned | 232,000 |
| | | Discounts | 97,000 |
| | | Profits on sales of stocks and bonds | 419,000 |
| | $32,182,000 | | $32,182,000 |

**NORTH STAFFORDSHIRE TRAMWAYS CO. (LTD.)**—The directors' report for 1900 states that during the past year the expenditure on electrical equipment, permanent way, depôt, &c., amounted to £14,348. 15s. 3d. The profit from the rental of the lines, after payment of debenture interest, is £4,858. 3s., which, added to £12. 11s. 2d. from last account, makes £4,870. 14s. 2d. The dividends on the 6 per cent. preference shares is recommended and 5 per cent. on the ordinary shares, £70. 14s. 2d. being carried forward. The lines are being worked by the Potteries Electric Traction Co. under the terms of the agreement sanctioned by the shareholders at the last general meeting.

**STOCK EXCHANGE NOTICES.**—The Stock Exchange committee has appointed May 2 as a special settling day in the further issue of 10,000 ordinary £10 fully paid shares (Nos. 60,001 to 70,000) of the *City and South London Railway Co. (Ltd.)*, and has ordered the same, as well as £120,000 5 per cent. second debenture stock (in lieu of provisional certificates now quoted) and 100,000 £5 fully-paid ordinary shares (Nos. 1 to 100,000) of the *Buenos Ayres and Belgrano Electric Tramways Co. Ltd.*, 21,000 ordinary £5 fully-paid shares (Nos. 1 to 21,000) and £90,000 4 per cent. debenture stock of the *Kensington and Knightsbridge Electric Lighting Co. (Ltd.)*, and the further issue of £26,991 4 per cent. debenture stock of the *Kensington and Knightsbridge Electric Lighting Co. (Ltd.)* and the *Notting Hill Electric Lighting Co. (Ltd.)* to be quoted in the official list. The committee has also been asked to appoint a special settling day in and to grant a quotation to 18,000 5 per cent. cumulative preference £10 fully-paid shares (Nos. 7,001 to 25,000) and £150,000 4 per cent. first mortgage debenture stock of the *General Electric Co., 1900, (Ltd.)*, and to allow £100,000 5 per cent second debenture stock (in lieu of the provisional certificates now quoted) of the *Edison and Swan United Electric Light Co. (Ltd.)* and the further issue of 2,200 ordinary £10 fully-paid shares (Nos. 10,001 to 12,200) of the *Notting Hill Electric Lighting Co. (Ltd.)* to be quoted in the official list.

**SUBMARINE CABLES TRUST.**—Tenders are invited from holders of certificates to be redeemed out of surplus income accrued to 15th inst., at a price not to exceed £120 per certificate. Certificate-holders desirous of surrendering their certificates should communicate at once with the secretary, Mr. Sidney Collett.

Thirty certificates of the trust will be redeemed by a drawing to take place on Friday next (April 26), at noon, at the offices, Winchester House, Old Broad-street, London, E.C.

**ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.**

| Line. | Week ended | Amount. | Inc. or Dec. | No. of weeks | Aggregate. Amount. | Aggregate. Inc or Dec. |
|---|---|---|---|---|---|---|
| | 1901 | £ | £ | | £ | £ |
| Aberdeen Corporation... | Apl. 13 | 633 | + 12 | 45 | 29,860 | + 3,538 |
| *Birmingham Tramways | „ 13 | 4,846 | + 594 | 14 | 57,476 | + 1,542 |
| *Blackburn Corporation.. | „ 12 | 688 | + 192 | 15 | 6,310 | + 880 |
| Blackpool Corporation... | „ 11 | 1,092 | + 860 | †2 | 1,242 | - 882 |
| Blackpool and Fleetwood | „ 13 | 706 | + 218 | 15 | 2,973 | - 206 |
| Bolton Corporation ...... | „ 14 | 1,471 | + 135 | 2 | 3,171 | + 817 |
| Bradford Corporation... | ... | ... | ... | ... | ... | ... |
| Brisbane Trams ......... | ... | ... | ... | ... | ... | ... |
| *Bristol Trams & Carriage | „ 12 | 5,050 | +2,016 | 14 | 55,941 | +16,592 |
| *Buenos Ayres & Belgrano | Mar. 17 | 2,796 | + 423 | 11 | 30,601 | + 4,762 |
| Carlisle Trams. Co. ...... | Apl. 13 | 209 | ... | 15 | 1,838 | ... |
| Central London Railway | „ 13 | 6,652 | ... | 15 | 91,541 | ... |
| City & South London Ry. | „ 14 | 1,946 | + 787 | 15 | 30,090 | +11,612 |
| Cork Elec. Trams ......... | „ 11 | 438 | + 83 | 14 | 5,060 | + 683 |
| Dover Corporation ...... | „ 13 | 252 | + 41 | 2 | 473 | + 103 |
| Dublin & Lucan Rly. ... | „ 13 | 157 | + 41 | 15 | 1,176 | + 182 |
| Dublin United ............ | „ 12 | 3,825 | - 169 | 15 | 37,329 | + 651 |
| Dublin Southern Dist... | „ 12 | 1,213 | + 45 | 15 | 10,983 | |
| *Dundee Corporation .. | ... | ... | ... | ... | ... | ... |
| *Glasgow Corporation .. | „ 13 | 8,790 | - 239 | 15 | 125,619 | + 1,648 |
| Halifax Corporation..... | ... | ... | ... | ... | ... | ... |
| *Huddersfield Corpn. ... | „ 13 | 1,034 | + 331 | 2 | 1,773 | + 489 |
| Hull Corporation ........ | „ 19 | 1,739 | + 550 | 41 | 59,923 | +32,070 |
| *Liverpool Corporation... | „ 6 | 8,605 | +1,401 | 14 | 110,338 | +15,851 |
| Liverpool Overhead Rly | „ 14 | 1,871 | + 520 | 15 | 22,684 | + 1,879 |
| Perth Elec. Trams ...... | „ 12 | 925 | + 545 | 41 | 26,449 | ... |
| Portsmouth Corporation | „ 13 | 724 | + 102 | ... | ... | ... |
| *Sheffield Tramways ..... | „ 14 | 3,670 | +1,619 | 15 | 43,479 | +15,902 |
| Southampton Corporat'n | „ 11 | 748 | + 146 | ... | ... | ... |

* Partly electrical. † Minus 3 days.

# ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price. Apr. 10. | | Price Wednesday. Apr. 17. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Apr. 17. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **ELECTRICITY SUPPLY COMPANIES.** | | | | | £ s. d. | | Highest | Lowest |
| [illegible]00,000 | 1 | ... | Bl'ckh'th & Gr'nw'ch D'st'ct Elec. Lt. Ord. (fully pd.) | [illegible] | [illegible] | [illegible] | [illegible] | ... | ... | ... | ... |
| £100,000 | Stock | [illegible] | Do. 4½ 1st [illegible] Stock Pre Certs. [illegible] & con.) | 70 | 75 | 70 | 75 | ... | ... | ... | ... |
| 6,000 | 10 | 12/0 | Bournemouth and Poole Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | ... | ... | ... |
| 6,000 | 10 | 4/6 | Do. 4½ per Cent. Cumulative Pref. | 10 | 11 | 10 | 11 | 4 1 10 | ... | 10½ | ... |
| £70,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 101 | 104 | 101 | 104 | 4 7 7 | ... | ... | ... |
| 19,861 | 5 | 3/6 | Brompton & Kensington Elec. Supply Ord | 7½ | [illegible] | 7½ | [illegible] | 3 12 9 | ... | ... | ... |
| 12,000 | 5 | 3/6 | Do. 7 per Cent. Preference | [illegible] | [illegible] | [illegible] | [illegible] | 4 0 0 | March and September | [illegible] | ... |
| 20,000 | 5 | 1/6 | Calcutta Elec. Supply Ordinary (fully paid) | 6½ | [illegible] | 6½ | [illegible] | ... | ... | [illegible] | ... |
| 50,000 | 5 | 4/0 | Charing Cross & Strand Electricity Supply Corp. | 9 | 10 | 9 | 10 | 4 10 0 | February and August | [illegible] | ... |
| 50,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5 | 5½ | 5 | 5½ | 4 1 10 | " " | [illegible] | [illegible] |
| 34,000 | 5 | 3/0 | Chelsea Electricity Supply Ordinary | 5½ | 6½ | 5½ | 6½ | 4 8 0 | March | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½ per Cent. Debenture Stock (red.) | 109 | 112 | 109 | 112 | 4 0 4 | June and December | ... | ... |
| $1,200,000 | $1,000 | 5% | Chicago Edison 1st Mort. 5% 30 yr. Gold Bonds (red.) | 100 | 110 | 100 | 110 | 4 10 11 | April and October | ... | ... |
| 70,579 | 10 | 8/0 | City of London Electric Lighting Ord. | 7 | 8 | [illegible] | 9½ | 4 4 3 | February and August | 9[illegible] | 8½ |
| 40,000 | 10 | 6% | Do. 6 per Cent. Cumulative Pref. | 12 | 13 | 12 | 13 | 4 12 4 | January and July | ... | ... |
| £400,000 | Stock | 5% | Do. 5 per Cent. Debenture Stock (red.) | 121 | 126 | 121 | 126 | 4 0 4 | June and December | ... | ... |
| £200,000 | Stock | ... | Do. 4½% 2nd Deb. Stock Certs. (all pd.) | 101 | 103 | 101 | 103 | ... | ... | ... | ... |
| 40,000 | 10 | 4/0 | County of London and Brush Prov. Ordinary ... xd | 9½ | 9½ | 8 | 9 | 4 [illegible] 11 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference ... xd | 11½ | 12½ | 11 | 12 | [illegible] 0 | March and September | [illegible] | ... |
| £300,000 | Stock | 4½% | Do. 4½ Deb. Stock (all pd.) (red.) | 106 | 109 | 106 | 109 | 4 2 7 | ... | ... | ... |
| 10,300 | 5 | 4/0 | Folkestone Electric Supply Co. Ordinary ... xd | 5½ | 5½ | 5 | 5½ | 3 12 9 | ... | ... | ... |
| 11,000 | 5 | 4/6 | Hove Electric Lighting Ordinary ... xd | 7½ | 8½ | 7 | 8 | 2 15 3 | ... | ... | ... |
| 21,000 | 5 | 11% | Kensington and Knightsbridge Ordinary | 11 | 12 | 10½ | 11½ | 4 11 4 | ... | ... | ... |
| 10,000 | 5 | 6% | Do. 6 per Cent. 1st Pref. | 6½ | 7 | 6½ | 7 | 4 2 7 | January and July | ... | ... |
| £[illegible] | Stock | ... | Do. 4 Deb. Stock (red.) Deb. Stk (red.) | ... | ... | 1[illegible] | 101 | ... | ... | ... | ... |
| £[illegible] | Stock | 1[illegible] | Kensington & Knightsbridge & Notting Hill Co (Jt. Stck.) | 101 | 103 | 101 | 103 | 3 17 8 | ... | ... | ... |
| 110,000 | 5 | ... | London Electric Supply Ordinary | 1½ | 1½ | 1½ | 1½ | ... | ... | ... | ... |
| 49,840 | 5 | 3/0 | Do. 6 per Cent. Preference | 3½ | 4½ | 3½ | 4½ | 6 13 4 | ... | [illegible] | ... |
| £250,000 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Debentures | 99 | 101 | 99 | 101 | 3 12 3 | Mar., June, Sept., Dec. | ... | ... |
| 55,000 | 10 | 8/0 | Metropolitan Elec. Supply Ord. | 11½ | 12½ | 11½ | 12½ | 4 16 0 | April and October | 12½ | 11½ |
| 18,760 | 10 | [illegible] | Do. (£7 10s. paid) | 9 | 10 | 9 | 10 | ... | ... | ... | ... |
| £220,000 | Stock | 4½% | Do. 4½ per Cent. Deb. Stock First Mortgage | 110 | 113 | 110 | 113 | 3 19 5 | June and December | ... | ... |
| £260,000 | Stock | 3½% | Do. 3½ per Cent. Mort. Deb. Stock (red.) | 97 | 100 | 97 | 100 | 3 10 5 | ... | ... | ... |
| 6,452 | 10 | 6/0 | Notting Hill Electric Ordinary | 15½ | 16½ | 15½ | 16½ | 4 13 4 | March | ... | ... |
| 10,000 | 5 | 5/0 | Oxford Electric Ordinary | 6½ | 6½ | 6½ | 6½ | 3 16 11 | " | ... | ... |
| 200,000 | 1 | 1/6 | Rand Electric | [illegible] | [illegible] | [illegible] | [illegible] | 12 0 0 | ... | ... | ... |
| £135,000 | Stock | 5% | River Plate El. Lt. & Tr'ct'n, Ltd., 5% 1st Mor. Deb. | 65 | 75 | 65 | 75 | ... | January and July | ... | ... |
| 15,000 | $100 | $2 | Royal Electric Company of Montreal Shares | 210 | 220 | 210 | 220 | 3 12 9 | April and October | ... | ... |
| £115,800 | 100 | 4½% | Do. 4½ per Cent. 1st Mortgage Debentures | 102 | 104 | 102 | 104 | 4 6 2 | " " | ... | ... |
| 40,000 | 5 | 9/6 | St. James's and Pall Mall Electric Ordinary | 13½ | 14½ | 13½ | 14½ | 5 0 0 | February and August | 14½ | 14½ |
| 20,000 | 5 | 3/6 | Do. 7 per Cent. Preference | 8½ | 9½ | 8½ | 9½ | 3 13 8 | " " | ... | ... |
| £150,000 | Stock | 29/0 | Do. 3½ per Cent. Debenture Stock (red.) | 99 | 101 | 99 | 101 | 3 9 4 | ... | ... | ... |
| 12,000 | 5 | ... | Smithfield Markets Electric Supply Ordinary | 2 | 2½ | 2 | 2½ | ... | ... | ... | ... |
| £80,000 | Stock | 4% | Do. 4% Debentures | 80 | 90 | 80 | 90 | 4 10 11 | ... | ... | ... |
| 65,000 | 5 | ... | South London Electric Supply Ordinary | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 103,518 | 5 | 5/0 | Westminster Electric Supply Ordinary | 11½ | 12½ | 11½ | 12½ | 4 4 0 | March and September | 12½ | 11[illegible] |
| | | | **ELECTRIC RAILWAYS, TRAMWAYS, &c.** | | | | | | | | |
| 200,000 | 5 | 2/[illegible] | Anglo-Argentine Shares (1 to 200,071) | [illegible] | 4½ | [illegible] | 4½ | 4 17 0 | April and October | 4[illegible] | 3[illegible] |
| £[illegible] | Stock | 6% | Do. Permanent 6% Deb. Stock | 123 | 125 | 123 | 125 | 4 14 10 | ... | ... | ... |
| [illegible] | 10 | 4/0 | [illegible] Tramways Ordinary | ... | ... | 9½ | 10½ | 1 1[illegible] 1 | ... | ... | ... |
| 10,000 | [illegible] | [illegible] | Do. Cumulative Preference | ... | ... | 9 | 10 | 5 [illegible] | ... | ... | ... |
| £[illegible] | 100 | ... | Do. Debentures | ... | ... | [illegible] | 101 | 5 [illegible] 0 | ... | ... | ... |
| £1[illegible] | Stock | 4½ | Do. 4½ Debenture Stock (red.) | ... | ... | 92 | 97 | 4 11 9 | ... | ... | ... |
| 15,[illegible] | 10 | [illegible] | Blackpool and Fleetwood Tramways | 14 | 15 | 14 | 15 | 4 0 8 | ... | 14[illegible] | ... |
| 75,000 | 5 | ... | [illegible] Electric Tract. Investment Ord. | 2½ | 3½ | 2½ | 3½ | ... | ... | ... | ... |
| 75,[illegible] | 5 | ... | Do. [illegible] Cum. Pref. | 4½ | 4½ | 4½ | 4½ | ... | ... | [illegible] | 4½ |
| £400,[illegible] | Stock | ... | Do. 4½ Deb. Prov. Certs. | 99 | 101 | 99 | 101 | ... | ... | 100 | 99 |
| 50,000 | 10 | 5½% | Bristol Tramways and Carriage Ordinary | 23½ | 24½ | 23½ | 25½ | 3 5 3 | February and August | ... | ... |
| 25,000 | 10 | 4% | Do. Cumulative Preference (fully pd.) | 10½ | 10½ | 10½ | 10½ | 3 15 4 | ... | ... | ... |
| £100,000 | Stock | 4% | Do. 4 per Cent. Debentures | 114 | 116 | 114 | 116 | 3 [illegible] 5 | February and August | ... | ... |
| 20,000 | 10 | ... | British Columbia Electric Railway Ordinary | 6½ | 7½ | 6½ | 7½ | ... | ... | ... | ... |
| 13,600 | 10 | [illegible] | Do. 5% Preference | 10 | 10½ | 10 | 10½ | 4 15 [illegible] | May and November | ... | ... |
| £[illegible] | 100 | 4½ | Do. 4½% 1st Mort. Debs. ... xd | 10[illegible] | 10[illegible] | 10[illegible] | 10[illegible] | 4 [illegible] 3 | ... | ... | ... |
| 6[illegible],000 | 10 | [illegible] | British Elec. Trac. Ord | 14 | 16 | 15½ | 16 | 5 0 3 | ... | 16½ | 15[illegible] |
| 60,000 | 10 | 6/0 | Do. 6% Cum. Pref. | 12½ | 12½ | 1[illegible] | 13 | 4 12 4 | February and August | 1[illegible] | 1[illegible] |
| £340,000 | Stock | 5% | Do. 5 per Cent. Perpetual Debentures | 1[illegible] | 122 | 119 | 122 | 4 2 0 | ... | 1[illegible] | 1[illegible] |
| 1[illegible] | ... | ... | Buenos Ayres & [illegible] Ordinary | ... | ... | 1½ | 1½ | ... | ... | ... | ... |
| 40,000 | 5 | 3/0 | Do. 6% "A" Cum. Pref. | 5 | 5½ | 5½ | 6½ | 5 4 4 | ... | [illegible] | [illegible] |
| 27,500 | 5 | ... | Do. "B" | 4½ | 5 | 4½ | 5½ | ... | ... | [illegible] | 4½ |
| £320,000 | Stock | 5% | Do. 5 per Cent. Debentures | 104 | 107 | 104 | 107 | 4 13 6 | ... | 1[illegible] | ... |
| £100,000 | Stock | 5% | Do. 5% 2nd Deb. Stk. Prov. Certs. (all pd.) | 96 | 99 | 96 | 99 | 5 1 8 | ... | [illegible] | 97½ |
| 31,440 | 10 | [illegible] | Calcutta Tramways (Nos. 1 to [illegible]) | 10½ | 11½ | 10½ | 11½ | ... | ... | ... | ... |
| £[illegible] | 100 | ... | Do. 4½ 1st Deb. Stock (Red) | 1[illegible] | 1[illegible] | 101 | 1[illegible] | ... | ... | [illegible] | ... |
| 100,000 | 1 | ... | Cape Electric Tramways Shares | 1½ | 1½ | 1½ | 1½ | ... | ... | [illegible] | ... |
| 206,297 | 10 | 2/6 | Central London Ordinary | 9 | 9½ | [illegible] | 9½ | 2 18 0 | June and December | [illegible] | 9[illegible] |
| [illegible] | 5 | [illegible] | City of Birmingham Tramways Co. [illegible] Cum. Pref. ... xd | 5½ | 5½ | [illegible] | 5½ | 4 6 11 | ... | ... | ... |
| £[illegible] | 100 | [illegible] | Do. [illegible] 1st Mort. [illegible] ... xd | 10[illegible] | 104 | 1[illegible] | 104 | 3 16 11 | ... | ... | ... |
| £655,000 | Stock | 1½ | City and South London Railway Con. Ordinary | 46 | 50 | 4[illegible] | 50 | 2 10 0 | February and August | ... | ... |
| 17,500 | 10 | 2/[illegible] | Do. Ordinary (Nos. 22,511 to 40,010) | 4 | 5 | 4 | 5 | ... | " " | ... | ... |
| £150,000 | Stock | 5% | Do. 5 per Cent. Perpetual Preference (1891) | 132 | 137 | 132 | 137 | 3 13 0 | " " | ... | ... |
| £[illegible] | Stock | 5% | Do. (1896) | 132 | 137 | 132 | 137 | 3 1[illegible] 9 | ... | ... | ... |
| £344,815 | Stock | 4% | Do. 4 per Cent. Perpetual Debenture | 112 | 1[illegible] | 112 | 114 | 3 [illegible] 0 | May and November | ... | ... |
| 60,000 | 10 | [illegible] | Dublin United Tramways (1896), Ordinary | 13 | 14 | 13 | 14 | [illegible] 3 | ... | ... | ... |
| 5[illegible] | 10 | [illegible] | Do. 6 per Cent. Preference | 15 | 16 | 15 | 16 | 3 16 0 | ... | ... | ... |
| £[illegible] | 100 | 4½ | Do. 4½ per Cent. Mort. Debs. (red.) | 9[illegible] | 102 | 9[illegible] | 102 | ... | ... | ... | ... |
| [illegible] | ... | ... | Dudley, Stourbridge & District Elec. Traction Pref. | ... | 5½ | ... | 5½ | ... | ... | ... | ... |
| [illegible] | 5 | ... | Electric Lt. & Traction of Australia 6% Cum. Pref. | 4½ | 4½ | 4½ | 5½ | ... | ... | ... | ... |
| 20,000 | 10 | 7½% | Hastings Tramways Ordinary | 21½ | 22½ | 21½ | 22½ | 3 13 8 | March and September | ... | ... |
| 10,000 | 10 | 6% | Do. 6 per Cent. Preference | 14½ | 15 | 14½ | 15 | 3 19 8 | " " | ... | ... |
| £1[illegible],000 | Stock | 4½% | Do. 4½ per Cent. Debentures | 112 | 114 | 112 | 114 | 3 19 11 | January and July | ... | ... |
| [illegible] | 10 | 1/3 | Kidderminster & District E. L. & Tr'ct'n 6% Pref. | ... | ... | ... | ... | ... | May and November | ... | ... |
| 37,600 | 10 | 3½% | Liverpool Overhead Railway Ordinary | 7½ | 8 | 7½ | 8 | 4 1 7 | February and August | ... | ... |
| [illegible] | 10 | 5% | Do. 5 per Cent. Preference | 13 | 13½ | 13 | 13½ | 3 15 6 | " " | ... | ... |
| £125,000 | Stock | 4% | Do. 4 per Cent. Debentures | 102 | 104 | 102 | 104 | 3 17 2 | January and July | ... | ... |
| $[illegible] | $1,000 | [illegible] | London Street Railway, Ontario, 1st Mt. 5% Dbs (red.) | 100 | 102 | 100 | 102 | 4 1[illegible] 0 | ... | ... | ... |
| £[illegible] | Stock | [illegible] | Lond. Utd. Trams. 4% 1st Mt. Deb. Stk. Prv. Certs. (fully pd) | 102 | 104 | 102 | 104 | ... | ... | ... | ... |
| £[illegible] | 100 | 5 | Montreal Street Railway Sterling 5% Mor. Debs. (1908) | 102 | 104 | 102 | 104 | 4 16 2 | ... | ... | ... |
| £150,000 | 100 | 4½ | Do. Sterling 4½% Debentures (1922) | 102 | 104 | 102 | 104 | 4 6 7 | ... | ... | ... |
| 24,000 | 5 | ... | New General Traction Ordinary | 2½ | 3½ | 2½ | 3½ | 3 [illegible] 5 | ... | ... | ... |
| 60,000 | 5 | 6/0 | Do. 6 per Cent. Cumulative Preference | 4½ | 5½ | 4½ | 5 | 6 [illegible] | May | ... | ... |
| 4,000 | 10 | ... | Oldham, Ashton and Hyde Elec. Tramway Ord. | ... | ... | ... | ... | ... | February and August | ... | ... |
| 4,000 | 10 | 5/0 | Do. 5 per Cent. Preference | ... | ... | ... | ... | ... | " " | ... | ... |
| 13,334 | 10 | [illegible]/0 | Potteries Electric Traction Ordinary ... xd | 11 | 12 | 11 | 12 | 1 18 4 | ... | ... | ... |
| 20,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative Preference | 10 | 11 | 10 | 11 | 5 10 11 | February and August | ... | ... |
| £1[illegible] | Stock | 47/0 | Do. 4½ per Cent. Debenture Stock | 107 | 109 | 107 | 109 | 4 [illegible] | ... | ... | ... |
| £[illegible] | Stock | 3% | [illegible] Ordinary | [illegible] | [illegible] | [illegible] | [illegible] | 3 [illegible] | June and December | ... | ... |

## ELECTRICAL COMPANIES' SHARE LIST.

| Present Amount. | Amount of Share. | Last Dividend. | Name. | Previous Week's Price, Apr. 10. | | Price Wednesday, Apr. 17. | | Rate per Cent. Yielded. | Dividend Due. | Business Done During Week Ending Apr. 17. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | **TELEGRAPHS.** | | | | | £ s. d. | | Highest | Lowest |
| £96,900 | 100 | 4% | *African Direct Telegraph 4% Mort. Deb. (red.) | 98 | 102 | 98 | 102 | 3 18 5 | January and July | ... | ... |
| 28,000 | 10 | ... | Amazon Telegraph | ... | | ... | | ... | June and December | ... | ... |
| £119,700 | 100 | 5% | Do. 5 per Cent. Debentures | 55 | 65 | 55 | 65 | ... | ... | ... | ... |
| £227,720 | Stock | 15/0 | Anglo-American x d | 51 | 54 | 50 | 53 | 5 17 11 | Feb., May, Aug., Nov. | ... | ... |
| £3,068,640 | Stock | 30/0 | Do. Preferred x d | 95 | 97 | 94 | 96 | 6 5 0 | " " | 95¾ | 95 |
| £3,068,640 | Stock | 5/0 | Do. Deferred | 8½ | 8¾ | 8½ | 8¾ | 2 17 2 | " " | 8½ | ... |
| 13,333,300 | $100 | $1¾ | Commercial Cable Capital Stock | 170 | 180 | 160 | 170 | 4 14 2 | Jan., Apr., July, Oct. | ... | ... |
| £1,741,039 | Stock | 4% | * Do. 4 per Cent. Debenture Stock | 101 | 103 | 100 | 102 | 3 18 5 | " " | 101¾ | 101 |
| 16,000 | 10 | 5/0 | Cuba Submarine Ordinary | 7½ | 8½ | 7½ | 8½ | 6 9 5 | February and August | ... | ... |
| 6,000 | 10 | 10/0 | Do. Preference 10 per Cent. | 16 | 17 | 16 | 17 | 5 17 8 | " " | ... | ... |
| 13,000 | 5 | 2/0 | Direct Spanish Ordinary | 3 | 4 | 3 | 4 | 5 0 0 | April and October | 3½ | ... |
| 6,000 | 5 | 5/0 | Do. 10 per Cent. Cumulative Preference | 9 | 10 | 9 | 10 | 5 0 0 | " " | ... | ... |
| £30,000 | 50 | 4½% | Do. 4½ per Cent. Debentures | 100% | 104% | 100% | 104% | 4 6 7 | January and July | ... | ... |
| 60,710 | 20 | 3/0 | Direct United States Cable | 9¾ | 10½ | 9¾ | 10½ | 6 16 7 | Jan., Apr., July, Oct. | 10¹⁄₁₆ | ... |
| £108,300 | 100 | 4½% | Direct West India Cable 4½% Reg. Db. (within Nos. 1 | 99 | 102 | 99 | 102 | 4 8 3 | June and December | ... | ... |
| £4,000,000 | Stock | 35/0 | Eastern Ordinary [to 1,200) (red.) x d | 141 | 148 | 140 | 145 | 4 16 7 | Jan., Apr., July, Oct. | 142½ | 141 |
| £1,929,438 | Stock | 17/6 | Do. 3½ per Cent. Preference Stock x d | 92 | 96 | 91 | 9[illegible] | 3 14 6 | " " | ... | ... |
| £1,432,368 | Stock | 4% | * Do. 4 per Cent. Mort. Deb. Stock (red.) | 113 | 117 | 113 | 117 | 3 9 0 | May and November | 115¼ | 114 |
| 250,000 | 10 | 2/6 | Eastern Extension | 14½ | 14¾ | 14½ | 14¾ | 4 14 11 | Jan., Apr., July, Oct. | 14¾ | 14½ |
| 50,000 | 10 | ... | Do. (Nos. 250,001 to 300,000) £5 pd, is'd at £3 pm, all pd | 13¾ | 14½ | 13¾ | 14¾ | ... | ... | 13¹³⁄₁₆ | 13¾ |
| £2,120,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock | 111 | 116 | 111 | 115 | 3 9 3 | February and August | ... | ... |
| £300,000 | 100 | 4% | *Eastern and S. African 4% Mort. Deb., 1900 | 99 | 102 | 99 | 102 | 3 18 3 | February and August | ... | ... |
| £300,000 | 25 | 4% | Do. 4 per Cent. Mauritius Sub. Debs. (red.) | 101% | 104% | 101% | 104% | 3 17 8 | May and November | ... | ... |
| 180,227 | 10 | 1/9 | Globe Telegraph and Trust | 9¾ | 10¼ | 9¾ | 10¼ | 5 2 5 | Jan., Apr., July, Oct. | 10¼ | 9¾ |
| 180,042 | 10 | 3/0 | Do. 6 per Cent. Preference | 14¾ | 15¼ | 14¾ | 15¼ | 3 19 8 | " " | 15⅛ | 14¾ |
| 150,000 | 10 | 5/0 | Great Northern of Copenhagen | 33 | 34 | 33 | 35 | 3 11 5 | January and July | ... | ... |
| £33,000 | 100 | 4½% | Halifax & Bermuda Cable 4½% 1st Mort. Deb (wthn Nos | 99 | 103 | 99 | 103 | 4 9 1 | June and December | ... | ... |
| 17,000 | 25 | 12/6 | Indo-European [1 to 1,200) (red. | 48 | 50 | 45 | 49 | 5 2 0 | May and November | 48 | ... |
| £100,000 | 100 | 6% | London Platino-Brazilian 6 per Cent. Debs., 1904 | 103 | 106 | 103 | 106 | 5 13 2 | March and September | ... | ... |
| £100,000 | 100 | 4% | Pacific & European Tel. 4% Guar. Debs. (red.) | 99 | 103 | 99 | 102 | 3 19 5 | June and December | ... | ... |
| 11,839 | 8 | 4/0 | Reuter's | 7½ | 8½ | 7½ | 8½ | 4 14 1 | April and October | 7¾ | ... |
| 3,381 | £100 Cert. | 6% | Submarine Cables Trust x d | 121 | 123 | 121 | 123 | 4 15 3 | " " | ... | ... |
| 15,809 | 10/0 | ... | West African Telegraph | 2¾ | 3¼ | 2 | 3 | 4 9 9 | December and July | ... | ... |
| £171,100 | 100 | 5% | * Do. 5 per Cent. Debentures (red.) | 97 | 100 | 97 | 100 | 5 0 0 | March and September | ... | ... |
| [illegible] | 3½ | ... | West Coast of America | ½ | ¾ | ½ | ¾ | ... | ... | ... | ... |
| £150,000 | 100 | 4% | * Do. 4 per Cent. Debentures | 99 | 102 | 99 | 102 | 3 14 5 | January and July | ... | ... |
| 88,321 | 10 | 6d. | West India and Panama | ⅝ | ⅞ | ⅝ | ⅞ | ... | May and November | ... | ... |
| 34,563 | 10 | 6/0 | Do. 6 per Cent. 1st Preference | 6 | 7 | 6 | 7 | 3 11 6 | " " | 6¾ | 6⁷⁄₁₆ |
| 4,669 | 10 | 6/0 | Do. 6 per Cent. 2nd Preference | 5 | 7 | 5 | 7 | 3 11 6 | " " | ... | ... |
| £80,000 | 100 | 5% | * Do. 5 per Cent. Debentures | 103 | 106 | 103 | 106 | 4 11 4 | January and July | ... | ... |
| 307,980 | 10 | 3/0 | Western Telegraph (late Brazilian Submarine) | 13¾ | 14¼ | 13¾ | 14¼ | 4 18 3 | Mar., June, Oct., Dec. | 14⅛ | 13¾ |
| £75,000 | 100 | 5% | * Do. 5 per Cent. Debs. (2nd Series, 1906) | 101 | 104 | 101 | 104 | 4 16 2 | June and December | — | — |
| £340,777 | Stock | 4% | Do. 4 per Cent. Deb. Stock (red.) | 102 | 105 | 102 | 105 | 3 16 2 | — | ... | ... |
| | | | **TELEPHONES.** | | | | | | | | |
| 44,000 | £5 | 4/0 | Chili Telephone (fully paid) | 3 | 3½ | 3 | 3½ | 5 14 4 | August | 3¼ | — |
| 314,850 | 10 | 3% | Consolidated Telephone Con. and Manfg. | 2/3 | 2/9 | 2/3 | 2/9 | 10 18 2 | April and October | — | — |
| 72,600 | 1 | 3½% | Monte Video Telephone Ordinary | ⅝ | ⅞ | ⅝ | ⅞ | 5 0 0 | November | — | — |
| 96,492 | 1 | 1/0 | Do. 5 per Cent. Preference | ⅞ | 1 | ⅞ | 1 | 5 0 0 | " | — | — |
| 590,000 | 5 | 2/6 | National | 3½ | 3¾ | 3 | 3½ | 8 9 2 | February and August | 3³⁄₁₆ | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 1st Preference | 11 | 13 | 11 | 13 | 4 12 4 | " " | ... | ... |
| 15,000 | 10 | 6/0 | Do. 6 per Cent. Cumulative 2nd Preference | 10 | 12 | 10 | 12 | 5 0 0 | " " | ... | ... |
| 250,000 | 5 | 3/6 | Do. 6 per Cent. Non-Cumulative 3rd Pref. | 4½ | 4¾ | 4½ | 4¾ | 5 11 1 | " " | ... | ... |
| ‡£1,000,000 | Stock | 3½% | * Do. Debenture Stock 3½ per Cent. (red.) | 90 | 91 | 89 | 91 | 3 16 11 | June and December | ... | ... |
| £500,000 | Stock | 4% | Do. 4 per Cent. Debenture Stock (red.) | 95 | 99 | 95 | 99 | 4 2 8 | ... | 95½ | ... |
| 171,504 | 1 | 3/6 | Oriental | ¾ | 1¼ | ¾ | 1¼ | 5 3 9 | April and October | — | ... |
| 58,000 | 5 | 2/6 | United River Plate | 4½ | 5 | 4½ | 5 | 7 0 0 | July | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5% Cumulative Pref. | 4½ | 5½ | 4½ | 5½ | 4 15 3 | June and December | ... | ... |
| £179,947 | tock | 5% | * Do. 5 per Cent. Debenture Stock (red.) | 103 | 106 | 103 | 106 | 4 14 9 | June and December | 103½ | — |
| | | | **ELECTRIC MANUFACTURING &c. COMPANIES.** | | | | | | | | |
| [illegible] | 1 | 6d. | Alliance Electrical Co. 5% Cum. Pref. | ½ | ¾ | ½ | ¾ | 5 14 3 | ... | ... | ... |
| 125,[illegible] | 1 | 7½d. | Aron Electricity Meter 6% Cum. Pref. | ¾ | ⅞ | ¾ | ⅞ | 6 17 2 | March and September | ... | ... |
| [illegible] | 1 | ... | British Electric Works Co. Ordinary | ¹⁄₁₆ | ⅛ | ¹⁄₁₆ | ⅛ | ... | ... | ... | ... |
| [illegible] | 1 | ... | Do. 6 per Cent. Cumulative Preference | ¹⁄₁₆ | ⅛ | ¹⁄₁₆ | ⅛ | ... | ... | ... | ... |
| £80,000 | 100 | 4½% | Do. First Mortgage Debentures | 85 | 90 | 85 | 90 | 5 0 0 | ... | ... | ... |
| 70,000 | 5 | 10/0 | British Insulated Wire Ordinary | 10 | 11 | 10 | 11 | 6 16 4 | July and February | ... | ... |
| 70,000 | 5 | 3/0 | Do. 6 per Cent. Preference | 5¾ | 6¼ | 5¾ | 6¼ | 4 16 0 | January and July | ... | ... |
| 100,000 | 5 | 3/0 | British Westinghouse 6% Preference | 4¾ | 5 | 4¾ | 5 | 6 0 0 | ... | 4¾ | ... |
| 90,060 | 2 | 2/0 | Brush Electrical Engineering x d | 1⅛ | 1¼ | 1⅛ | 1¼ | 3 6 7 | September | 1⅛ | 1⅛ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | 2⅛ | ... |
| 90,000 | 2 | 1/2½ | Do. 5 per Cent. Pref. Non-Cum. x d | 2 | 2¼ | 2 | 2¼ | 5 6 8 | " | 2¼ | 2⅛ |
| 15,731 | 2 | ... | Do. £1 paid | ... | | ... | | ... | ... | ... | ... |
| £125,000 | Stock | 4½% | Do. 4½ per Cent. Perpetual 1st Deb. Stock | 103 | 108 | 103 | 108 | 4 3 2 | March and September | ... | ... |
| £125,000 | Stock | 4½% | Do. Perpetual 2nd Debenture Stock | 101 | 103 | 101 | 103 | 4 7 5 | January and July | ... | ... |
| 80,000 | 5 | 5/0 | Callender's Cable Construction Ord. | 15 | 16 | 15 | 16 | 4 13 9 | " " | ... | ... |
| 40,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¼ | 6 | 5¼ | 6 | 4 3 4 | " " | 5⅝ | ... |
| £90,000 | Stock | 4½% | Do. 4½ per Cent. 1st Mortgage Deb. (red.) | 109 | 113 | 109 | 113 | 3 19 10 | November and May | ... | ... |
| 450,000 | 1 | 0 9½ | Castner-Kellner Alkali Co. (fully paid) | ¾ | 1¼ | ¾ | 1¼ | 7 2 3 | — | ... | ... |
| £160,000 | Stock | 4½% | Do. 4½% First Mort. Deb. (red.) | 95 | 98 | 95 | 98 | 4 12 0 | — | ... | ... |
| 60,000 | 1 | 0 7½ | Chadburn's Ship Telegraph Ordinary | ¾ | 1 | ¾ | 1 | 6 10 0 | March | ... | ... |
| 60,000 | 1 | 0 7½ | Do. 6 per Cent. Cumulative Preference | ¾ | 1¼ | ¾ | 1¼ | 5 6 8 | ... | ... | ... |
| 54,000 | 3 | 1/9½ | Crompton and Co. (Nos. 1 to 54,000) | 3¾ | 4 | 3¾ | 4 | [illegible] 12 7 | January and July | 3¾ | ... |
| £100,000 | 100 | 5% | * Do. 5 per Cent. First Mortgage Deb. (red.) | 100 | 103 | 100 | 103 | 4 17 6 | " " | ... | ... |
| 60,000 | 1 | 0 7½ | Davis and Timmins 6 per Cent. Cum. Pref. | ¾ | 1 | ¾ | 1 | 6 0 0 | ... | ... | ... |
| 99,261 | 5 | 1 6 | Edison & Swan United ("A" Shares) (£3 paid) | 1¾ | 2 | 1¾ | 2 | 9 0 0 | February and August | ... | ... |
| 17,139 | 5 | 2 6 | Do. (£5 paid) | 3 | 4 | 3 | 4 | 6 11 3 | " " | ... | ... |
| £344,023 | Stock | 4% | Do. 4 per Cent. Mortgage Deb. Stock (red.) | 87 | 90 | 87 | 90 | 4 9 6 | June and December | ... | ... |
| £100,000 | Stock | 5 | Do. 5% 2nd Deb. Standing Pro. Cos (all pd) | 94 | 98 | 94 | 98 | 5 2 0 | — | ... | ... |
| 35,600 | 5 | 2 6 | Edmundson's Electricity Corporation Ord. | 4½ | 4¾ | ... | 3¾ | 7 11 7 | Half-yearly | ... | ... |
| 13,503 | 5 | ... | Do. Cumulative Preference | 5½ | 6 | 5½ | 6 | ... | ... | ... | ... |
| £140,000 | Stock | 4½% | Do. 4½ per Cent. First Mort. Deb. (red.) | 103 | 106 | 103 | 106 | 4 5 1 | ... | 103½ | — |
| 112,100 | 2 | 1/2½ | Electric Construction Co. (Limited) | 1¾ | 2¼ | 1¾ | 2¼ | 5 6 8 | January and July | — | ... |
| 25,000 | 2 | 2/9½ | Do. 7 per Cent. Cumulative Preference | 2¾ | 3 | 2¾ | 3 | 4 13 4 | July | — | ... |
| £182,500 | Stock | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 16 11 | January and July | — | ... |
| 110,000 | 1 | ... | Gilfre Electro-Chemical and Power Co. Ord. | ⅛ | | ⅛ | | ... | ... | ... | ... |
| 35,000 | 5 | 16/0 | Henley's Telegraph Works Ordinary | 15 | 16 | 15 | 16 | 6 6 0 | February and August | 15¾ | 15 |
| 35,000 | 5 | 2/3 | Do. 4½ per Cent. Preference | 5¼ | 6 | 5¼ | 6 | 3 15 0 | " " | 5⅞ | — |
| £50,000 | Stock | 4½% | Do. 4½ per Cent. Mortgage Deb. Stock (red.) | 107 | 111 | 107 | 111 | 4 1 1 | " " | 110½ | — |
| 50,000 | 10 | 15/0 | India Rubber, Gutta Percha, &c., Works | 21 | 22 | 21 | 22 | 4 10 11 | " " | 21⅛ | 21 |
| £300,000 | 100 | 4% | Do. 4 per Cent. 1st Mortgage Deb. (red.) | 101 | 104 | 101 | 104 | 3 17 0 | March and September | ... | ... |
| 37,350 | 12 | 20/0 | Telegraph Construction and Maintenance | 37 | 41 | 37 | 40 | 5 4 6 | March and July | 38½ | 38 |
| £150,000 | 100 | 4% | Do. 4 per Cent. Debenture Bonds, 1909 | 101 | 104 | 101 | 104 | 3 17 0 | January and July | ... | ... |
| 25,000 | 5 | 4/0 | Do. Manufacturing Ordinary | 11 | 13 | 11 | 13 | 6 12 6 | — | ... | ... |
| 20,000 | 5 | 2/6 | Do. 5 per Cent. Cumulative Preference | 5¼ | 6 | 5¼ | 6 | 4 3 4 | ... | 6½ | ... |
| 30,000 | 5 | 7/0 | Willans and Robinson Ordinary | 11¼ | 12¼ | 11 | 12 | 5 0 0 | April and October | 11¾ | 11¾ |
| 40,000 | 5 | 3/0 | Do. 6 per Cent. Cumulative Preference x d | 6¾ | 7¼ | 6¾ | 7¼ | 4 2 9 | " " | 7⅛ | 6¾ |
| £100,000 | Stock | 4½% | * Do. 4½ per Cent. 1st Mortgage Debentures | 105 | 107 | 105 | 107 | 4 0 0 | May and November | ... | ... |

* In calculating the yield on this security, allowance has been made for accrued interest, but not for redemption.

‡ The London Stock Exchange Committee refuses to quote these.

# THE ELECTRICIAN

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF ELECTRICAL ENGINEERING, INDUSTRY, & SCIENCE.

No. 1,196. [No. 26. VOL. XLVI.]
Registered at the General Post Office.

FRIDAY, APRIL 19, 1901.

SINGLE COPY SIXPENCE; BY POST 6½d.
Abroad 8d, or 16 cents, or 80c., or 70pf.
Ann. Sub. (U.K.) 26s. Abroad 32s.

**"HELSBY" CABLES AND WIRES.**

FOR LIGHTING.
POWER,
TELEPHONY,
TRAMWAYS,
TELEGRAPHY,
SIGNALS, &c.

FOR ANY VOLTAGE and
ANY SITUATION.
SINGLE,
CONCENTRIC,
THREE-PHASE
CABLES, &c.

OF VALUE and INTEREST to EVERY ENGINEER.
The most Complete CATALOGUE yet issued. 81 pp!

**The TELEGRAPH MFG. CO., Ltd., HELSBY, nr. WARRINGTON.**

11, Queen Victoria St., LONDON.
2, Parsonage, MANCHESTER.
177, West George St., GLASGOW.
8, Victoria St., BELFAST.
8, Mosley St., NEWCASTLE-ON-TYNE.

**JOHNSON & PHILLIPS' CABLES**

TESTED GUARANTEED

SAMPLES AND LISTS FREE TO THE TRADE.

Telegrams:—"CABLES, OLD CHARLTON." Telephone:—45 Woolwich.

**JOHNSON & PHILLIPS' ELECTRIC CABLE WORKS,**

Head Office and Factory: OLD CHARLTON, KENT.

THOUSANDS OF MILES READY FOR IMMEDIATE DELIVERY.

*Depots: London, Bristol, Manchester and Glasgow.*

*Speciality:*—MAIN CABLES FOR LAYING UNDERGROUND.

FELTEN & GUILLEAUME CARLSWERK
ACTIEN-GESELLSCHAFT, MÜLHEIM-ON-RHINE,

Speciality **TROLLEY WIRE**

In all Sizes. THE BEST IN THE MARKET. Soldered to any length required. Hundreds of Miles Supplied.
**COPPER RAIL BONDS and CABLES for ELECTRICAL TRAMWAYS.**
Sole Agents for the United Kingdom: W. F. DENNIS & CO., 23, BILLITER STREET, LONDON, E.C.

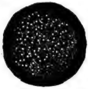
THE WORLD-RENOWNED

**"EDISWAN" LAMP**

*THE BEST AND CHEAPEST IN THE END.*

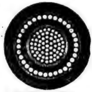
Head Office: EDISWAN BUILDINGS, QUEEN STREET, LONDON, E.C.

Telephone: 5781 BANK. Telegrams: "HENLEY'S WORKS LONDON."



TELEPHONE.

**HENLEY'S CABLES**



ELECTRIC LIGHT.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

27, MARTIN'S LANE, LONDON, E.C.
Works: NORTH WOOLWICH.
CROMWELL BUILDINGS, MELBOURNE


STIFF'S WIRE TUBES

**W. H. WILLCOX & CO., Ltd.,**

Sole Agents for the
PATENT
**Penberthy Injector**
The Cheapest and Best Feeder for
MARINE, STATIONARY, TRACTION AND PORTABLE BOILERS.
SIMPLE, RELIABLE, DURABLE.

Absolutely AUTOMATIC and RESTARTING.
JETS INTERCHANGEABLE.
Engineers who have once used them will now use no other kind.
Largest Sale of any Automatic Injector.
SEND for LISTS
130,000 IN USE.

Warehouse: 34 & 36, SOUTHWARK STREET.
Offices: 23, SOUTHWARK ST., LONDON, S.E.

The "XL"
EJECTOR OR STEAM JET PUMP
With Interchangeable Parts.
*RELIABLE and ECONOMICAL.*
May be placed Horizontally or Perpendicularly.

Sole Proprietors of the
"WILLCOX NEW SEMI-ROTARY"
**PATENT PUMPS.**
BEST PUMP in the MARKET.
These Pumps are double-acting. The working parts are of metal, and the wear and tear is reduced to a minimum, no leather or rubber being used. They are lighter and occupy less space than any other pump of equal capacity, and are self-contained.
ONCE USED, ALWAYS USED.
THE PUMP OF THE FUTURE.
SIMPLE, RELIABLE, DURABLE.
Will Pump up to 6,000 gallons per hour.

Agents for Ireland for our Semi-Rotary Patent Pumps:
J. JONES & SON, 15, Parliament St., Dublin.

**LANGDON-DAVIES ELECTRIC MOTOR CO., LTD.**
101, Southwark Street, LONDON, S.E.
Telegraphic Address: DAMOPHON LONDON. Telephone 277 HOP.
ALTERNATE CURRENT MOTORS.

SCHULTZ'S "ISOTROPIC" IRON
DYNAMO MAGNET BARS AND FORGINGS
in Sets up to 15 TONS each.
ROUGH, PARTLY OR COMPLETELY FINISHED.
- TEEL MAGNET CASTINGS -
COPPER COMMUTATOR SEGMENTS, PLAIN OR SHAPED, H.C. COPPER WIRE STRIPS, SHEETS, BRASS RODS, &c.
**GEORGE SCHULTZ & CO.,**
90, Cannon Street, LONDON, E.C. *Telegraphic Address:* "STEELHEAD LONDON."

Also SOLE SELLING AGENTS for
**W. GILBERTSON & CO., Ltd.,**
FOR
"ISO" Brand Armature Sheets and Stampings.

NEW and EXTENSIVE WORKS for the PRODUCTION of
ROUND DISCS.
PLAIN or NOTCHED, up to 60in. dia.,

SEGMENTS up to 54in. long.

TRANSFORMER-STAMPINGS, LAMINATED POLES, &c.
Works: PONTARDAWE, S. WALES.

**BENHAM & FROUD LTD.**
TRADE MARK
DESIGNERS & MANUFACTURERS of
ELECTRIC-LIGHT-FITTINGS
HIGHEST CLASS — EVERY STYLE
CHANDOS WORKS, CHANDOS ST.
LONDON. W.C.

*If You Want*
**A PLATING OR DEPOSITING PLANT**
GO TO
**CARL OPPERMANN,**
2, Wynyatt Street, Clerkenwell, E.C.
LIGHTING AND PLATING DYNAMOS IN STOCK.
Also all REQUISITES for PLATERS, including Anodes & Chemicals
SEND STAMP FOR PAMPHLET AND CATALOGUE.

**Willesden Paper**
FOR ALL CLIMATES.
8-PLY for GABIONS and PANELS.
4-PLY for WASHERS, PETROLEUM JOINTS, and DISCS.
2-PLY for COLD STORAGE.
**DYNAMO INSULATING**
VENTILATING TUBES, WATER PIPES, &c.
ESTABLISHED 1870.
WILLESDEN PAPER AND CANVAS WORKS, LD., Willesden Junction, LONDON, N.W.

THE
**BRITISH THOMSON-HOUSTON**
COMPANY, Ltd.,
*Electrical Engineers and Contractors,*
83, CANNON STREET, LONDON, E.C.
*See Large Advertisement on page xxi*

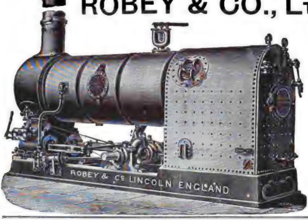
Digitized by Google

THE "CASTLE"

SLOW SPEED.
HIGH EFFICIENCY.

J. H. HOLMES & Co.,
NEWCASTLE-ON-TYNE,
AND
17, SOHO SQUARE, LONDON, W.

DYNAMOS



ROBEY & CO., LTD., GLOBE WORKS, LINCOLN.

Highly Efficient
And Economical
STEAM ENGINES.

PERFECT REGULARITY OF SPEED.
MINIMUM OF FRICTION.
GREAT SIMPLICITY.
ECONOMICAL IN FUEL.

Upwards of 21,000 Engines of all sizes at work in different parts of the World.

Makers of
PORTABLE, HORIZONTAL HIGH-SPEED STEAM ENGINES.
Also GAS and OIL ENGINES specially suitable for ELECTRIC LIGHT WORK.

LONDON OFFICES:
79, Queen Victoria St.,
LONDON, E.C.

Branches and Agencies in all parts of the World

GOLD MEDAL, Paris Exhibition, 1900

The LONDON ELECTRIC WIRE COMPANY, Ltd.

Telegrams: Electric London.
ANCHOR WORKS, PLAYHOUSE YARD, GOLDEN LANE, LONDON, E.C.
Telephone: No. 105 Bank

MANUFACTURERS:—CABLES of Light, Medium, and High Insulation,
COVERED WIRES, STRIPS, CABLES, &c., for Dynamo Machines.
SILK COVERED WIRES for Instruments.
LINE WIRES, CABLES AND CORDS for Telephones, Bells, &c.
FLEXIBLE CORDS and CABLES.
MARTINO'S PLATINOID for RESISTANCES.
GAUZE BRUSHES and Sundry Appliances.
*Engineers' Specifications Carefully Worked to.*

PRICE LIST
ON
APPLICATION

Agents for Australia and New Zealand: LAWRENCE & HANSON, 3, Wynyard Street, Sydney, and 167, Queen Street, Melbourne.

TURBINES. THE BEST for Electrical Purposes
IS THE
"Little Giant."
Made in 76 Sizes and Styles. PELTON WHEELS.

S. HOWES, 64, Mark Lane, LONDON, E.C.
CONTRACTOR to H.M. GOVERNMENT.
Also to the Russian, French, Dutch, Turkish, Egyptian, Indian and Cape Governments.

HORIZONTAL.

VERTICAL.

Digitized by Google

THE

# ELECTRIC CONSTRUCTION Co.

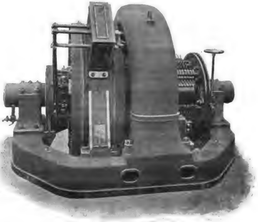
*LONDON AND WOLVERHAMPTON.* LTD.

**CONTRACTORS FOR**

## CENTRAL STATIONS, RAILWAYS, TRAMWAYS, AND TRANSMISSION OF POWER PLANT OF THE LARGEST CAPACITY.

*HEAD OFFICE:*
Dashwood House,
9, New Broad Street,
LONDON, E.C.

*TELEGRAPHIC ADDRESS:*
"CONCORDANCE
LONDON."



200 H.P. POLYPHASE CONTINUOUS CURRENT MOTOR GENERATOR.

*WORKS:*
WOLVERHAMPTON.

*TELEGRAPHIC ADDRESS:*
"ELECTRIC
WOLVERHAMPTON."

# Electric Railway & Tramway Equipments

CITY AND SOUTH LONDON, GLASGOW, MANCHESTER, ISLE OF MAN, HARTLEPOOL, HALIFAX, MADRAS, BUENOS AIRES, SOUTH STAFFORDSHIRE, LIVERPOOL, CROWN REEF MINES JOHANNESBURG, EAST LONDON, &c., &c.

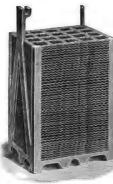
**Cable Address (Registered with the Eastern Telegraph Co., Ltd.): "QUANTITY LONDON."**
**Codes used: A 1 and A B C (Fourth Edition).**

# MONOBLOC

# THE TRACTION ACCUMULATOR.

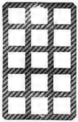
(FULLY COVERED BY PATENTS.)

**Complete Cell.**



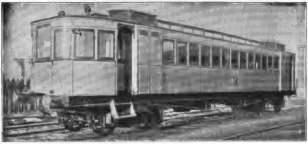
**Positive Block.**

The positive block is built up with horizontal sheets having holes punched for reception of the negative rods arranged vertically, thus :—



**Negative Rods.**

***THE RESULT OF YEARS OF EXPERIENCE.***



CAR FOR USE ON THE BELGIAN STATE RAILWAYS.

Send for Particulars of ***MONOBLOC CELLS*** suitable for ELECTRIC LOCOMOTIVES, TRAMCARS 'BUSES, LORRIES, MOTOR CARS, TRAIN LIGHTING, and other Rapid Discharge Work.

## DRAKE & GORHAM,

*SOLE AGENTS FOR THE*

## MONOBLOC ACCUMULATOR SYNDICATE, LTD.,

**66, Victoria Street, Westminster, LONDON, S.W.**

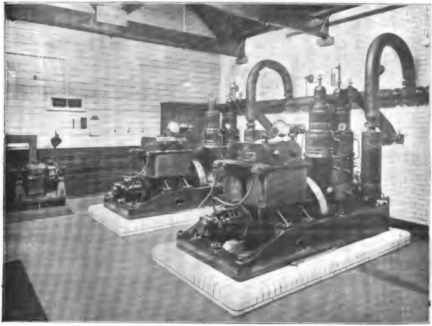
*Telegrams : "ACCUMULATOR, LONDON."* *Telephones, 71 and 393, Westminster.*

Also at 100, King Street, MANCHESTER; Baltic Chambers, 50, Wellington Street, GLASGOW; and Westminster Chambers, East Parade, LEEDS.

SPECIALISTS FOR THE DESIGN AND ERECTION OF

# ELECTRIC GENERATING PLANTS

IN ENGLAND AND ABROAD.

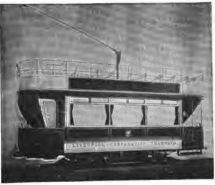


ARRANGEMENT OF ELECTRIC LIGHTING PLANT AT Messrs. IND, COOPE'S BREWERY, ROMFORD.

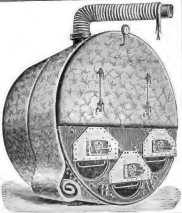
*The experience acquired under varying conditions enable the working cost per unit to be determined beforehand, so that any user can decide whether it is to his advantage to continue taking current from the supply station or to erect his own plant, as is usual in most ot the large buildings in America.*

# DRAKE & GORHAM,

ELECTRICAL, MECHANICAL AND HYDRAULIC ENGINEERS,
**66. Victoria Street, Westminster, LONDON, S.W.**
*Telegrams: "Accumulator, London."* *Telephones, 71 and 393, Westminster.*
Also at 100, King Street, **MANCHESTER**; Baltic Chambers, 50, Wellington Street, **GLASGOW**; and Westminster Chambers, East Parade, **LEEDS**.


LIVERPOOL CORPORATION TRAMWAYS

---



# The

# B. I. W. CO., L$^{\text{TD}}$

HAVE SUPPLIED

# ALL CABLES

INCLUDING

## THE 3-CORE CABLES

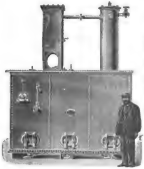
## FOR

## TRI-PHASE WORKING

## AT 5,000 VOLTS

TO THE

# ISLE OF THANET LIGHT RAILWAY C$^{\text{o}}$.



# RE &S EVERED & CO., Ltd., RE &S

***LONDON and BIRMINGHAM.***

## Manufacturers of ELECTRIC LIGHTING ACCESSORIES,

**HIGH VOLTAGE LAMP SOCKETS, SWITCHES, PLUGS, &c.**

X 1092—Dwarf Socket, "S" Interior.

X 907—Key Socket

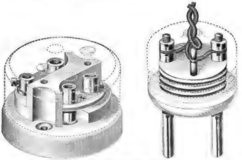
NOTE.—
Quite New
Interior.

X 988—Batten Socket.

X 1101—Patent Two-Way Tumbler Switch.

X 868—Tumbler Switch, from 5 to 20 amperes.

**We only**
**Supply**
**the Trade.**



X 1102—Two-Pin Plug, 5 amperes.

X 1109—Knife Switch, 25 to 500 amperes.

**Warehouse and Showrooms** { Drury Lane .. .. .. .. / High Street, Shoreditch } **LONDON.**
**Works** .. .. .. .. .. .. .. .. .. .. { Barnet Works .. .. .. **BIRMINGHAM.** / Surrey Works .. .. .. **SMETHWICK.**

**WITTING BROS., Ltd.** (ELECTRICITE & HYDRAULIQUE),

ELECTRIC POWER & TRACTION ENGINEERS,

Telegrams: WITTING LONDON.
Telephone: 5795 Bank.

***Head Office: 49, CANNON STREET, LONDON, E.C.***

Tramway Equipments.

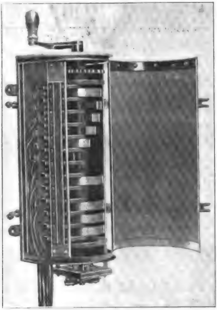
Continuous-Current Generators.

Continuous-Current Motors.

Balancers and Boosters.

Rotary Converters.

Single-phase Motors.



STANDARD CRANE CONTROLLER.

Polyphase Motors.

Single and Polyphase Transformers.

Single and Polyphase Alternators.

Continuous and Three-phase Current Motors and Controllers for Crane Work.

SOCIÉTÉ D'EXPLOITATION DES CÂBLES ÉLECTRIQUES
(SYSTEM BERTHOUD, BOREL and CO.)
**CORTAILLOD, SWITZERLAND.**

**PATENTED**
**LEAD-COVERED CABLES**
MANUFACTURED FOR
**TELEPHONE, TELEGRAPH,**
ELECTRIC LIGHT.

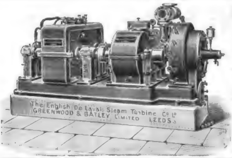
Special highly-insulated CABLES for High-Tension Alternate Currents,
As used at Vienna, Insbruck, Lucerne, Vevey, Montreux, Cologne, Monaco, &c.

CHICAGO: HIGHEST AND ONLY AWARD FOR TROLLEYS. DIPLOMA AND MEDAL FOR INSULATORS.
BRUSSELS: 1897, "HORS CONCOURS, MEMBRES DU JURY."

**ROBT. W. BLACKWELL & CO.,**
LIMITED,
ENGINEERS AND CONTRACTORS FOR
**ELECTRIC TRAMWAY CONSTRUCTION AND EQUIPMENT.**
POLES, TROLLEY-WIRE, FEEDERS, RAILBONDS, INSULATORS, TROLLEYS, MOTOR-TRUCKS, ENGINES, LINE MATERIAL and SUPPLIES
OF EVERY DESCRIPTION,

Telegrams: "Kurkee London
**59, CITY ROAD, LONDON, E.C.**
Codes: "A B C," "A 1," "Liebers, &c.
Telephones: 1479 & 1480 London Wal.

Digitized by Google

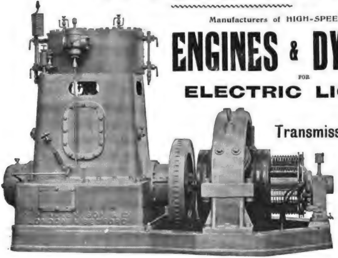

The English De Laval Steam Turbine Co Ld
GREENWOOD & BATLEY LIMITED LEEDS

# W. H. ALLEN, SON & Co., LIMITED

## QUEEN'S ENGINEERING WORKS, BEDFORD.

AND

27, OLD QUEEN STREET, WESTMINSTER, S.W.



Manufacturers of HIGH-SPEED ENCLOSED

## ENGINES & DYNAMOS

FOR

## ELECTRIC LIGHTING

AND

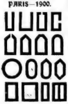
## Transmission of Power.

COMPLETE
INSTALLATIONS
CARRIED OUT.

**STANDARD SIZES of ENGINES from 10 to 1,000 Horse Power.**

---

Gold Medal,
PARIS—1900.



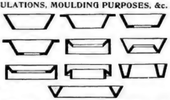
# MEIROWSKY & CO.,

WORKS:
KÖLN-EHRENFELD.

**MICA** in original BLOCKS or SHEETS or Cut to Shapes for COMMUTATORS, &c.

*MANUFACTURERS OF*

**MEGOMIT** in SHEETS for COMMUTATOR INSULATIONS, MOULDING PURPOSES, &c.



MICA COMMUTATOR RINGS and COLLARS
OF HIGH INSULATION RESISTANCE, GUARANTEED
not to Exude under Heat or Pressure

MICA INSULATION CHANNELS, TUBES,
TROUGHS, &c. MICA CLOTH & PAPER.

*SOLE AGENTS FOR UNITED KINGDOM:*

**GEORGE SCHULTZ & CO.,** 90, Cannon St., LONDON, E.C.

Telegraphic Address: Meirowsky London. Telephone No. 5031 Bank.

---

# LUNDBERG'S

Telegrams: "LUNDBERG LONDON." Telephone: 154 KING'S CROSS.

ELECTRIC LIGHT FITTINGS.

PIONEER ELECTRICAL WORKS,
477 to 487,
Liverpool Road,
LONDON, N.

REGD LEKTRIK TRADE MARK

---

# CHEMICALS

ALL KINDS for ELECTRICAL WORK, and also for INDIA RUBBER & CUTTA-PERCHA MANUFACTURERS.
BICHROMATES and BICHROMATE SALT for EXPORT.

**G. BOOR & CO.** 1 & 2, Artillery Lane, Bishopsgate, **LONDON, E.C.**

CONTRACTORS TO THE POST OFFICE WAR OFFICE, ADMIRALTY, INDIA AND NEW ZEALAND OFFICES AND LEADING TELEGRAPH COMPANIES.

THE

# ST. HELENS CABLE CO., L^TD

## WARRINGTON.

***Sole Makers and Patentees of–***

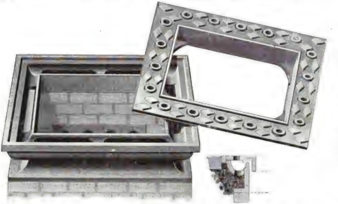
# H—

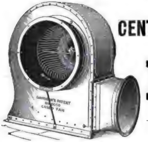
# DIA'S CABLES

TRADE MARK

**"Impregnable" Paper Cables, Lead Covered up to 3½in.**
**Vulcanised Bitumen Cables without Lead Covering.**
**Vulcanised Rubber Cables.**
**Flexibles, D.C.C., I.R. Wires.**
**N Rubber Tape.**
**Pure Rubber Tape.**
**Jointing Tape.**
**Rubber Goods for Electrical Purposes.**
**Steel Ropes.**
**Bare Copper.**
**Patent Trolley Wire.**

**WARRINGTON.**
**ST. HELENS.**
**32, VICTORIA STREET, WESTMINSTER, S.W.**
**Scottish Agency, 19, Waterloo Street, GLASGOW.**




DAVIDSON'S PATENT
SIROCCO
FAN


CASH
BILLS
NOTICE

# THE UNION CABLE CO., LTD

23, College Hill, Cannon Street, LONDON, E.C.

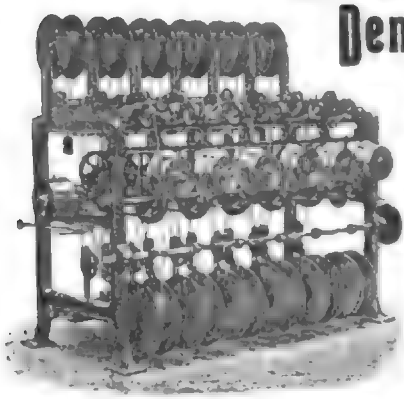
*Manufacturers of*

## VULCANISED CABLES AND WIRES

OF ALL CLASSES
FOR ALL PURPOSES.

Telegrams: "CABLEWELL." Telephone: 6100 BANK.

The BEST and MOST PERFECT WIRE-COATING MACHINE is



## Demuth Bros.' Automatic Wire-Coating Machine.

AWARDED, Exposition Universel Paris, 1900, 2 GOLD MEDALS.

*PATENTS:* GERMAN PATENTS, Nos. 107 and 116. AUSTRIAN PATENTS, Nos. 2,794, 2,795 and 3,040
GERMAN D. R. G. M. ENGLISH PATENT, No. 7,776.

## DEMUTH BROS.,

Foundry and Machine Works, **VIENNA**, Linzerstrasse 141-3, **AUSTRIA.**

SPECIALITIES: MACHINES for TWISTING WIRES, SINGLE TWIST and CABLE MACHINES for TWISTING and COATING WIRE CABLES, &c.

ALWAYS IN STOCK.

Wire Twisting Machines, Wire LAYING and COVERING Machines.
Indiarubber Covered Wire Twisting Machines. Armature Machines.

*Interchangeable Parts, as Spare Parts, in Stock. Installations for Wire Cable Manufacturers.*

**300 Machines supplied to the most important Factories.**

DEMUTH BROS. invite Correspondence, and hold Letters of Reference to many of the **first Firms in Europe using their Twisting and Wire Covering Machines**, and all up-to-date facilities for Wire Cable Manufacturers **of Guaranteed First-Class Workmanship.**

# LORD KELVIN'S PATENTS.

## Awarded the Grand Prix, Paris Exhibition, 1900.

## MULTICELLULAR ELECTROSTATIC VOLTMETERS.

FOR

HIGH AND LOW TENSION CIRCUITS.

## LARGE MARGIN OF SAFETY.

*Each Instrument is TESTED to DOUBLE its MAXIMUM SCALE READING before sending out.*

| | | | |
|---|---|---|---|
| Multicellular Electrostatic Voltmeter | Ranges | 20— 3,000 | Volts. |
| Dial Multicellular Electrostatic Voltmeter | " | 1,500— 10,000 | " |
| Volt Balance | " | 5,000—150,000 | " |

USE NO CURRENT.
HAVE NO TEMPERATURE ERROR.
UNAFFECTED BY STRAY FIELDS.
DEAD-BEAT ACTION.
CORRECT ON DIRECT OR ALTERNATING CIRCUIT.
GUARANTEED ACCURACY.

SOLE MAKERS:

## KELVIN & JAMES WHITE, Ltd.,

16 to 20, Cambridge St., GLASGOW.
66, Victoria Street, LONDON.

Digitized by Google

**DIATRINE PAPER INSULATED.**

# GLOVER'S CABLES.

**Trafford Park,** **MANCHESTER.**

---

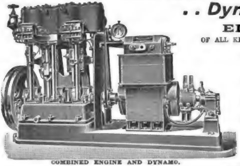
# CLARKE, CHAPMAN & CO., Ltd.,

**Specialities:** ***ELECTRICAL ENGINEERS.***

## MULTIPHASE ALTERNATORS AND MOTORS.

FOR POWER TRANSMISSION.

**DIRECT-COUPLED ENGINES & DYNAMOS.**



COMBINED ENGINE AND DYNAMO.

***. . Dynamos and Motors . .***

**ELECTRIC CRANES.**

OF ALL KINDS AND SIZES, WITH ONE OR THREE MOTORS.

**ELECTRIC WINCHES, CAPSTANS, DRILLS, &c.**

**PROJECTORS, LAMPS, MIRRORS and LENSES.**

**ELECTRIC LIGHT and POWER INSTALLATIONS of all kinds.**

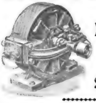
**RESTLER'S PATENT HIGH-SPEED ENGINE**

## GATESHEAD-ON-TYNE.

---

# CRYPTO MOTORS

AND



**DYNAMOS.**

**TRANSFORMERS.**

Small Alternators.

## CRYPTO WORKS CO., L^TD.

29, Clerkenwell Road, LONDON, E.C.
Telegrams: "COMMUTATOR LONDON."

---

# Jules RICHARD (Late RICHARD FRÈRES)

— PARIS —

Electric Measuring Instruments.

AMMETERS,
VOLTMETERS,
WATTMETERS,
SELF-RECORDING and INDICATING.

Self-Recording and other Instruments for all Scientific and Industrial Purposes.

Samples and Stock at **JOSEPH LEVI & CO.,** Sole Wholesale Agents.
97, Hatton Garden, LONDON, E.C.
*Formerly 40, Furnival Street, Holborn.*
Telegraphic Address: "Leviathan London." Telephone No 1801 Holborn

# THE "DESRUMAUX"

## - - AUTOMATIC - -

# WATER SOFTENER & PURIFIER.

## 3,000 Installations in Active Operation, Purifying upwards of 250 Million Gallons per day,

INCLUDING :—

The Corporation of Weston-Super-Mare.

The Corporation of Hull.

The Bournemouth & District Electric Supply Co.

The Swansea United Breweries, Ltd.

Messrs. J. Dickenson & Sons, Ltd., Watford.

Sir Titus Salt, Bart., Sons & Co, Ltd., Saltaire.

Messrs. Thornton, Hannam & Marshall, Brighouse.
*(Branch of the Bradford Dyers' Association.)*

Messrs. G. Root & Co., Shipley.
*(Branch of the Yorkshire Woolcombers' Association.)*

Messrs. Smith, Stone & Knight, Ltd., Birmingham.

Messrs. John Holdsworth & Co., Halifax.

The Electrical Power Distribution Company.

The Arlington Laundry, London.

Isle of Thanet Light Railway.

The Tower Oil Co., Ltd., Hull.

The Railways of England.
,, ,, France.
,, ,, Germany.
,, ,, Italy.
,, ,, Austria.
,, ,, Russia.
,, ,, Spain.

Jaffa to Jerusalem Railway, Asia Minor.

Railway of Vladi Kavkaz, Russia.

The French Admiralty.

The French Ministerial Department.

The German Emperor } Royal
The Austrian Emperor } Palaces.

Messrs. F. Krupp & Co., Essen, Germany (14 Installations).

The Berlin Electricity Company (16 Installations)

Thomson-Houston Company, Seine.

Ville de Paris.

Tramways of Marseilles.

Registered Offices:

## 23, CHEAPSIDE, BRADFORD.

Telegrams: "Purifier Bradford." Telephone: 1899.

London Offices:

## 5, QUEEN VICTORIA ST., E.C.

Telegrams: "Desrumaux London." Telephone: 6074 Bank.

# THE BEST.

## STANDARD INSULATING VARNISH

**RESISTS**
- HIGH TEMPERATURES,
- ACTION OF WATER,
- LUBRICATING OIL.

**REDUCES** FERMENTATION AND CORROSION TO A MINIMUM.

TRADE MARK GUTTA PERCHA

HAS
HIGHEST INSULATING
PROPERTIES.

Apply for Prices and Particulars to

## PINCHIN, JOHNSON & CO., Ltd.,

*Pinchin's Wharf, Ratcliffe, LONDON, E.*

---

OKONITE
TRADE MARK

## OKONITE

Tapes & Cables

## MANSON

TAPES

Are Best, Most Durable, and Well Tried.

EUROPEAN AGENTS:

## GEIPEL & LANGE,

Parliament Mansions, WESTMINSTER, S.W.
Telegrams "PATELLA LONDON"

---

Telegraphic Address: "MANAGEMENT LONDON." Telephone No. 152 AVENUE.

## W. J. DAVY ARC LAMPS,

The Pioneer of the Alternating Enclosed Arc Lamp.

***ONLY ADDRESS:***

## W. J. DAVY,

*3, Crown Court,*
*Old Broad Street.*

Works: 17, WHITE LION STREET, PENTONVILLE, LONDON, N.

---

---

## JOHNSON & PHILLIPS

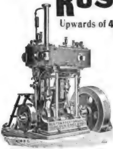
14, UNION COURT, OLD BROAD STREET, E.C., and CHARLTON, KENT.

**MAKERS** of the most Modern Machines for

| | |
|---|---|
| CABLE MAKING | CABLE LAYING |
| STRANDING | BRAIDING |
| TAPING | WINDING |
| COMPOUNDING | LAPPING |

RUBBER, SILK & COTTON COVERING

**RUSTON, PROCTOR & CO.,** Limited,



Upwards of **48,000** Engines and Boilers
MADE AND SOLD.

**Paris, 1900**

The Grand Prix.
Two Gold Medals.
Three Silver Medals.

CATALOGUES
FREE.
Please quote this paper

**LINCOLN, England,**
And at 27a, CANNON STREET,
LONDON, E.C.

**KABELFABRIK ACTIEN-GESELLSCHAFT**

*WORKS:* VIENNA (AUSTRIA) and
PRESSBURG (HUNGARY).

General Offices :—
VIENNA 13/2.

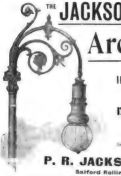
*Sole Agent for the United Kingdom :—*

JAMES LITTAUER
4, Cross St., Finsbury,
**LONDON, E.C.**

**K. A. G.**
STANDARD QUALITY
***CABLES and WIRES.***

Prompt delivery from London Stock. **Prices on Application.**

THE **JACKSON-MENSING**
Arc Lamps



FOR
INDOOR or OUTDOOR
LIGHTING.

Mechanically and
Electrically Perfect.

*Send for New Pocket Price List to the Sole Makers:*

**P. R. JACKSON & CO., Ltd.,**
Salford Rolling Mills, MANCHESTER.

**ELECTRIC WIRE CASINGS.**

BLOCKS, CLEATS, BOARDS *for* SWITCHES
In Stock and Made to Any Design.
ACCUMULATOR CASES,
BATTERY BOXES, &c.,
MADE TO ORDER ON SHORTEST NOTICE.

**J. F. & G. HARRIS,**
TIMBER MERCHANTS AND MOULDING MANUFACTURERS,

YARDS and MILLS
58F, WILSON STREET, FINSBURY, E.C.
42, ORANGE ST., Gravel Lane, SOUTHWARK, S.E.
PALMER RD., Green St. BETHNAL GREEN, N.E.
LONDON.
Telephone No. 1168 LONDON WALL.
*Please Write for Latest Illustrated Price Lists.*

**SUN** ***BEST QUALITY.***
**ELECTRIC**
***MODERATE PRICE.*** **FANS**

SUN FAN CO., Ld., 4a, Thornton Road, BRADFORD.
LONDON.—6a, Billiter Buildings, Leadenhall Street, E.C.
GLASGOW.—65, Waterloo St. MANCHESTER.—82, Deansgate Arcade.
*FULL PARTICULARS ON APPLICATION.*

THE
**NEW BROTHERTON TUBE CO.,**
Limited,
Commercial Road, WOLVERHAMPTON.

ENAMELLED STEEL
**CONDUIT TUBES**
AND
**FITTINGS**
**For Electric Wiring.**
*LONDON STOCK kept at 66, VICTORIA ST., WESTMINSTER.*

Tubes and Fittings for Gas, Steam and Water.
Seamless Steel Tubes for Cycles. Handle Bars, Cycle Forks, &c.

Head Office and Works: **COMMERCIAL RD., WOLVERHAMPTON.**
London Office: 60, QUEEN VICTORIA ST.
Manchester Office: 16, DEANSGATE.
Coventry Office: 140, FOLESHILL RD.
Leicester Office: 80, RUTLAND ST.

Digitized by Google

# BELLISS & MORCOM LTD.

(SUCCESSORS TO G. E. BELLISS & CO., LTD.),

**LONDON OFFICE: 9, Victoria Street, S.W.** **ENGINEERS,** **BIRMINGHAM.**

## SPECIALITY: PATENT SELF-LUBRICATING QUICK-REVOLUTION ENGINES FOR ELECTRIC LIGHT, POWER OR TRACTION.

**OVER 190,000 H.P. SUPPLIED OR IN HAND FOR**

**MUNICIPAL AUTHORITIES (Lighting and Tramways)**—St. Pancras, Shrewsbury, Southampton, Bury, Croydon, Chester, Port Elizabeth (South Africa), Wolverhampton, Kingston-on-Thames, Bedford, Ayr, Cheltenham, Taunton, Leeds, Blackburn, Sunderland, Gibraltar, Belfast, Llandudno, Shoreditch, Edinburgh, Canterbury, Leith, Burnley, West Hartlepool, Bootle, Gloucester, Aberdeen, Coventry, Worcester, Rochdale, Darwen, Harrogate, Wakefield, Hammersmith, Woking, Newport, Battersea, Hampstead, Bournemouth, East London (South Africa), Cardiff, Buxton, Bloemfontein (South Africa), Tynemouth, Hereford, Glasgow, Bury St. Edmunds, Hastings, Govan, Ealing, Stirling, Greenock, Beckenham, Hoylake and West Kirby, Middleton, Hackney, Grimsby, Southport, Halifax, Poplar, Birmingham.

**ELECTRIC SUPPLY COMPANIES (Lighting and Tramways)**—Charing Cross and Strand, Winchester, Reading, Guernsey, Carlow, Northampton, Hove, Oswestry, Electricity Supply Co. for Spain, Madrid; Windsor, Blackheath and Greenwich, Colombo, House-to-House Co., London; Crystal Palace, London; Bristol Tramways, London United Tramways, Queenstown Electric Tramways, Central London Railway, Ventnor, Bromley, Alderley Edge, Salisbury, Montrose, Brechin, Newcastle.

**TRACTION**—Waterloo and City Railway, Metropolitan and District Railway, Hull, Blackburn, Plymouth, Isle of Thanet Light Railways (Electric), Sunderland, Wolverhampton, Bury, Belfast, West Hartlepool, Bootle, Aberdeen, Rochdale, Darwen, Waterloo and Baker Street Railway, Great North of Scotland Railway, Tynemouth, East London (South Africa), Russian Railways.

Large numbers of these Self-Lubricating Engines have also been supplied to the British and other Governments, the principal Shipbuilding, Engineering and Steel Works in the United Kingdom, to Railway and Steamship Companies at home and abroad, and to many Public Institutions

**Established 1852.**

Telegraphic Address:
"BELLISS, BIRMINGHAM."

Representing our TEC/5 STANDARD ENGINE, 450 B.H.P.—*OVER 30 IN USE OF THIS SIZE ALONE*

# SUNDERLAND CORPORATION

## Electric Supply Station.

*The Official Figures of the Test at the above Station of*

# RANSOMES & RAPIER'S

# "TRIUMPH"

# STOKERS

***Will be sent on application to***

## RANSOMES & RAPIER, LTD.

39, Victoria St., London, S.W.

# MOVING COIL RECORDERS.

Run
1 or 7 DAYS
as required
WITHOUT
ATTENTION.

ABSOLUTELY
DEAD BEAT
THEREFORE
**BEST** FOR
TRACTION LOADS
OR
GAS ENGINE
PLANTS.

## EVERETT, EDGCUMBE & Co.

HEAD OFFICE AND WORKS:
22, CHARTERHOUSE SQUARE, E.C.
Telephone 1052 HOLBORN.
SHOW ROOMS:—
11, VICTORIA STREET, WESTMINSTER, S.W.

## TENDERS INVITED.

## TONBRIDGE URBAN DISTRICT COUNCIL.

### ELECTRICITY WORKS.

The Tonbridge Urban District Council are prepared to receive TENDERS for the SUPPLY and ERECTION of the following Plant for the Municipal Electricity Works:—

Section A.—BOILER HOUSE PLANT.
Two Lancashire Boilers and Accessories, Steam Pump, Injecter, and Economiser.
Section B.—ENGINE HOUSE PLANT.
Two 50kw. Steam Dynamos, Motor Transformer and Accessories.
Section C.—CONDENSING APPARATUS and PIPEWORK.
Section D.—OVERHEAD TRAVELLING CRANE.
Section E.—SWITCHBOARD and INSTRUMENTS.
Section F.—ACCUMULATORS.
Section G.—ELECTRICITY SUPPLY MAINS.
Section H.—PUBLIC ARC LIGHTING.
Section I.—HOUSE METERS.
Section K.—PUBLIC INCANDESCENT LIGHTING.

The whole bound up in one Specification.

Applicants must state for which Section or Sections they wish to Tender, in order that the requisite drawings may be forwarded to them.

Tenderers are at liberty to Tender for either Section but not for part of a Section.

Specification, with Terms and Conditions, and Forms of Tender, may be obtained by manufacturers at the Offices of Mr. Robert Hammond, M.Inst.C.E., the Consulting Engineer to the Council, 64, Victoria-street, Westminster, London, S.W., on and after Thursday, April, 25th, 1901, on payment of £5 5s., which sum will be refunded on the return of the Specification filled up with a bona-fide Tender. Extra copies of the Specification may be obtained by bona-fide tenderers at a charge of £5 5s. per copy, which sum also will be refunded on the return to the Engineer of each extra copy of the Specification. Tenders (sealed and marked "Tender for Electricity Works") must be addressed to me at The Castle, Tonbridge, and be delivered on or before 4 p.m. on THURSDAY, May 30th, 1901.

Each Tender must contain the names of two sureties who will be prepared to execute a joint and several Bond for the due performance of the Contract in the sum of 20 per cent. of the Contract amount.

The Committee do not bind themselves to accept the lowest or any Tender.

A. H. NEVE, Jun., Clerk to the Council.

Offices of the Council,
The Castle, Tonbridge, 10th April, 1901.

## COUNTY BOROUGH OF CARDIFF.

### ELECTRICAL TRAMWAYS DEPARTMENT.

CONTRACT No. 8.

The Cardiff Corporation invite TENDERS for the following **OVERHEAD LINE MATERIALS**:—

Section 1.—POLES, BASES, REFUGE PILLARS, &c.
Section 2.—BRACKETS.
Section 3.—FEEDER and SECTION PILLARS, &c.
Section 4.—TROLLEY and OTHER WIRE.
Section 5.—INSULATORS and LINE SUSPENSIONS.

Specifications and Form of Tenders may be obtained on application from the Engineer and Manager, Arthur Ellis, Esq., M.I.E.E., Old Post Office Buildings, Cardiff.

Sealed Tenders, endorsed "Section 8, Tramways," to be delivered on or before TUESDAY, April 30th.

By Order,
J. L. WHEATLEY, Town Clerk.

April 1, 1901.

## TENDERS INVITED—*continued.*

## CITY OF MANCHESTER.

### ELECTRICITY DEPARTMENT.

The Electricity Committee of the Manchester Corporation are prepared to receive TENDERS for the SUPPLY, DELIVERY and ERECTION at their Stuart-street Generating Station of the following:—

SPECIFICATION No. 1.—WATER-TUBE BOILERS.
SPECIFICATION No. 2.—PLANT of 15,000 I.H.P., in Generating and Sub-stations.
Sections A, B, and C.—STEAM ENGINES with CONDENSING and AUXILIARY PLANT.
Section D.—THREE-PHASE GENERATORS.
Section E.—MOTOR TRANSFORMERS.

Specifications, Drawings and Forms of Tender may be obtained on application to Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall, Manchester, on payment of the fee of £5 5s. for each Specification, which amount will be returned on receipt of a bona-fide Tender.

Specifications and Drawings may also be inspected (but not obtained) at the Offices of the Engineers, Messrs. Kennedy and Jenkin, 17, Victoria-street, Westminster, S.W.

Tenders, duly endorsed, and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall on or before TUESDAY, the 7th May proximo.

The Corporation do not bind themselves to accept the lowest or any Tender.

WM. HENRY TALBOT, Town Clerk.

Town Hall, Manchester, 9th April, 1901.

## BURGH OF MOTHERWELL.

### ELECTRICITY WORKS EXTENSIONS No. 2.

The Electric Light Committee of the Town Council invite TENDERS for the following:

CAST-IRON LAMP COLUMNS, ARC LAMPS, SWITCHES, FITTINGS, &c.

A copy of the Specification and Form of Tender may be obtained on application to the undersigned on payment of Two Guineas, which sum will be returned on receipt of a bona-fide Tender.

Sealed Tenders, endorsed "Electricity Supply Extension, Contract No. 2," must be sent in not later than 18th MAY, 1901, addressed to

JAMES BURNS, Town Clerk.

Motherwell, April, 1901.

**Contracts Open, Appointments Vacant, and other Official Notices, &c., can be received up to 7 p.m. on Thursdays for insertion in the current week's issue.**

## TENDERS INVITED—*continued.*

## CORPORATION OF MIDDLETON.

The Corporation of Middleton are prepared to receive TENDERS for the ERECTION of a **REFUSE DESTRUCTOR** to work in conjunction with their Electricity Works.

Firms desiring to tender may obtain further particulars and ground plan of Electricity Works from myself, and must be prepared to give a guarantee of the evaporative efficiency of their apparatus.

Tenders, accompanied by Plans and Specifications, addressed to the "Chairman, Destructor Committee," must be delivered at my office not later than SATURDAY, the 27th instant.

The Corporation do not bind themselves to accept the lowest or any Tender.

FREDERICK ENTWISTLE, Town Clerk.

Town Hall, Middleton, 12th April, 1901.

## GREAT EASTERN RAILWAY.

### CONTRACTS FOR STORES.

The Directors of this Company are prepared to receive TENDERS for the SUPPLY of STORES and MATERIALS, including :—

1. Galvanized Iron, Lead, Tin, &c.
2. Enamelled Iron Slips, Plates and Boards.
3. Cast Iron Pipes, Stoves, &c.
4. Bolts, Screws, Rivets.
5. Nails.
6. Tools, &c.
7. Hardware, Locks, &c.
8. Gas, Water, and Steam Pipes and Fittings.
9. Lamp and Carriage Fittings.
10. Tinwork.
11. Glass.
12. Colours, Drysalteries, &c.
13. Baskets, Woodwork, &c.
14. Brushes, Mats, &c.
15. Carpeting, Trimmings, &c.
16. Cotton Waste, Sponge Cloths, Wicking, Bunting, &c.
17. Telegraph Materials.
18. Canvas, Cordage, Floorcloth.
19. Leather, and India Rubber Feed Pipes.
20. Portland Cement, Slates, Drain Pipes, &c.
21. Stone.
22. Paper and Envelopes.
23. Stationary and Inks.

Forms of Tender may be had on application to the Secretary's Office, Liverpool-street Terminus, E.C., on and after the 30th April.

The Patterns may be seen at the Company's Stores, Stratford, between 10 a.m. and 4 p.m. from 30th April to 4th May and from the 6th to 11th May inclusive. The Company's patterns cannot be sent away for inspection.

Parties applying must state the particular contract or contracts for which they propose to tender,

Tenders endorsed "Tender for Stores" to be forwarded by post, in the envelope provided by the Company, to the undersigned so as to be received not later than 10 a.m. 14th May, 1901.

Tenders which do not comply in every respect with the Company's terms, conditions, schedules and specifications will not be considered.

The Directors do not bind themselves to accept the lowest or any Tender.

W. H. PEPERCORNE, Secretary.

Liverpool-street Terminus,
London, E.C., April, 1901.

## TENDERS INVITED—*continued.*

## BOROUGH OF ASHTON-UNDER-LYNE.

ELECTRICITY WORKS DEPARTMENT.

The Electricity Committee are prepared to receive TENDERS for

**TWO CONTINUOUS-CURRENT GENERATING UNITS**, each of 250 to 300 H.P. with **DOUBLE-ACTING ENCLOSED ENGINES.**

Copies of the Specification and Form of Tender can be obtained from the undersigned on payment of One Guinea, which will be returned on receipt of a bona-fide Tender.

Tenders must be delivered addressed to the Town Clerk, Ashton-under-Lyne, sealed and marked "Tender for Steam Dynamos," and must be received by him not later than 12 o'clock noon on MONDAY, April 29th, 1901.

The lowest or any Tender not necessarily accepted.

NEVILLE APPELBEE, Electrical Engineer.

Electricity Works, Ashton-under-Lyne.

## DUNDEE CITY TRAMWAYS.

ELECTRICAL ENGINEER'S DEPARTMENT.

### TENDERS FOR COPPER BONDS.

The Dundee Town Council are prepared to receive TENDERS for the supply of COPPER BONDS.

Specifications and Form of Tender may be had from Walter H. Tittensor, City Electrical Engineer, Dudhope Crescent-road, Dundee.

Tenders to be lodged with Sir Thomas Thornton, LL.D., Town Clerk, City Chambers, Dundee, not later than WEDNESDAY, May 1st, 1901, marked on the outside "Tenders for Copper Bonds."

The lowest or any Tender may not be accepted.

WALTER H. TITTENSOR, City Electrical Engineer.

Dundee, 17th April, 1901.

### INQUIRY.

WOULD anyone knowing ADDRESS of Mr. JOHN LAVENDER, Jun., Electrical Engineer, late with Mackenzie and Holland, Vulcan Iron Works, Worcester, communicate with his wife at "Peru Mount," 284A, Great Cheetham-street, Higher Broughton, Manchester.

## APPOINTMENTS VACANT.

### PARISH OF WILLESDEN.

**CONSULTING ELECTRICAL ENGINEER.**

The Guardians of the Poor require the services of a CONSULTING ELECTRICAL ENGINEER in connection with the preparation of plans, specifications and superintendence of the execution of an Electrical Light Installation at their New Infirmary (400 beds), Acton-lane, Willesden. The Guardians are prepared to pay the usual commission of 5 per cent. upon the total cost of the installation.

Applications for the appointment, accompanied by particulars of recent work, to be sent to me not later than TUESDAY, April 23rd, 1901.

By order,
J. HUTTON HAYLOR, Clerk to the Guardians.

Guardians' Offices, 320, High-road, Kilburn, N.W.
11th April, 1901.

### BOROUGH OF SUTTON COLDFIELD.

**APPOINTMENT OF ELECTRICAL ENGINEER.**

The Corporation of Sutton Coldfield are prepared to receive applications for the appointment of Resident Electrical Engineer. Applicants must have a thorough knowledge of the management of Electrical Supply Undertakings. The person appointed will be required to devote the whole of his time to the duties of the office and to act as Clerk of the Works, under the direction of the Consulting Engineer, during the construction of the Electricity Supply Works. Salary £200 per annum.

Applications, giving full particulars of past experience, accompanied by copies of not more than three recent testimonials, and endorsed "Electrical Engineer," to be sent to the undersigned not later than 25th APRIL, 1901.

Personal canvassing will disqualify.

THOS. V. HOLBECHE, Town Clerk.

Sutton Coldfield.

**J. W. BARNARD,**
Offices: 4, GREAT WINCHESTER ST., E.C.
Warehouse: 6, Great Winchester St., E.C.
(For Recharging and Repairs)
SOLE AGENT FOR
**E.P.S. SMALL STORAGE BATTERIES**
FOR Sale or Hire,
MANUFACTURED BY THE
ELECTRICAL POWER STORAGE CO., Ld.,
Battery Makers by appointment to H.M.

### THE EASTERN EXTENSION, AUSTRALASIA AND CHINA TELEGRAPH COMPANY (Limited).

NOTICE is Hereby Given that the FIFTY-FIFTH HALF-YEARLY ORDINARY GENERAL MEETING of this Company will be held on WEDNESDAY, the 24th day of APRIL, 1901, at 2.30 o'clock in the afternoon, at WINCHESTER HOUSE, 50, Old Broad-street, London, when the Report and Accounts for the Half-year ended 31st December, 1900, will be submitted, a dividend and bonus declared, and the ordinary business of the Company transacted.

And NOTICE is further Given that the REGISTER of TRANSFERS will be CLOSED from the 17th to the 24th APRIL, both days inclusive.

Dated this 13th day of April, 1901.

By order of the Board,
F. E. HESSE, Manager and Secretary.

Winchester House,
50, Old Broad-street, London, E.C.

### THE AFRICAN DIRECT TELEGRAPH COMPANY, LIMITED.

**FOUR PER CENT. MORTGAGE DEBENTURES.**

NOTICE is Hereby Given that in conformity with the conditions upon which the above issue was made the TENTH DRAWING for payment of these Debentures, 146 in number, will take place in the presence of a Notary Public of the City of London on WEDNESDAY, the 1st of May, at noon, at the Offices of the Company, WINCHESTER HOUSE, Old Broad-street, London, E.C.

By order,
H. E. PLANK, Secretary.

Winchester House, Old Broad-street,
London, E.C., 18th April, 1901.

### SUBMARINE CABLES TRUST.

NOTICE is Hereby Given that in accordance with the terms of the Trust Deed, THIRTY CERTIFICATES will be redeemed from the surplus funds of the Trust by a DRAWING which will take place on FRIDAY, the 26th April instant, at noon, at the Offices of the Trust, Room No 180, WINCHESTER HOUSE, 50, Old Broad-street, London, E.C., for payment at £120 per Certificate, on and after that day at the Banking House of Messrs. GLYN, MILLS & CO., 67, Lombard-street, London, E.C.

The Coupon of Reversion, which will be found attached to each Certificate, should however, be retained by the Holder of any Certificate which may be drawn.

Any Certificate Holder may be present at the Drawing.

By order of the Trustees,
SIDNEY COLLETT, Secretary.

Winchester House, E.C., 18th April, 1901.

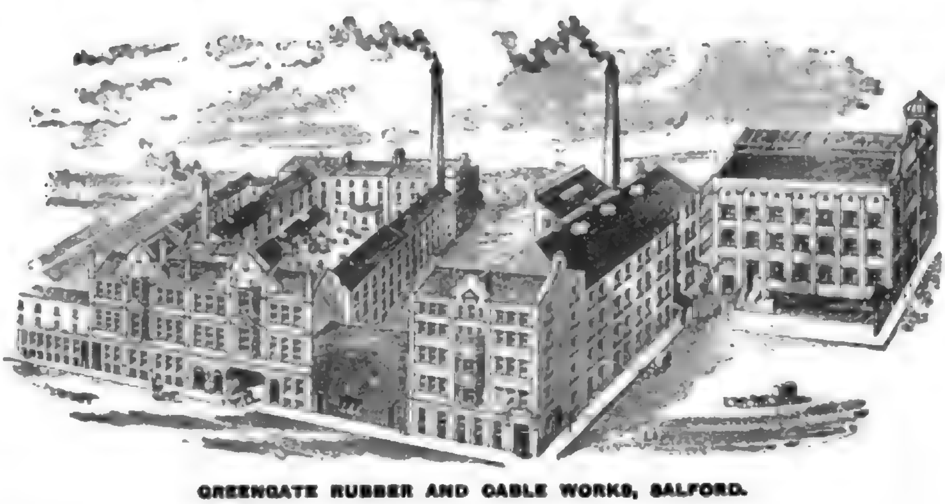
## PARTNERSHIP.

PARTNERSHIP.—An old-established firm of electrical engineers desire a PARTNER who is fully qualified to design and direct manufacture of continuous-current generators and motors. Will be required to invest capital, but the amount of investment not so essential as undoubted ability to design and direct as above. Strictest investigation both sides, principals or solicitors only. Address S. S., care of Messrs. R. F. White & Son, General Advertising Agents, 33, Fleet-street, E.C.

**VULCANISED INDIARUBBER**

# *Electric Light Cables.*

Supplied to Corporations, Electric Lighting Companies,



Engineers and Contractors.

GREENGATE RUBBER AND CABLE WORKS, SALFORD.

# I. FRANKENBURG. LTD., MANCHESTER.

**LONDON OFFICE:**
**128a, Queen Victoria St., E.C.**

**GLASGOW: Messrs. J. & A. ANDERSON, 62, Robertson St.,** Agents for Scotland.

**Large Stock.** **Prompt Delivery.**

Digitized by Google

## CHEAP PREPAID ADVERTISEMENTS

*relating to* **SITUATIONS VACANT AND WANTED, MISCELLANEOUS PLANT WANTED, FOR SALE, AND FOR EXCHANGE,** *are inserted in* "THE ELECTRICIAN" *at the following special low rates:*

| | |
|---|---|
| *Three Lines and under* ... ... ... ... | 1s. 6d. |
| *Per Line after* ... ... ... ... | 6d. |

Nine Words to the Line.

*Cash must accompany all orders for advertisements inserted at these rates; if inserted "to account" they will be charged full scale rate.*

## SITUATIONS VACANT AND WANTED, &c.

WANTED, an energetic young ELECTRICIAN as ASSISTANT in the Wiring and Fittings Department of a provincial public supply authority. Must be able and willing to canvass and estimate for Light and Power Installations, and to carry out same under supervision. Apply, stating age, experience and salary required, to W. F. C., *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, experienced DRAUGHTSMAN, capable of designing electrical machinery, including small motors. Quick and accurate at figures. Address, stating age, experience, and salary required, to DESIGN, care of Street's Agency, 30, Cornhill, E.C.

WANTED, WORKING CHARGE-HAND capable of taking charge of wiremen on marine electric light installations in large shipyard under superintendent. Must have considerable experience in single wiring and have held similar position with responsible firm. Apply, stating fully, qualifications and wages, to W. H. ALLEN, SON & CO., Ltd., Queen's Engineering Works, Bedford.

ELECTRIC TRACTION.—The British Electric Traction Company are prepared to admit a limited number of qualified electrical students as PUPILS to pass through the various departments of the business. Particulars as to premium and otherwise on application to the SECRETARY Donington House, Norfolk Street, Strand.

SWITCHBOARD ATTENDANT WANTED for large continuous current plant. Apply, stating experience, and wages required, to 4,296, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, by Electrical Specialities Merchants, TYPEWRITER (male) having knowledge of Electrical business.—Apply, full particulars, experience, age, salary, to 3,981, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, young IMPROVER, quick at figures, to assist Mains Superintendent in well-known Cable Company, small salary.—Apply, by letter, to A. B., *Electrician* Office, Salisbury-court, Fleet-street, London.

B.Sc., M.A., with honours in Mathematics and Natural Philosophy, having knowledge of Applied Electricity, desires APPOINTMENT.—90,500 *Electrician* Office, Salisbury-court, Fleet-street, London.

MESSRS. JOHNSON & PHILLIPS, Old Charlton, Kent, are prepared to appoint AGENTS for the sale of electrical goods in Northampton, Norwich, Plymouth, Cork, Isle of Man, Liverpool, Reading, Brighton, Barrow and North Wales. Preference will be given to those having technical knowledge and existing business connections.

FIRST-CLASS GERMAN FIRM wants active REPRESENTATIVE for their Stranding and all kinds of Cable Covering Machines.—Apply, 3,983, *Electrician* Office, Salisbury-court, Fleet-street, London.

**IMPORTANT TO MANUFACTURERS.**

AN enterprising ITALIAN FIRM having head offices in Rome and a good connection, desires to REPRESENT BRITISH MANUFACTURERS of AUTOMOTORS, CYCLES, ELECTRICAL MACHINERY, FITTINGS and APPLIANCES, AUTOMATIC CONTRIVANCES, &c. Where desirable consignments will be received for sale and proper securities given. New useful patents bought or agency for undertaken. Satisfactory references. Apply, in first instance, to F. V., care of Messrs. Lazarus & Rosenfeld, 3 and 4, Bevis Marks, St. Mary Axe, E.C., London.

## SECONDHAND
# ELECTRICAL MACHINERY.

Messrs. THOMPSON, SON & CO., of New York, have a LARGE QUANTITY of

***DYNAMOS, MOTORS, SWITCHES, ARC LAMPS, ENGINES, BOILERS, &c., &c.,***

in Stock, of Standard makes, for Immediate Delivery.

*COMPLETE EQUIPMENT FOR ELECTRIC LIGHTING PLANTS OR STREET RAILWAY SERVICE.*

Write for Catalogue and particulars to—

**W. H. MERRIMAN,** 39, Victoria St., LONDON, S.W.

## ELECTRICAL ENGINEERING TAUGHT BY MAIL

Thousands are successful and gaining better positions and salaries studying at home by our mail system. We teach Electrical Engineering, Mechanical Engineering, Mechanical Drawing, Electric Lighting, Electric Railways. Short Popular Electrical Course, Elementary Mathematics, &c., by mail. Study in spare time only. Institute endorsed by Thomas A. Edison and other prominent men of U. S. and England. Catalogue free.

Electrical Engineer Institute of Correspondence Instruction, Dept. 8, 240 to 242, West 23rd-st., New York, U.S.A.

## KING'S COLLEGE, LONDON.

ELECTRICAL ENGINEERING. The SPECIAL EVENING COURSE of LECTURES and LABORATORY WORK on ALTERNATING CURRENTS commences APRIL 29th. For Prospectus apply to the SECRETARY.

***Specially-prepared Copyright Lists***

OF

# NAMES AND ADDRESSES

OF

## MEMBERS OF THE ELECTRICAL AND ALLIED PROFESSIONS AND INDUSTRY

AND

**Chief Officials of Home and Foreign Government Works Departments; British Railways and Tramways Undertakings; Municipal Lighting, Tramways and Telephone Committees; Technical Training Institutions; Societies and Institutions; and the Chief Technical and Trade Journals,**

ARE

# NOW READY.

THE LISTS HAVE BEEN CAREFULLY REVISED AND BROUGHT UP TO DATE TO MARCH, 1901.

*Full Particulars may be had on application to the Publisher of "The Electrician," Salisbury Court, Fleet Street, London.*

***Ready Shortly.***

The NEW EDITION of

## A POCKET BOOK OF ELECTRICAL ENGINEERING FORMULÆ.

**By W. GEIPEL and H. M. KILGOUR.**

**Over 800 pages. Price 7s. 6d. net.**

Prospectuses of the New Edition will be ready in a few days, and will be sent post free on application to the Publisher.

***In the Press.***

A HANDBOOK FOR

## THE ELECTRICAL LABORATORY AND TESTING ROOM.

**By Dr. J. A. FLEMING, M.A., F.R.S.,**

*Professor of Electrical Engineering at University College, London.*

This Handbook has been written especially to meet the requirements of Electrical Engineers in Supply Stations, Electrical Factories and Testing Rooms. The Book consists of a series of Chapters each describing the most approved and practical methods of conducting some one class of Electrical Measurements, such as those of Resistance, Electromotive Force, Current, Power, &c., &c. It does not contain merely an indiscriminate collection of Physical Laboratory processes without regard to suitability for Engineering Work. The Author has brought to its compilation a long practical experience of the methods described, and it will be found to be a digest of the best experience in Electrical Testing. The Book includes a Chapter on the Equipment of Electrical Laboratories and numerous Tables of Electrical Data, which will render it an essential addition to the library of every practical Electrician, Teacher, or Student.

"THE ELECTRICIAN" PRINTING & PUBLISHING CO., Limited, 1, 2 & 3, Salisbury Court, Fleet Street, London.

☛ Every Lamp bears the Company's Trade Mark **"BROCHIPEL."**

**THOROUGHLY RELIABLE, EFFICIENT and DURABLE.**

# BROCKIE-PELL

## PATENT

# ARC LAMPS

FOR

## TRAMWAY LIGHTING.

SEND FOR PRICES AND FULL PARTICULARS.

*OWNERS OF PATENTS and SOLE MAKERS:*

# BROCKIE-PELL ARC LAMP, Limited.

**60, WORSHIP STREET, LONDON, E.C.**

---

## PLANT, &c., FOR SALE.

ELECTRIC LIGHT PLANT FOR SALE.—Consisting of Best Crossley Petroleum Engine of 4 B.H.P., with fly-wheels, vapouriser pumps, and all other appliances. An excellent shunt-wound Dynamo, of approved make, 135 volts 30 amperes. A set of E.P.S. accumulators, 53 cells, with all necessary appliances. Handsome Switchboard, enamelled slate, and all necessary instruments and fittings, embracing a complete electric plant, quite new and in perfect condition. For price and other inquiries apply to H. W. PIERCE, Electrical Engineer, Trinity Square, Llandudno.

WATER POWER! WATER POWER!

WATER POWER, near London and on the Banks of the Thames.

TO BE SOLD by PRIVATE TREATY an exceedingly valuable and important FREEHOLD ESTATE, comprising about 90 acres of most productive meadow land, with very extensive river frontage and close to the London and South Western Railway. There is also a magnificent private river of almost unlimited water power. The property presents most eligible sites for building or for the erection of works. Possession can be had immediately. Apply by letter to X., care of Mr. Botting, Chertsey, Surrey.

## WANTED and FOR SALE.

WANTED, a small ALTERNATOR, 25kw. to 30kw., belt or rope driven, frequency about 83. Machinery to be safe when run to give 100 ∿.—Particulars, stating type of machine, &c., to ALTERNATOR, *Electrician* Office, Salisbury-court, Fleet-street, London.

WANTED, a TEMPORARY IRON CHIMNEY STALK about 100 feet high by from 4ft. 6in. to 6ft. diameter. Address in first instance, giving price, date of delivery and other particulars, to T. C. R., *Electrician* Office, Salisbury-court, Fleet-street, London.

VULCANITE CELLS (150) new, height 10½ by 7 by 3¾, 2s. 6d. each; also quantity ditto, secondhand, various sizes; also several Motors, Dynamos, Drilling Machines, Switches, Accumulator Plates, Acid, &c. Bargains. Must be cleared.—REPOSITORY, 45, Broadway, Walham Green, London, W.

WANTED, LAMP TOPS, with Platinum, Scrap Platinum, &c.—EDEY & Co., 29, Ludgate-hill, London, E.C.

THE WATER POWER AGENCY.—Applications are invited at once from those requiring power of various amounts, up to **60,000 H.P.**—Apply SECRETARY, 212, West George-street, Glasgow.

ACCUMULATOR CHARGING.—C. H. CATHCART and CO., having plant specially adapted for this purpose, Charge Cells of all sizes promptly, thoroughly and cheaply. Terms on application. Accumulators on Hire for temporary lighting, experimental uses, &c.—3, Dorset-buildings, Salisbury-square, Fleet-street, E.C. (Telephone No. 200.)

---

**NAME**

ADDRESS TABLETS IN IVORY AND BONE

BRASS, COPPER, GERMAN SILVER, ZINC, LETTERS, ENGRAVED OR IN RELIEF.

TABLETS LETTERED FOR ALL PURPOSES

ENDOLITHIC MFG. C° LTD

61½ FORE ST. LONDON·E·C·

**PLATES.**

---

SHEETS RODS TUBES WASHERS VALVES

**FIBRE**

USED BY ELECTRICAL & GENERAL ENGINEERS BRASS FOUNDERS PLUMBERS &c

HARD. J. BURNS. 76, LITTLE BRITAIN, LONDON E.C. FLEXIBLE.

---

**LEHMANN BROTHERS** (Late T. Lehmann), *ORIGINAL MAKERS OF THE*

BRITISH ASSOCIATION STANDARD SCREW THREAD

In Taps, Dies, Screw Plates, Chasers, &c.

Hampshire Works, Station Rd.
(Near St. James St., G.E.R.),
WALTHAMSTOW, E.

*Our Latest Price List of B.A., Whitworth and Gas Taps, Dies, &c., free on application*

# WILLANS CENTRAL VALVE ENGINES

FOR

**Electric Lighting**

AND

**Traction.**

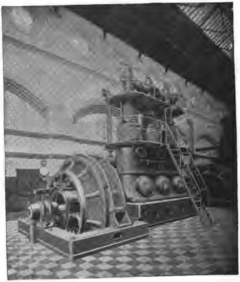
**15**

**1,200 H.P. SETS**

HAVE BEEN SUPPLIED FOR THE

LIVERPOOL
CORPORATION
TRAMWAYS.

***STANDARD SIZES UP TO 3,000 H.P.***



1,200 H.P. Set.

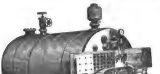
# WILLANS & ROBINSON, LTD., RUGBY, England.

---

# DAVEY, PAXMAN & CO., Ltd., Engineers, COLCHESTER.

MAKERS of a GREAT VARIETY of STEAM ENGINES and BOILERS.

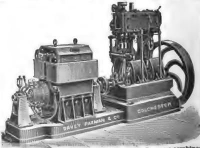
**SPECIALITY:** Steady Running Engines for Electric Lighting.



Paxman's Patent "Economical" Boiler, from 8 h.p. upwards.

This Boiler is one of the Best Steam Generators before the public, not only for Efficiency, but for Economy and Durability. It contains particularly good features and high qualities.

PAXMAN'S PATENT
AUTOMATIC EXPANSION GEAR
and
ADJUSTABLE GOVERNORS
Ensure a Steady and Constant Speed
in any emergency.



"Windsor" Vertical Compound Engine, with Dynamo combined made in all sizes.

Telegraphic Address: "PAXMAN COLCHESTER."

Catalogues and full particulars, with Photos and Prices, post free on application to

**DAVEY, PAXMAN & CO., Ltd., Engineers, Colchester.**
LONDON OFFICE—78, QUEEN VICTORIA STREET, E.C.

**ELECTRIC BELLS.**

**HAVE YOU SEEN OUR NEW LIST?** *FREE TO THE TRADE.*

---

**THE GENERAL ELECTRIC CO. (1900), Ltd.,**

Head Offices, Warehouses and Showrooms:

**69, 71, 88 & 92, Queen Victoria St., LONDON, E.C.**

BRANCHES:
Victoria Bridge, MANCHESTER.
71, Waterloo Street, GLASGOW.
56, Barwick Street, BIRMINGHAM.
13, Westgate Rd., NEWCASTLE-ON-TYNE.
16, St. Andrew's Street, DUBLIN.
East Wharf, St. Mary Street, CARDIFF.

WORKS:
Peel Works, Adelphi, SALFORD.
Sherlock Street, BIRMINGHAM.
Brook Green, HAMMERSMITH.
Union Street, SOUTHWARK.
CLERKENWELL.

REGᴰ TRADE MARK

Agents for Australia: LAWRENCE & HANSON, 3, Wynyard St., SYDNEY, and 167, Queen St., MELBOURNE.

---

**THE UNITED ASBESTOS Cº LIMITED,**

DOCK HOUSE,
**Billiter Street**
LONDON, E.C.

**PIONEERS OF THE ASBESTOS TRADE.**

"SALAMANDER" THE UNITED ASBESTOS COMPANY LIMITED LONDON TRADE MARK

**The ONLY COMPANY in the WORLD owning & working Asbestos Mines in both ITALY and CANADA.**

- FINE ASBESTOS PAPER, for Dynamos, &c.
- ASBESTOS TUBES and CEMENT, for Electric Light Leads.
- ASBESTOS FIRE-PROOF PAINT, for protecting woodwork, troughs for leads, &c.
- ASBESTOS MILLBOARD STRIPS, for ditto
- FINE ASBESTOS THREAD, for covering wires
- ASBESTOS COVERED WIRES.
- PATENT SALAMANDER LUBRICANT, for Dynamos, &c.
- PACKING, NON-CONDUCTING COVERING for Boilers, &c.

**All Goods are made at our Works, near London, and are of the best possible description.**

*Specify "SALAMANDER" Brand.*

Depots: NEWCASTLE-ON-TYNE, Quay Side. MANCHESTER, 34, Deansgate. LIVERPOOL, 33, James St. BRISTOL, Providentˡ Buildings Clare St. GLASGOW, 56, Bothwell Circus. HULL, Queen's Dock. ANTWERP, Rue Montevideo.

**"SALAMANDER" LUBRICATING OILS AND GREASES.**

These Lubricants are of the very Best Quality and are supplied to suit all conditions of working and climate.

---

**D. H. BONNELLA & SON, LTD.,**

58 & 60, MORTIMER STREET, LONDON, W.
Steam Works: 43, Kirby Street, Hatton Garden.
Telegrams: "Bondinello London." Telephone: 1882 Gerrard.

**IVORY, BONE, HORN & WOOD TURNERS.**

*MANUFACTURING ELECTRICIANS.*

**Bell Pushes, Indicators, Bells, &c.**

Wall Sockets, Pressel Switches, Fuse Boards. Name and Address Tablets.

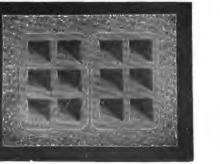
INCANDESCENT LAMPS. FLAME LAMPS A SPECIALITY.

---

**Doulton Conduits**

*For Underground Feeders in connection with*

**Electric Traction.**



DOULTON & CO., LIMITED.
LAMBETH, LONDON, S.E.

# CLASSIFIED TRADES' INDEX TO ADVERTISERS IN "THE ELECTRICIAN."

Advertisers are entitled to entries in this List FREE OF CHARGE according to the size and series of their Advertisements.

Additional entries are made at a low charge, particulars of which will be forwarded on application to "The Publisher."

Bold Type entries or additional matter can also be arranged for with the Publisher.

# Classified Index to Electrical Trades—*Continued.*

| | PAGE |
|---|---|
| **ENGINEERS AND CONTRACTORS.** | |
| Allen (W. H.), Son & Co., Bedford; and 27, Old Queen-st., Westminster, S.W. | 17 |
| Bellis and Morcom, Ledsam-street Works, Birmingham; and 9, Victoria-street, London, S.W. | 26 |
| Blackwell (R. W.) & Co., Ltd., 59, City-road, London, E.C. | 15 |
| British Thomson-Houston Co., 83, Cannon-street, London, E.C. | 3, 21 |
| British Westinghouse Electric and M'f'g Co., Westinghouse Building, Norfolk-street, Strand, London, W.C. | 41 |
| Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. | 45 |
| Chloride Electrical Storage Syndicate, 39, Victoria-street, London, S.W. | 12 |
| Clarke, Chapman & Co., Newcastle-on-Tyne, & 50, Fenchurch-st., London, E.C. | 12 |
| Crompton & Co., Mansion House-buildings, London, E.C.; and Chelmsford | 47 |
| Dick, Kerr & Co., 110, Cannon-street, London, E.C. | 9 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 6,7,8 |
| Electric Construction Co., Wolverhampton; and Dashwood House, Old Broad-street, London, E.C. | 5 |
| Elec. Power Storage Co., 4, Gt. Winchester-st., London, E.C.; and Millwall, E. | 54 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, E.C.; & Charlton, Kent | 1, 24 |
| National Electric Wiring Co., 34, Victoria-street, London, S.W. | 27 |
| Witting Bros. (Electricite and Hydraulique, Societe Anonyme), 49, Cannon-st., London, E.C. | 18 |
| **ENGINES.** | |
| Allen (W. H.), Son & Co., Bedford; and 27, Old Queen-st., Westminster, S.W | 17 |
| Bellis and Morcom, Ledsam-street Works, Birmingham; and 9, Victoria-street London, S.W. | 26 |
| Blackwell (R. W.) & Co., Ltd., 59, City-road, London, E.C. | 15 |
| British Westinghouse Electric and M'f'g Co., Westinghouse Building, Norfolk-street, Strand, London, W.C. | 41 |
| Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. | 45 |
| Clarke, Chapman & Co., Gateshead-on-Tyne; and 50, Fenchurch-street, London | 12 |
| Crossley Bros., Openshaw, Manchester; and 10, St. Bride-st., London, E.C. | 46 |
| Davey, Paxman & Co., Colchester; and 78, Queen Victoria-street, London, E.C. | 82 |
| Robey and Co., Globe Works, Lincoln; and 79, Queen Victoria-street, E.C. | 4 |
| Ruston, Proctor & Co., Lincoln, England | 25 |
| Shanks (A.) and Sons, Arbroath, Scotland; and Bush-lane House, Cannon-street, London | 41 |
| Willans and Robinson, Rugby | 32 |
| **ENGINE PACKING.** | |
| United Asbestos Company, Dock House, Billiter-street, London, E.C. | 33 |
| Willcox (W. H.) & Co., 23, Southwark-street, London, S.E. | 3 |
| **EXPANSION SHEETING AND RINGS.** | |
| United Asbestos Company, Dock House, Billiter-street, London, E.C. | 33 |
| **FANS.**—Davidson and Co., Sirocco Engineering Works, Belfast | 19 |
| Sun Fan Co., 4A, Thornton-road, Bradford; and London, Manchester and Glasgow | 25 |
| **FIBRE** | |
| Burns, J., 76, Little Britain, London, E.C. | 30 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1,18 |
| **FITTINGS FOR ELECTRIC LIGHT.** | |
| Benham and Froud, 40-42, Chandos-street, Strand, London, W.C. | 8 |
| Dorman and Smith, Salford, Manchester; and London and Glasgow | 35 |
| Edison and Swan United Electric Light Company, Ediswan Buildings, 36-37 Queen-street, London, E.C., and Branches | 1, 38 |
| Evered and Co., 27-35, Drury-lane, London, W.C.; and Birmingham | 13 |
| General Electric Co., 69, 71, & 88, Queen Victoria-st., London, E.C., & Salford | 33 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London; & Charlton, Kent | 1, 24 |
| Lundberg, A. P., Pioneer Electrical Works, 477-489, Liverpool-road, London, N. | 17 |
| Macfarlane (W.) & Co., Saracen Foundry, Glasgow | 41 |
| New Brotherton Tube Co., Commercial-road, Wolverhampton | 25 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| **FLUORESCENT SCREENS.** | |
| Cossor, 67, Farringdon-road, London, E.C. | 41 |
| **FUSES.**—Edison & Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| General Electric Co., 69, 71, & 88, Queen Victoria-st., London, E.C., & Salford | 33 |
| **GENERATORS.** | |
| British Westinghouse Electric and M'f'g Co., Westinghouse Building, Norfolk-street, Strand, London, W.C. | 41 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Witting Bros. (Electricite and Hydraulique, Societe Anonyme), 9, Cannon-st, London, E.C. | 15 |
| **GAS LIGHTERS (ELECTRIC).** | |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| General Electric Co., 69, 71, & 88, Queen Victoria-st., London, E.C., & Salford | 23 |
| **GLOBES AND SHADES.** | |
| Dorman and Smith, Manchester; and London and Glasgow | 35 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 6,7,8 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Evered and Co., 27-35, Drury-lane, London, W.C.; and Birmingham | 13 |
| General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C., & Salford | 33 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, & Charlton, Kent | 1, 24 |
| **HYDROMETERS.**—Edison and Swan United Electric Light Co., Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| **INDIA RUBBER.** | |
| Harburg India Rubber C. Co. (F. Winter), 8, Redcross-street, London, E.C. | 45 |
| St. Helens Cable Co., Warrington & St. Helens, & 32, Victoria-st., London, S.W. | 18 |
| **INSTRUMENTS.** | |
| Berend (O.) & Co., Dunedin House, Basinghall-avenue, London, E.C. | 40 |
| Crompton and Co., Mansion House-buildings, London, E.C., and Chelmsford | 47 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Electrical Company, 122-124, Charing Cross-road, London, W.C. Fittings Department: 162, Shaftesbury-avenue, London, W.C. | 37 |
| Elliott Brothers, Century Works, Lewisham, and 101, St. Martin's-lane, London | 36 |
| Ericsson (L. M.) & Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 16 |
| Everett, Edgcumbe & Co., 22, Charterhouse-square, London, E.C. | 26 |
| Evershed and Vignoles, Woodfield Works, Harrow-road, London, W. | 28 |
| General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C.; & Salford | 33 |
| Johnson and Phillips, 14, Union-ct., Old Broad-st., London, & Charlton, Kent | 1, 24 |
| Kelvin and James White, 16-20, Cambridge-street, Glasgow | 20 |
| Paul, R. W., 44, Hatton-garden, and Great Saffron-hill, London, E.C. | 28 |
| Pitkin, J., 56, Red Lion-street, Clerkenwell, London, E.C. | 28 |
| Richard Jules, Paris—Agents: Levi (J.) & Co., 97, Hatton-garden, London, E.C. | 21 |
| Scientific Instrument Company, Cambridge | 21 |
| Stanley, W. F., Great Turnstile, Holborn, London, E.C. | 27 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| **INSULATORS.** | |
| Blackwell (R. W.) & Co., Ltd., 59, City-road, London, E.C. | 15 |
| Doulton and Co., Lambeth Pottery, London, S.E. | 27, 33 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, E.C., and Branches | 1, 38 |
| General Electric Co., 69, 71, & 88, Queen Victoria-st., London, E.C.; & Salford | 33 |
| Henley's (W.T.) Tel. Works Co., 27, Martin's-ln., Cannon-st., Lon., & N. Woolwich | [illegible] |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent | 1, 24 |
| Stiff (J.) and Sons London Potteries, Lambeth, London, S.E. | 2 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| **INSULATING MATERIAL.** | |
| Blackwell (R. W.) and Co., Ltd., 59, City-road, London, E.C. | 15 |
| Burns, J., 76, Little Britain, London, E.C. | 30 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, E.C., and Branches | 1, 38 |
| Pinchin, Johnson and Co., Pinchin's Wharf, Ratcliffe, London, E. | 21 |
| Willesden Paper and Canvas Works, Willesden Junction, London, N.W. | 3 |
| **LAMPS.** | |
| Berend (O.) & Co., Dunedin House, Basinghall-avenue, London, E.C. | 40 |
| Blackwell (R. W.) and Co., Ltd., 59, City-road, London, E.C. | 15 |
| Bonnella (D. H.) and Son, Ltd., 58 and 60, Mortimer street, London, W. | 23 |
| British Thomson-Houston Co., 83, Cannon-street, London, E.C. | 3, 31 |
| Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. | 45 |
| Cossor, 67, Farringdon-road, London, E.C. | 44 |
| Crompton and Co., Mansion House-buildings, London, E.C.; and Chelmsford | 47 |
| Davy, W. J., 3, Crown-court, Old Broad-street, E.C. | 21 |
| Dorman and Smith, Manchester; and London and Glasgow | 35 |
| Drake and Gorham, 66, Victoria-street, Westminster, London, S.W. | 6,7,8 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, E.C.; and Branches | 1, 38 |
| Electrical Co., 122-124, Charing Cross-road, London, W.C. Fittings Department: 162, Shaftesbury-avenue, London, W.C. | 37 |
| Electric Construction Company, Wolverhampton; and Dashwood House, Old Broad-street, London, E.C. | 5 |

# THE ELECTRICAL CO., L^TD.

***122 and 124, CHARING CROSS ROAD, LONDON, W.C.***

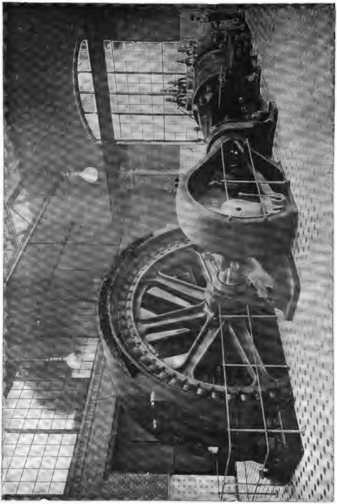
Telegraphic Address: "GALVANOSCOPE." Telephone No. 5028 GERRARD

CONTRACTORS TO H.M. GOVERNMENT.

**LIGHTING, POWER, TRACTION & CENTRAL STATION PLANTS.**

***PARIS EXHIBITION, 1900. HIGHEST AWARD FOR OUR GOODS.***

## 6 GRANDS PRIX.



**DYNAMOS** and **MOTORS** for EVERY CLASS of WORK, and for DIRECT or THREE-PHASE CURRENT CIRCUITS.

ANNUAL OUTPUT, **17,000** MACHINES, **154,000** KILOWATTS.

REFERENCES AS TO MACHINES SUPPLIED ON APPLICATION. ADVICE AND ESTIMATES FREE OF CHARGE.

Showrooms for Electric Fittings: 162, SHAFTESBURY AVENUE, LONDON, W.C.

**MANCHESTER BRANCH:**
21, CORN EXCHANGE BUILDINGS, FENNEL STREET.
Telephone No. 4358 CENTRAL.
Telegraphic Address: "CIRCUIT MANCHESTER."

**SOUTH COAST BRANCH:**
134, NORTH STREET, BRIGHTON.
Telephone No. 05986.

# EDISWAN

## DURABLE.

ABSOLUTELY RELIABLE, Every Lamp being CAREFULLY TESTED.

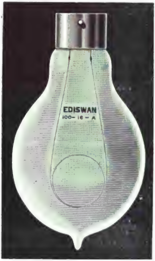
◆

EQUALITY of LIGHT throughout the LIFE of the LAMP.

◆

Noted for Economy in the Consumption of Current.

**Large Stocks.**



STANDARD LAMP.
*100 VOLTS, 16 C.P. FULL SIZE*

***All other Lamps which claim either made in accordance SWAN Patents, or in close***

***WHY*** *IS THE*

***EDIS***

**so JUSTLY**

***BECAUSE***

BEST AND CHEA

**Contractors to:—The Admiralty, War Office, Royal Arsenal, Post Office, India Office.**

**Provincial Depots, Sale and Showrooms:**

BIRMINGHAM:—International Exchange Buildings, Edmund Street.
BELFAST:—134, Royal Avenue.
CARDIFF:—Westgate Street.
DUBLIN:—12, Dawson Street.
DUNDEE:—17, Castle Street.
GLASGOW:—153, West George Street.

**Head Offices, Warehouse,**

The Edison & Swan United Electric Light Co., Ltd.,

***Works:*****—PONDER'S END, MIDDLESEX; SELBORNE WORKS, WALSALL;**

# LAMPS

***to be of First Quality are with the* EDISON *or the imitation of these inventions.***

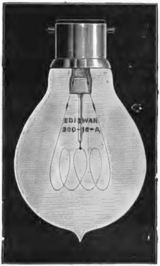
## ECONOMICAL.

## *WAN LAMP*

**WORLD RENOWNED ?**

***IT IS THE***

## PEST IN THE END



HIGH VOLTAGE LAMP.
*200 VOLTS, 16 C.P. FULL SIZE.*

Of Purely BRITISH MANUFACTURE.

Made in various Voltages and Candle Powers.

ACCURATELY MARKED.

**Immediate Delivery.**

**Contractors to:—The Colonial Governments, Railway and Steamship Companies, Corporations and Municipal Authorities.**

**Provincial Depots, Sale and Showrooms:**

HULL:—1, Grosvenor Buildings, Carr Lane.
LEEDS:—127, Albion Street.
LIVERPOOL:—11, St. George's Crescent.
MANCHESTER:—30, King Street.
NEWCASTLE-ON-TYNE:—38, Gray Street.

**and Showrooms:**

Ediswan Buildings, Queen Street, E.C.

**BROADHEATH, MANCHESTER; SOUTH BENWELL, NEWCASTLE-ON-TYNE.**

**NOVEL.**
**UNSURPASSED.**
**UNRIVALLED.**

FOR

## "PROMETHEUS"

# ELECTRIC

# RADIATORS

Write to

## O. BEREND & CO., L^TD

**Dunedin House,**
**Basinghall Avenue,** **LONDON, E.C.**

Telegrams: YTTRIUM LONDON.

OR TO

G. A. STEINTHAL, 41, PICCADILLY, BRADFORD.
*Sole Agent for—*
BRADFORD,
MANCHESTER,
HARROGATE.

OR TO

ERNEST G. CRAVEN, 37, QUEENSFERRY STREET
EDINBURGH.
*Sole Agent for—*
EDINBURGH.

## Classified Index to Electrical Trades—*Continued.*

PAGE

**LAMPS.**—*Continued.*
Electrical Transmission Co., Albert Works, Beavor-la., Hammersmith, London 2
Evered & Co., 27-35, Drury-lane, London, W.C.; and Birmingham 13
General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C. & Salford 33
Holmes (J. H.) and Co., Newcastle-on-Tyne, and 17, Soho-square, London, W. 4
Jackson (P. R.) & Co., Salford Rolling Mills, Manchester 25
Johnson & Phillips (Arc), 14, Union-ct., Old Broad-st., London; & Charlton, Kent ..1, 24
Zurich Incandescence Lamp Co., 47, Victoria-street, London, S.W. 36

**LAMPHOLDERS.**—Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Evered and Co., 27-35, Drury-lane, London, W.C.; and Birmingham 13
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 33

**LAMP PILLARS.**—Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 33
Macfarlane (W.) & Co., Saracen Foundry, Glasgow 41

**LIGHTNING CONDUCTORS.**
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 33
Johnson & Phillips, 14, Union-ct., Old Broad-st., London; & Charlton, Kent .. 1, 24

**LUBRICANTS.**
Willcox (W. H.) and Co., 23, Southwark-street, London, S.E. 3

**MANUFACTURING ELECTRICIANS.**
Dorman and Smith, Salford, Manchester; and London and Glasgow 35
Drake and Gorham, 66, Victoria-street, London, S.W. 6, 7, 8
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Ericsson (L. M.) & Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg 16
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C.; & Salford 33
Henley's (W. T.) Tel. Works Co., 27, Martin's-lane, London, and N. Woolwich 1
Johnson & Phillips, 14, Union-ct., Old Broad-st., London; & Charlton, Kent ..1, 24
Telegraph Manufacturing Company, Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow and Belfast 1

**METERS (Electricity).**
British Thomson-Houston Co., 83, Cannon-street, London, E.C. 3, 21
British Westinghouse Electric and M'f'g Co., Westinghouse Building, Norfolk-street, Strand, London, W.C. 44
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 33
Johnson & Phillips, 14, Union-ct., Old Broad-st., London; Charlton, & Kent ..1, 24

**MICA.**—Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Sanders, Wake and Co., 23, Great St. Helens, London, E.C. 2
Schultz (G.) & Co., 90, Cannon street, London, E.C. 3
Tully and Straker, 16, Water-lane, Gt. Tower-street, London, E.C. 44

**MICROPHONES.**
Consolidated Telephone Construction & Manufacturing Company, 28, Victoria-street, Westminster, S.W.; and Coventry, England 19
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Ericsson (L. M.) & Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St Petersburg 16
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 33

**MOTOR-SPEED REGULATORS, &c.**
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Geipel and Lange, Parliament-mansions, Westminster, S.W. 24

**MOTORS (Electric).** PAGE
British Thomson-Houston Co., 83, Cannon-street, London, E.C. 3, 14
British Westinghouse Electric and M'f'g. Co., Westinghouse Building, Norfolk-street, Strand, London, W.C. 44
Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. 45
Crompton & Co., Mansion House-buildings, London, E.C.; and Chelmsford 47
Crypto Works Co., 29, Clerkenwell-road, London, E.C. 21
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Electric Construction Co., Wolverhampton; and Dashwood House, Old Broad-street, London, E.C. 5
Electrical Co., 122, and 124, Charing Cross-road, London, W.C. Fittings Department: 102, Shaftesbury-avenue, London, W.C. 37
General Electric Co., 69, 71 & 88, Queen Victoria-st., London, E.C., and Salford 33
Holmes (J. H.) & Co., Newcastle-on-Tyne; and 17 Soho-square, London, W. 4
Johnson and Phillips, 14, Union-ct., Old Broad-st., London; & Charlton, Kent 1, 24
Langdon-Davies Electric Motor Co., 101, Southwark-street, London, S.E. 3
Newton Electrical Works, Taunton, England 2
Witting Bros. (Electricite and Hydraulique Societe Anonyme), 49, Cannon-street London, E.C. 15

**NON-CONDUCTING COMPOSITION.**
United Asbestos Co., Dock House, Billiter-street, London E.C. 31

**NON-MAGNETISABLE WATCHES.**
Smith (S.) and Son, 9, Strand London, W.C. 43

**OIL CANS.**
Kaye (Jos.) and Sons, Lock Works, Leeds, and 93, High Holborn, London 41
Willcox (W. H.) and Co., 23, Southwark-street, London, S.E. 3

**OIL FILTERS.**
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C.; & Salford 33

**OIL SEPARATORS.**
Baker's Patent Appliances Co., 13, Huntriss-row, Scarborough 13

**"OILLESS" TROLLEY BUSHES AND WHEELS.**
Fleming, Birkby & Goodall, Woodfield Works, Liversedge Yorks 2

**PAINTS, &c.**—Indestructible Paint Co., 31, Cannon-street, London, E.C. 43

**PATENT AGENTS.**—Chapman (J. C.) & Co., 70, Chancery-lane, London, W.C. —
Lorrain (J. G.), Norfolk House, Norfolk-street, Strand, W.C. 41

**PUMPS.**
Allen (W. H.) Son & Co., Bedford; and 27, Old Queen-st., Westminster, S.W. 17
Belliss & Morcom, Ledsam-st. Works, Birmingham; and 9, Victoria-street, London, S.W. 26
Blackwell (R. W.) and Co., Ltd., 59, City-road, London, E.C. 15
Merryweather & Sons, 63, Long-acre, London, W.C. 21
Willcox (W. H.) and Co., 23, Southwark-street, London, S.E. 3

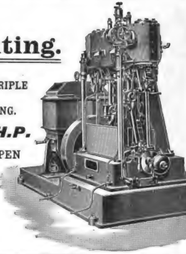
**REFLECTORS.**
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38

**RHEOSTATS.**
Geipel & Lange, Parliament-mansions, Westminster, S.W. 24

**SCREWS, TERMINALS, &c.**
Automatic Standard Screw Co., Halifax 35
Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
Lehmann Bros., Hampshire Works, Station-road, Walthamstow 30
Smithson (G. R.) & Co., Cannock-road Works, Wolverhampton 2

**SOCKETS.**—Edison & Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches 1, 38
General Electric Co., 69, 71 and 88, Queen Victoria-st., London, E.C., & Salford 33

**STAMPING AND PIERCING.**
Schultz (G.) & Co., 90, Cannon-street, London, E.C. 3
Smithson (G. R.) & Co., Cannock-road Works, Wolverhampton 2



## Classified Index to Electrical Trades—*Continued.*

| | PAGE |
|---|---|
| **STEEL MAGNET CASTINGS.** | |
| Schultz (G.) & Co., 90, Cannon-street, London, E.C. | 3 |
| **STOKERS (MECHANICAL).** | |
| Ransomes and Rapier, 39, Victoria-street, London, S.W. | 2 |
| **STONEWARE AND PORCELAIN.** | |
| Doulton and Co., Lambeth, London, S.E. | 27,31 |
| Stiff (J.) and Sons, The London Potteries, Lambeth, London, S.E. | 2 |
| **SUPPLIES FOR CABLE SHIPS.** | |
| Duncan, Wallet and Co., 114, Fenchurch-street, London, E.C. | 43 |
| Indestructible Paint Co., 31, Cannon-street, London, E.C. | 49 |
| Johnson and Phillips, 14, Union-ct., Old Broad-st., London; & Charlton, Kent | 1, 24 |
| **SWITCHES AND SWITCHBOARDS.** | |
| Berend (O.) & Co., Dunedin House, Basinghall-avenue, London, E.C. | 40 |
| Blackwell (R. W.) & Co., Ltd., 59, City-road, London, E.C. | 15 |
| British Westinghouse Electric and M'f'g Co., Westinghouse Building, Norfolk-street, Strand, London, W.C. | 44 |
| Crompton and Co., Mansion House-buildings, E.C., and Chelmsford | 47 |
| Dorman and Smith, Salford, Manchester; and London and Glasgow | 35 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 6,7,8 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Electric Construction Company, Wolverhampton; and Dashwood House, Old Broad-street, London, E.C. | 5 |
| Electrical Transmission Co., Albert Works, Beavor-lane, Hammersmith, London | 2 |
| Evered and Co., 27-35, Drury-lane, London, W.C.; and Birmingham | 13 |
| General Electric Co., 69, 71 and 85, Queen Victoria-st., London, E.C., and Salford | 33 |
| Holmes (J. H.) & Co., Newcastle-upon-Tyne; and 17, Soho-square, London, W. | 4 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London; and Charlton, Kent | 1, 24 |
| **TAPE.** | |
| Blackwell (R. W.) and Co., Ltd, 59, City-road, London, E.C. | 15 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 34 |
| General Electric Co., 69, 71 and 85, Queen Victoria-st., London, E.C., and Salford | 33 |
| **TELEGRAPH ENGINEERS.** | |
| Elliott Brothers, Coventry Works, Lewisham, and 101, St. Martin's-lane, London | 36 |
| Henley's (W. T.) Tel. Works Co., 27, Martin's-lane, London, and N. Woolwich | 1 |
| Johnson and Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 24 |
| Telegraph Manufacturing Co., Helsby, near Warrington, and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| **TELEPHONES.** | |
| C.T.C. and Manufacturing Co., 38, Victoria-street, Westminster, S.W. | 19 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Ericsson (L. M.) and Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 16 |
| General Electric Co., 69, 71 and 85, Queen Victoria-st., London, E.C., & Salford | 33 |
| Telegraph Manufacturing Co., Helsby, near Warrington, and 11, Queen Victoria-street, London, E.C.; Liverpool, Glasgow, and Belfast | 1 |
| Western Electric Co., Bridge-chambers, 171, Queen Victoria-st., London, E.C. | 2 |
| **TELEPHONE APPARATUS.** | |
| C.T.C. and Manufacturing Co., 38, Victoria-street, Westminster, S.W. | 19 |
| Ericsson (L. M.) and Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 16 |
| **TOOLS.** | |
| Knox (John) and Co., 290, Upper Thames-street, London, E.C. | 36 |
| **TRANSFORMERS.** | |
| British Thomson-Houston Co., 83, Cannon-street, London, E.C. | 3, 21 |
| British Westinghouse Electric and Manufacturing Co., Westinghouse-building, Norfolk-street, Strand, London, W.C. | 44 |
| Brush Electrical Engineering Co., 49, Queen Victoria-street, London, E.C. | 45 |
| Crompton and Co., Mansion-House-buildings, London, E.C., and Chelmsford | 47 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Electric Construction Co., Wolverhampton; and Dashwood House, Old Broad-street, London, E.C. | 5 |
| General Electric Co., 69, 71 and 85, Queen Victoria-st., London, E.C., & Salford | 33 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 24 |
| **TRAVELLING CRANES.** | |
| Electric Construction Company, Wolverhampton, and Dashwood House, Old Broad-street, London, E.C. | 5 |
| General Electric Co., 67, 71 and 85, Queen Victoria-st., London, E.C., and Salford | 33 |
| **TRANSMITTERS.** | |
| C.T.C. and Manufacturing Co., 38, Victoria-street, Westminster, S.W., and Coventry, England | 19 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Ericsson (L. M.) and Co., 154-6, Temple-chambers, Temple-avenue, London, E.C.; and at Stockholm and St. Petersburg | 16 |
| General Electric Co., 69, 71 and 85, Queen Victoria-st., London, E.C., & Salford | 33 |
| **TROLLEY BUSHES AND WHEELS.** | |
| Blackwell (R. W.) & Co., Ltd, 59, City-road, London, E.C. | 15 |
| **TURBINE MAKERS.** | |
| Howes, S., 64, Mark-lane, London, E.C. | 4 |
| **TURNERS (Ivory and Hard Wood).** | |
| Bonnella (D. H.) and Son (Ltd.), 58 and 60, Mortimer-street, London, W. | 33 |
| **UNDERGROUND MAINS.**—Callender's Cable and Construction Co., Hamilton House, Victoria Embankment; and Belvedere, Kent | 41 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, & Charlton, Kent | 1, 24 |
| Suddeutsche Kabelwerke A.-G., Mannheim-Neckarau, Germany | 36 |
| **VACUUM TUBES.** | |
| Bonnella (D. H.) and Son (Ltd.), 58 and 60, Mortimer-street, London, W. | 33 |
| Cossor, 67, Farringdon-road, London, E.C. | 44 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| **VARNISH.**—Pinchin, Johnson & Co., Pinchin's Wharf, Radcliffe, London, E. | 21 |
| **VENTILATING ENGINEERS.** | |
| Bellis and Morcom, Ledsam-street Works, Birmingham; and 9, Victoria-street, London, S.W. | 23 |
| **VOLTMETERS.** | |
| Crompton & Co., Mansion House-buildings, London, E.C.; and Chelmsford | 47 |
| Drake and Gorham, 66, Victoria-street, London, S.W. | 6, 7, 8 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Electric Construction Co., Wolverhampton; and Dashwood House, Old Broad-street, London, E.C. | 5 |
| Elliott Brothers, Century Works, Lewisham, and 101, St. Martin's-lane, London | 36 |
| Everett, Edgcumbe and Co., 22, Charterhouse-square, London, E.C. | 28 |
| Evershed and Vignoles, Woodfield Works, Harrow-road, London, W. | 28 |
| General Electric Co., 69, 71 & 85, Queen Victoria-st., London, E.C., and Salford | 33 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 24 |
| Kelvin & James White, 18, Cambridge-street, Glasgow | 20 |
| Pitkin, J., 56, Red Lion-street, Clerkenwell, E.C. | 28 |
| Richard Jules, Paris—Agent: Levi (J.) & Co., 97, Hatton-garden, E.C. | 32 |
| **VULCANITE.** | |
| Harburg India Rubber C. Co. (F. Winter), 6, Redcross-street, London, E.C. | 43 |
| **WATER HEATERS AND SOFTENERS.** | |
| Baker's Patent Appliances Co., 13, Huntriss-row, Scarborough | 12 |
| "Desrumaux" Automatic Water Softener and Purifier, Ltd., 5, Queen Victoria-street, London, E.C., and 23, Cheapside, Bradford | 23 |
| Doulton and Co., Lambeth, London, S.E. | 27,33 |
| **WIRE COVERING MACHINES.** | |
| Demuth Bros., Linzerstrasse 141-3, Vienna, Austria | 21 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, and Charlton, Kent | 1, 24 |
| **WIRE (Covered and Uncovered).** | |
| British Insulated Wire Co., Prescot, Lancs. | 10,51 |
| Edison and Swan United Electric Light Company, Ediswan-buildings, 36-37, Queen-street, London, E.C., and Branches | 1, 38 |
| Felten and Guilleaume Carlswerk Actien-Gesellschaft—Sole Agents: W. F. Dennis and Co., 28, Billiter-st., London | 1 |
| Frankenburg, I., Manchester; and 128a, Queen Victoria-street, London | 21 |
| General Electric Co., 69, 71 & 85, Queen Victoria-st., London, E.C., & Salford | 33 |
| Glover (W. T.) & Co., Trafford Park, Manchester; & 3, Queen Anne's-gate, S.W. | 22 |
| Henley's (W. T.) Tel. Works Co., 27, Martin's-lane, London, & N. Woolwich | 1 |
| Johnson & Phillips, 14, Union-ct., Old Broad-st., London, & Charlton, Kent | 1, 24 |
| Kabelfabrik Actien-Gesellschaft, Vienna, Austria—Agent for United Kingdom, James Littauer, 4, Cross-street, Finsbury, London, E.C. | 25 |
| London Electric Wire Co., Playhouse-yard, Golden-lane, London, E.C. | 4 |
| Sievert, Max, Stockholm, Sweden | 24 |
| Suddeutsche Kabelwerke A.-G., Mannheim-Neckarau, Germany | 16 |
| St. Helens Cable Co., Warrington & St. Helens, & 32, Victoria-st., London, S.W. | 18 |
| Telegraph Manufacturing Co., Helsby, near Warrington; and 11, Queen Victoria-street, London, E.C.; Liverpool Glasgow and Belfast | 1 |

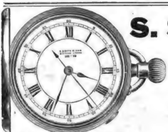
# S. SMITH & SON, Ltd.,

Watch Makers to the Admiralty, Jewellers and Clock Makers,

**9, Strand, London, W.C.**

*Our only Address is **9, STRAND, under the Clock,***

5 Doors from Charing Cross.



**ALL ENGLISH, ¾ Plate.**

Fully Jewelled, Compensation Balance, LEVER Escapement, Overcoil Balance Spring, and all Latest Improvements. CENTRE SECONDS. NON-MAGNETISABLE.

Heavy Silver Crystal Cases, £6 6 0

18-ct. Gold Crystal Cases, £17 15 0

Full or Half-Hunter Case, Silver, £1 extra.

" " 18ct. Gold, £4 extra.

Non-Magnetisable **21s.** extra.

**PRIZE Paris,**

**MEDAL, 1900.**

Our EXHIBIT at the GLASGOW 1901 EXHIBITION will be in the CENTRAL HALL, where we have secured a Large Space.

**CLOCKS.**

*The 1901 Edition of our Book "J" on Watches, post free on application.*

Beautifully-Finished Case and Movement, POLISHED OAK.

| | | |
|---|---|---|
| Ormolu Mounts.<br>Gilt and Silver Dial. | 12in. high.<br>9½in wide. | £6 10s. |
| 8-day, ¼-Strike on 2 Gongs. | Ditto, chiming on 4 Gongs, | £15 10s. |

NOTE THE DIAL OF THIS WATCH. EVERY FIGURE IS UPRIGHT.

Split-Seconds Chronograph, Minute Recorder, Compensated Lever, Movement fully Jewelled. Special System of Chronograph Work.

Silver Cases, **£12 12**

18-ct. Gold Cases, **£27 10**

Non-Magnetisable, **21s.** extra.

THE "STRAND."

**ALL ENGLISH, KEYLESS.**

Gold, 18-ct., Demi-Hunter or Full Hunter.

£16 16s.

Crystal Glass, £13 15s.

Silver Cases, Crystal Glass, £5.

£6 6s. and £6 15s.
Full Hunter. Demi-Hunter.

Non-Magnetic, **21s.** extra.

**No. 46.**—Large Size **Hall-Marked Sterling Silver**, Plain or Engine-turned Cases, ¾-plate, Lever, with Compensation Balance, Gold Winder, Crystal Glass, Ruby Jewelling throughout. £2 2s.

**SPECIAL NOTE.**—No. 46 Non-Magnetisable, for Electricians, same price.

***NON-MAGNETISABLE LEVER CLOCKS.***

Especially Manufactured for Electric Lighting Stations, Dynamo Rooms, Electric Railways, &c.

Cases made for fixing to Switchboards, Bulkheads, &c.

Lever Movement. Solid Brass Cases. Palladium Escapement.

From **£3 3s.** to **£20.**

**Nos. 137 and 133.**

Stout 18-ct. Gold Dust-Proof Plain Case £15 15s.

**NON-MAGNETISABLE,** £16 16s.

In Beautifully-Finished Silver or Steel Cases, £5 5s. **NON-MAGNETISABLE,** £6 6s.

**60 MINUTE RECORDERS.**

Silver, £8 8s. 18-ct. Gold, £21.

**WATCHES for ELECTRICIANS.**

*Guaranteed Magnetic Force Resisting.*

Prize Medal, Electrical Exhibition, 1892, for Non-Magnetisable Chronographs.

*In answer to many inquiries,* **ALL OUR WATCHES and JEWELLERY** *can be had on "The Times" ENCYCLOPÆDIA BRITANNICA system of payment by monthly instalments. Full particulars and a copy of our "Guide to the Purchase of a Watch," Book J, will be sent post free. Also Jewellery Catalogue.*

**The ELECTRIC RAILWAY & TRAMWAY CARRIAGE WORKS, Ld.,**
**PRESTON, Lancs.**

*Manufacturers of **RAILWAY CARRIAGES, TRAMCARS** for Horse and Electric Traction, and all kinds of **ROLLING STOCK** for Light Railways.*

**Registered Office and Works: STRAND ROAD. PRESTON. LANCS.**

ALSO
IN COPPER OR BRASS
for
ELECTRICAL PURPOSES.

**KAYE'S**
LATEST PATENT
STEEL
SEAMLESS OIL CAN,
Fitted with
New Patent Thumb Button
and
Patent Seamless Spout.

SOLE MAKERS; **JOSH. KAYE & SONS, Ld.** Lock Works, LEEDS,
And 93, HIGH HOLBORN, LONDON, W.C.
Contractors to H.M. Navy, War Department, Home Office, and Indian State Railways.

**Westinghouse**

Engines.
Generators.
Motors.
Everything Electric.

The Standard
of the
World.

The
**British**
**Westinghouse Electric**
**& Mfg. Co., Ltd.,**

Head Offices:
Norfolk St., Strand, London, W.C.

Branch Office:
5, Cross St., Manchester.

For Australia, New Zealand and Tasmania, communicate with:
Noyes Bros., 31, O'Connell St., Sydney.
Noyes Bros., 15 & 17, Queen St., Melbourne.

For South Africa, communicate with:
Leaycraft & Co., Capetown.

**TULLY & STRAKER,** 16, Water Lane, Great Tower Street, LONDON E.C.

**MICA**

MICA SEGMENTS
FOR
COMMUTATORS.

Prepared by special machinery ensuring mathematical accuracy.

*Telegrams* – "GLIST, LONDON."
Contractors to H M. Government.

**COSSOR,**
ACTUAL MAKER,
67, FARRINGDON ROAD,
LONDON, E.C.
*EXPERIMENTAL AND SCIENTIFIC GLASS-BLOWING*

SMALL LAMPS A SPECIALITY

X-RAY TUBES, VACUUM TUBES, INDUCTION and TESLA COILS, MERCURY PUMPS.

**ELECTRICAL PATENTS.**

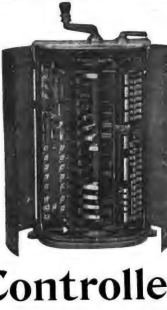
Mr. J. G. LORRAIN, M.Inst.E.E., M.Inst.M.E., Fellow of the Chartered Institute of Patent Agents.
NORFOLK HOUSE, NORFOLK STREET, STRAND, LONDON, W.C.
"PATENTEES' HANDBOOK," post free on application, gives Full Information to Inventors and upon all the chief points of the Patent Law.
*Telegrams; "Lorrain London."*

**DISINFECTANTS.**

**THE "SANITAS" CO., Ld.,**
MANUFACTURERS OF
***ALL KINDS OF DISINFECTANTS***
(FLUIDS, POWDERS, SOAPS, &c.).

"HOW TO DISINFECT" Book, Free.

THE "SANITAS" COMPANY, Ltd., Bethnal Green, LONDON, E.



Manufactured by
THE BRUSH
ELECTRICAL
ENGINEERING
COMPANY, LTD.,
49, Queen Victoria Street,
London, E.C.

# Controllers

**Ebonite.**

Telegrams:
INSTANTLY LONDON.

*Large Stock kept* of
**Sheets, Rods,
Tubes,
Accumulator
Boxes, &c.**

THE HARBURG INDIA-RUBBER C. CO.
London Warehouse: F. WINTER, 8, Redcross St., E.C.

***Vulcanite.***

## TEMPERATURE COEFFICIENTS OF "CONDUCTIVITY" COPPER.

To the Telegraph Engineer it is a matter of great importance to know with accuracy the temperature coefficient of a wire with which he is dealing, since the inferences to be drawn as to the perfection of the insulation of a cable laid in deep water depend largely upon a knowledge of the temperature of the sea bottom. In the absence of soundings with suitable thermometers, these temperatures can only be calculated from the resistance of the conductor.

The compilers of TEMPERATURE COEFFICIENTS OF "CONDUCTIVITY COPPER" (Messrs. CLARK, FORDE and TAYLOR, the well-known consulting engineers) have recently made fresh investigations of the temperature coefficient over the range of temperatures to which cables are usually exposed, and the results of their investigations are now published.

**Table I.** gives the resist. at different temperatures when the Res. at 32°F.=1
**Table II.** gives the resist. ditto ditto when the Res. at 60°F.=1.
**Table III.** gives the resist. ditto ditto when the Res. at 75°F.=1.
And
**Table IV.** gives the log. reciprocals of coefficients in Table III.

*These Tables are strongly bound in cloth, price* **2s. 6d.** *net.*

**SHEET TABLE showing**

**LOG. RECIPROCALS of COEFFICIENTS for COPPER RESISTANCES**

At different temperatures from 32°F. to 84·9°F.

*Printed on strong cardboard, price* **6d.** *net.*

"The Electrician" Printing & Publishing Co., Ld., Salisbury-court, Fleet-st., E.C.

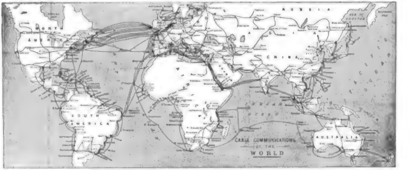
HAMBLET'S
BLUE BRICKS
FOR
MANHOLES & ENTRANCES
FOR
ELECTRIC
INSTALLATIONS ETC
UNEQUALLED BY ANY
OTHER MATERIAL
FOR SUCH PURPOSES.

CONDUITS MADE
TO ANY SECTION.

For Catalogue of Various Manufactures
address,
HAMBLET'S LTD.,
West Bromwich.

Digitized by Google

## THE EASTERN TELEGRAPH COMPANY'S SYSTEM AND ITS GENERAL CONNECTIONS.



THE

# EASTERN TELEGRAPH COMPANY

(LIMITED).

IN CONNECTION WITH THE

**EASTERN EXTENSION, WESTERN, EASTERN AND SOUTH AFRICAN, EUROPE AND AZORES, WEST AFRICAN, PACIFIC AND EUROPEAN, AND AFRICAN DIRECT TELEGRAPH COMPANIES, AND THE DEUTSCHE SEE-TELEGRAPHEN GESELLSCHAFT.**

**By DIRECT TRIPLICATE CABLES to Spain, Portugal, Gibraltar, Malta, Egypt, Aden, and India.**

**By DIRECT DUPLICATE CABLE ROUTES to Madeira, St. Vincent, Brazil, Argentine Republic, Uruguay, also to Peru, Chili, and other parts of South America; and to Suakin, Perim, Penang, Malacca, Singapore, Labuan, Java, Australia, New Zealand, Tasmania, New Caledonia, Bangkok, Cambodia, Saigon, Tonquin, Hainan, China.**

**By ALTERNATIVE CABLES to Zanzibar, Mombasa, Mozambique (duplicate), Lourenço Marques (Delagoa Bay), Durban and Capetown; Bathurst, Sierra Leone, Accra, Lagos, Bonny, Bolama, Bissao, Cameroons, St. Thome, Principe, Loanda, Benguella, Mossamedes, Conakry, Grand Bassam, and Gaboon.**

**By SINGLE CABLE to the Azores, Tangier, Tripoli, Cyprus, Seychelles, Mauritius, and Manila.**

---

Telegrams should be sent from the Company's Stations—

**LONDON**—11, OLD BROAD STREET, E.C.; 8, LEADENHALL STREET; 3, GREAT TOWER STREET; 42, PARLIAMENT STREET, S.W.; 208a, WINCHESTER HOUSE, E.C.; 37, HOLBORN VIADUCT, E.C.; FOREIGN AUCTION HALL, COVENT GARDEN MARKET, W.C., and 449, STRAND, W.C.

**MANCHESTER**—20, Brown Street. **LIVERPOOL**—K13, Exchange Buildings.

**GLASGOW**—5, ROYAL BANK PLACE.

---

### COMPANY'S LEVANT SYSTEM:

Odessa, Constantinople, Dardanelles, Tenedos, Salonica, Smyrna, Chio, Syra, Candia, Rettimo, Canea, Sitia Rhodes, Trieste, Corfu, Zante, Patras, Corinth, Athens, Cephalonia, Santa Maura, Tinos, Andros, Zea, and all the Greek Islands.

---

**This Company's Cables are worked by Muirhead's System of Duxplex and Automatic Curb Transmission upon all its Main Sections.**

---

In sending Telegrams from Postal Stations care should be taken to mark them— "VIA EASTERN" these words being signalled gratuitously by the Postal Authorities

---

Books of Forms and Tariffs forwarded post free on application at the Company's Chief Offices as above, or at

**37, RUE CAUMARTIN, PARIS; and HOTEL DES POSTES ET TELEGRAPHES, MARSEILLES.**

Winchester House, 50, Old Broad Street, E.C.

By Order GEORGE DRAPER, *Secretary.*

# THE INDO-EUROPEAN TELEGRAPH COMPANY, LIMITED.

## Shortest and Most Direct Route to India and the Far East, BY SPECIAL WIRES.

## DIRECT OVERLAND TELEGRAPHS

CONNECTED WITH

INDIA, CEYLON, BURMAH, PENANG, SINGAPORE, AND OTHER PLACES IN THE STRAITS SETTLEMENTS, CHINA, MANILA, COCHIN CHINA, JAPAN, JAVA, AUSTRALIA, NEW ZEALAND, NEW CALEDONIA, PERSIA, SOUTHERN RUSSIA, CONSTANTINOPLE, AND OTHER PLACES IN TURKEY & THE EAST GENERALLY.

The greatest possible SPEED and ACCURACY in the Transmission of Messages are secured by the VERY LIMITED NUMBER of TRANSMITTING STATIONS on the LINE, by the use of INK-WRITING RECORDING INSTRUMENTS, by the employment of a Special Staff of Skilled TELEGRAPHISTS throughout the Line, and by a System of Control which is exercised over every Message.

*Messages are accepted at the Company's Offices—*

**LONDON: 18, Old Broad Street, E.C., 6 and 8, Lime Street Square, and 10 and 11, Mincing Lane, E.C.**
**LIVERPOOL: African House, 6, Water Street.**
**MANCHESTER: 60, Spring Gardens.**

Where receipts are given gratis for the charges made, and whence messages are sent direct by Special Wire, and at any Postal Telegraph Office throughout the Kingdom.

ALL TELEGRAMS SHOULD BE MARKED "VIA INDO."

No Charge is made by any Telegraph Station for the transmission of the "Via."

Books of Forms and Tariff Books containing Rules and Regulations, Lists of Stations, &c., are forwarded post free on application to the Company's Stations or Head Offices, 18, Old Broad Street, London, E.C.

T. W. STRATFORD-ANDREWS, *Managing Director.*

# INDESTRUCTIBLE PAINT.

CLEOPATRA'S NEEDLE TRADE MARK.

## PAINTS, COLOURS and VARNISHES

TO SUIT ALL PURPOSES.

FOR FURTHER PARTICULARS WRITE TO THE MANUFACTURERS,

THE INDESTRUCTIBLE PAINT COMPANY, LIMITED.

*CONTRACTORS TO H.M. GOVERNMENT, &c.,*

HIGHEST AWARDS OBTAINED AT EXHIBITIONS

**31, Cannon Street, London, E.C.**

THE MOST NUTRITIOUS.

# EPPS'S

GRATEFUL—COMFORTING.

# COCOA

BREAKFAST—SUPPER.

# Duncan Wallet & Co.,

EXPORT PROVISION MERCHANTS

Shippers of Wines, Spirits, Teas, Coffees, &c., in Bond.

*114, FENCHURCH STREET, LONDON, E.C.*

*Special Arrangements made for supply of Telegraph Stations & Cable Steamer abroad*

Messrs. D. W. & Co. supply Provisions and Bonded Stores to the CABLE STEAMERS of several Companies, also to VARIOUS STATIONS of the EASTERN, EASTERN AND SOUTH AFRICAN, and EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANIES, and are prepared to execute orders on specially favourable terms on shortest notice. Telephone No. 893 Avenue.

# KIRKALDY'S PATENT ANTI-FOULING COMPOSITIONS

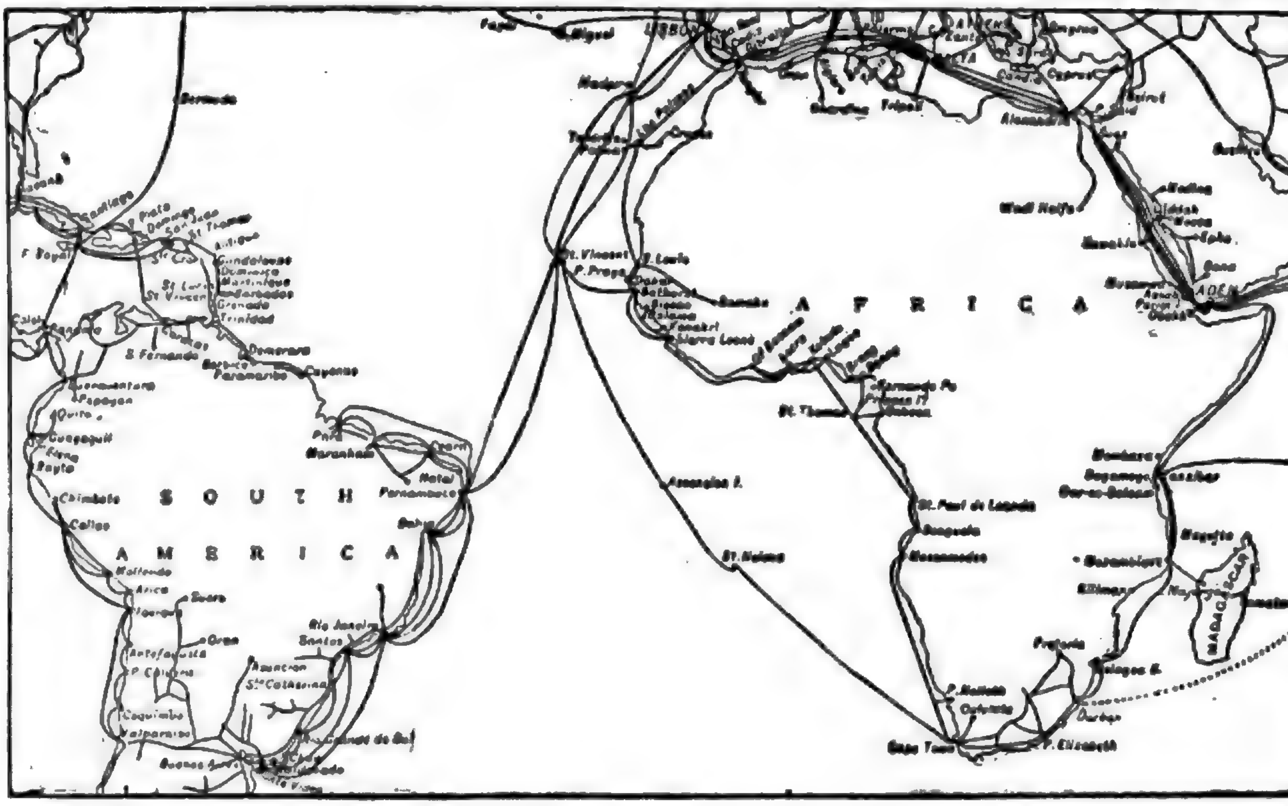
AS SUPPLIED TO THE

WHITE STAR ROYAL MAIL STEAMERS, Messrs. SHAW SAVILL, & ALBION CO.'s ROYAL MAIL STEAMERS, DUCAL LINE, CLAN LINE, NATIONAL LINE, STAR NAVIGATION CO., Messrs. GEORGE THOMPSON & CO., Messrs. LAMPORT & HOLT, Messrs. MILBURN & CO., Mr. W. LUND, The EASTERN & AUSTRALIAN STEAM NAVIGATION CO., and other large Fleets of Steam and Sailing Vessels. Agents at all the Principal Ports.

Particulars, Circulars, and Testimonials will be sent in answer to application made to the SOLE MAKERS,

**JOHN KIRKALDY & SON,** East London Works, **GARFORD ST., LONDON, E.**

TELEGRAPHIC ADDRESS: "KIRKALDY LONDON."



THE

# WESTERN TELEGRAPH COMPANY

(LIMITED).

**THE above Company connects the Continent of Europe with that of South America by means of the DIRECT DUPLICATE Cables from Lisbon via Madeira and St. Vincent to Pernambuco, Ceara, Maranham, and Para, by TRIPLICATE CABLES from Pernambuco to Bahia, Rio de Janeiro, Santos, Santa Catharina, Rio Grande do Sul, Monte Video and Buenos Ayres.**

Under working arrangements with

## THE PACIFIC & EUROPEAN TELEGRAPH Co., Ltd.,

— AND —

## THE WEST COAST OF AMERICA TELEGRAPH CO., Ltd.,

**Telegrams for Chili, Peru, and Bolivia are forwarded by the direct land lines between Buenos Ayres and Valparaiso and by the West Coast Cables to destination.**

TELEGRAMS from GREAT BRITAIN can be sent at the following Charges per word:—

| | s. | d. | | s. | d. |
|---|---|---|---|---|---|
| Madeira | 1 | 2 | Brazil—Pernambuco | 3 | 0 |
| Cape Verde Islands—St. Vincent | 2 | 6 | Amazon Telegraph Company's Stations, via: | | |
| ,, ,, St. Iago | 3 | 5 | Breves, Cametá, Chaves, Gurupá, Macapá, Monte Alegre, Mosqueiro, Pinheiros, Santarem, Souré | 4 | 10 |
| Uruguay—All Stations | 4 | 6 | | | |
| Argentine Republic—All Stations | 4 | 6 | | | |
| Paraguay—All Stations | 4 | 6 | Alemquer, Itacoatiara, Manáos, Obidos, Parintins | 5 | 7 |
| Bolivia—All Stations | 6 | 2 | | | |
| Chili—All Stations | 6 | 2 | ,, All other Stations | 4 | 0 |
| Peru—All Stations | 6 | 2 | French and Dutch Guiana | 6 | 9 |

**Tariff-Cards, Books of Forms, and all information can be obtained at the Head Offices of the Company. Messages should be marked "Via Eastern."**

By Order,

E. STEER HODSON, *Secretary*,

WINCHESTER HOUSE, OLD BROAD STREET, LONDON, E.C.


DOMINION OF CANADA
LABRADOR
NEWFOUNDLAND
Montreal
UNITED STATES OF AMERICA
Chicago
Denver
San Francisco
Cincinnati
New Orleans
MEXICO
Mexico
CUBA
HAYTI
PORTO RICO
JAMAICA
CENTRAL AMERICA
BERMUDA
AZORES
MADEIRA
ATLANTIC OCEAN
AFRICA
UNITED KINGDOM
FRANCE
SPAIN
Lisbon
AUSTRIA-HUNGARY
ITALY
RUSSIA
PACIFIC OCEAN

# THE DIRECT UNITED STATES CABLE COMPANY, LTD.

## Direct Cable Route for Telegrams

— TO —

NEW YORK, BOSTON, PHILADELPHIA, BALTIMORE, ST. LOUIS, CHICAGO, SAN FRANCISCO, NEW ORLEANS, MONTREAL, QUEBEC, TORONTO.

And all places in the United States of America, Canada, West Indies, and Central and South America, &c.

**TARIFF** to many of the principal Telegraph Stations in the United States of America and Canada. **1s. PER WORD.**

For further particulars, Books of Forms, Tariffs, &c., apply at the General Offices of the Company.

*The Name of the Place from which Messages originate is Transmitted Free of Charge.*

HEAD STATIONS (*Always Open*).

LONDON............ 30, MARK LANE, E.C.
LIVERPOOL ......... D 5, EXCHANGE BUILDINGS.
NEW YORK........... 40, BROADWAY.

HALIFAX (Nova Scotia) 48, BEDFORD ROW.
BOSTON... OLD STATE HOUSE, STATE STREET, and POST OFFICE BUILDING, POST OFFICE SQUARE.

BRANCH STATIONS IN LONDON.

4, BISHOPSGATE STREET WITHIN, E.C.
EAST INDIA AVENUE, LEADENHALL STREET, E.C.
142A, WINCHESTER HOUSE, OLD BROAD STREET, E.C.
THE COMMERCIAL SALE ROOMS, MINCING LANE, E.C.
34, THROGMORTON STREET, E.C.

PROVINCIAL STATIONS.

BRISTOL...BACK HALL CHAMBERS, BALDWIN STREET.
GLASGOW...4, WATERLOO STREET.

To save time, the Public in **London, Liverpool, Bristol, Glasgow** and **New York** are recommended to hand in their Telegrams at the Company's Stations as above, where receipts are given for the amounts charged.

Telegrams for this Company's Cables handed in at Postal Telegraph Offices must be marked "Via DIRECT CABLE." This instruction is signalled Free of Charge.

General Offices: WINCHESTER HOUSE, 50, Old Broad Street, London, E.C.

T. FINNIS, *General Manager and Secretary.*

# ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

## FOUR DIRECT CABLE ROUTES

(AUTOMATIC DUPLEX SYSTEM)

FROM THE UNITED KINGDOM AND FRANCE TO

**All places in the United States, Canada, Newfoundland, West Indies, Mexico, Central America, South America, &c.**

**RATE to NEW YORK CITY and all places Easterly thereof 1s. PER WORD.**

The name of the place from which Telegrams originate is transmitted Free of Charge.

For other charges and particulars apply at the Company's Offices, Stations, Agencies, or any Postal Telegraph Office.

If using other than the forms issued by the Company, messages should be marked **"VIA ANGLO."**

The Public are recommended, in order to save time, to hand in their Telegrams at the following STATIONS of the Company:—

| | |
|---|---|
| LONDON | 71, OLD BROAD STREET, E.C. |
| | 24, THROGMORTON ST., E.C. |
| | 109, FENCHURCH ST., E.C. |
| | 2, NORTHUMBERLAND AVENUE, CHARING CROSS, W.C. |
| | HAY'S WHARF, TOOLEY STREET, S.E. |
| | 46, MARK LANE, E.C. |
| LIVERPOOL | A1, THE EXCHANGE. |
| MANCHESTER | 7, ROYAL EXCHANGE. |
| GLASGOW | 29, GORDON STREET. |
| BRISTOL | BACK HALL CHAMBERS, BALDWIN STREET. |
| NEWCASTLE-ON-TYNE | 1, SIDE. |
| BRADFORD | 10, FORSTER SQUARE. |
| EDINBURGH | 50, FREDERICK STREET. |
| DUNDEE | 1, PANMURE STREET. |
| LEITH | EXCHANGE BUILDINGS. |
| HAVRE | BOULEVARD DE STRASBOURG, 118. |
| NEW YORK | STOCK EXCHANGE. |
| | 8, BROAD STREET. |
| | 16, BEAVER STREET. |
| | 445, BROOME STREET. |
| MONTREAL | Corner ST. SACRAMENT AND ST. FRANCOIS XAVIER STREETS. |

Tariffs and other information may also be obtained at the following Agencies of the Company:—

| | |
|---|---|
| CARDIFF | 20, MOUNT STUART SQUARE. |
| PARIS | 37, RUE CAUMARTIN |
| ANTWERP | 1, RUE TERNINCK. |
| AMSTERDAM | PRINSENGRACHT 506. |
| ROME | 49, VIA VENTI SETTEMBRE. |
| BARCELONA | PORTICO XIFRE 16, PRINCIPAL. |
| COPENHAGEN | CHR. WINTHERSVEJ 2. |

General Offices of the Company, 26, Old Broad-street, London, E.C.

T. H. WELLS, *Secretary.*

---

---

Printed and Published for the Proprietors by GEORGE TUCKER, at the Editorial, Printing and Publishing Offices, 1, 2 and 3, SALISBURY COURT, FLEET STREET, in the City of LONDON, FRIDAY, APRIL 19, 1901.